Yadav, Expert Opin Environ Biol 2013, 2:1
http://dx.doi.org/10.4172/2325-9655.1000102

Expert Opinion on Environmental Biology

Short Communication

A SCITECHNOL JOURNAL

Slash-and-Burn Agriculture in North-East India

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Introduction

Traditional slash-and-burn agricultural cycles are characterized by the alternation of cropping and fallow phases, when secondary vegetation grows. At the end of fallow phases, trees are cut and burnt, and the ashes enrich the soil, thereby allowing a new cropping phase. Slash-and-burn agriculture is considered to be well adapted to tropical climates and soils, and accessible to small farmers because of its low cost. It comprises the contiguous seven sister States (North-east India)-Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland Tripura and the Himalayan state of Sikkim. Slash-and-burn agriculture also known as shifting cultivation, swidden or rotational bush fallow agriculture, and as jhum cultivation, is an ancient method of agriculture that is still practiced by tribal communities in many parts of the world, particularly in the wet tropics. It is regarded as one of the traditional methods for cultivation in hilly areas of tropical regions in which forest vegetation is cut and burned on site (Figure 1). Slash-and-burn agriculture has a rich traditional ecological knowledge base and remains an important component of forested landscape in many parts of north-east India states. Indigenous shifting cultivators have a vast store of local knowledge about their particular landscape and how best to use it for survival, and have much to teach the world about the efficient use of their landscape for combined agriculture, forestry and biodiversity conservation. The practice involves a series of steps such as selection of a site on the hilly slopes, slashing of primary/secondary forests; burning the slashed vegetation after drying followed by cultivation of crops of agricultural importance for 1-3 years and finally leaving the land fallow. Nonetheless, the productivity of the system depends on the temporary increase in nutrient availability of the soil, the buffering aptitude of ash and the regenerative capacity during the fallow periods.

Figure 1: Burning of cited forest for shifting cultivation.

The main difference between the shifting cultivation and practices of present and two three decades back is the increases in the scale and shorting of jhumming period. The practice of shifting cultivation is reported to account for 60 % forest losses worldwide each year [1]. With the phenomenal increase in human population the jhum cycle has been increased from 20 to 30 years in the past to about 5 years and in many areas even up to 3 years [2]. Due to short fallow cycles in north-east India resulted in arrested succession, since weedy species were not succeeded by pioneer woody species, and over time the soil seed bank was replaced with seeds of weedy shrubs. Fallows as old as 10 years in the region were dominated by bamboo cover [3,4]. However, early colonizers such as bamboo, with relatively faster growth rates in comparison with woody tree species, may have facilitated soil-nutrient recovery and provided microhabitats for regeneration of shade-loving species. The continuance of jhum in the north-east states is closely linked to ecological, socio-economic, and cultural and land tenure systems of tribal communities. Since the community owns the lands the village council or elders divide the jhum land among families for their subsistence on a rotational basis.

Importance of Slash-and-Burn Agriculture

The eastern Himalayan region of north-east India is one of the 34 'biodiversity hotspots' of the world [5]. Increasing human intervention and excessive exploitation of resources have resulted in great changes and provide alarming signals of accelerated biodiversity loss [6]. However, although it is one of the richest regions in the world in terms of biodiversity resources, it is also home to some of the poorest people, whose livelihoods are heavily dependent on those same resources. Shifting cultivation, being a labour intensive and low subsidy based forming system, provides an assured source of food security to the substance level formers of the hills region. It may be emphasized that shifting cultivation systems have been much more than a way to manage soil fertility and agricultural productivity. At the same time, by combining farming activities with collective access to a wide range of natural resources in the forest 'granary', shifting cultivation systems are able to secure the energy, protein and medicinal components of the household economy and to establish a vital linkage between biological and social reproduction.

The use of fire is an integral part of shifting cultivation, and helps in the organic management (Figure 2). The environmental movement tends to focus on fires as an indication that shifting cultivation is bad, but fires are not necessarily harmful, especially when they are controlled. Burning of slashed vegetation is only carried out once in the jhum cycle of many years, although some communities also burn crop residues before planting in the second year. The main reason that farmers use fire is that it enables them to manage soil fertility and control weeds and pests in a labour efficient manner. Use of fire is one of the major reasons that use of agrochemicals can be avoided. For example the per hectare consumption of chemical fertilizers (N, P, K and N+P+K) for cropped area during the year 1999/2000, was only 2.8 for Nagaland, and 2.0 for Arunanchal Pradesh, as compared

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Received: January 05, 2013 **Accepted:** February 21, 2013 **Published:** February 27, 2013

to 95.6 for India as a whole [7]; and in Nagaland, no plant protection chemicals are used, the Department of Agriculture only produces chemicals for research use. Still, it will be a long time before farmers will be able to get a premium price for their products, or indeed a reasonable price at all. However, the dependence on slash and burn as means of land clearing by jhumias (People who involve in slash-and-burn agriculture) is reasonable. Its beneficial effects in clearing bush debris and reduction of weed infestation that would have been competing with crops for sunlight, water and soil nutrients have been reported by [8]. The ash deposits after burning, helps to fertilize the soil. This is done by immediate release of the occluded mineral nutrients-Mg, Ca, and available P, for crop use [9,10]. Ojima et al. and Brye also submitted that increased soil temperatures after burning, stimulate biological activity; increases organic matter mineralization to enhance nutrient availability [11,12].

Characteristics of Jhum Cultivation in North-East States

Entertainingly, the time frame for slash-and-burn agriculture are practically strict, specially keep in mind that heavy rainfall of the area, requiring the land be cleared and seed sowed in time for the monsoons. Generally village community chooses where the fields for coming season will be established slashing and subsequent burring are precondition of this traditional forming system. Slashing operation is usually done in last week of November by simply slashing the vegetation to dry in the sun about 3-4 week and then burnt during last week of December. Burning is a fabulous and noisy operation, causing huge flame on the hills reduce visibility and pollute the atmosphere. Following the burning and cleaning of the newly burnt sites sowing and broadcasting of millets and other vegetable crops from January. Each jhum area is generally cultivated for two cropping cycle. Crops totally depend on monsoon due to lack of irrigation facilities.

This traditional farming system linked with ecological, socio-economic and cultural life of indigenous people and closely concerned to their sacrament and festival that revolve their jhum fields and are organized to make place at various stage of the cultivation. The life of the jhumias comprises many traditional activities throughout the year, revealing their total confinement to agriculture. This traditional farming system usually offers scope for cultivation and on-farm conservation of a wide variety of local agricultural crops. According to the local cropping calendar, the jhumias usually manage their field by distinguishing it into two different phases, as the new field and the old field.

Figure 2: Slash-and-burn forest lands for jhuming.

In North-East India, increasing human population density has resulted in the practice of unsustainable form of slash-and-burn that includes shortening of the fallow period (Tables 1 and 2) as well as permanent conversion of forest to permanent agricultural expansions [13]. Perhaps the most important and universal impact of slashing and felling in regard to sustainability is the disruption of natural nutrient cycling and the acceleration of nutrient flow out of the agro ecosystem. This impact is particularly obvious in tropical forested systems where natural nutrient cycles are virtually closed and trees are often credited with removal of insoluble nutrients such as phosphorus from the subsoil. Furthermore, the decay of fine roots immediately follows tree death results in the release of associated nutrients which may leach from the forest soil. Commonly, the presence of slash serves to protect the soil from erosion; however, bare patches of the soil surface may be directly exposed to incoming precipitation and radiation. The loss of a protective plant canopy may cause a sharp increase in surface soil temperatures, thereby stimulating volatilization (i.e. loss of nitrogen to the atmosphere) and increasing rates of organic matter decay. Concentrated human activity during slashing and felling and the physical impact of falling trees, may result in localized increases in bulk density. Finally, slashing and felling can disrupt populations of soil micro and macro-fauna and favor the germination of seeds from photophyllic opportunists. After clearing, slash is usually allowed to dry before burning. Burning plays an extremely important role in soil fertility. Nutrients released from biomass and even parent material during burning may become available for crop uptake, escape via volatilization, leaching or surface runoff, or remain bound in recalcitrant ash complexes. These outcomes are highly dependent upon the intensity of the burn, which may be the most important factor influencing jhum soil fertility. The burnt organic matter (Figure 2) releases the nutrients which were locked up in the biomass. The soils can be exploited only one to three years before the nutrients are exhausted and the farmers are forced to move to a new site.

Improved slash-burn-agriculture (Figure 3) which has ideal jhum cycle (20-30 years), good soil characteristics, sufficient biomass for burning and promoting plantations of horticultural crops, could not only reduce rural poverty, but also contribute to community goals of the north-east India. There are also niche and high value crops, such as pulses instead of maize and millet, and cabbage, cauliflower and tomato instead of traditional pumpkins and brinjal, have emerged as favorite in many shifting cultivation areas. In tropical agriculture, the key to realizing local and global benefits is seen to lie in agricultural growth and improved fallow management, reduction in the area in cropland while amplification of agricultural production, adoption of agro-forestry, cash crops, expansion of the extent of fallow land or delaying of forest conversion, lengthening of fallows, enhancement of forest species composition and raising the value of secondary forests through diversification of forest products as well as the commercialization of environmental services improved shifting cultivation systems could not only reduce rural poverty; but also contribute to societal goals of the tribal community of north-east states of north-east India.

Impact of Slash-and-Burn

Land use is an important component to understand global land

status. It shows present as well as past conditions of the earth surface and it is a central component and strategy for managing natural resources and monitoring environmental changes [14]. Forest felling and burning are parts of the shifting cultivation cycle that supports thousands of people throughout the north-east India (Table 1). These practices are also the precursors of permanent agriculture, cash crop, pasture establishment and plantation forestry. Tropical deforestation is of great current concern especially because of its potential impacts on biodiversity and on environmental issues.

Slash-and-burn land clearing on sloping land (Figure 4) may lead to increased soil run-off following disappearance of the protective vegetative cover. In turn, soil run-off and redeposit ion affects soil fertility and spatial patterns of fertility parameters in a field. Soil erosion is an irreversible phenomenon causing land degradation and deterioration of surface water quality. It is caused due to inappropriate land use and poor management. Soil degradation is responsible for making 0.3-0.8% of the world's arable land unsuitable for agricultural production every year and an additional 200 million ha of cropped area would be required over the next 30 years to feed the increasing population [15,16]. Therefore, this precious finite resource must be safeguarded against all kinds of degradation and deterioration for sustainability of agricultural production and environment protection. Soil run-off is expressed here (Figure 4) as the quantity of downward moving soil that passed the specific location of a flow trap. Existing physical soil run-off barriers and crop performance were scored. Despite serious soil run-off from the steeper upper slopes little soil was actually lost because of the slope form of the field, presence of natural soil run-off barriers and the planted crop. In contrast, fire is often responsible for large nutrient losses due to particulate movement off the field and volatilization during the fire. Also, nutrients may be lost by soil run-off, which is the process of downward moving of soil caused by water flow and gravity forces. Soil run-off is enhanced by disappearance of vegetative cover and surface litter following the burn.

Figure 3: Cultivated Jhum (healthy paddy field) land.

Figure 4: Slash-and-burn land clearing on sloping land, leading for runoff.

This farming system may not be productive as it suffers from lack of proper designing and scientific management. Nevertheless, intervention of proper scientific approach is needed to make such a policy which can provide enough quality food and economic security to the jhumias together with conservation of the traditional crop wealth, sustainability of the production systems and environmental conservation. If such a step is not taken, then the very livelihood of the farmers would be in danger, as most of the villages of this region are still remote and isolated. Due to increasing agricultural population pressure in the north-east India regions a significant deforestation has been experienced, which brings the new land cover cultivation. Thus, population pressure first exert its impact on expansion of marginal land under cultivation and some extent shortening the fallow period (Figure 5), which in turn increase in gross agriculture production as well as exploitation for fodder, fuel wood and timber.

Recommendations

Any policies related to shifting cultivation and land management in shifting cultivation will affect the livelihoods of thousands of marginal farmers. Across north-east India generally, more than 443,000 families (Table 1) most of them indigenous, are dependent on shifting cultivation for their livelihood. In all of north-east states, an estimated 1466 thousands hectares (Table 1) of land are under shifting cultivation. However, there is a clear need for strengthening and improvement in other cases. Strengthening rather than replacement of shifting cultivation is recommendable, especially considering the benefits shifting cultivation has to offer. These recommendations may be quite useful in developing ideal cropping systems as a modified shifting cultivation system.

1. In general more multipurpose (usually nitrogen fixing) tree species should be protected during the clearance (slash-and-burn) phase and intercropping economic trees.
2. There should be innovative technologies, institutions and polices that can address two fundamental challenges like poverty alleviation and biodiversity conservation.
3. Wide spectrum of fallow management strategies should be improved the shifting cultivation to accommodate the needs of the growing population.
4. In response to the shorting fallow period and increasing pressure on land resources, farmers should be developing innovations that allow them to produce more and stay longer on the same plot, under the same soil fertility conditions. They can thus postpone the clearing of a new plot, and allow the forest on that

doi:http://dx.doi.org/10.4172/2325-9655.1000102

Figure 5: Abandoned jhum land after slash-and-burn agriculture.

Table 1: Slash-and-burn agriculture in North-East India.

State	Annual area under shifting cultivation (ha)	Fallow period (Years)	Minimum area under jhum at a given time ('000 ha)	Number of jhumias families ('000 nos)	Jhum land/ family (ha)
Arunachal	70,000	3-10	210	54	1.29
Assam	69,600	2-10	139	58	1.20
Manipur	90,000	4-7	360	70	1.29
Meghalaya	53,000	5-7	265	52	1.01
Mizoram	63,000	3-4	189	50	1.26
Nagaland	19,000	5-8	191	116	0.16
Tripura	22,300	5-9	112	43	0.51
Total	386900		1466	443	

Source: G. B. Pant Institute of Himalayan Environment and Development (GBPIHED), 2006

Table 2: Temporal dynamics of shifting cultivation in North East India.

Parameter	1970-71	1976-77	1980-81	1985-86	1990-91	1995-96
Families involved in jhum (nos)	78,990	66499	78542	86038	94357	109093
Net land under jhum (ha)	87220	71901	66220	72555	73000	84002
Jhum land per family (ha)	1.10	1.08	0.84	0.84	0.77	0.70
Net permanent agricultural land (ha)	28006	40013	52012	76759	92616	81281
Permanent agricultural land per family (ha)	0.35	0.60	0.66	0.89	0.98	0.74

Source: GBPIHED, 2006

plot to grow a few years longer, which in the long run saves labour.

5. Plantations should be promoted by governments and extension agencies in a bid to find alternatives to shifting cultivation that provide farmers with a livelihood, while at the same time maintaining forest cover. Species may be for this includes several timbers, rubber, tea, cashew and areca nut.

6. Market development and commercialization should be encouraged of traditional and new niche products of shifting cultivation systems.

7. There should be investment in research and extension to document and scientifically validate traditional shifting cultivation practices, increase their productivity, profitability, and enhance ecological and social benefits, providing formal recognition of the innovations practiced by farmers.

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