

Slash-and-burn agriculture in Eastern Himalayan zone of Arunachal Pradesh, North East India

'Jhum kheti', commonly known as slash-and-burn or shifting cultivation, is the most predominant farming system practised by the hilly communities of North East (NE) India¹, where the jhumias transform forests into rural landscapes. This farming system still persists and plays an important role in providing subsistence livelihoods to at least 300–500 million people worldwide², which is intricately linked to socio-cultural, ecological and economic aspects of the ethnic hill communities³. 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 fallow⁴. Nonetheless, the productivity of the system depends on the temporary increase in nutrient availability of the soil, the buffering capacity of ash and the regenerative capacity during the fallow periods⁵.

Here we report the various activities performed and the peculiar role of slash-and-burn agriculture that could provide insights into developing appropriate management strategies for further improvement and sustainable development of the marginal societies living in the biodiversity-rich Arunachal Himalaya, NE India.

The study was conducted in Tirap District (26°38'–27°47'N lat. and 96°16'–95°40'E long.) situated in the Eastern Himalayan zone of Arunachal Pradesh, NE India. The approximate elevation of the district ranges from 200 m amsl (in the foothills) to 4000 m amsl (in the mountains). Geologically, the district has the surface build of Disang, Baruil, Tipam and Dining series of Tertiary sediments⁶. Tirap District is inhabited by the ethnic Noctes, Tutsas and Wanchos, with a myriad of colourful sub-tribes. Interestingly, these tribes do not have a common dialect/language. So Hindi and Assamese are the common languages for oral communication. Geographically, the district occupies an area of 2362 sq. km, with a total human population of 111,997 (57,992 males and 54,005 females; according to the 2011 census). These ethnic groups trace their ancestry to the

Mongoloid race, and their local dialects are believed to be of Indo-Burman origin. Their ethnic cultural traits and origins remain distinctive, mainly due to their geographical location. These societies are traditionally governed by a council of chieftains, where the 'king' is the head of the council. The people mostly live in raised houses made of bamboo, wood and leaves of *Livistona jenkinsiana*. The community has developed this type of housing as a survival strategy against calamities like floods, soil erosion, earthquakes, etc. Nevertheless, the insurgency problem, lack of proper roads and marketing facilities add to the poverty of the indigenous people.

The Noctes and Wanchos are typically agrarian in nature and have rich traditional ecological knowledge. As in many other regions of the tropics, the slash-and-burn agriculture still persists in Tirap District due to its undulating hilly terrain and is considered to be a key element of farming, with the potential for sustainable development and enhanced livelihoods among the rural poor^{7,8}. The system involves a series of steps (Figure 1). Nonetheless, the selection of site and management decisions are typically made at the village level⁹ and may differ from village to village.

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. In the new field, they usually intercrop important and subsidiary cereals like foxtail millet (*Setaria italica* L.), proso millet (*Panicum miliaceum* L.), finger millet (*Eleusine coracana* L.) and pearl millet (*Pennisetum glaucum* (L.) R.Br.), maize (*Zea mays* L.), topioca (*Manihot esculenta* Crantz.), *Dioscorea* sp., *Colocasia esculenta* L., sweet potato (*Ipomoea batatas* (L.) Lam.), ginger (*Zingiber officinale* L.) and local vegetables such as pumpkin (*Cucurbita moschata* Poir.), white gourd (*Benincasa hispida* Thunb.),

coriander (*Coriandrum sativum* L.), soybean (*Glycine max* (L.) Merr.), brinjal (*Solanum melongena* Linn.), *Solanum nigrum* L., chilli pepper (*Capsicum* spp.), bitter gourd (*Momordica charantia* L.), tomato (*Lycopersicon esculentum* L.) and sesame (*Sesamum indicum* L.), whereas the old field is mainly used for the cultivation of paddy. Nevertheless, after a short cultivation cycle (18 months to 2 years), the used plot is left fallow and the farmers shift to another site. The duration of fallow period in the sampled district varies from 8 to 10 years. The farmers believe that during the fallow period the land undergoes secondary succession restoring soil fertility status and improving physical properties such as soil aggregation and water-holding capacity through litter decomposition¹⁰.

On the contrary, globally, many ill-effects of this farming practice have also been discussed by several researchers. For instance, due to the ever-increasing human population and the pressure on land, the jhum cycle which earlier extended to 10–20 years has now been shortened to 2–3 years, leading to a decrease in productivity and fertility³. Repeated jhumming on short fallow rotation coupled with grazing and anthropogenic interferences has arrested secondary succession at several community stages, favouring weed infestation, loss of accumulation of woody biomass and reduction of floral diversity. Although jhumming has been projected as harmful, no other alternatives were found suitable for Tirap District due to the undulating hilly terrain and lack of modern scientific methods. Further, the traditional lifestyle, culture and resistance to government policies by the ethnic communities have led to non-adoption of any suggested alternatives. Nevertheless, jhumming is considered as a kind of blessing in disguise because factors like belief, tradition, culture, festivals, legends, myths, prejudice, practice and food security are deep-rooted in the tribal farming communities¹¹.

Thus, the present study concludes that despite many limitations and shortcomings the slash-and-burn agriculture still enjoys a pivotal position in the Eastern Himalayan zone of Arunachal Pradesh.



Figure 1. **a**, Slashed vegetation; **b**, burning of slashed vegetation and **c**, fallow land.

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.

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Monitor lizards and geckos used in traditional medicine face extinction and need protection

There are over 3000 lizard species in the world, of which about 270 are found in the Indian subcontinent. Lizards are among the group of reptiles whose flesh is believed to have curative powers; their skin is also used widely in the manufacture of leather goods and they face exploitation because of these reasons. Here, we discuss the common monitor lizard and the Tokay gecko as examples and describe the ways in which they are being used and the need to protect them so that they do not become endangered.

Hunting reptiles for potential medicinal value or as an ingredient in food is common among hunter-gatherer communities, especially the Irulas of Tamil Nadu in southern India. Tribals use a wide variety of medicine derived from

wild animals, both vertebrates and invertebrates. For example, the harmless red sand boa (*Eryx johnii* Russell, 1801, a burrowing snake), and the spiny-tailed lizard (*Uromastix hardwickii* Gray, 1827) of the desert region are both used by local medicine-men for treating skin diseases and, thus, are highly priced. Nevertheless, these reptiles are being hunted, making them endangered.

The practice of using reptiles in medicine is prevalent among tribals around the world. The Tegus (*Tupinambis teguixin* Linnaeus, 1758) found in Eastern Paraguay, South America is also believed to have medicinal value: its fat or oil is believed to cure a wide range of ailments, it is effective in closing skin wounds that are slow to heal; it cures skin irritations

such as pimples, pustules and boils and it is also believed to cure measles, eye infections, insect bites, ear aches, rheumatism and inflammation¹.

Monitor lizards are large-sized reptiles found throughout Asia, Africa and Australasia, and occur as ground-dwelling, arboreal and semi-aquatic forms. Of the 24 species of these lizards recorded across the world today, 4 are found in different geographical zones in India. The common monitor lizard (*Varanus bengalensis* Daudin, 1802; Figure 1) is one such species. It has a snake-like tongue, well-developed toes and long tail. It is a carnivore and not averse to eating carrion², and is oviparous, laying eggs sometimes in termite mounds for protection. In India, products derived