Alternatives of Shifting Cultivation in North-eastern region of India

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Abstract: Shifting cultivation has been practiced in the hill regions of north-eastern India in an environmentally sustainable way since time immemorial. In recent times, for ensuring food security of the increased population, it demands for bringing more land under shifting cultivation. As the land resources are limited there was no other option than horizontal expansion of the shifting cultivation by clearing primary vegetation and reducing fallow period of abandoned *jhum* plots. The pressure on land and forests resources increased over a period of time resulting into environmental degradation. The clearing of vegetation for *jhum* cultivation and fallowing of *jhum* plots has threatened the sustainability of forest resources. There is a loss of native species, invasion of invasive alien species. The traditional ecological knowledge of the ethnic shifting cultivation practitioners and their practices are essential for better understanding and decision making. There are several modified/improved farming practices (like off farm practice of sericulture, apiculture and in farm combination of new crop geometry, Areca nut, Cashew nut, Oil palm, and rubber plantations, tea and coffee cultivation etc.) which have evolved over a period of time and space in this region. The present paper gives an account of some of the modified/improved farming practices as an alternatives to shifting cultivation within the limits of cultural and environmental importance**.**
[Verma, P. K; Kumar, V. Chandra, A. & Thounaojam, B. **Alternatives of Shifting Cultivation in North-eastern region of India.** *Rep Opinion* 2017;9(12):1-8]. ISSN 1553-9873 (print); ISSN 2375-7205 (online). http://www.sciencepub.net/report. 1. doi:10.7537/marsroj091217.01.

Keywords: Shifting Cultivation, Alternatives, North-eastern region, India

1. Introduction

Shifting cultivation, also known as '*slash and burn*' agriculture is one of the most complex and multifaceted form of agriculture system. According to Conklin (1961) shifting cultivation is defined as '*any agriculture system in which fields are cleared by firing and are cropped discontinuously'*. It is an age-old practice believed to have evolved since as early as 10,000 BC or Neolithic period (Spencer 1966). It is known as '*Podu*' and '*Jhumming*' in India, '*Milpa*' in Mexico, '*Troza*', '*Monte*' and '*Cadong*' in Indonesia, '*Chena*' in Sri Lanka, '*Lua*' in Vietnam, '*Kalingn*' in Philippines, *'Taungya'* in Myanmar, '*Swidden*' in Europe. Reflecting an adaptation by farmers over the centuries in response to the problems posed to cropping by steep slopes and heavy seasonal rainfall, shifting cultivation is practiced by the tribal people of the hilly region since time immemorial. This diverse system is characterized by rotation of fields rather than crops (Satapathy *et al.* 2003). Brady (1996) estimated 300 – 500 million people around the globe engaged in Shifting Cultivation. It has been estimated that 7% of mankind of the world is still practising this type of cultivation in about 300 million ha of land i.e. 5% of cultivated soil throughout the world. The basic philosophy of shifting cultivation is to '*recreate forest and not to destroy forest'* for without forests the next *jhum* cannot be cultivated (Darlong 2004).

Shifting cultivation locally known as *jhuming,* is a traditional system of agriculture of hill people of north-eastern India characterized by series of traditional operations involving cultural activities, selection of site on the hill slope or *jhum* land, clearing vegetation of selected site and at the same time retaining useful trees and plant varieties. Earlier jhum plots were cultivated for two to three years and then abandoned for 10-20 years, which allow the soil to regain its fertility for natural forest to grow back.

Traditionally, the ownership of the land comes under the community in a village. The community head or *Gaonbuda* select site for jhuming and then distribute the land among families depending on the size of family and their needs. The distributed land is prepared for cultivation by slashing, burning and cleaning. These activities are carried out generally by mutual cooperation. The sowing of seed is based on selection of crops which entirely depends on their needs like hill paddy, maize, mustard, tapioca, ginger, chillis, cucurbits, potato and some horticulture crops. Mostly these crops are sown by digging and applying zero tillage method. It is followed by intercultural operations like weeding, protection from birds, wild animals etc. by constructing a temporary hut/tower within the *jhum* land. The land is abandoned after cultivation for a period of 3 to 5 years depending upon the *jhum* cycle of a particular site and next year

cultivation is shifted to another site (Anonymous 2009; Borthakur 2002; Cairns 2004).

2. Shifting Cultivation in North-east India

It is a common land use system in North Eastern hill regions of India, and locally known as *jhum* or *Jhuming*. The eight states of Northeastern region has geographical area of 2,62,180 Km^2 which is approximately 9.8% of the total area of the country with more than thirty nine million population. Shifting Cultivation is inheritance in the culture of the ethnic communities. It is a fact that still a significant portion of the cultivating population is extremely poor. Traditionally, shifting cultivation has been productive and sustainable with a multiple cropping system having 2 – 3 years of cultivation phase and 10 -20 (25) years fallow phase. The mosaic of land, fallow period and forest at different stages of succession together were not only of cultural importance but also for edible, medicinal, ritual, fuel and forage resource. In earlier days in *jhum* land when forest is cleared some useful trees and other plants were preserved and others were planted (Anonymous 1999; Maikhuri et al. 2007; Maithani 2005).

3. Present scenario of Shifting Cultivation

The present time shifting cultivation systems include an extremely diverse range of land use practices developed and altered over time by farmers in various social, ecological, economic, and political ways. It has been estimated that about 0.443 million families are dependent on shifting cultivation for their livelihood in North-eastern states. The maximum (0.16 million) families are in Nagaland followed by Manipur (0.07 million) (Tomar et al. 2012) (Table 1).

4. Problems associated with *jhum*

The natural topography compels the people in the North-east region of India to adopt the age-old traditional cultivation which is the only means to sustain a living but the destruction of natural vegetation in *jhum* cultivation is alarmingly on the rise. It causes mass scale destruction of forests genetic resourses, degradation of lands, loss of economic and ecologicaly important flora and fauna. Lack of overall baseline information, iineffective implementing machinery, proper monitoring system complex ownership over land among tribal's, soil degradation and soil erosion due to clearing the natural vegetation, transportation facilities to market are some of the hurdles for socio–economic upliftment of *jhumias*. Now a days most of the North-eastern states are facing increased pressure over *jhum* land resources as a result of population growth. The *jhum* cycle has reduced to less than 5 years. Lack of availability of high yielding varieties of agriculture crop, horticulture crop and tree crop is also contributing to the problem. Lack of coordination between the executing agencies of various research and development projects is another problem which needs to be addressed (Kumar 2011; Tomar et al. 2012).

5. Research Based Alternatives for Shifting Cultivation

The traditional *jhum* system needs to be redeveloped through an increment pathway as the demand and supply ratio increases, the adequate supply of food, fiber and fuel for growing population is insufficient. The farm-level studies of existing farming systems are aimed at understanding the farmer's overall environment, farm enterprise, and constraints to increased productivity, all of which facilitate determining priorities and strategy. In recent times integrated approach for development of *jhum* areas as mixed land use system seems suitable. The approach includes watershed management, integration of forest trees in *jhum* plots, intercropping, diversification in cropping mixtures with local preference, soil conservation with new measures, horticulture, animal husbandry, fishery, etc (Jamir et al. 2004; Khisa et al. 2004; Ramakrishnan et al. 1998; Ramakrishnan 1992, 2007; Swift and Ingram 1996; Tawnenga and Tripathi 1997). Barik (2007) has proposed contour hedgerow intercropping technology for rehabilitation of degraded *jhum* land areas. Some new innovation to abolish the *jhum* or transformation of *jhum* to settled cultivation are as follows:

5.1. Promotion of modern agriculture

In order to avoid regular plot rotation practice in shifting cultivation the land should be allotted to each family with a minimum area of land to cultivate and to maintain their livelihood and gather all their necessities. There is one very popular traditional agriculture practiced in Arunachal Pradesh '*Apatani Wet Rice Cultivation',* where the hilly slope constructed in terrace at the base of hill slopes and formed a saucer –shaped structure, where wet rice cultivated.

5.2. *Jhum* fallow management

Nutrient status of *jhum* fallow soil can be increased significantly by the application of legume green manure. Enhancement of chemical properties of soil was recorded due to addition of *Crotalaria pallida* followed by *Sesbania bispinosa* (Singh et al. 2004). *Thysanolaena maxima* a major source of Carbon sink, has wider adaptability and ability to check soil erosion can be used as a tool for reclamation of degraded *jhum* land. Further, intercropping of leguminous crop like *Cajanus cajan* with *Thysanolaena maxima* can significantly increase nutrient status of soil and ultimately leads higher production (Borah 2011).

5.3. Agroforestry approach

Agroforestry can be a suitable practice in *jhum* land. It is depended on suitable selection of trees, horticulture crops and intercropping of seasonal vegetables and plantation geometry design to make use of horizontal as well as vertical spacing properly. Different agro-forestry models based on land adaptability criteria are as follows.

a.) Agro–pastoral (includes both growing of crops and raising of livestock).

b.) Horti - pastoral (crops, horticulture and livestock production).

c.) Agro -Horti - Silvi - pastoral (growing of ideal combination of grasses, legumes vegetable crops, horticulture crops with pastoral).

d.) **Multistorey agroforestry .**

The multiple cropping, an integrated system of land use, are now a days best model for agroforestry, where the horizontal utilization of the land maximized and vertical utilization of land depend on canopy structure of species. It consists of crop of varying canopy orientation with different root pattern. (*Areca* nut – patchouli-betel nut AF model; *Cocos nucifera* + black pepper + pineapple AF Model; Areca nut + Black pepper + Pineapple AF Model, etc.)

As an alternative to shifting cultivation, intercropping, chronological cropping (two or more crop on the same land), relay cropping, triple cropping, double cropping, ratoon cropping (harvest then again harvest second time), etc. may be accomplished.

e.) Bamboo based agroforestry

The northeastern region of India contributes 65% of total bamboo resources in India. The short gestation period, sustainable production for many years, wider ecological adaptability and versatility of use (application in craft, timber, hedgerow, wind breaks, Carbon sequestration crop, ornamental, edible shoot) makes it an essential agroforestry component especially for *jhum lands*.

(i). *Bamboo + Tea* based agroforestry Model- Bamboo as component in boundary plantation.

(ii). *Bamboo + vegetable* based agroforestry Model- Different vegetable crops intercropping with bamboo for first and second year. The selection of the crops always based on root zone competition.

(iii). *Bamboo-Areca nut-Livingstonia*- Medicinal plant based agroforestry Model- Bamboo intercropping with overstory components like *Areca* nut while understory components are *Livingstonia jenkinsiana, Atropa beladona,* Turmeric and Zinger etc.

(iv). *Bamboo- Pineapple- Citrus-Areca nut* based agroforestry Model- Overstory components are Bamboo spp, *Areca catechu* and understory components are *Citrus maxima, C. lemon*, pineapples etc.

(v). Bamboo-*Areca nut- Betel nut -Banana* based agroforestry Model

(vi). *Bamboo-Areca nut- Banana*- Paddy based agroforestry Model- Overstory components are Bamboo *spp, Areca* nut and understory components are Banana spp, and wetland rice etc.

(vii). *Bamboo-Citronella- Tea based agroforestry*- Over story components are Bamboo spp, shade tree species and understory components are Tea and *Citronella* etc.

(viii). *Bamboo Fishery Model- Bamboo* spp. on the bank of the fish ponds and fishery as major component.

f.). Other agroforestry models

(i) Areca nut-coconut based agroforestry Model- Areca nut and *Cocos nucifera* as overstory component while banana spp, citrus, chilli, *zinger*, turmeric etc as understory component.

(ii) Tea based agroforestry Model- Tea is chief understory components and *Melia, Glihardia, Aqualaria* or *Acacia mangium* is over story component as boundary or as shade tree.

(iii) Rattan – rice agroforestry Model- Rice intercropping in between Rattans. Some time Rattan may be intercropped with tubers.

(iv) *Alnus/Schima* – Cardamom based agroforestry Model- Cardamom intercropping in between *Alnus/ Schima.* This model now popularized in Nagaland which is popular practiced in Sikkim.

(v) *Alder based Agroforestry:* This is another alternatives of shifting cultivation. The farmers of Kohima and Phek district of Nagaland have practiced Alder based agroforestry system which is an outstanding model of sustainable land use which has evolved through community participation. Alder trees (*Alnus nepalensis*) are pollarded or lopped in a certain height. The high rate of alder re-growth helps in supplying good quality of biomass for nutrient enrichment to the soil. The tree intercrops with hill paddy, tapioca, maize, chilli, colocasia, pumpkin, ginger, turmeric and other crops.

5.4. Water shed Management

One way of water conservation practice is contour trenches or terrace farming as in Nagaland and Meghalaya. Mulching, check basins, check dams etc. are also water conservation practices.

5.5. Hill Soil Management

Soil may be conserved by making terraces, contours, trenches, benches, half moon, terrace etc. In Nagaland and Meghalaya this system is used widely for hill paddy and vegetable crops like cabbage, carrot, potato.

5.6 Tree Farming

Tree farming is now a very common alternative in Shifting Cultivation areas. Different states have selected different tree combinations on the basis of altitudinal, edaphic and climatic conditions. The spacing geometry is an important tool for plantation of these species. In Arunachal Pradesh, hills of Assam, Mizoram, and Meghalaya the preferred altitude wise tree farming practices are as following:

1.) Up to 750 m- *Gmelina arborea*, *Michelia champaca*, *Delenia indica*, *Mesua ferrea*, *Anthocephalus cadamaba*, *Artocarpus chaplasha*, and *Eucalyptus* (as boundary plantation) etc.

2.) Up to 1500 m- *Terminialia myriocarpa*, *Albizia procera*, *Lannea axillaris*, *Betula alnoides*, *Pinus petula* and *Chickrasia tabularis*.

3.) Up to 2000 m- *Cedrela*, *Terminalia* spp. and *Alnus nepalensis* etc.

5.7. Multipurpose trees (MPTs)

MPTs signifies the environmental and agro-ecological purposes of trees (soil and water conservation, soil fertility maintenance, biodiversity conservation, etc.) as well as their diverse role of production (food, fodder, wood, medicines, and other useful etc.). MPTs form an important part of diverse agroforestry interventions in crop sustainability. These trees include timber, fodder, fruit, gums, resin and even fire wood species. These also include native as well as exotic trees *viz., Parkia roxburghii*, *Pinus kesiya*, *Alnus nepalensis*, *Pinus roxburghii*, *Artocarpus* spp*., Azadirachta indica, Cocos nucifera*, *Mangifera indica, Tamarindus indica, Morus* (mulberry) *etc.*

5.8 Rubber plantation:

Rubber plantation can be good alternative of shifting cultivation of other hilly areas of the region as it provides tangible income as done in Tripura.

5.9 Cashew Nut Cultivation:

In Garo hills of Meghalaya, Cashew nut is planted in large shifting cultivation areas which uplifted the livelihood of *Jhumias*. In the initial years, cashew nut was intercropped with cotton, ginger, colocosia, turmeric etc.

6.0 Areca Nut cultivation:

Areca nut is one of the most rapidly expanding crops in north-eastern states of India specially in '*jhum*' lands of Assam, Meghalaya and Nagaland.

7. Off-farm alternatives

For extra income generation some off –farm alternatives may be adopted.

7.1. Edible mushroom cultivation

Edible mushroom farming of Paddy straw mushroom (*Volvariella volvacea*), Oyster (*Pleurotus* spp.), button mushroom (*Agaricus bisporus*), milky mushroom (*Calocybe indica*) in low cost manner may be adopted.

7.2. Floriculture

In North-eastern region, the hilly climate is much suitable for floriculture as a new alternative for shifting cultivation. There is a very good demand for some traditional flowers like Jasmine, Gerbera, Gladiolus, Carnation, *Lilium*, *Chrysanthemums*, *Anthurium*, *Zantedeschia*, *Heliconia*, *Alstroemeria*, Marigold, Roses, and Hybrid *Petunia* etc. In floriculture, the orchids are one of the most beautiful flower which is in great demand. In North-east India, about 825 out of 1145 species of orchids are found in various parts. Some of the most commercially used Orchids are *Dendrobium, Schoenorchis, Pleione, Asconcentrum*, *Herminium*, *Calanthe*, *Coelogyne*, *Eria*, *Phaius*, *Liparis*, *Diplomeris*, *Paphiopedilum*, *Cymbadium* and *Vanda* etc.

7.3 Honey bee keeping or apiculture

In India bee-keeping is practiced in mountains, foot hills, forest, agricultural lands. Nowadays, bee-keeping is an important, sustainable, integral agricultural activity under the rural development programme in north-east India since it provides nutritional, economic and ecological security and balance. Sustainable apiculture activity for honey production and better pollination in cross pollinated crops is an alternatives for *jhumias.*

7.4 Small home gardens

The traditional home gardens are maintained by the people of North-eastern region as a part of rural survival over generations, with a complex vegetational structure harbouring diverse types of local plant species with multiple functions. It includes *Areca* nut and banana as well as some economic trees like *Averrhoa carambola* (Kordoi tenga), *Citrus decumana* (Rebab tenga), *Areca catechu, Dillenia indica* (Au tenga)*, Ardisia colorata (*Nal tenga) *Tamarindus indica,* beetle nuts and Black pepper, some important native edible bamboos like *Dendrocalamus hamiltonii*, *D. giganteus*, *D. sikkimensis* and *Melocanna baccifera*.

7.5 Sericulture

Sericulture is playing an important role in rural economy of people of Northeastern state. Muga and Eri based sericulture hold tremendous scope for the hilly people due to availability of abundant host plants like *Heteropanyx* and *Morus* etc.

7.6. Livestock rearing

Pig production, among other species has a high potential to contribute to high economic gain and is an important occupation of the rural society especially the tribal people. Mithun (*Bos frontalis*) also known as "Cattle of Hilly Region" is a rear species of livestock and has got good potential for production of quality meat, milk and leather. Livestock farming also

includes goat, sheep, cow, buffalo, yak etc. for dairy and milk production.

7.8. Organic farming

The organic way of farming provides some extra income generation. Bio-fertilizer is a live formulates of such beneficial microorganisms which on application to seed, root or soil mobilize the availability of nutrients by their biological activity and are eco-friendly [*eg. Azolla*, *Mycorhiza*, *Trichoderma*, *Rizobium* spp. and blue green algae (BGA) etc.]. It not only prevents damaging the natural source but also helps to some extent cleanse the plant from precipitated chemical fertilizers. These can be easily multiplied on farm or off-farm and used to enhance the productivity of *jhum land.*

The plant biomass can be converted to quality vermicompost by selective use of raw material in low cost vermicompost unit for small scale production as well as permanent vermicompost unit for large scale production. Vermicomposting is faster than traditional composting methods, requires less space, and creates no odour. *Jhum* people can simply use a bamboo or areca stem made box or plastic food-storage containers for vermicomposting.

7.9. Small scale aquaculture

The preferred fish rearing species include *Labeo rohita, Catla catla, Labeio calbase, Clarius, batrachus, Cirrihinus mirigale, Macrobrachum rosenbergii, M. malconsoni, Channa punetatus,* and even prawn culture.

7.10. Cultivation of commercially important medicinal and aromatic plants

North Eastern Region is a treasure house of large number of medicinal and aromatic plants. Local people make use of these plants in folklore and traditional medicines. The *jhum* people can cultivate selected commercially important plants like *Acorus calamus*, *Aloe vera*, *Pogostemon cablin*, *Artemisia annua*, *Andrographis paniculata*, *Dioscorea floribunda*, *Oroxylum, indicum*, *Bacopa monnieri*, *Rauwolfia serpentina*, *Plumbag*, *Zanthoxylum alatum*, *Plantago*, *Abelomoscus moscatus*, *Indigofera tinctoria*, *Sesbania*, *Coptis teeta*, *Gymnadaenia archids, Curcuma caesia*, *Crotalaria tetragona*, *Aconitum ferox*, *Panax sikkimensis, Picrorrhiza kurroa, Rubia cordifolia, Flemingia macrophylla*, *Desmodium rensonii*, *Cajanus cajan*, *Tephrosia candida*, *Tinospora cordifolia*, *Withania somnifera* and *Gliricidia maculata.* Practically any type of land available can be used to cultivate one or the other medicinal plant. Thus, they are useful for *jhum* fallows.

7.11. Cultivation of useful wild plants

Nowadays in other part of India more and more attention is given on cultivation of very useful wild plants due to increasing demand from urban areas. North-eastern region is a major gene pool or ethno-botanical treasurer house of these plants. Their cultivation on *jhum* lands will not only enhance socio-economic condition of *jhumias* but also conserve local biodiversity. These wild plants includes some useful Lichens, *Gnetum, Pteridum* spp., *Stenochlaena palustris, Calotropis gigantean, Centella asiatica, Crotolaria pallid, Rubus* spp., *Senna alata, Cyathula prostrate, Antidesma acidum, Oxalis corniculata, Ecbolium viride, Pasiflora edulis*, *Stereospermum chelonoides, Solanum kurzii, Diplazium esculantum, Oenanthe javanica, Clerodendrum* spp. and *Portulaka* etc.

7.12. Seed born tree species/and other essential oils plants

The North-east India is endowed with its abundant oil based plant resource viz. *Jatropha curcas* (Jatropha), *Simmondsia chinesis* (Jojoba), *Pongamia pinnata* (Karanja), *Eucalyptus, Litsea* spp., *Garcinia indica* (Kokum), *Prunus armeniaca* (Wild apricot), *Mesua sp.* (Nahar), *Azadirachta indica* (Neem), *Aleurites fordii* (Tung), while herbs includes *Citronella* oil, *Pogostemon cablin* (Patchouli) etc. The way to promote these plants for large scale cultivation is to create awareness through training, workshop, publication & publicity etc. among farmers for Post-harvest management, storage and marketing practices.

7.13. Poultry farming

Poultry is a category of domesticated birds kept by humans for the purpose of collecting their eggs, or killing for their meat and/or feathers. This is now used as alternatives (off-farm product) in hilly region of north-eastern states. Males avian are sold for meat purpose and females avian are kept for egg production.

7.14. Value adding and marketing

The produce of *jhum* either vegetable or fruits will be used for fruit processing in small level. It will convert fruits, vegetables and spices into value-added products. Fruit product may be Juice, jam, jelly, fruit toffee, squash, fruit snack, fruit pulp even dried fruits, while Vegetable products may be canned vegetable, mixed pickle, tapioca and potato chips, dried vegetable, sago and starch. To enable marketing the produce with reasonable profit to the *jhumias*, the produce will be collected by the village committee and cooperated with district level.

8. Conclusion

In recent decades number of examples and suggestions are given by different Scientific Institutes, Academics, NGOs, social Institutions and others for innovations as alternatives of Shifting cultivation. These alternatives are merely based on ethno-sociological facts rather than scientific facts and figures. The ideal approach is to integrate both with

more and more community to participate in the process. Lastly, a network of Noble system of extension will be the main reason for the success of all these alternatives.

Table: 1. The status of Shifting Cultivation in North-eastern region of India

Northeast Indian State	No. of Families	Total area (%)	Districts involved in *Jhum*	Forest Area Affected (in km^2)	Major Tribes involved in Shifting Cultivation	Control On Forests	Fallow period (Years)	Abandoned *jhum* area (in km^2)
Arunachal Pradesh	54,000	2.61	10	8,521	Aka, Adi, Bangni, Miji Minyong, Nokte Miri Idu Mishmi, Padam, Tangsa, Nishi, Singpho, Wancho,	Village community/ traditional institutions	3	496
Assam	58,000	3.10	3	7,276	Garo, Karbi Khasi, Kuki, Mizo, Naga,	Village community	5-6	3495
Manipur	70,000	3.60	5	13,846	Kuki, Naga, Mizo, Paite	Village community	5-6	3697.14
Meghalaya	52,290	2.65	5	6,812	Biate, Garo, Jantia, Khasi,	Traditional Village Institutions	5-6	116.62
Mizoram	50,000	0.45	3	12,442	Chakma, Mizo, Kuki, Pawai Kuki, Mizo, Reang	Village Council under intimation to govt.	3-5	2870.86
Nagaland	1,16,046	6.33	7	10,641	Angami, Ao, Sema, Kuki, Rengma, Konyak, Chang, Lotha, Tangkhul, Yimchungur	Village Council	4-7 (–8)	801.30
Tripura	43,000	1.08	3	3,3315	Chakma, Garo Halam, Mag, Kuki, Jamatia, Lushai, Notia, Reang, Tripuri,	Village community	5	110.37
Total	4,43,336	19.82	36	92,853			3-7	11587.19

Source: Darlong 2004, National Forestry Commission 2006, Saravanan 2009, Wastelands Atlas of India (2010), State of Forest Report (2010), Kumar (2011), Tomar et al. (2012). Ministry of Rural Development, Govt. of India

Acknowledgments

We are thankful to Director, Rain Forest Research Institute, Jorhat, Assam, for his encouragement and Indian Council of Forestry Research and Education, Dehradun for financial support under project RFRI/26/2009-10/SC.

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References

1. Anonymous (1999) State of Forest report. Forest Survey of India, Ministry of Environment & Forests, Govt. of India p. 113.
2. Anonymous (2009) Draft report of the inter-ministerial national task force on rehabilitation of shifting cultivation land. Report submitted to the Ministry of Environment and Forests, Government of India. pp 95.
3. Barik SK (2007) Spatial and temporal variations in shifting cultivation in north- east India: Is sustainable land use possible with Jhum around? In: Saxena KG, Luohui L, Rerksem K (eds) Shifting Cultivation in Asia: implications for

environmental conservation and sustainable livelihood Bishen Singh Mahendra Pal Singh, Dehradun. pp. 53 -64.
4. Borah IP (2011) Improvement of degraded shifting cultivation lands through introduction of *Thysanolaena maxima* (Broom grass) along with *Cajanas cajan* as N_2 fixing plant, Project Completion Report submitted to ICFRE, Dehradun.
5. Borthakur DN (2002) Jhum cultivation in North-East India: problems, potentialities and strategies. ICAR Research Complex for NEH Region, Shillong.
6. Brady NC (1996) Alternative to Slash-and-burn: A Global Imperative. Agricultural Ecosystems and Environment 58**:**3-11.
7. Cairns M (2004) Conceptualizing indigenous approaches to fallow management: Road map to this volume, In: Cairns M (ed), Voices from the Forest: Farmer Solutions towards Improved Fallow Husbandry in Southeast Asia, Johns Hopkin University Press, Baltimore, MD, pp. 15–32.
8. Conklin HC (1961) The study of Shifting Cultivation. Current Anthropology 2(1): 27-61.
9. Darlong VT (2004) To *Jhum* or Not to *Jhum*: policy Prospective on Shifting Cultivation, Missing Link, Guwahati.
10. Singh J, Barua A, Bora IP (2004) Effect on green manuring and inorganic fertilizer in soil properties and yield. J. Non-Timber Forest Product, 1(4): 11-14.
11. Jamir A, Tiwari BK, Choudhury D, Yim, SK, Singh LJ, Roy S, Nakaro V, Darlong VT, Wotsa Q (2004) Farmers' Innovations in Different Shifting Cultivation Systems in the Eastern Himalayas: North East India. Report prepared for ICIMOD, Kathmandu, Nepal.
12. Khisa SK, Gafur A, G. Rasul, M. K. Alam, M. Mohiuddin, Zashimuddin M (2004) Farmers' Innovations in Different Shifting Cultivation Systems in the Eastern Himalayas: Case Studies from Chittagong Hill Tracts, Bangladesh. Report prepared for ICIMOD, Kathmandu, Nepal.
13. Kumar V (2011) Documentation of baseline information on shifting cultivation in North East India and restoration of selected stress sites under shifting cultivation through agroforestry in NE India. Project Completion Report, ICFRE, Dehradun.
14. Maikhuri RK, Rao KS, Saxena KG (2007) Shifting Cultivation in north – east India: village ecosystem approach. In: Saxena KG, Luohui, Rerksem K (eds), Shifting Cultivation in Asia: implications for environmental conservation and sustainable livelihood Bishen Singh Mahendra Pal Singh, Dehradun. pp. 189 -203.
15. Maithani BP (2005) Shifting cultivation in north-east India: Policy, issues and options. Mittal publications, New Delhi.
16. Report of the National Forestry Commission, Ministry of Environments and Forests 2006.
17. Ramakrishnan PS (1992) Shifting Agriculture and sustainable development: An Interdisciplinary study from North – Eastern India. UNESCO – MAB Series, Paris, Parthenon Publ., Carnforth, Lancs. U. K. p 424.
18. Ramakrishnan PS, Saxena KG, Rao RS, Maikhuri RK, Das AK (1998) Contributions of Ethnic Diversity to the Evolution of Diverse Coexisting Mountain Agroecosystems: A Study of the North East Indian Himalayan Region. In: Partap.
19. TB, Sthapit (eds) Managing Agrobiodiversity: Farmers' Changing Perspectives and Institutional Responses in the Hindu Kush-Himalayas, pp 33-40. Kathmandu: ICIMOD.
20. Ramakrishnan PS (2007) Shifting Cultivation in transition: the way forward. In: Saxena KG, Luohui, Rerksem K (eds), Shifting Cultivation in Asia: implications for environmental conservation and sustainable livelihood. Bishen Singh Mahendra Pal Singh, Dehradun. pp. 1-16.
21. Saravanan V (2009) Political economy of the recognition of Forest Rights Act, conflict between environment and tribal development. South Asia Research 29:199-22.
22. Satapathy KK, Sarma BK, Goswami SN, Verma ND (2003) Developing Land resources. Ministry of Rural Development, Govt. of India New Delhi.
23. Spencer J (1966) Shifting cultivation in southeastern Asia. University of California publication geography 19. University of California Press, Berkeley.
24. Saxena KG, Ramakrishnan PS (1984) Growth and patterns of resource allocation in *Eupatorium odoratum* L. in the secondary successional environment following slash and burn agriculture (Jhum). Weed Research, 24: 127 – 134.
25. State of Forest Report (2010) Forest Survey of India (Ministry of Environment & Forests), Dehradun, 1- 187.
26. Swift MJ, Ingram JS (1996) Effects of global change on multi-species Agroecosystem: Implementation plan, GCTE Report No. 13. GCTE Focus office, Wallingford, U. K.
27. Tawnenga SU, Tripathi RS (1997) Evaluating second year cropping on jhum fallows in

Mizoram, north-eastern India: energy and economic efficiencies. J Biosci. 22:605–613.
28. Tomar JMS, Das A, Puni L, Chaturvedi OP, Munda GC (2012) Shifting cultivation in northeastern region of India - status and strategies for sustainable development. Indian Forester 138 (1): 52-62.
29. Wastelands Atlas of India (2010) Published by National Remote Sensing Centre and Ministry of Rural development.

12/12/2017