JHUM IMPROVEMENT FOR SUSTAINING FARM LIVELIHOOD AND NATURAL RESOURCE CONSERVATION IN NORTH EASTERN HILL REGION : VISTAS AND FRONTIERS

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UMROI ROAD, UMIAM, MEGHALAYA

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CONTENT

STATUS OF SHIFTING CULTIVATION (*JHUM*) IN ARUNACHAL PRADESH, INDIA

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Introduction

Traditional shifting cultivation or *Jhum* is the most important livelihood of farming community of Arunachal Pradesh. Around 52 per cent of gross cropped area of Arunachal Pradesh is under *Jhum* cultivation. The difficult topography, inhospitable terrain, incessant rains and harsh climatic conditions in the hilly regions of Arunachal Pradesh led these indigenous communities to adopt this age old practice of *Jhuming*. The traditional *Jhum* cultivation was found to be economically and energetically efficient compared to other form of agriculture (terrace or valley cultivation) in heavy rainfall areas of the hill tracts of Arunachal Pradesh with average annual rainfall of above 3500 mm. Recently, the facet of *Jhum* cultivation is changing towards a detrimental farming system with rise in human population density in the hills and lowering of fallow period not giving ample time to restore soil fertility and rejuvenate the lost of flora and fauna. The role of *Jhum* is being widely recognized for ecologically sustainable and economically viable form of agriculture (FAO 2014). Though the practice is being considered to be major factor responsible for loss of biodiversity and causing imbalance in the ecosystem, but the fact remains that the majority of the world mega biodiversity area coincide with the area occupied by the indigenous people practicing similar system of agriculture from ages. The entire *Jhum* system in Arunachal Pradesh depends on the natural indicators and seasons that governs their stages of activities like selection of land, clearance & burning, sowing, harvesting etc. Integrated Farming System (IFS) is found to be a vital step for the improvement of *Jhum* cultivation. The *Jhumias* traditionally follow the technique of crop diversification that should be encouraged and promoted through planned research for suitable cropping sequence. Agri-horti-silvi-pastoral system or multi-storey system and agroforestry will be more successful in hilly areas to support *Jhum* farmers.

Total area under *jhum* cultivation in Arunachal Pradesh

Around 52 per cent of gross cropped area of Arunachal Pradesh is under *Jhum* cultivation. According to 2010-11 Census the area under shifting cultivation in different districts is Tirap (1956 ha), Changlang (1522 ha), Lohit (1244 ha), Lower Dibang Valley (1266 ha), East Siang (2801 ha), West Siang (3211 ha), Upper Siang (1101 ha), Upper Subansiri (2987 ha), Lower Subansiri (2566 ha), Kurung Kumey (789 ha), Papum Pare (3001 ha), East Kameng (1563 ha), West Kameng (108 ha) and Tawang (373). Total Jhum area is 24488 ha.

Characteristic of *jhum* cultivation

The major characteristics of the traditional *jhum* cultivation are: site selection and clearing, burning, sowing, weeding, protection, harvesting and storage. Special and crucial decision concerning the location, scheduling, crops and the labour inputs needs to be taken in each

stages of cultivation. This decision making process is very vital in the process and, though needs to take care of the agro-climatic and environmental conditions, and are also moulded by the social and cultural factors. The decision makers largely depend on the natural indicators for making vital decisions. Each tribe has some location-specific traditional calendar of events for *jhum* with different local names. A distinction is made by the native tribes in the pattern of *jhum* based on the locality where it is undertaken. Even within the same location, each site was found to have characterised by different time of sowing, harvesting *etc*. depending upon altitude of the site and vicinity to habitat. Further the fellow cycle is also very location-specific depending on nearby forest type and soil of the selected site. *jhum* cycle has a very interesting and nature-scientific relation with the natural indicators that worth further systematic study. Normally the *jhum* cycle begins in the month of December-January with calls of some particular bird (*Chou pou*) or insects (*Goi*) or other location specific indicators. This cycle involves selection of new plots based on presence/absence of some selective vegetation. The selection criteria also depend on soil type of the area and nature of crop planned to grow. Some sites are considered to be sacred due to presence of some rare vegetation and likewise some areas nearby villages are considered to be cursed and cutting of trees in such area is strictly prohibited. Some tribes before felling of trees in common wastelands, they seek permission of deities. On one hand their mercy is sought for felling the tree and on the other they are thanked for rearing the tree for so long. During clearing of the forest they avoid cutting of some particular tree species so as not to invoke the spirits of the woods. A particular mention may be made of *Sengri & Sengne* (*Ficus sp*.), which are considered to be the abode of spirits and to cut them or to use their wood as firewood is tabooed. It is followed by cutting and slashing of under growth, shrubs, twigs and trees. Cutting and Slashing are done by a selected group of skilled persons, and they use to cut trees of medium girth up to certain height keeping in mind the crop variety that they are planning to grow at that particular site and keep the height of slashed trees 6-8 inch lower than the expected height of the crop at its maturity. And also they were found to be uniformly distributed throughout the field. The next cycle is in the months of January-February with calls or coming of *Pipiar* birds or blooming of certain wild flower like *Bombax ceiba*, and the cycle involves burning of slash and clearing of charred remains. Very strict customs were followed while burning the slashed field in which the persons responsible are not supposed to take full meal and the event is celebrated overnight. The resulting ash was uniformly distributed throughout the field. This stage also involves sowing of some early paddy and other location based crops. The months of February-March are the third cycle that begins with singing of *Pakyo tabo* bird and flowering of *Mekahi* (*Phoebe Cooperiana).* The main activities involve terracing of steep slopes and higher areas, along with contours with half burnt old logs, weeds, stems, *etc*. Mainly sowing of maize is done during this period. In March-April, sowing of some vegetables like cucumber, cucurbits, chillies, ginger, beans, tapioca *etc.* are done randomly mainly in the boundaries. Different tuber varieties are sown along the peripheries that act as live fence for protection against animals. *Mithuns (Bos frontalis)*, the most important domesticated

herbivore animal is generally kept under temporary community confinement called *Lura* during the growing season. Chirping of *Tuk pipipi* and *pinching* birds starts the next cycle during the months of April-May that goes on till the time the frog starts croaking. Here the main activities involve weeding in pervious crops and sowing of paddy. The paddy is sown by dibbling techniques where farmers make a small hole with the help of a sharpen stick and drops two-three seed into the hole with expertise that they gain with years of experience and practice. Sowing of paddy in some place also coincide with flowering of *Gynocardia odorata* known locally with different names. The sowing is mainly done by women folks and it involves minimum disturbance of soil. Almost all their festivals and rituals revolve around *Jhum* and they keep close monitoring over their field for weeding and other activities. The harvesting is done generally in the months of October-November in which the women plug the head of rice bunch and carry them in bamboo basket called *Egin*. The dried grains are stored in specially built rodent free granary called *Nehu*. Before using the new grains for food, they very religiously keep some portion of grains separately for future seed purpose. Mixing seed of different variety is tabooed.

The main crop grown in the jhum field is rice for their own consumption. Paddy is their staple food and is also used to prepare their local beer *apong.* There are wide varieties of local rice produced by the Galos in their jhum fields. Other important food crops grown are the maize and millet as traditional substitutes and complementary to paddy. Since most of the farmers produce for their own consumption, they grow different vegetables, fruits and tuber crops, spices in the same land. Various crops are grown on the contour bunds where the wooden poles are laid along the contour for soil conservation.

Vegetables grown include cucumber, pumpkin, beans, chilli, soybeans, gourds, tomato, cabbage, brinjal, etc. Root crops are sown near tree stump or on the slope. These crops help in soil conservation from erosion. Potato, sweet potato, root potato, turnip, beets, radish, Yam, Cassava, Tapioca, Elephant's foot yam, etc are some root crops grown in the jhum fields. Usually creepers like cucumber, pumpkin, beans, etc are grown as margin crops as they tend to disturb other crops and to demarcate field boundaries. Apple, orange, kiwi, pineapple, banana, passion fruit are some of the fruits grown by the jhum farmers. Some farmers have started cultivating Cash Crops like turmeric, ginger and large cardamom for commercial purpose.

Impact of *jhum* cultivation on natural resources

Jhum was widely condemned as threat to biodiversity: both natural and agricultural. The indigenous *Jhumias* maintain natural biological asset balance (the assets whose initial form was determined by ecosystem of the location) rather than giving more priority to some selected groups of biological assets. During the site selection for *Jhum* they strictly avoid those locations that are dominated by rare or/and medicinally important plants. They avoid felling certain big trees (regarding them as abode of spirit) as they knew its significance to immediate ecosystem and its sustainability. Such big trees also provide habitat to innumerable birds, animals and insects who are their guide in agricultural activities.

Associating such practices with rituals and customs make them moral and spiritual responsibility of the society and individual. *Jhum* is concerned not only with the preservation of flora-fauna, but those culture and traditions that evolved as a result of interdependence of the inhabitant with their immediate environment. It also induces understanding of nature and its phenomenon and their impact on society today and tomorrow. They have very cordial relationship with the seasonal birds, insects and animals; and are considered to be messenger of weather and fertility god, thus indiscriminate killing is strictly prohibited. The indigenous community socialize the natural phenomenon and social phenomenons are described in ecological terms. The *Jhumias* consider themselves inside the system (ecosystem) which is by its nature a diverse system. Biodiversity is the major source of information and people gathers information by interacting with their immediate biological environment. In the biologist's sense of the world, biological diversity is the natural stock of genetic material within an ecosystem. The importance of genes lies on the fact that they determine the particular characteristics of a given organism and encode the information which determines the specific capabilities of that organism. Greater the varieties in the gene pool, greater are the variety of organisms, characteristics and traits. Beside forest biodiversity, agricultural bio-diversity is maintained by *Jhumias.* They preserve their original crop varieties in a very religious way. They also use to grow diverse crops or varieties as per land location and possible weather conditions. They have a huge repository of *germplasm* which they maintain as per their culture and tradition. Under the given environmental condition, a species is best to its own niche. The region under investigation is the centre of origin of important crops like citrus, rice, etc. The crop wild relatives and landraces maintained by indigenous community have been considered to be essential to future viability of global food production irrespective of climate change. It is the people and the practices associated with them, not the landscapes, conserve agricultural diversity. The hesitation of indigenous *Jhumias* in adopting foreign varieties is a great step towards biodiversity conservation because the uniform cultivated varieties that are now substituted for the resident diversity worldwide is posing major threat to biodiversity. Studies found that the lake of adequate stock of the species from which it might regenerate itself has been the major reason behind any species being endangered. Traditional management system like use of more varieties, species and landscape patches helps in conservation of biodiversity as found in several studies across the globe. Grazing management through *Lura* is another innovative technique of biodiversity conservation of *Jhumias*, in which during the cropping and growing seasons all the *Mithuns* (*Bos frontalis*) of the community are temporarily confined in a sufficiently large selected site (that provide adequate food and water) which is changed every year. The confinement checks *Mithuns* from continuous, free and random grazing of forest vegetation during the growing season, besides protecting *Jhum* fields. During the growing and rainy season the confinement of *Mithuns* in *Lura* avoid disturbance of soil surface due to treading that check soil erosion and compaction; and allow free regeneration of grazed vegetations as well as seedling germination throughout the forest. *Jhum* is mainly targeted as threat to climate change as it relies on fire, thus

emitting carbon dioxide into atmosphere enhancing atmospheric concentration of greenhouse gases. Fire and land & natural resource management are indispensible for indigenous people. Indigenous people promote diversity of habitat by regular burning of parts of ecosystem thereby increase stability and sustainability. In fact fire has been used by the indigenous people as a tool to manage diverse ecosystem. The *Jhumias* never go for reckless burning of slashed area. They know the science to control the fire and the ceremony keep them awake whole night so to avoid spread of fire. They avoid full meal during the time which may help them to avoid sleep. Also the ash increases the fertility of soil and help to lower the acidity of the soil which is the major constraints in the soils of hilly regions having high rainfall. Previous studies indicated that ash addition to the soil after burning mitigates the soil acidity and increases fertility. *Jhum* is considered to be one of the major factors of deforestation and forest degradation. But deforestation implies long-term (>10 years) or permanent loss of forest cover. As per the definition of deforestation by FAO, the clearing of forest for *Jhum* is not deforestation but it is "forest modification". The GHG emission (which is mainly carbon dioxide) during *Jhum* is not at all a luxury emission. Also if we consider whole budget of carbon dioxide (CO_2) emission of *Jhum*, the net emission is negligible. Whatever is emitted during burning is nullified by land use, chemical-free managements, almost permanent land cover with alternate crops, non-flooded fields, forest regeneration in left out sites etc. The forest clearing for shifting cultivation releases less carbon than permanent forest clearing because fallow period allow forest re-growth. It was found in the previous studies that if the fallow periods are long enough, shifting cultivation can be carbon neutral maintaining soil fertility. Tillage can cause loss of significant amounts of carbon (lost as CO_2 bursts) immediately after tillage. Reduced tillage or zero-tillage practices were found to decrease net emissions of carbon dioxide from soil also retaining plant residue on the soil surface. The dibbling method of sowing by *Jhumias* is zero tillage emitting practically no carbon dioxide and retains soil organic matter. Minimum disturbance of soil also lowers soil erosion and surface runoff. Soil erosion is also controlled by placing the half burn logs across the slopes of the field that lowers the speed of running rain water and retain the top soil. Thus, *Jhum* also reduce CO_2 emission by avoiding soil erosion. Studies found that exposure of soil organic carbon to aeration during soil erosion increases CO_2 emissions. Soil erosion and degradation never been an issue with *Jhum* cultivation though highlighted widely. An over-emphasis on sequestering carbon in soil as a means of climate change mitigation may eclipse other issues that are at least as significant. One such issue is to identify ways to decrease emissions of non-CO_2 gases from agricultural practices, in view of the estimate by the IPCC that 70% of the total GHG emissions from agriculture are associated with nitrogen fertilizer that released N_2O which has many times GHG potential compared to carbon dioxide. Chemical free cultivation and management practices results almost no emission of such gases during *Jhum*. Their system of cultivation is absolutely organic and natural, using only farm residues, animal wastes etc. Most of their insect and pest management strategies are based on performing field activities with natural phenomenon and indicators. They have very good understanding of insect pest and disease

dynamics through ages of observations. They lower incidence of insect and pest by proper selection of date of sowing and other cultural management depending on lunar cycle. Sowing during the days in the vicinity of Full Moon found to lower insect attack and favour germination. Slashing medium girth plants to a certain height depending on the expected height of the crop to be shown is a unique insect control technique of *Jhumias*. During initial growth of the crop especially rice, the stumps acts as platform for birds to sit and feed on the insects in the leaf of crop, but when the plant grow to maturity it outgrow the stumps and avoid birds from feeding on its grains. Burning of vegetations at *Jhum* sites besides adding carbon to the soil, also help neutralization of soil acidity. Soil acidity may be one of the main reasons of prevalence of diseases and pests in these areas, but burning not only control soil acidity but also help to get rid of spores of pests in the soil. The *Jhumias* are very particular about fallow period and 15 years fallow was found to be sufficient for regeneration of vegetation and rejuvenation of soil. For the tropical forest the fallow period of minimum 10 years is generally sufficient for the recovery of the vegetation, but it depends on the nature of soil and vegetation. The inspection of stem diameters of the recovered plants indicates the rejuvenation of the soil and the vegetation. The approach of *Jhumias* reflects that their culture coevolved with environment to create a sustainable food procurement system.

Socio-cultural aspect of *jhum* cultivation

According to the oxford dictionaries shifting or jhum cultivation is defined as a form of agriculture, in which an area of ground is cleared of vegetation and cultivated for a few years and then abandoned for a new area until its fertility has been naturally restored. Shifting cultivation is an age old practice that occupies a distinct place in the tribal agriculture and its economy. It constitutes a vital part of the socio-economic framework of the tribal life. Shifting cultivation is conventionally still prolonged by the people in the north east region due to the difficult topography, inexorable rains and harsh climatic conditions. Due to poor acidic content of the soil in the undulating terrain and the diversified flora and fauna it creates difficulties in establishing an agro-ecosystem. Though shifting cultivation is also considered to be an exploitative system which is destroying the nature by the optimal use of its natural resources, deforestation and ecological exploitation it is considered to be the major source of production in this parts of India i.e. the North-East India. Jhum cultivation is not just a source of livelihood in the north east but is traditionally allied to the culture, customs and ethnicity but to sum it up, entire tribal civilization and their life envelops around it. In jhum both men and women are involved but women's responsibility is the most prominent of them all. In the entire process of jhum cycle while the men folk performs the more laborious and scrupulous work which ranges from slashing and burning of the woods from the jhum land, big and straight logs being sorted out and removed and fencing being done, the women bag the task of clearing of undergrowth, big creepers and climbers, the important jobs like field preparation, sowing, weeding, harvesting, husking, thrashing, and the storage of crops.

In view of the fact that jhum fulfills their wholesome consumption needs for the entire jhum year hence the farmers can be termed as self sufficient. They just depend on the market for basic needs like salt, oil etc. But some economically more viable farmers also grows cash crops like ginger, turmeric, large cardamom, etc and fruits like orange, kiwi, passion fruit, apple etc in large scale. They have a great demand for these organic products in the national market. Hence the prosperous and affluent farmers also become wholesale dealers and employ several small scale production farmers who gains from such a business.

Ongoing schemes/projects of State and central government on *Jhum* improvement in Arunachal Pradesh

S. N.	Name of the scheme/project	Date of sanction	Facilities supposed to have been created/activities undertaken as per the scheme/ project	Name of implementing agency
1.	Flagship programme on "Improvement of *Jhum* through Horticulture Interventions"	2012 to 2017	Five different modules have been evaluated and identified three effective modules for jhum areas.	ICAR
2.	Integrated Community Large Cardamom and Orange Plantation in Jhum land at Restaring, Korapu, Tarak Langdi and Galang Putung Villages under Tarak Circle of Kurung Kumey District	08.01.2010/ March, 2012	Covering four jhuming sites across which 200 ha and 300 ha. (total 500 ha.) would be brought under large cardamom and orange plantation respectively.	Director of Horticulture, Govt. of Arunachal Pradesh
3.	Establishment of Large Cardamom Garden at Rissi village under Palin Circle of Kurung Kumey District	20.01.2010/ March, 2012	The concerned state Govt. has taken up this project to encourage commercial plantation of large cardamom so as to provide avenues for economic upliftment of the farmers. Plantation in 89 ha area of land.	Director of Horticulture, Govt. of Arunachal Pradesh
4.	Establishment of Orange and Cardamom at Chesing Rijo (Magria) village of Eastern Circle, Upper Subansiri District	05.02.2010/ March, 2013	Orange Cultivation in 98 ha & Large Cardamon Cultivation in 34 ha.	Director of Horticulture, Govt. of Arunachal Pradesh
5.	Cultivation of Hi-Tech Orange Garden at Logyi area of Karbak village of Kambang Circle, West Siang District of Arunachal Pradesh	22.03.2010/ March, 2012	The concerned state Govt. Deptt. has taken up this project to encourage commercial plantation of orange so as to provide avenues for economic upliftment of the farmers.	Department of Horticulture, Govt. of Arunachal Pradesh

			Cultivation of Orange plantation in 30 acres 5area.	
6.	Establishment of Biotechnology Training and Development Centre at Ziro	23.05.2011/ March, 2013	Establishment of Bio Technology Research Training and Development centre at Ziro for taking advantage of the Bio diversity in the State.	Department of Horticulture, Govt. of Arunachal Pradesh
7.	Organic Cultivation of Kiwi and Large Cardamom at Ziro, Lower Subansiri District, Arunachal Pradesh	05.09.2011/ August, 2013	Kiwi cultivation in 72 ha., with expected yield going upto 15 MT per ha. in the 9th year of the project and cardamom cultivation in 35 ha., with expected yield going upto 3.54 MT per ha. in the 9th year of the project.	Department of Horticulture, Govt. of Arunachal Pradesh
8.	Establishment of Orange Garden at Rantiwa of Mebua-III Village, Seppa Circle of East Kameng District, Arunachal Pradesh	26.03.2012/ March, 2015	Plantation of Orange over a gross area of 288 ha. With an expected return (on completion of the project of 5540 kgs of Orange per ha	Department of Horticulture, Govt. of Arunachal Pradesh
9.	Cultivation of Hi-Tech Orange Garden at Lutak Area of Gensi Circle, West Siang District, Arunachal Pradesh	26.03.2012/ March, 2013	Hi-Tech Orange plantaion in 30 ha. area of community land along with security fencing Khasi Mandarin orange is to be cultivated. It is supposed to have yields over 30 years period.	Department of Horticulture, Govt. of Arunachal Pradesh
10.	Compact Area Horticulture Garden with Orange, Pineapple and Banana Cultivation at Radum (Nyoya) Village under Kamporijo Circle in Lower Subansiri District, Arunachal Pradesh	26.03.2012/ March, 2015	The wasteland in the form of Jhumlands/abandoned jhuming sites under optimum utilisation to mitigate adverse ecological degradation and generate self employment for rural people to achieve sustainable	Department of Horticulture, Govt. of Arunachal Pradesh
11.	Establishment of Kiwi Garden at Dora Morey of Hija Village under Lower Subansiri District, Arunachal Pradesh	23.03.2012/ March, 2014	The project will evolve a holistic approach for technology demonstration for reclamation of settled cultivation areas horti-silvi model.	Department of Horticulture, Govt. of Arunachal Pradesh
12.	Estt. Of orange/Large Cardemom Horticulture Garden at Rikung village under Chetam circle	7.09.2012 / Sept., 2015	To establish orange & large cardamom in 84 ha land. Cultivation in 70 Ha area.	Department of Horticulture, Govt. of Arunachal Pradesh

	of Upper Subhansiri Dist Arunachal Pradesh			
13.	Cultivation of Citronell a in Pongchau and Wakka circles Tirap District, Arunachal Pradesh	23.11.2012/ Nov., 2015	To cultivate the citronella plants and to extract citronella oil.	District Horticulture Officer, Tirap District, Department of Horticulture, Govt. of Arunachal Pradesh

Constraints and challenges in improving the *jhum* cultivation system

Jhuming lies in the fact that the land can produce crops only once in several years (5 to 19 years) depending on the *jhum* cycle. But under settled farming, the same field can be brought under multiple cropping with scientific management under irrigation, which can produce two or more crops. Thus, productivity per ha under *jhum* cultivation is significantly lower than the settled cultivation. As a result of low productivity on jhum land, the average earning per family is trifling among the farm households. Jhum land is free and capital investment is insignificant. Seeds, the main capital inputs are all domestically produced. Keeping these facts in mind, the productivity and value products per hectare and return per man-day is very low. Thus, the level of income from jhuming appears to be very poor compared to prevailing wage rates. So both in respect of productivity of land and return of labour, jhuming suffered from disadvantages of a primitive technology. Since such lands are free and there is no private ownership, this does not encourage the farmers to take adequate soil conservation and improvement measures. Due to low productivity, there is no surplus, which can be ploughed back. The growing population has brought about a vicious circle of more area being jhum leading to shortening of fallow period and consequent deterioration of soil fertility, which requires bringing more plots under jhuming.

Significant achievement of ICAR AP Centre, Basar in the area of *jhum* improvement

Under flagship programme on jhum improvement through horticultural interventions the ICAR AP Centre, Basar evaluated five different modules in different jhum areas. The objective was to increase the overall productivity of *jhum,* improve the livelihood opportunities of *jhum* cultivators, provide the year round employment opportunity in *jhum, s*ilent conversion of *jhum* towards profit earning settled cultivationand study the dynamics and sustainability parameters of soil-water-plant quality in *jhum* land. Different modules were Rice based *jhum* system, Khasi mandarin based cropping system, Banana based cropping system, Pineapple based cropping system and Tuber crops based cropping system. Some common interventions in all the modules were Intercropping: Maize, legumes, vegetables, spices, Agroforestry trees, Water harvesting structures, Site specific soil and water conservation measures, Polyhouse for production of seedlings and high value crops, Vermicomposting and In-situ nutrient management, Bamboosetum and livestock interventions: Pigs. During 2012 to 2017 total 123.22 hectare had been covered through different modules. Among these banana based cropping system, colocasia based cropping

system and pineapple based cropping system were found most profitable with benefit cost ratios of 3.68:1, 3.30:1 and 2.24:1, respectively.

Success stories of *jhum* improvement

Under NAIP-lll project of ICAR AP Centre, Basar Ms. Yalom Lida of Lida village of Gusar circle of Daporijo started activities under the guidance of of ICAR scientists. She had 1.2 ha under jhum land and her earnings were just enough to feed her family. Under NAIP intervention it was targeted to convert her jhum land to settled cultivation by integrating livestock and crops with fish farming. With her own cultivation practices she was harvesting the cereals 1.14 t/ha, vegetables 3.45 t/ha and tuber crops 5 t/ha with the respective area. The total return from her traditional way of cultivation was 13896/- only. However, after integrating the various components she has increased her production and productivity of cereals by 2.71 t/ha, vegetables 5.25 t/ha and started earning Rs. 73,800/- from the same area and components. She mostly earned the said amount from livestock and fish.

Strategies and action points for *jhum* improvement in the state

Integrated Farming System (IFS) is found to be a vital step for the improvement of *Jhum* cultivation. The basis behind IFS is direct use of by-product of one system as the input to other production system for efficient use of resources and resource recycling within the systems. The approach proved to be location specific, technically skill based, play multi-dimensional role in fulfilling the domestic requirements, generate new employment avenues, enable rational and sustainable use of resources, rejuvenation of resources and increase resilience of the farming system. The system includes suitable combination of agricultural crops, horticultural crops, multi-purpose trees and shrubs, livestock and fisheries enabling resource poor farmers to become self-sufficient and economically competitive by producing quality edible products from various enterprises with minimum external inputs. The development of horticultural land use system with mixed horticultural crops including fruits, vegetables, root crops, spices and ornamentals grown under optimum management conditions is another crucial step for restoration of left *Jhum* and could be remunerative on long term basis with least gestation cycle. Arunachal Pradesh has its potential advantage and strength of surplus production of fruits, vegetables and spices because of its climate, soils and interest of growers in managing orchards. Climatically, Arunachal Pradesh has three distinct regions for growing temperate, subtropical and tropical horticulture and different zone specific crops are grown. Apple, kiwi, walnut, peanut, peach, plum, pear, saffron, large cardamom, star anise etc are grown in temperate zone; orange, pineapple, straw berry, passion fruit, ginger, turmeric, tuber crops in subtropical zone whereas mango, arecanut, coconut, jackfruit and guava are leading crops of tropical horticulture of the state. Crop diversification is prime area of cropping system. The *Jhumias* traditionally follow the technique of crop diversification that should be encouraged and promoted through planned research for suitable cropping sequence. Growing leguminous vegetables like cowpea, pea, French bean etc with heavy nutrient feeder crop like ginger and turmeric proved beneficial for maintaining the fertility of the

soil. Agri-horti-suilvi-pastoral system or multi-storey system and agroforestry will be more successful in hilly areas to support *Jhum* farmers. Organic farming is a sustainable crop and soil management practice especially for the *Jhum* farmers who are resource poor and are organic by tradition and wisdom. It promotes soil health and carbon sequestration and provides multiple ecosystem services including mitigation of climate change. The *Jhumias* generally are using locally available organic materials for their cropping system and are reluctant in using chemical fertilizers and pesticides. Therefore, there is need for standardization of dosages of different organic fertilizers like FYM, green manures, vermin-compost, neem cake, biofertilizers etc in different crops to enable farmers to judiciously use the products. The botanicals to control insect pest and disease should be encouraged and promoted. Introduction and development of secondary agriculture is very important for livelihood improvement especially for extra income and source of earning during failure of major crop due to climate extremes. Mushroom cultivation, honey bee rearing, and backyard poultry befitted their culture and food habits and widely accepted especially by the women farmers of Arunachal Pradesh. Vermicomposting unit is also profitable enterprise accepted and established by the farmers in the state. The state is especially lacking in post harvest management of produce leading to loss of harvest and poor income of the farmers creating lack of interest for large scale commercial production. Need-based research and demonstration was done on value addition of bamboo through processing, maturity indices and value addition of indigenous fruits like *Taktir* (*Gracinia lancifolia*), packaging and storage condition of Khasi Mandarin/pineapple and preparation of various products of available fruits. There is also need for integrated research for post-harvest handling, packaging, transportation, storage and quality control of perishable commodities. There is need to establish processing units in Arunachal Pradesh to formulate value addition products of excess produce and market intelligence and facilitation of marketing of produce. Arunachal Pradesh is also regarded as nature's repository of medicinal plants where around 500 medicinal plants were identified during preliminary survey. The traditional *Jhumias* have extensive knowledge of the medicinal plants from generations and they are already in the habit of growing these plants/crops in their *Jhum* field. Research should specially focus on identification and utilities of such crops. The farmers should be encouraged and supported to grow such crops in commercial mode. Since these crops do not require much attention or care and no serious disease or insect damages are observed, they get preference as risk aversion crops in this difficult regions and climate. It the biologist's sense of the world, biological diversity is the natural stock of genetic materials within an ecosystem. The importance of genes lies on the fact that they determine the particular characteristics of a given organism and encode the information which determines the specific capabilities of that organism. Greater the varieties in the gene pool, greater are the variety of organisms, characteristics and traits. Agricultural-biodiversity is always been in the forefront agenda of indigenous community practicing *Jhum*. They preserve their original crop varieties in a very religious way. They also grow diverse crops or varieties as per land location and weather conditions. They have huge repository of indigenous *germplasm* which they maintain as per

their culture and tradition. Under the given environmental condition, a species is best to its own niche. The crop wild relatives and landraces maintained by indigenous community have been considered to be essential to future viability of global food production irrespective of climate change. It is the people and the practices associated with them, not the landscapes, conserve agricultural diversity. It is the uniform cultivated varieties that are now substituting for the resident diversity worldwide is posing major threat to biodiversity. The lack of adequate stock of the species from which it might regenerate itself has been the major reason behind any species being endangered. Some of the species in mixed cultivation system practiced by indigenous *Jhumias* help maintain ecosystem structure and function. There is need for extensive survey of the region and collection of all the germplasm available in the region for bioprospecting which in turn help in the search for previously unknown compounds in organisms that have never been used. These germplasm should be utilized in strategic breeding programme involving high yielding national/exotic varieties to make it more resilient to biotic-abiotic stress and economical profitable. Shifting cultivation can be improved to obtain higher production, economic returns and check deteriorative in soil fertility by growing pineapple, turmeric, ginger, chillis, rice, maize, sesame and cotton across the slope in the centre

In a nut shell to ensure sustainable maintenance of the environment and productivity of *Jhum* cultivation some suggestions are pertinent:

1. Introducing of Alder trees (*Alnus nepalenis*).
2. Encouraged settled cultivation.
3. Topography of the district is undulating, use of broom grass on contours as vegetative barriers to reduce soil erosion.
4. Use of salt to control weeds must be banned as it loosens the soil which leads to soil erosion.
5. Introduction of leguminous crops in Jhum fields during cropping years to enhance land productivity and crop yields.
6. Afforestation must be encouraged under the guidance of village councils, district authorities along with forest department, NGO’s and other agencies.
7. Organic farming must be encouraged.
8. Balanced use of fertilizer to maintain soil fertility.

STATUS OF SHIFTING CULTIVATION IN MANIPUR : AN OVERVIEW

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Introduction

Shifting cultivation or *Jhum* is a traditional landuse system cultivated predominantly in North Eastern Hill region. Our neighbouring countries like Bangladesh, Myanmar, Nepal and Bhutan have various nomenclature for this practice. In Bangladesh, it is called as *'Jhum'*, '*taungya'* or hill crop land in Myanmar, *'khoriya'* and *'basme'* in Nepal, *"tseri*" in lower elevation and "*phangzing"* in higher elevation in Bhutan (Kherkhoff and Sharma, 2006). In India, this cultivation is practiced predominantly by the tribals of NEI and in some parts of Orissa, Andhra Pradesh, Chhattisgarh and Karnataka. In India, the different tribes call shifting cultivation by different names. It is called as *Jhum* by Naga, *penda* by Maria of bastar, *podu* by Khond, and *bewar* by Baiga (Saraogi, 2013). Shifting cultivation was classified into four types: traditional, distorted, innovated and modified (Tiwari, 2005). The traditional shifting cultivation is mostly found in villages which have not experienced much pressure of population increase. The distorted shifting cultivation is the result of population increase, reduced fallow period and cultivation in steep slopes. The innovated shifting cultivation is the outcome of switching to newer methods of cultivation by traditional shifting cultivators. Modified shifting agriculture was introduced during the past decade with implementation of two developmental projects in shifting cultivation area. One is Nagaland Environmental Protection and Economic Development (NEPED) and another is North East Region Community Resource and Management Project (NERCORMP) which have been instrumental in developing *Jhum* farmers with microfinance and human resource development activities in Meghalaya, Manipur and hill districts of Assam.

Status on statistics of *Jhum*

"The actual number of shifting cultivators in South East Asia varies between 14 and 34 million" (Mertz *et al*., 2009). "There were 5 million tribal families in India who are involved in shifting cultivation on 4.37 million hectares of land "(Sahu *et al*., 2005). The total estimated area under the shifting cultivation in India is 0.9 million ha which includes both current *Jhum* (53%) and abandon *Jhum* (47%). The North Eastern Region (NER) occupies 83 per cent of the total shifting cultivation in India (GoI, 2011). Of the total schedule tribe rural population of Manipur, *Jhumias* contribute 36.46 per cent (GoM, 2015). Hence, there are sizable number of people who depend on *Jhum* for their livelihood in Manipur. Adding to the above, among the NEI, compared to 2005-06, the reduction of current *Jhum* was observed during 2008-09 (GoI, 2011). The reduction is higher (64%) in Manipur followed by Tripura (62%), Assam (61%), Mizoram (40.42%), Nagaland (22%), Meghalaya (6.62%) and Arunachal Pradesh (6.24%) calculated based on the data of Wasteland Atlas of India. The reasons of reductions might be due to shifting cultivators dependence on other sources of livelihood. The area of shifting cultivation in Manipur for the year 2014-15 was reported as

1,35,000 ha whereas, the shifting cultivation area in the wasteland atlas for the year 2005-06 is 85,220 ha and 2008-09 is 47,163 ha and *Jhum* area for the year 2017 reported by Manipur Remote Sensing Application centre (MARSAC) found to be 1,22,147 ha (Table 1).

Table 2. Distribution of Shifting Cultivation Area in Manipur

S.N.	Districts	Shifting Cultivation	
		Current *Jhum* (Ha)	Current *Jhum* (Ha)
1.	Senapati	4714.77	27611.40
2.	Tamenglong	5736.02	14826.09
3.	Ukhrul	5342.50	13384.89
4.	Chandel	6354.90	25630.90
5.	Churachandpur	10091.55	8454.40
TOTAL		**32239.74**	**89907.68**

It is stated that, "Country by country analysis shows that both area under swidden and the number of people dependent on swidden are largely unknown and the data from each country are highly variable." (Mertz *et al*., 2009). Similarly, the above data of wasteland atlas gives a decreasing trend whereas, the data of Department of Agriculture shows increasing trend in shifting cultivation area. Hence, the data of the national remote sensing centre and the data portrayed by the Department of Agriculture, Manipur is highly variable. The above data set describes that there is a need to have proper documentation for the shifting cultivation area and the ***Jhumias*** population in India and NEI in particular. The number of households and the population who are dependent on ***Jhum*** in Manipur are described in Table 2. The above observation was supported by the document which portrayed that database on shifting cultivation area need to be updated (NAAS, 2016).

Table 2. Distribution of households depending on *Jhum* in Manipur

S.N.	District	Household (No.)	Population (No.)
1.	Churachandpur	25830	99185 (34.37)
2.	Ukhrul	23972	47857 (16.58)
3.	Chandel	15870	30450 (10.55)
4.	Tamenglong	27858	83574 (29.02)
5.	Senapati	9150	27450 (9.51)
	Total	1,02,680	2,88,516 (100)

Note : Figure in the parenthesis are per cent to total *Jhum* population in the state

Characteristics of *Jhum*

The shifting cultivation practice invariably involves slashing of woody vegetation, burning, clearing including debris followed by cultivation of crops and sowing of various crops in which upland paddy was the predominant crop (Bhattacharjee, 2016). Both private and common property tenure found in the shifting cultivation system. The practice varies from place to place. However, the selection of *Jhum* block starts in the month of January. In the Khasom Khullen block, the *Jhum* land is hereditary. Felling of trees takes place in the month

of last week of January to February. The villagers celebrate the festival called as "*Ramtho Phanit"* local Thangkhul dialect. "Ram" means land, "tho" means starting and "Phanit" means festival. The drying of felled trees will take place from February and March and then at the end of march and April, a day is fixed for burning of felled trees. The dibbling of rice and other crops takes place from last week of April to first week of June. This is followed by first weeding and second weeding of the crop. The harvesting of rice takes place in the month of October. The harvesting is accompanied with festival celebrating and enjoying with the community members.

Schemes in shifting cultivation area

Since 1994-95, Watershed Development Project in Shifting Cultivation Area (WDPSCA) was implemented in all the North East India. The WDPSCA scheme was purely a central government sponsored scheme implemented by Government of India since 1stapril 1995 to 31st march 2012. The Department of Horticulture and Soil conservation were the nodal department for implementation of the scheme. The main aim of the scheme was to develop the *Jhum* areas on watershed basis and to improve the socio economic condition of the *Jhumias.* The eligibility criteria for implementation of the scheme were as follows. A minimum of 25 per cent of watershed area is under shifting cultivation; more than 50 percent of the population is dependent on shifting cultivation as a means of livelihood; the willingness of *Jhumias* to opt for improvement of *Jhum*. The scheme was implemented on watershed basis with a cost of H 12,000 per ha in plain areas and H 15,000 per ha in difficult and hilly areas. The common guidelines for watershed development projects (GoI, 2015) included were ridge area treatment, drainage line treatment with a combination of vegetative and engineering structures, development of water harvesting structures such as low cost farm ponds, check dams, percolation tanks, nursery raising for fodder, fuel, timber and horticultural species with special emphasis on local importance, land development including in-situ soil and moisture conservation, bench terracing, contour bunding, crop demonstrations for popularising new crops and varieties, pasture development, sericulture, bee keeping, backyard poultry, small ruminant, other livestocks and micro-enterprises, fisheries development and promotion and propagation of energy saving devices, bio-fuel plantations *etc*. After 2012, this scheme were merged under Rastriya Krishi Vikas Yojana.

Determinants and livelihood of *Jhum*

The causes of continuance of shifting cultivation was studied by Rahman *et al.* (2011) who stated that older and non educated farmers due to their tradition have the tendency to practice shifting cultivation. Large family size and lack of opportunities of off-farm earnings significantly increase the farmers' possibility to opt for shifting cultivation. The younger farmer with small household size decreases the probability to practice shifting cultivation. The farmers practice shifting cultivation as it gives relatively stable net cash flow each year. Further his logistic regression analysis reveals that, tradition and custom, still play a decisive role for the continuance of shifting cultivation. Gupta (1994) studied *Jhumias* of Tripura, which revealed that 50.47 per cent of the *Jhumias* households continue *Jhum* as a way of

life. While inadequacy of government assistance for giving up the practice was reported by 73.77 per cent, 60.46 per cent of the *Jhumias* were expressive of the need to find a supplementary source of income if the practice of *Jhum* had to be given up.

Tripura and Chand (2015) did a case study in a Tripura *Jhumia* community. He observed that tribes of Tripura had occupational change over the recent years. The study revealed that, of the primary occupation, 50 per cent *Jhumias* pursue occupation as wage laborers followed by 31 per cent in bari agriculture, 10 per cent in government job, 2 per cent in weaving, *Jhuming,* business and herding. He further opined that earlier whole community undertake *Jhum* as a livelihood option but now *Jhum* as a secondary occupation occupy only 12 per cent. Education, shortage of family labour, less availability of forest product and shortage of food grain made their occupational change of *Jhum* only to other sources of livelihood. Datta *et al.* (2014) studied the perception of Tripura *Jhumias* on the livelihood status. It revealed the following findings. 54.29 per cent of farmers perceive that returns from selling *Jhum* products gives satisfactory income, 72.86 per cent satisfied that livestock provide guaranteed additional income.100 per cent of *Jhumias* were highly satisfied on the access and benefits from common property resources, 82.14 per cent were less satisfied with the returns from forest and NTFP, 52.85 per cent and 47 per cent were less satisfied and satisfied respectively for the family members that they were engaged in *Jhuming* and livestock rearing occupation and 100 per cent of the *Jhumias* were highly satisfied by the quality of labour available at household level. More than 80 per cent of *Jhumias* were highly satisfied on the ability to call friends on crisis situation and the assurance of community support during crisis situation. 72.86 per cent of the respondents were less satisfied with the stock of money or savings they own.

Socio-economic condition of *Jhumias*

The study by Punitha *et al.,* (2016) in *Jhumias* of Manipur revealed that 71 percentage of *Jhumias* family members had completed matriculation. It was also found that, 48 percentage of *Jhumias* household had completed higher secondary and above level. Further study in Jhumias of Tripura revealed that education was found to be positively and significantly related with livelihood status of tribal people. The family size was found to be averaging 6.7 and the standard deviation was 2.14. It was found that 71.72 percentage of the respondents found to belong to the category of 5-7 number of family size. Similar findings with an average family size of 7 were found reported in the study in Ri bhoi district in Meghalaya (Deb *et al*., 2013). The mean *Jhum* experience of the respondents were 21 years with a standard deviation of 11 years. The variable exposure to number of mass media revealed that 77 percentage of the respondents had access to two to three sources of mass media. Further, it was found that 84 percentage of the respondents had no access to any form of extension contact. Another 16 percentage of the respondents had extension contact because of the access to Krishi Vigyan Kendra (KVK) near to the village at Tamenglong and also because of the intervention through North East Regional Community Resource Management Project (NERCORMP) staffs through International Fund for Agricultural Development assistance at Ukhrul and Senapati districts. It was found that 71 percentage of

the respondents family members had not migrated either within or outside the state. Hence, most of them were pursuing *Jhum* as a livelihood. 29 percentage of the respondents' family members had migrated within the state for education and employment purpose. 91 percentage of the respondents received power supply in their villages. It is increasingly said that *Jhumias* were giving pressure to their land and the fallow period were getting reduced day by day (Arunachalam, 2002). Interestingly in the study area of Manipur, the average fallow period was 10.7 years.

Intervention under *Jhum* farming

Inclusion of pulses in shifting cultivation: The continuance of *Jhum* in the state is closely linked to ecological, socio-economic, 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. The dry broadcast or 'punghul' method involves sowing in the month of March/April and harvesting in August/September. Wet sowing or 'pamphel' is done in the month of May/June and harvested during October/November. Transplanted paddy or 'aringba' is also sown in the month of May/June and harvested in the month of October/November. In the hilly areas of Manipur, shifting cultivation is widely practiced, with settled terrace farming in foothill or low slope areas, above the adjacent rivers and streams. Depending on the slope, wet broadcast on bunded fields or dry broadcast on unbunded fields is practiced.

The technology demonstrated like Pigeonpea (UPAS-120), Ricebean (Local), Rajma (Chitra)-Potato, Ricebean (Local), Rajma (Chitra)- Potato, Rajma (Chitra)- Pea (Rachna), Ricebean (Local)-Pea (Azad pea), Groundnut (ICGS-76)-Lentil (HUL-57). The farmers produced 1.2 to 1.76 tonnes of pigeonpea/ha, 1.3 to 1.7 tonnes ricebean/ha, 1.4 to 1.9 tonnes Rajma/ha, 1.4 to 1.8 tonnes pea/ha and 0.85 tonne lentil/ha. They have earned net returns varied from. The beneficiaries especially from *Jhum* cultivated areas received net returns of Rs 56000 to 105000/ha, where, rice mixed farming is dominant with low productivity (0.5 to 0.9 ha^{-1}) and less economical (Ansari *et al.* 2017).

Figure 1. Diversified the rice mixed farming with legumes and pulses at Haochong Village, Tamenglong District, Manipur

When considering economic returns, the legumes can be a valuable alternative crop for replacing rice from *Jhum* areas. Besides that, pulses crop fixed the atmospheric nitrogen in soil, improved the soil health, and reduced the soil loss, conserve the soil and water and suppress the weed growth through smothering effects. Pulses production in hill agriculture plays a significant role in nutritional security and used for various purposes and as well as for second cycle produce in livestock farming. There is tremendous opportunity to enhance pulses production especially in Jhum areas, where farmers are growing crops in mixed cropping on rotational basis. There are some potential pulses for *Jhum* areas are pigeonpea, ricebean, soybean, mungbean/urdbean, broadbean, Makhyatmubi, winged bean, cowpea, lima bean and tree bean either as sole cropping or intercropping or agro forestry system.

Conclusion

The statistics of *Jhum* population is highly variable. Hence suitable strategy has to be find out the exact population who are depending on *Jhum*. For that, inserting a question " are you depending on *Jhum* " in the census will be a more appropriate strategy. Short Message Service (SMS) should be sent to farmers in advance related to agricultural and allied activities which will create awareness on training programme and make *Jhumias* more informed. The KVK in each district should be motivated to collect few contact numbers of village head man and other *Jhum* farmers in each village. These contact numbers should be utilised by KVK to disseminate training schedule through SMS so that interested farmers could attend training either in KVK of the respective districts or at ICAR or Central Agricultural university at Imphal conducted time to time on various agriculture, horticulture and allied activities. To maintain statusquo of fallow period and to reduce the dependency on *Jhum*, location specific suitable livelihood activities should be promoted so that dependency on *Jhum* would be reduced in the future. Further, diversification of the rice mixed farming with legumes and pulses has to promoted among the *Jhumias* for *Jhum* improvement. Social participation by the *Jhumia* households was found to be less in the study area due to non existence of social groups like Self Help Groups. Notably, NERCORMP through International Fund for Agricultural Development is promoting Natural Resource Management Group (NRMG) in Ukhrul and Senapati districts of Manipur. The policy makers while thinking about *Jhumias* and *Jhum* should take into consideration the socio-cultural aspects before intervention in *Jhum* and their livelihood.

References

Ansari M A, Saraswat P K, Sharma SK, Prakash N, Meitei Ch. Bungbungcha, Monsang TS Leenda, Singh N. Ajitkumar, Singh L. Somendro, Singh Deepak, Lal N, Ramakrishna Y, Das Anup, Hazarika S and Ngachan SV (2017). Changing from subsistence to remunerative cropping: A success story of diversification through legume in Jhum land. *(In)* Book of Abstract of National Seminar on Smart Farmin g for Enhancing Input Use efficiency, Income and Environmental Security (SFEIES) during September. 19-21st, 2017 at ICAR RC for NEH Region, Umiam, Meghalaya. Pp: 160.

Arunachalam, A. (2002). Dynamics of soil nutrients and microbial biomass during first year cropping in an 8-year jhum cycle. *Nutr.Cycl. Agro-ecosyst*., 64: 283-291.

Bhattacharjee, S. (2016). A micro-level study on dimensions of emerging livelihood pattern of rural tribal youth in Tripura. Ph.D thesis. Submitted to School of Social Sciences, College of Post Graduate Studies, Central Agricultural University, Umiam, Meghalaya.

Deb, S., Lynrah, M.M., and Tiwari, B.K. (2013).Technological innovations in shifting agricultural practices by three tribal farming communities of Meghalaya, North East India. *Trop.Ecol.,* 54(2): 133-148.

GoI. (2011). Wasteland Atlas of India. Department of land resources. National Remote Sensing Centre. http//:www.dolr.nic..in/dolr/wasteland_atlas.asp. Accessed 31 March 2015.

GoM. (2015). District wise number of jhumia household and number of population engaged in jhuming cultivation. Department of Agriculture.Government of Manipur, Imphal.

Kherkhoff, E. and Sharma, E. (2006). Debating shifting cultivation in the Eastern Himalayas farmers' innovations as lessons for policy. International Centre for Integrated Mountain Development. http://www.*lib.icimod.org/record/7409. Accessed 13 February 2015.*

Mertz, O., Padoch, C., Fox, J., Cramb, R.A., Leitsz, S.J., Lam, N.T., and Vien, T.D. (2009). Swidden change in South East Asia: understanding causes and consequences. *Hum. Ecol*., doi **10.1007**/s10745-009-9245-2.

NAAS.(2016). Policy paper No.83 issues and challenges in shifting cultivation and its relevance in the present context. National Academy of Agricultural Sciences. New Delhi. http://www.www.naasindia.org. Accessed 3 March, 2017.

NAAS.(2016). Policy paper No.83 issues and challenges in shifting cultivation and its relevance in the present context. National Academy of Agricultural Sciences. New Delhi. http://www.www.naasindia.org. Accessed 3 March, 2017.

Punitha, P., Pandey, D.K., Feroze, S.M., Singh, R.J., Ram, D., Singh, N.O., Jyothi, S.S.P. and Monika, A. 2016. Socio-economic profile and perceived livelihood diversification choice of Jhumias of Manipur in North East India. Progressive Research- An international Journal. 11 (VI):4314-4319.

Sahu, S.K., Nayak, R.K., and Sarangi, D. (2005). Sustainable soil and land management under shifting cultivation in Orissa. http://www.odisha.gov.in/e-magazine/Orissa review/ jan2005/.../Sustainable_soil.pdf. Accessed 22 February 2015.

Saorogi, A.(2013). Shifting cultivation in India. *http:/ /*www. important india. com/9442/ shifting-cultivation-in-india/. Accessed 23 September 2016.

Tiwari, B.K.(2005). Shifting agriculture in North Eastern India: some insights in spatiotemporal patterns and processes. Proceedings of workshop on shifting agriculture, environmental conservation and sustainable livelihoods of marginal mountain societies, October 6-10, 2005, Guwhathi, India.

SHIFTING CULTIVATION: SOME OPTIONS FOR SUSTAINABLE DEVELOPMENT IN MEGHALAYA

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Introduction

Shifting cultivation or slash and burn agriculture locally known as "*jhuming"* is a widely practiced farming system in the hills of North Eastern India consisting of Assam, Tripura, Arunachal Pradesh, Meghalaya, Sikkim, Nagaland, Manipur and Mizoram. It has been estimated that about 500 million peoples practice shifting cultivation in 410 m ha area (forest land) in the world. In Asia alone, about 80 m people spread over nearly 120 m ha are involved in shifting cultivation (Haokip, 2003). The shifting cultivation is a time-tested system of agricultural practice, most often evolved indigenously and strongly based on traditional knowledge. It is considered to be an appropriate and sustainable land use practice in diverse socio-economic setup, where the dependent human population was within the carrying capacity of a 10-15 year *jhum* cycle. Today the shifting cultivation became unsustainable due to reduced jhum cycle of 3-6 years owing to the increase in population that led to increase in food demand. Because of reduced jhum cycle at present the average *jhum* land per family is about 1.3 ha while the *jhum* cycle is of four years (Anonymous, 1987). This has caused decrease in productivity necessitated in bringing more virgin forest area under *jhuming.*

It's a tribe specific cultivation practice and varies widely in different parts of North East India. The system involves cultivation of crops in steep slopes. Land is cleared by cutting of forests, bushes, etc up to the stump level in December – January, leaving the cut materials for drying and finally burning to make the land ready for sowing of seeds of different crops before the onset of rains. The cultivation is confined to a village boundary and often after two or three years the cultivated area is abandoned and a new site is selected to repeat the process. The hutments of the village remain at the same place. Earlier whole village used to shift to the new site. After 2 – 3 years of cropping when the land losses its fertility farmers shift to another piece of virgin forestland for cultivation. After 3 – 15 years, when the vegetation in deserted land regenerates during fallow period, the farmer again come back for farming to the same piece of land, which he left fallow a few years back. Thus, the cycle of cropping and fallow continues. With rising population, the *jhum* cycle in most areas, which used to be 10 – 15 years earlier, now reducing to 2 – 3 years only. In this system, generally all the agricultural operations are performed manually, using only a few traditional and primitive tools. Regeneration of forest and soil fertility within farming system are also achieved cost-free and effortlessly. Munda et al. (1996) described some common features of shifting cultivation as follows:

- Done for food items (rice, maize, yam, tapioca, ginger, sesame etc)

- Performed on hill slopes
- Fire used for clearing cut forests
- Rotation of fields
- Slash and burn operation of vegetative species
- Keeping the land fallow for a number of years for regeneration of forests
- Overuse of human labour for farm operation
- Under-employment of drought animals.

All essential crops viz., rice (*Oryza sativa*), maize (*Zea mays*), tapioca (*Manihot esculenta*), colocasia (*Colocasia esculenta*), sweet potato (*Ipomoea batatas*), ginger (*Zingiber officinale*), finger millet (*Eleusine coracana*), cotton (*Gossypium* spp), tobacco (*Nicotiana* spp.) and many other grown on the same field as mixed land use system resembling latest cafeteria system of cultivation. The multiple cropping with as many as 30 or more crop species on a plot of about 2 hectare would meet the varied needs of the family of an isolated community.

Jhum is an efficient system of agriculture from the viewpoint of energy efficiency. Unlike mechanized agricultural systems which consume five to ten units of fuel energy to produce a single unit of food energy (Steinhard and Steinhard, 1974) 17 to 20 times energy is obtained during first year cropping, and 13 to 15 times energy is obtained during second year cropping of rice. The energy efficiency may still be higher, 41 to 48 **(**Toky and Ramakrishnan, 1982), or from 18 to 55 (Maikhuri and Ramakrishnan, 1991) under mixed cropping system.

Munda et. al., (1996) described the short-term benefits from shifting cultivation as follows:

- The *jhum* fire quickly render dense forests and foliage fit for growing crops.
- *Jhum* fire is a great labour saving device.
- *Jhum* soils of hill slopes receiving high rainfall are generally acidic. The ashes correct the soil acidity and make the soil more fertile.
- Fire clears the area of extensive preponderance of fungi, insects and pests along with their larvae and eggs and acts as sterilizer.
- Fire also retards the weed growth in the *jhum* cleared by destroying the roots, tubers and seeds of weeds.
- Fire improves soil temperature regimes. Seeds in the fired warmed hill soils sprout early, i.e., in the first fortnight of April.
- Upland rice is grown as the principal food crop under *jhuming* and is also mixed with other priority crops such as maize, finger millet, foxtail millet, beans, sesame, sweet potato, ginger, turmeric, cotton, chillies and leafy vegetables. This provides *jhum* cultivators almost everything they need for their daily use.
- Less labour input/day is required over and extended period of time.

Resource degradation, low productivity, tendency to encourage large family size and little or practically no scope for adoption of modern agricultural technology are some of the drawbacks in this system (Christanty, 1986).

Earlier it was agreed at one point that shifting cultivation being a way of life had become integral part of the socio-cultural system of the tribal people and it should be disturbed as minimum as possible. The Indian Council of Agricultural Research has established an Agricultural Research Complex for North Eastern Hills Region at Shillong, Meghalaya with the subsequent set up of its centers in the states of Arunachal Pradesh, Manipur, Mizoram, Nagaland, Sikkim and Tripura, with the major objective to study the shifting cultivation systems in details and to suggest viable and socially acceptable alternatives to replace/improve the age old practice. Since then various concepts have been developed which have brought a number of interesting facts.

According to the estimates by the various agencies, shifting cultivation in North Eastern States varies between 2.80 – 7.40 million hectare. According to task force on the shifting cultivation, Ministry of Agriculture 1983, the area under shifting cultivation is estimated at 3.869 square km and number of families that depends on shifting cultivation for their livelihood is estimated at 4,43,3361. According to Waste Land Atlas of India (2010), the area under shifting cultivation in NE India is about 0.76 m ha. It is not only the source of livelihood but also has high cultural importance among the people of the North East. According to a survey of Government of Meghalaya, the average *jhum* area cultivated per family for both clean felling and *Bun* cultivation had been estimated at 0.8 hectares. The extent of such cultivation is maximum in Nagaland, accounting for 38.18% of its geographical area, followed by Mizoram and Manipur. Ethnic groups practicing shifting cultivation in different parts of the country has been indicated by Mahapatra (1983).

Problems related to shifting cultivation

Haokip (2003**)** outlined the basic problems related to shifting cultivation as –

- Lack of basic information
- Ineffective implementing machinery
- Lack of proper monitoring system
- Complex land tenure system (Farmers has no legal right /ownership over his land)
- Lack of transport and marketing infrastructure
- Lack of improved varieties of crops and livestocks
- Lack of scope for appropriate modern technology due to poor technical and financial backup. Illiteracy/ignorance of *jhumias* for any change from traditional *jhuming* to scientifically sound technologies.
- Increasing population reduced *jhum* cycle to less than 5 years
- Lack of coordination among the implementing agencies.

Shifting cultivation was thought to be good for the time when it emerged. Least disturbance to soil, mixed cropping on slopes under purely rainfed conditions and dependence on local

resources were some of its merits. But with passes of time the pressure on land increases and the progressive degradation of the product base has become prominent today. Munda et. al., (1996) stated that shifting cultivation causes mass scale destruction of forests resources, degradation of lands, losses of valuable flora and fauna and animal resources besides creation of ecological environment non-conducive for crop production. In this section various adverse effects of shifting cultivation is discussed.

In fact unsustainability of shifting cultivation begins with the reduction in *jhuming* cycle, accelerating both on- and off-site degradation due to erosion, runoff, nutrient losses, loss of biodiversity and deterioration in watershed hydrology. Ill effects of *jhum* on the environment are well-established facts. Such conclusions are based on the scientific data and experiments conducted world-wide including north-east India **(**Ghosh et al. 2009). Sharma (1998), stated that shifting cultivation played a major role in the rapid deforestation in the region**.**

Extent of soil erosion and nutrient loss due to shifting cultivation

Soil erosion under shifting cultivation is highly erratic from year to year depending on rainfall characteristics. Studies on steep slopes (44 - 53 %) have indicated the soil loss to the tune of 40.9 tons per hectare and the corresponding nutrient losses per hectare are 702.9 kg of organic carbon, 145.5 kg of P_2O_5 and 7.1 kg of K_2O (Munna Ram and Singh, 1993). The soil loss from hill slopes (60 – 79 %) under first year, second year and abandoned *jhum* was estimated to be 147, 170 and 30 t/ha/year **(**Singh and Singh, 1981). During first few years of clearing, carbon and nitrogen levels decrease rapidly. According to one estimate annual loss of topsoil, N, P and K due to shifting cultivation is 88346, 10669, 0.372 and 6051 thousand tones in the region (Sharma, 1998). Consequently the total production from this cultivation is pitifully low: the per hectare paddy yield in Khasi hills (Meghalaya), Garo hills (Meghalaya), Khonsa (Arunachal Pradesh), Siang (Arunachal Pradesh) are reported to be 0.13, 0.5.0, 0.4.1 and 0.83 t/ha respectively. The serious adverse effect of *jhuming* is soil erosion, which is mainly of splash and wash types. As the soil in the upper reaches in a ridge are exhausted in the process, the cultivator's move to the adjoining lower elevation. The process continues till the entire ridge is exhausted. Singh et. al., (1996), reported nutrient loss to the tune of 6.0 million tons of organic carbon, 9.7 tons of available phosphorus and 5690 tons of potash from the NEH region. Nutrient losses from the *jhum* field through runoff and percolation are rather heavy during cropping. The data for N, P and K loss are given in Table.1, for a low elevation system (Toky and Ramakrishnan, 1981a). Similar conclusions apply to the high elevation *jhum* too (Mishra and Ramakrishnan, 1983a).

Table 1. Nitrogen, phosphorus and potassium losses (kg/ha/year) through runoff under different *jhum* cycles at lower elevation and in fallows.

Site	Runoff losses			Infiltration losses		
	NO_3-N	PO_4–P	K	NO_3-N	PO_4-P	K
5 year *jhum* cycle	5.3	0.9	51.0	9.2	0.1	13.7
10 year *jhum* cycle	4.2	1.3	91.2	10.7	0.1	21.2
30 year *jhum* cycle	3.7	1.1	64.7	9.8	0.1	15.1

Singh and Singh, 1981, described the magnitude of soil loss associated with different practices of shifting cultivation and established a comprehensive soil erosion calendar of shifting cultivation. Although from *bun* cultivation of several crops have been obtained, yet it leads to a larger amount of soil erosion. It was observed that for every one tone of potato produced by the system, the soil loss was 2 tones (Singh and Singh, 1981). It has been observed that as the time advances the horizontal spacing between the two beds goes on increasing due to loss of soil and the land is abandoned when soil is almost exhausted and even green grasses fail to grow some time exposing the bed rocks (Borthakur, 1992). Cultivation of tuber and rhizomatous crops cause soil erosion to the tune of 40 – 50 t/ha while pineapple cultivation along slopes eroded 24 to 62.6 t/ha/yr (Singh and Singh, 1981). The entire area in and around shillong (Shillong plateau), Meghalaya is denuded by this system of jhum cultivation.

Strategy for Sustainable Development/Alternatives of Shifting Cultivation Areas with respect to Meghalaya

Sustainable agriculture in respect of North East region should entail development of managements systems that ensure adequate supply of food, fibre and fuel to the growing population. These systems must simultaneously ensure improving living standard of people by efficient utilization of all natural resources including land and water and external inputs in a practical and profitable manner while enhancing the environmental safety.

The concept of development of sustainable agriculture take cognizance of the geophysical and environmental factors, which greatly govern and regulate the agricultural pattern to be adopted in situations abound with above factors. The characteristic geophysical and environmental factors prevalent in North Eastern region can be enumerated as below:

1. The undulating topography
2. The wide range of altitude
3. Varying rainfall and climates, as well as low temperature during winter season.
4. The need of specific land use and soil conservation measures depending on the slopes of the hills.
5. Water availability, water harvesting and retention, favourable soil and water balance, soil erosion, hydrological behaviour of watershed and finally the ecology and environment all dependent on forest cover and the degree of deforestation (Singh et. al. 1996).

In midst of all these above features of the North East India promise for potential development of agriculture including, horticulture, fishery, forestry, animal husbandry etc. The present agricultural activities in this region are not exposed by adequate scientific base in circumventing the land degradation process and scientific exploitation of water resources. There is, therefore, an urgent need to develop sustainable agricultural strategy for hill areas of North Eastern hill region to conserve soil, water and ecology while carrying out various agricultural practices. Various scientific studies and approaches suggest that mixed land use systems are better in the hilly areas, from the conservation as well as production point of view. Further, the system should be so designed so as to meet the various needs effective

land and water management techniques i.e., watershed management programme integrating soil conservation measures, land development, agriculture, plantation crops, horticulture, animal husbandry, fishery and forestry should be considered as vital and most important. These alternatives are discussed below:

Agricultural Land Use System

The agronomic crops can be adopted on hill slopes up to 50 % gradient where soil depth is greater than 1.0 m. Contour bunding at 0.5 to 1.0 m vertical interval draining into a common grassed waterway is an essential requirement. The criteria for selection of crops should be based on the priority of crops that are already grown in the area, crops which have market potential such as spices and introduction of *rabi* crops such as mustard (*Brassica* spp), potato (*Solanum tuberosum*), pea (*Pisum sativum*), buckwheat (*Fagopyrum esculentum*) etc. in the irrigated area. Rice crop should be preferred in lower terraces. In general, ridge should be kept under fuel-fodder-timber trees, which can be planted, based on the requirement of farmers. On steep slopes about 30 % of land is to be occupied under bunds and terrace risers. These areas have a great potential for taking fodder crops. Amongst perennial grasses and legumes for the North East *Setaria sphacelata*, Napier (*Pennisetum purpureum*), Guinea (*Panicum maximum*) and *Stylosanthes guyanensis* were found good for terrace risers.

Yield potential of rice, maize, millets, soybean (*Glycine max*), pegionpea (*Cajanus cajan*)**,** maize + soybean, maize + pigeonpea and maize + ginger under rainfed terraced condition at 3000 m altitude has been reported as 0.17, 0.21, 0.16, 0.53, 0.13, 0.21 + 0.24, 0.17 + 0.14 and 0.18 + 0.39 t/ha, respectively (Awasthi, 1984**).** The cultivation of *kharif* crops i.e. maize, paddy, cowpea (*Vigna sinensis*), sesamum (*Sesamum indicum*), groundnut (*Arachis hypogea*), maize + cowpea, maize + soybean and *rabi* crops viz., wheat (*Triticum aestivum*), potato, cole crops, turnip (*Brassica rapa*), tomato (*Lycopersicom esculentum*), etc. have been recommended in irrigated condition in the Nagaland situation. Paddy-cum-sericulture system for lowland was found more viable as the cash return were frequent with 4 cocoon crops in a year besides paddy yield.

Horticultural and Plantation Crops Land Use System

Slope of land for horticultural and plantation crops use should preferably be less than 100 % (Singh *et. al.* 2000). Soil depth must be minimum 1.0 m. Contour bunds at 2 meter vertical interval, half-moon or crescent shape circle should be made at the location of planting, grassed waterways and making of few bench terraces at the lower slope towards foothills for growing vegetables and pineapple are essential conservation measures.

The agro-climatic condition of North East India is ideal for cultivation of plantation crops. Tea (*Camellia* spp.), as a plantation crop was introduced in the region very early while other plantation crops such as coffee (*Caffea* spp), rubber (*Hevea brasiliensis*), arecanut (*Areca catechu*), black pepper (*Piper nigrum*), etc. were introduced initially with the idea of providing alternative method of livelihood for the farmers doing shifting cultivation. Various bodies such as National Committees for Agriculture and other commodity committees had

recommended that in order to provide a better method of agriculture it would be useful to introduce plantation crops in the region as one of the important alternatives.

The studies with pineapple cultivation, even when planted across the slope, resulted in soil loss to the tune of 24.0 – 62.6 t/ha/year during second year (Singh et. al., 1996). Some horticultural crops grown on hill slope gave extremely encouraging and economic return. Yield potential of newly planted Assam lemon (*Citrus* spp) orchard was found to be 11300, 12800 and 37200 fruits/ha during 3rd, 4th and 5th year after planting.

Agri–Horti–Silvipastoral Land Use System

This system comprises land use at the foothills with agricultural crops, horticulture in the mid portion of the hill slope and silvipastoral land use towards the top of the hill. Land up to 100 % slope having soil depth greater than 1.0 m can be used for agri-horti-silvi-pastoral system (Singh et. al., 2000). Contour bunds, bench terraces, half-moon terraces, grassed waterways and stilling basins are the conservation measures required for the treatment of land. An experiment was conducted by dividing watershed into three tier system viz., upper 1/3 area under pasture and silviculture for rearing livestock (goats and pigs), middle 1/3 area under horticulture including orange (*Citrus* spp.), guava (*Psidium guajava*) and pineapple (*Ananus comosus*) and remaining 1/3 lower area under agriculture for cultivation of cereals, pulses, vegetables, spices, fodder, etc. The middle portion of micro watershed of which 50 % area was put under orange, 25 % under guava and 25 % area was put under Assam lemon. The economic evaluation revealed that agri-horti-silvi-pastoral system with guava as horticulture component is viable system (Rao, 1991). Agri-horti-silvi-pastoral system with livestock, dairy farming and Agro-pastoral system recorded a input/output ratio of 1:2.14, 1:2.08 and 1:2.05 respectively and was recommended as an viable alternative to shifting cultivation in north east (Panwar et. al., 2007).

Multi-Storey Cropping Land Use System

This is highly productive, sustainable and very practicable system. To increase the cropping intensity multi-storey crop combination consisting of crop of varying canopy orientation and rooting have also been developed which entails differential harvesting of solar energy and recycling of nutrients of variable depth based on the principle of canopy dimension and rooting pattern. One crop combination is coconut (*Cocos nucifera*) + black pepper + pineapple. In such high intensity cropping programmes a higher efficiency in utilizing of solar energy in incident on a given area is obtained as it is intercepted at vertical intervals by the canopies of the crops (Singh and Singh, 1997).

Livestock-based Land Use System

For livestock-based land use system, the land up to 100 % slope with minimum 0.5 m soil depth can be utilized for livestock farming. Contour bunds, trenches and grassed waterways are minimum requirement of land treatment. Crops and cropping pattern of such land uses will differ depending on the type of enterprise. The fodder production system has to ensure stability of fertility status of soil, availing the opportunity of moisture supply towards maximum fodder production for larger period during the year and conservation of fodder

for lean season. Important grasses for the purpose are *Chrysopogon fulvus, Chloris gyana, Dichanthium annulatum, Panicum antidolate, Setaria anceps, Sehima nervosum*; legumes are *Atylosia scarabaeoides, Macroptilium atropurpureum, Slylosanthes gracilis, Glycine javanica* and important tree and shrub species are *Albizia chinensis, Albizia lebbek, Albizia procera, Artocarpus heterophyllus, Sesbania grandiflora, Sesbania sesban* for humid topics and for temperate and sub temperate areas, suitable trees and shrubs *atre Betula alboides, Celtis australis, Morus serrata, Robinia pseudoacacia* etc., and grasses and legumes are *Bromus inermis, Dactylis glomerata, Poa pratensis, lespedeza ceraces, Lupinus augustifolis, Trifolium incernatum, Trifolium prantensis, Trifolium incernatum, Trifolium response* (Singh and Srivastava, 1990). Selection of leguminous and non-leguminous annuals and perennials, shrubs and trees will depend on the type of enterprises. Carrying capacity of such high land use has been estimated to be 4 to 5 livestock/unit/ha with setaria and stylo (1:1) mixture of fodder production. This system has potential for substantial income (1:1.78) from the farmyard manure and self-sufficiency in fuel production through biogas plant. About 90 % of annual rainfall could be retained in the watershed and soil loss was restricted to 2 t/ha/year (Verma et. al., 2001).

A land use model for resource conservation in sloping land

A land use model (0.53 ha, 30-40% slope) involving natural forest, fodder crops, leguminous cover crops, intercropping of maize + legume, residue management, conservation tillage, micro rain water harvesting structure (5 x 4 x 1.5 m^3) etc. were implemented for climate resilient agriculture in hills. Hedge rows (*Tephrosia* sp.) in alternate terrace risers and toe tranches (25 cm x 15 cm) in the inner side of terraces were made for collecting run-off and increase infiltration. After harvest of *kharif* crops, the residues were retained on the surface and *toria*, French bean and lentil were grown under no-till (NT) with residual moisture. The cropping sequence followed beginning with the top to bottom hill slopes were natural pine forest with catch pits - fodder crops - cover crops - maize + legume intercropping - rice based system at the foot hills. The highest fodder and legume (cover crop) grain yields were recorded with guinea grass (91.5 t/ha) and groundnut (2.5 t/ha), respectively. Among different maize + legume intercropping systems, maize + groundnut system recorded the highest maize equivalent yield (5.6 t/ha). The rice crop under minimum tillage and NT recorded similar but higher yield than conventional tillage. Residue retention and NT resulted about 10% higher soil moisture stock in dry season frenchbean crop compared to residue removal and conventional tillage (CT). The productivity of succeeding French bean/rapeseed crop after legume/maize + legume intercropping system under NT and residue retention were significantly higher compared to farmer's practice of residue removal/CT. Among the different cropping systems, fodder crop based system recorded maximum soil organic carbon (1.80 %) and SOC stock (29.7 t/ha) followed by cover crop based system (1.61%, 26.8 t/ha) at the end of three cropping cycles in 0-15 cm soil depth. On an average, the above model enhanced SOC stock by 10% and reduced soil loss substantially over farmers' practice (Das *et al*., 2017).

Improved jhum rice cultivation – case study in Sonidan, Meghalaya

Five local rice varieties (Mannar, Kba Khasi, Kba Slu, Pnah Lai Spah, Pnahiong) and six improved varieties (Bhalum-1, Bhalum-2, Bhalum-3, Bhalum-4, RCM-5 and IURON-514) were evaluated under both local and improved management practices. Soybean and groundnut were grown as intercrops with rice. *Tephrosia* spp. were grown along the contour at suitable intervals for checking soil loss and improving soil fertility. Under farmer's practice, seeds were broadcasted in the sloping land after spading, no manure/fertilizer are being applied, no pesticide applied and there was no water management practices. However, under-improved practice seeds were sown in line across the slope at 25 cm spacing, 50% recommended dose of fertilizers (RDF) @30:30:20 kg N, P_2O_5, K_2O /ha were given. The full dose of P, K and 50% of N was applied at basal, whereas remaining 50% of N was applied in two equal splits at 30 and 60 days after sowing (DAS). Two manual weeding was done immediately before top dressing of N fertilizer. The N dose was applied as in the form of urea (46–0–0) while the P_2O_5 and 40 kg K_2O ha^{-1} were applied in the form of single super phosphate (SSP) (0–7.2–0) and muriate of potash (MOP) (0–0–50), respectively. Need based insect and disease management practices were followed. Under improved agronomic management practices, both local and high yielding rice varieties performed well. The highest rice yield was obtained under IURON 514 (3.084 t/ha) followed by Bhalum -3 (2.89 t/ha) and RCM -5 (2.88 t/ha). On an average, 68% and 116% yield enhancement was recorded with local and high yielding rice varieties, respectively, when grown under improved agronomic management practices as compared to farmers' practice (control).

Sowing in lines 25 cm apart across the slope in *jhum* land as well as dibbling resulted in significant enhancement in rice yield as compared to broadcasting. The highest yield of Mannar and IURON 514 was recorded with line sowing (2.42 and 2.97 t/ha, respectively) as compared to dibbling (2.05 and 2.34 t/ha) and broadcasting. Application of 50% recommended dose of nutrients (RDN) (30:30:20 kg N:P_2O_5: K_2O/ha) either through fertilizer or fertilizer + FYM both recorded 40 to 60% enhancement in rice yield in *jhum* field. Foliar spray of DAP twice at 30 and 60 days after sowing resulted in 20 to 35 % yield enhancement in rice across the varieties as compared to farmers' practice (no manure or fertilizer).

Integrated Approach for Improvement of Shifting Cultivation Areas

The comprehensive strategies for improving the system of shifting cultivation in North-Eastern Indian Himalayas was suggested by Ramakrishna (1992) and Munda et al. (2010) based on a multidisciplinary study. Many of these proposals have already been put into practice. These conclusions are very relevant to similar land use systems prevelant all over Asia, Africa and Latin America (Ramakrishna, 2000).

- The wide variations in cropping and yield patterns under *jhum* practiced by over a hundred tribes under diverse ecological situations should be continued, where transfer of technology from one tribe/area to another alone could improve the *jhum,* valley land and home garden ecosystems. For example, emphasis on potatoes at higher elevations

compared to rice at lower elevations has led to a manifold increase in economic yield despite low fertility of the strong acid soils at higher elevations.

- *jhum* cycle should be a minimum of ten years (this cycle length was found critical for sustainability when *jhum* was evaluated using money, energy, soil fertility biomass productivity, biodiversity and water quality as currencies) by greater emphasis on other land use system such as the traditional valley cultivation or home gardens.
- Where the *jhum* cycle length cannot be increased beyond the five-year period that is a great concern in the region, re-design and strengthen the agroforestry system incorporating ecological insights on tree architecture (e.g. the canopy form of trees should be compatible with crop species at ground level so as to permit sufficient light penetration and provide fast recycling of nutrients through fast leaf turnover rates. Local perceptions are extremely important in tree selection for introduction into the cropping and fallow phases of *jhum*, as can be seen in a major initiative in the state of Nagaland in north-east India.
- Improvement in nitrogen economy of *jhum* at the cropping and fallow phases by introducing nitrogen-fixing legumes and non-legumes. A species such as the Nepalese alder (*Alnus nepalensis*) is readily incorporated because it is based on the principal of adaptation o traditional knowledge to meet modern needs. Another such example is the lesser known food crop legume *Flemingia vestita*, traditionally used by tribes as an important species when *jhum* cycles decline below five years.
- Making use of some of the important bamboo species, highly valued by tribes, which can concentrate and conserve important nutrient elements such as N, P, and K. They could also be used as wind breaks to check wind-blown loss of ash and nutrient losses in water.
- Speeding up the fallow regeneration after *jhum* by introducing fast growing native shrubs and trees.
- Condensing the time-span of forest succession and acceleration restoration of degraded land based on an understanding of tree growth strategies and architecture, by adjusting the species mix in time and space.
- Improvement of animal husbandry through improved breeds of swine and poultry and training the tribal farmers about the improved animal husbandry developed by research institutes.

References

Ahlgren, I.F. and Ahlgren, C. E. 1965. Effect of prescribed burning on soil microorganisms in a Minnesota jack pine forest. Ecology. 46 : 304-310.

Anonymous, 1987. Basic statistics for North Eastern Region (Shillong – North Eastern Council), India.

Anonymous, 1997. State of Forest Report , Forest Survey of India, Dehradun.

Awasthi, R.P. 1984. Farming system reseaech. Annual report. ICAR Research complex for NEH Region, Umiam-793 103, Meghalaya.

Boerner E.J. 1982. Fire and nutrient cycling in temperate ecosystems. Bioscience. 32 : 187-192.

Borthakur, D. N. 1992. Agriculture of the North Eastern Region with special Reference to Hill Agriculture. Beecee Prakashan, Guwahati.

Christanty, L. 1986. Traditional Agriculture in South East Asia. West View Press. Boulder PP. 240.

Das, A., Ghosh, P.K., Lal, R., Saha, R. and Ngachan, S.V. 2014. Soil Quality Effect of Conservation Practices in Maize–Rapeseed Cropping System in Eastern Himalayas. Land Degrad. Develop. DOI: 10.1002/ldr.2325.

Das, A., Mohapatra, K.P. and Ngachan, S.V. 2017. Conservation Agriculture for Restoration of Degraded Land and Advancing Food Security. In:Conservation Agriculture for Advancing Food Security in Changing Climate Vol. 1, Anup Das, KP Mohapatra, SV Ngachan, AS Panwar, DJ Rajkhowa, Ramkrushna GI and Jayanta Layek (Editors :), Today & Tomorrow's Printers and Publishers, New Delhi - 110 002, India 1-35.

Das, A., Patel, D.P., Lal, R., Kumar Manoj, Ramkrushna, G.I., Layek, J., Buragohain, J., Ngachan, S.V., Ghosh, P.K., Choudhury, B.U., Mohapatra, K.P. and Shivakumar, B.G. 2016. Impact of Fodder Grasses and Organic Amendments on Productivity and Soil and Crop Quality in a Subtropical Region of Eastern Himalayas, India. *Agriculture, Ecosystem and Environment*, (216): 274-282.

Ghosh, P.K., Das, Anup., Ngachan S.V., Saha, R., Munda, G.C., Patel, D.P., Lama, T.D. and Singh, R.K. 2009. In-situ soil moisture and nutrient conservation in North Eastern hill agriculture. Technical bulletin no. 68. ICAR Research Complex for NEH Region, Shillong Pp.50.

Haokip, D.D. 2003. Shifting cultivation in Manipur: Problems and Prospects. In: Proc. Approaches for increasing agricultural productivity in hill and mountain ecosystem. (Eds. B.P. Bhatt, K.M. Bujarbaruah, Y.P. Sharma and Patiram,pp.332.) ICAR Research Complex for NEH Region, Umiam, Meghalaya.pp.331-335

Mahapatra, L. K. 1983. Ethnic groups and swidden cultivation. Shifting Cultivation in Asia (ed.book) Vol.1. UNESCO, Bangkok.

Maikhuri, R.K. and Ramakrishnan, P. S. 1991. Comparative analysis of the village ecosystem function of different tribes living in the same area in Arunachal Pradesh in North-Eastern India. Agric. Systems. 35 : 377-399.

Mishra, B.K. and Ramakrishnan, P. S.1981. The economic yield and energy efficiency of hill agro-ecosystem at higher elevations of Meghalaya in Northeastern India. Acta Oecol./Oecol.Applic.2:1369-1389.

Munda, G.C., Ngachan, S.V., Das, Anup., Satapaty K.K., Biswas, S and Malngiang, S. 2010. Livelihood improvement through farming systems and subsidiary activities in disadvantaged districts of North East India. *NAIP bulletin no. 1*. pp 46.

Munda. G.C., Ghosh, P.K and Prasad, R. N. 1996. Adopt alternative land-use systems to shifting cultivation. Indian Farming. April: 10-14.

Munna, Ram and Singh, B.P. 1993. Soil fertility management in farming systems. Lectures notes, off campus training on farming system. Aizawl, Mizoram, 5-7 October, PP. 46-50.

Panwar, A.S., Ngachan, S.V., Munda, G.C., Das, Anup and Satapathy. K.K. 2007. Agro-pastoral based farming system: a viable alternative to shifting cultivation in North East India. Third National Symposium on Integrated Farming Systems and its role towards Livelihood Improvement. Organized by Farming System Research and Development Association (PDCSR), Modipuram at ARS, Durgapura, Rajasthan, 26-28 October, pp.41-41.

Ramakrishna. P.S. 2000. An integrated approach to land use management for conserving agroecosystem biodiversity in the context of global change. International Journal of Agricultural Resources, Governance and Ecology. 1(1): 56-67.

Ramakrishnan P.S.1992. Shifting Agriculture and Sustainable Development; An Interdisciplinary study from Nortyh-Estern India UNESCO-MAB Series.Paris.Parthenon Publ., Carnforth.Lanes (Republished by Oxford University Press.New Delhi.1993).

Ramakrishnan, P.S and Toky, O.P.1981. Soil nutrient status of hill agro-ecosystems and recovery pattern after slash and burn agriculture (*jhum*) in north-eastern India. Plant and Soil. 60 : 41-64.

Rao, N.V. 1991. Ecopnomic aspects. Annual report. ICAR Research Complex for NEH Region, Umiam-793 103, Meghalaya.

Rappaport, R. A. 1971.The flow of energy in an agricultural society. Sci. Am. 225: 117-132.

Sharma, U.C. 1998. Methods of selecting suitable land use system with reference to shifting cultivation in NEH region. Indian Journal of Soil Conservation. 26 (3): 234-238.

Singh, A. and Singh, M. D. 1978. Effect of various stages of shifting cultivation on soil erosion from steep hill slopes. Indian Forester, 106 (2) : 115-121.

Singh, A. and Singh, M.D. 1981. Soil erosion hazards in North Eastern Hill Region. Research Bulletin No. 10. ICAR Research Complex for NEH Region, Umiam, Meghalaya, India.

Singh, A.K. and Singh, S.K. 1997.Orchard management of fruit crops. Farmer and parliament. 35 (9) : 9-24.

Singh, N.P., Singh, A.K. and Patel, D.P. 2000. Shifting cultivation and its alternate approaches towards sustainable development in North East India. Journal of North Eastern Council, 20 (2): 24-30.

Singh, N.P., Singh, O.P. and Jamir, N.S. 1996. Sustainable agriculture development strategy for North Eastern Hill Region of India. In Shukla, S. P. and Sharma, N. (eds) Pub. Mittal Publication, New Delhi. PP 346-351.

Singh, Punjab and Srivastava, A.K. 1990. Forage production technology. Pub. Director IGFRI, Jhansi, Uttar Pradesh ,India . pp. 24-30.

Smith, W. H., Bormann, F. H. and Likens, G. E. 1968. Response of chemoautrophic nitrifiers to forest cutting. Soil Science. 106: 471-473.

Steinhard, J.S and Steinhard,C.E.1974.Energy use in US food system. Science. 184 : 307-316.

Toky, O.P. and Ramakrishnan, P. S. 1982. A comparative study of the energy budget of hill agro – ecosystems with emphasis on the slash and burn system (Jhum) at lower elevations of North Eastern India. Agric. Systems. 9 : 143-154.

Verma, N.D., Satapathy, K. K., Singh, R. K., Singh, J.L. and Dutta, K.K.2001. Shifting cultivation and alternative farming systems.. In: Steps towards modernization of agriculture in NEH Region. Eds. N.D.Verma and B.P.Bhatt. ICAR Research complex for NEH Region, Umiam, Meghalaya, India. PP. 345-364

SHIFTING CULTIVATION SYSTEM IN MIZORAM – STATUS, DETERMINANTS AND STRATEGIES FOR VIABILITY AND SUSTAINABILITY

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Introduction

Mizoram state is one amongst the eight sister states of NEI. A landlocked state, Mizoram is extended between 21o 58' - 24o 35' N and 92o 15' - 93 o 29' E. It covers an area of 21087 km2. According to the Census of India 2011, total population of Mizoram was 1,091,014. Literacy rate was noticed 91.85%. Sex ratio was registered 975 and density of population was 52. Average altitude of the state is 1000 m. Blue Mountain is the highest point (2065 m). There are eight districts and 26 administrative blocks in the state. The term 'Mizoram' refers to the land of the highlanders. The mountainous part of it is nomenclature as 'the rolling hills'. Here, economy is based upon the production of biomass based agriculture. The state is economically backward region. Its economy is mainly dependent on the traditionally cultivating cereal crops. About 80% people are engaged in agricultural practices. Rice is the main food-grain. The total consumption of rice in Mizoram is 1,80,000 MT whereas, it produces only 44,950 MT rice (25%).

Under the traditional agriculture, shifting cultivation is dominant mainly in the highlands. Wet rice is grown in the lowlands and the valleys. Further, most of the agricultural practices are carried out through shifting cultivation. It is characterized by the dominance of subsistence crops. Crops are mostly grown during the monsoon season on the gentle to steep slopes without terracing of fields. Vegetables and fruits are also grown and consumed domestically. Commercial uses of these crops are largely negligible. Shifting cultivation has a tremendous impact on the socio-economy and on the environment. Being as a main source of livelihoods of the poor rural people, it has negative impacts on the environment. It is mainly due to clearing and burning of forests.

Status of Jhum cultivation

Out of the total geographical area (21087 km2), 75.6% area is forest cover. Total cropped area is 5.5%. Net sown area is registered only 4.9%. Irrigated area is 0.5%. Area under horticulture is 1.9%. Fallow land other than current fallow is 8.1% whereas current fallows (*Jhum* land) is 1.9% only. Land not available for cultivation is 6.6%. Land under miscellaneous tree-crops (not included in net sown area) is 2.5%. Cultivable waste land is 0.5%.During the past decades, 58.1% area under shifting cultivation in Mizoram has been decreased (from 68,114 ha in 1997-98 to 28,562 ha in 2010-11). Meanwhile, the area under wet rice cultivation has been increased by 28.4% (from 9,446 ha to 12,130 ha) in 2010-2011. The share of shifting cultivation in net sown area was calculated about 38.64 % during the recent past.

Table 1. The area utilized for *Jhum* during last 10 years

Year	Area under *Jhum* in Ha	Changes in %
1997	68,114	- -
1998	68,392	0.4
1999	36,285	-53
2000	35,798	-47.4
2001	40,305	-40.8
2002	41,356	-39.3
2003	43,447	-36.2
2004	40,969	-39.9
2005	40,100	-41.1
2006	41,465	-39.1
2010	28,562	-58.1

Source: Statistical Hand Book of Mizoram, 2012

Characteristic of jhum cultivation

The marginal farmers generally clear vegetation for agriculture during January and February. The slash dries on the hill slopes and is burned during March-April. Prior to the onset of pre-monsoon rain, sowing operations are carried out. Generally, each family inter-crops 15-20 crop species in a plot of 1-4 ha in area (Raman, 2001b).The fallow cycle under shifting cultivation has been decreased from 20-25 year to 2-3 years. It is now more intensive and frequent. Therefore, it has put excessive burden on the land thus, soil fertility has been reduced. As a result, the production and per ha yields of cereal crops and vegetables have been decreased considerably. In Mizoram, the economic life of the people has always been centered on shifting cultivation. It is their way of life. The crops grown are mixed. The principal crop is paddy. Others are maize, cucumber, beans, arum, ginger mustard, sesame and cotton. Some pulses like cowpea, rice beans and French beans are cultivated under shifting cultivation.

Impact of shifting cultivation on natural resources

There are two schools of thought, advocating about the impact of shifting cultivation on socio-economy and on the environment. The scholars of the first school advocate that shifting cultivation is a wasteful method that degrades natural landscape through soil erosion and depletion of forests. According to the Government of India's report of 1995, 'shifting cultivation is a major cause of land degradation that has constantly declined the agricultural productivity and thus income of the farmers. Whereas, the other scholars believe that it is a major source of livelihood of the people and a way of life to them. However, scientific studies have been consistent, suggesting that there is sub-optimal utilization of natural resources in the shifting cultivation regime, which is helpful for the stability and sustainability of agriculture in the mountains (Ramakrishna, 1993; Sharma, 1992). It becomes an imperative that controlling shifting cultivation will not only improve the ecological quality but also will enhance crop productivity.

Mizoram enjoys with rich biodiversity. It is one amongst the mega biodiversity hotspots of the world. Natural vegetation comprises of tropical evergreen in the lower altitudes and semi-evergreen on the upper slopes (Champion & Seth, 1968). The average annual rainfall is 2150 mm. It occurs mostly between June and September by the southwest monsoon. The winter (Oct-Jan) is a cool dry season with few rainy days. Summer (March-May) is largely hot and dry with occasional thundershowers and pre-monsoon rains in April-May. Temperature accedes to 32^{o}C during April and May and after occurrence of monsoon rain, temperature recedes slowly. During winter, average temperature remains 9^{o}C. The implication of shifting cultivation on the ecology has long been a serious concern for the agriculture scientists, scholars, economists and anthropologist.

Deforestation caused by shifting cultivation is often viewed as one of the most important environmental problems of Southeast Asia (FAO, 1995). In Mizoram, the studies on ecological impact of shifting cultivation have also been carried out by Tawnenga (1990), Tawnenga & Tripathi (1996) and Tawnenga *et al.,* (1997). Clearing forests for shifting cultivation can contribute to climate change, biodiversity loss, reduced timber supply, flooding, siltation, soil degradation and change of forest vegetation from primary to secondary and eventually to grassland (Holden, 2001). Clearing of forests and burning them for shifting cultivation are the main reason of deforestation (Monela and Abdallah, 2007; Zahabu, 2008).

The loss of vegetation cover increases the incidence of soil erosion. Mostly in the hilly areas, soils are the most susceptible to erosion (Shoaib *et al.*, 1998; Sfeir- Younis and Dragun, 1993). In Mizoram, the cycle of shifting cultivation has been reduced from 20-30 years to 3-4 years. It has accentuated soil erosion and loss of nutrients from top soil. About 16.84 metric ton of soil/ha has been lost/year. It is therefore, the fertility of soil has been reduced. This has resulted in low production and per ha yields of cereal crops from the shifting cultivation.

In Mizoram, 1.5 % of total area is being affected by shifting cultivation, annually (Maithani, 2005b) that costs about Rs. 1 billion forest resources loss (Lalkhana, 1985). The adverse effects of shifting cultivation on the environment are well established scientific facts. Biologist, foresters and conservationists have noticed the effects of shifting cultivation on biodiversity in the tropical forests (Raman, 2000). FAO (1957) reveals that shifting cultivation was identified long time ago as a threat to tropical forests. Many scholars believe that shifting cultivation effects are very destructive (Rao & Hajra, 1986; Lal & Prajapathi, 1990; Tiwari, 1991; Dwivedi, 1993). These conclusions are based on the scientific data and experiments conducted world-wide (FAO, 1984; Tawnenga *et al.,* 1997). Air pollution due to lashing and burning, loss of fauna and flora and other ecological implications are very common in the areas where shifting cultivation is practiced.

Determinants of shifting cultivation

Review of literature on shifting cultivation indicates that lack of viable employment and income earning opportunities were mostly responsible for the continuation of *jhum* cultivation. Lack of infrastructure, particularly irrigation, road, communication, market and rural electrification

were other important factors. Inadequate government support and lack of suitable lands for settled cultivation were also found to be major problems. Settled cultivation required higher initial investment both in terms of money for purchasing land from the chief, hiring of labour and other inputs. On the other hand, most of the *jhum*ias were in the grip of poverty. Thus, inadequacy of capital to invest in land improvement and generate other infrastructure on farm came out to be the fifth most important factor. Lack of institutional support and credit in the study area rather worsened the conditions of the *jhum*ias, thus compelling them to attach to the traditional *jhum*ing system. There is no institution or agency involved in conducting research in finding out viable alternatives to *jhum*ing or improvement of the present system through crop improvement, soil conservation, horticultural development, and agroforestry, etc. The agricultural research in the region had given more attention to valley based system of cultivation, keeping *jhum* cultivation in the embryonic stage of agricultural development. Similarly, most of the training and extension programmes were oriented towards valley agriculture and thus, did not cater to the needs of the *jhum*ias.

INITIATIVES AND STRATEGIES FOR CONTROLLING SHIFTING CULTIVATION

1) The National Mission on Greening India has proposed different activities for rehabilitation of shifting cultivation areas (MoEF, 2010). The major rehabilitation activities are: (1) providing employment opportunities and income generation to the marginal farmers who are engaged in shifting cultivation. These opportunities can be provided through the proper utilization of land resources to control on shifting cultivation. Various schemes of the Government under the tribal plan will have to pump in sufficient resources for proper reclamation and development of the wasteland. Agro-forestry practices can assist them. It helps to increase food and fodder, and protects the existing forest where unemployed and poor people earn their livelihoods (Elevitch and Wilkinson, 2000).

2) Prompt efforts should be made to involve the community people in carrying out forest-based activities. It should be made commercially viable by providing proper marketing facilities. This activity will reduce pressure on shifting cultivation practices. It will also enhance the opportunity to community people to involve in non-timber based forest products.

3) Degraded forestland should be protected and developed through formation of the village forest committees. These committees can divert the farmers from shifting cultivation. Suitable incentives should be provided to them at the time of harvesting.

4) The mountain eco-systems of NEI with shifting cultivation practices should be made ecologically sound. Shifting cultivation can partially be replaced to farm forestry through formulating an eco-development plan for ecological sustainability.

5) Land resource management will make shifting cultivation sustainable. Further, improve sustainable yields, changes in technology, innovative policy and better transportation facilities will all together contribute sustainability of shifting cultivation.

6) The forests in surrounding of a hill village are considered as 'support area'. Forest provides firewood, fodder, timber, water and animal bedding to the farmers. The marginal farmers are mainly dependent on forest resources. They do not want to move from their natural habitat.

7) Specific policies, keeping specificities of mountain niche in view, should be framed and implemented to avoid any discrepancies in practicing shifting cultivation.

8) Terracing fields, promoting cultivation of vegetables, fruits and high value crops, and proper use of timber and non-timber forest products may substantially contribute to sustainable practices of shifting cultivation.

Success Stories

State Government Initiatives

NLUP (New Land Use Policy) is a flagship programme of the Government of Mizoram that was started on the 15th of July 2010 with a budget of Rs.2873.13 crores.. The project being a multipurpose, multi-disciplinary and multi-pronged strategy aims in reducing the number of population depending on jhum cultivation. The overall economic impact on the Agriculture Sector as a result of the Implementation of New Land Use Policy (NLUP) can be briefly summarized as below: -

1) Expansion of rice cultivation areas: During the year 2010-2011 (initial stage of NLUP implementation), the total area under Rice cultivation (WRC) was12130 hectare which covers only 16.25% of the total Rice cultivation potential areas. The contribution of NLUP in terms of expansion of Rice cultivation areas is about 1840.66 hectare out of the total rice cultivation areas of 16170 hectare during 2013-2014 (whole of Mizoram) which accounts for about 11.38% increase in Rice cultivation areas.

2) Increase in Rice Production: At the initial stage of the implementation of NLUP (2010-2011), the total rice production in Mizoram was 47201 metric tones which increased to 58994 metric tones in 2013-14. Out of the total rice production in Mizoram i.e., 58994 metric tones (2013-2014), NLUP beneficiaries contributed 5317.10 metric tones of rice and the total percentage of the contribution of NLUP towards the total rice production in Mizoram state may be recorded as 9% increase from the 1st phase of implementation alone.

3) Decrease in Jhum Areas: One of the primary objectives of NLUP is to provide sustainable income to farming families by weaning away the destructive and unprofitable shifting cultivation practices. The total Jhum area and the total number of Jhumia families in Mizoram during 2010-11 are 28562 hectare and 68433 nos. respectively. As a result of the implementation of NLUP, the total Jhum area as recorded during 2013-2014 is 22633 hectare which shows that the decrease in Jhum area for the last 4 (four) years is 5929 hectare which accunts for about 20.75 % decrease in Jhum areas. Similarly, the total number of Jhumia families also decreased from 68433 nos. during 2010-2011 to that of

58751 nos. during 2012-2013 which accounts for about 14% decrease during the last 4(four) years.

4) Expansion in Oil Palm cultivation areas: Out of the total geographical area of Mizoram i.e, 21, 08,700 hectare, the total potential area for Oilpalm cultivation is recorded as 1, 01,000 hectare (as recommended by Chadha Committee and Rathinam Committee). During the year 2010-2011, the total Oil palm cultivation area in Mizoram was only 1878 hectare which constitutes only about 1.8% of the total Oil palm potential areas. During the year 2013-2014, the total area covered under Oil palm in Mizoram is 17588 hectare. Under NLUP, the total number of Oil palm beneficiaries till date is 2290 nos. and the total area covered under Oil palm is recorded as 2750 hectare. It may be concluded that out of the total area covered under Oil palm in Mizoram i.e, 17588 hectare, the contribution of Oil palm beneficiaries is about 2750 hectare which accounts for about 15.60% since the inception of NLUP.

5) Improvement in Farm Mechanization Programme: Due to convergence of RKVY & MMA with NLUP, a large number of Farm Machineries like Power Tillers, Mini Power Tillers were distributed at subsidized rates which increase the availability of man power thus boosting up rice production and productivity.

6) Construction of Potential Area Connectivity: Due to the convergence of NLUP with RKVY Scheme, at present the total length of Potential Area Connectivity (PAC) already constructed is 625 km. This will also greatly result in increase in the production of rice and other crops in one way or the other.

ICAR Initiatives

Large scale FLD on maize was organized in eight districts of Mizoram covering an area of 534.50 ha under TSP and NICRA programme in collaboration with KVKs and District Agriculture Offices of the respective districts. With these interventions, productivity of jhum field increased from 1.5 ton/ha (maize equivalent yield) to 4.6 ton/ha and their net income increased from Rs.30,400/ha to Rs. 90,000/ha by selling of maize seed.

Experiencing the grand success, the Centre has strongly recommended to the Government of Mizoram to include HQPM maize in jhum improvement programme. Accordingly, the Agriculture Department, Government of Mizoram is taking active role in propagating the HQPM maize in jhum areas of the state through RKVY and NLUP scheme and every year about 1500 ha area was brought under the variety. Three Multipurpose Feed Mills have also been established in Theiva, New Saiha – II and Lunglei under the NAIP project during March 2014 at the cost of Rs. 10 lakh each to meet the challenges of assured market by converting excess farm produce into quality feeds for animals.

During 2012-2015, ICAR Research Complex for NEH Region, Mizoram Centre has adopted 5cluster villages, viz. Theiva, Baulpuii NG, Km Sawm and Niawhtlang-I & II in Saiha district under NAIP Component III. Under this project, the centre has introduced soybean variety JS-388 after the harvest of first crop of maize i.e. in the first week of August in jhum fields to

increase the cropping intensity and improve the livelihood of Jhumias. Critical inputs such as quality seed, fertilizers, plant protection chemicals, etc. were provided for cultivation of soybean in an area of 50 hectare involving 100 households. The average seed rate per ha was 70-75 kg/ha and planted on jhum field with spacing of 45 cm x 10 cm. An average yield of 1.48 t/ha was obtained from the harvest crop. So, by introducing soybean as 2nd crop could earn an additional net income of Rs. 50,000 per ha with a benefit cost ratio of 2.98:1. Realizing the success of the soybean as second crop after maize, the Government of Mizoram has taken a strong initiative for popularization of the crop in more than 1000 ha area during the year 2016-17 under the New Economic Development Programme. Initiatives in post harvest and value addition also being taken up to filled up the gap between the supply and demand.

Demonstration of Sweet Charlie variety was conducted in Km Sawm village, Saiha district under NAIP project during August-September 2012-2014. Ten progressive farmers were selected based on the suitability of resources. An area of 1000 sq.m was selected for each farmer. After clearing of land, terraces of 1-1.5 meter width of convenient length were made manually. Ridges were opened with 10-15 cm height from the base of the furrows. Due to inherent acidity of the soil, liming at 4.5 t/ha was made before laying out of mulch polythene. Black polythene rolls of 1m width were laid out in terraces which covered both the ridges and furrows. Planting were done in ridges. Excess water of monsoon and water from natural streams was collected in Jalkunds for irrigation in winter. Jalkund (40,000 liter capacity) excavation in selected sites was completed before the onset of monsoon. Farmers used vermin culture and organic manure through low cost vermin composting unit, which sustained soil productivity. On an average each farmer is getting 1750 kg of strawberry and earning a net income of Rs. 1.61 lakhs per annum. After realising the success of beneficiary farmers, 105 terrace farmers in the area got motivated and have diverted to strawberry cultivation in small scale. The benefit cost ratio was estimated to be 2.59. At present the village is declared as strawberry village by the Government of Mizoram.

CONCLUSIONS

Shifting cultivation is not only the major source of livelihoods; it is a way of the life. Socioeconomic development of the people, those are engaged in the shifting cultivation and living in the highlands, are fully dependent on its practices to carry their livelihoods although, per ha yield from shifting cultivation crops is not sufficient.

The high growth of population, particularly in the areas where shifting cultivation is practiced, has put tremendous pressures on land. The extension of cropped land on the marginal mountain niche for increasing food production has also reduced the forest and grassland areas. Further, high soil and land degradation was due to high intensity and frequency of shifting cultivation.

Among the various determinants of shifting cultivation, economic factors were most dominating. Thus, diversification towards allied activities particularly dairy, piggery,

agroforestry and agro-based industries, etc. would provide regular employment and income to the jhumias and also, reduce human pressure on jhum cultivation. Efforts to popularise the adoption of various IFS models including high value crops particularly ginger and soybean would help the jhumia to improve their earnings and way of living.

References

Agalawtte MB and Abeygunawardena P (1994) Conservation farming as an alternative to shifting cultivation in Sri Lanka: An economic evaluation. Journal of Sustainable Agriculture 4(2):65-79.

Altieri M and Anderson K (1986) An ecological basis for the development of alternative agricultural systems for small farmers in the Third World. American Journal of Alternative Agriculture 1(1):30-38.

Anon (1992) Agro-climatic planning for agricultural development in Meghalaya. Working Group, Zonal Planning Team, Eastern Himalayan Region, AAU, Jorhat.

Ahsan E and Begum S (1992) Problems of sustainable agriculture: Shifting cultivation in the hills of Bangladesh. Annals of Bangladesh Agriculture 2(1):1-12.

NEC (1994) Basic Statistics of North-East India. Publication Unit, NEC Secretariat, Shillong, 220pp.

EI Moursi AWA (1984) The role of higher agricultural education in the improvement of shifting cultivation systems in Africa. In: Bunting AH and Bunting E, eds,The Future of Shifting Cultivation in Africa and the Task of Universities, pp 8-14. FAO, Rome.

Christanty L (1986) Traditional Agriculture in Southeast Asia. Westview Press, Boulder, 240pp.

Ganguli BN (1979) Integrated research on shifting cultivation in Arunachal Pradesh. Indian Journal of Agricultural Economics 4(1):55-58.

Gupta T and Sambrani S (1978) Control of shifting cultivation : The need for an integrated approach and systematic appraisal. Indian Journal of Agricultural Economics 33 (4): 1-8.

Indian Council of Agricultural Research (1983) Shifting Cultivation in North East India. Publication Unit, ICAR, New Delhi, 68 pp.

Keck A, Sharma NP and Feder G (1994) Population growth, shifting cultivation and unsustainable agriculture development: A case study in Madagascar. World Bank Discussion Paper 234, Washington DC.

Naresh Chandra and Singh RP (1992) determinants and impact of new technology adoption on tribal agriculture in Bihar. Indian Journal of Agricultural Economics 47(3):397-403.

Ramakrishnan PS (1992) Shifting Agriculture and Sustainable Development. Man and Biosphere Series, UNESCO, Paris, 424 pp.

Roy Burman BK and Sharma PS (1970) Tribal agriculture in India. Indian Journal of Agricultural Economics 25(3): 149-160.

Pezzey J (1989) Economic analysis of sustainable growth and development Environment Department Working Paper 15, World Bank, Washington DC.

Sain K (1978) Economic analysis of shifting cultivation. Indian Journal of Agricultural Economics 3(34): 8-13.

Sachchidananda (1989) Shifting Cultivation in India. Concept Publishing Company, New Delhi, 256pp.

Sukhatme BV and Koshal RS (1959) A contribution to double sampling. Journal of Indian Society of Agricultural Statistics 11:128-144.

Sukhatme PV, Sukhatme BV, Sukhatme S And Ashok C (1984) Sampling Theory of Surveys with Application. Iowa State University Press, Iowa, 520 pp.

Tisdell C (1988) Sustainable development: differing perspectives of ecologists and developed countries. World Development 16(3):12-15.

Toky OP and Ramakrishnan PS (1981) Cropping and yields in agricultural systems of the north-eastern hill region of India. Agro-Ecosystems 2:127-132.

Torquebiau E (1992) Are tropical agroforestry home gardens sustainable?. Agriculture Ecosystems Environment 41:189-207.

Zarzolien (1987) Religious beliefs and practices among the Hmars through the ages. Ph.D Thesis(unpublished), Department of History, Manipur University, Canchipur.

CHALLENGES, SCOPE, AND OPPORTUNITIES OF *JHUM* REJUVENATION IN NAGALAND

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Shifting cultivation has disappeared from many other areas of the world. On a global scale, however, the system still constitutes the basis for the livelihood of an estimated 300-500 million people in Central Africa, South America, Oceania, and Southeast Asia, and is practised on about 30% of all arable land but providing food to only 8% of the world population. The system is locally called, *Bukma* in Nepal, *Taungya* in Myanmar (Burma), *Kaingin* and *Lading* in the Philippines and *Jhum i*n India and Bangladesh. It may be emphasised that shifting cultivation systems have been much more than a way to manage soil fertility and agricultural productivity. They were also an essential feature of the expansion of the peoples and provided an important mechanism for establishing tenurial rights over vast expanses of land. 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 were 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 whole pattern of land use in various parts of the world where shifting cultivation is practiced derives from this historical legacy.

In India, shifting cultivation has been trapped in a low-level and unstable equilibrium owing to two equally unviable paradigms that operate at the policy and institutional levels. The dominant perspective is that shifting cultivation is a wasteful and ecologically dysfunctional system, detrimental to forests and soil, and hence needs to be eradicated by inducing cultivators to adopt other forms of livelihood. The other paradigm, which has come into play more dominantly in the recent period, is that shifting cultivation is a legitimate practice that ensures the survival of people living on marginal lands and hence should be allowed to carry on as it is without external influence.

Jhum (Shifting) cultivation is a primitive practice of cultivation in the States of North Eastern Hill Region of India occupying more than 80% (0.76 m ha) of land out of 0.94 mha of *jhum* land in India (Anon., 2011). People involved in such cultivation are called *Jhumia*. The practice involves clearing vegetative/forest cover on land/slopes of hills, drying and burning it before onset of monsoon and cropping on it thereafter. After harvest, this land is left fallow and vegetative regeneration is allowed on it till the plot becomes reusable for same purpose in a cycle. Meanwhile, the process is repeated in a new plot designated for *jhum* cultivation during next year. Initially, when *jhum* cycle was long and ranged from 20 to 30 years, the process worked well. However, with increase in human population and increasing pressure on land, *jhum* cycle reduced progressively (4-5 years) causing problem of land degradation and threat to ecology of the region at large (Ramakrishnan, 1985; Singh and

Bag, 2002). At the same time, shrinkage resources like arable land, water and energy, there is a dire need to design and develop new methods and cropping pattern of crop production to meet the increasing demand for food, feed and forage through effective utilization of *jhum* lands. The state is 33% deficit in food grain production (Anon., 2014). Small *Jumias* are unable to address their diversified domestic needs to sustain normal livings from their limited land, water and economic resources. This necessitates going for appropriate alternative and more efficient production systems such as strip cropping of cereals with legumes which can ensure proper utilization of resources to obtain increased production per unit area and time on a sustainable basis (Abdul Jabbar et al, 2010).

1. Land use pattern for *Jhum* cultivation in Nagaland

Shifting Cultivation (*Jhum*) is a way of life and is to stay in Nagaland. The tremendous diversity and combination of *Jhum* practices followed by different tribes and sub-tribes in state, addressing *Jhum* continues to remain a bigger challenge for policy makers and natural resource managers. Owing to the emerging Action Plan for Climate Change that discusses paradigms on *Jhum* at the national level that argues for its continuance based on considerations of food security and socio-cultural institutions embedded with it, as opposed to the dominant discourse that considers *Jhum* extremely detrimental to ecology, the shift in the *Jhum* at the national policy level are observed. As many as 1.9 lakh families in Nagaland practiced *jhum* cultivation bringing 94380 ha under this method of cultivation annually.

The continuance of *jhum* in the state is closely linked to ecological, socio-economic, 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. In this approach , we take a close look at *jhum* cultivation from the point of view of ecological sustainability and tribal livelihoods, examine the role of agro-forestry, sericulture and horticulture as alternatives/supplementary activities and review the current thinking on methods to upgrade and develop *jhum*.

1.1: *Jhum* lands in NEH Region of India

States	Current *Jhum* (Sq.Km)			Abandoned *Jhum* (Sq.Km)		
	2005-6	2008-9	Change	2005-6	2008-9	Change
Ar. Pradesh	1025.07	961.04	-64.02	506.39	1078.52	572.13
Assam	160.15	258.86	98.71	79.41	136.33	56.92
Manipur	752.10	270.31	-481.79	100.10	201.32	101.22
Meghalaya	291.87	272.52	-19.35	157.12	268.11	110.99
Mizoram	1028.53	612.71	-415.82	1589.03	1049.37	-539.66
Nagaland	1239.09	1514.95	275.86	1588.65	842.47	-746.18
Tripura	89.28	33.20	-56.08	164.83	68.99	-95.84
N.E. R	4586.09	3923.59	-662.49	4185.53	3645.11	-540.42

Source: Wastelands atlas of India, 2011

1.2 : *Jhum* lands in Nagaland

S.N.	Districts	Area (ha) under *jhum (Aprox.)*
1	Kohima	5400
2	Phek	1800
3	Mokokchung	9630
4	Tuensang	10440
5	Mon	16260
6	Dimapur	9410
7	Wokha	10470
8	Zunheboto	9530
9	Paren	6650
10	Kiphire	8730
11	Longleng	6060
Total	**Nagaland**	**94380**

Source : Statistical Handbook of Nagaland

1.3. District wise major crops in *jhum* land

1. **Zunheboto :** Maize is the major cereal crop in Zunheboto District a good numbers of with mixed cropping of some cereals like paddy, Foxtail Millet and Jobstear, Soybean, Sesamum, Chilli, Pulses, Oil Seeds and types of Vegetables.
2. **Wokha:** Paddy is dominant crop and practice dibbling method sowing, with mixed cropping of Colocasia, Cucurbits, Soybean, Millet, Chilli, Sesamum is practiced.
3. **Tuensang:** Massive sole crop of Maize. After the harvest of Maize cobs Kholar is sown taking the stalk of Maize as the staking.
4. **Mon:** Colocosia is dominant crop along with Paddy and Maize, Millet is grown widely followed by sowing of Soybean after the harvest of Millet.
5. **Kiphire:** Maize is the dominant crop and Kholar is taken as a second crop using Maize as staking.
6. **Mokokchung:** Paddy is dominant crop in Jhum field mixed with Vegetables and Cucurbits and root crop etc.
7. **Longleng:** Massive Jhuming with Maize and Paddy mixed with Colocosia.
8. **Kohima: J**huming is practiced in Tseminyu Sub Division taking Paddy as the major Crop.
9. Scattered of jhuming is done in Dimapur, Kohima, Phek and Peren districts in some pockets.

1.4: Existing crops management practices and yield for individual growing crops in *jhum*

Crops	Growing period	Cultivars used	Seed rate (kg/ha)	Sowing method (s)	Weed management	Crop yield (kg/ha)
Paddy	March-Sep	Local	75	Broadcasting	Salt application with four hand weeding	1,907.6
Maize	March-July	Local	40	Dibbling	Two hand weeding	1,953.8

Beans	March-June	Local (pole type)	70	Dibbling	Two hand weeding	8,166.7
Colocasia	March-Dec	Nagaland local	1,200	Line sowing on contours	Three hand weeding	12,000
Ginger	March-Jan	Nadia/Local	2,500	Line sowing on contours	Four hand weeding	7,500
Soybean	April-July	Local	40	Dibbling	Two hand weeding	1,220
Ricebean	March-Aug	Local	20	Dibbling	Three hand weeding	1,095
Cucumber	March-June	Mokukchung local	1.5	Dibbling	Two hand weeding	
Tapioca	May-Jan	Local	1,500	Dibbling	Two weeding	8,181
Chilli	April-Oct	Local	0.5	Transplanting	Four hand weeding	7,500

1.5: Availability of food from *jhum* land in Nagaland

January/ February	Chillies (*Capsicum ssp*), brinjal (*Solanum melongena*), pumpkin (*Cucurbita moschata*), turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), root crops, shoots, leaves and ferns from old *jhum* plot.
March	Baqmboo shoots (*Dendrocalamus ssp*) from new *jhum* plot that come after burning, chillies, brinjal, pumpkin, turmeric, ginger, root crops, shoots, leaves and ferns from old *jhum* plot.
April	Chillies, brinjal, pumpkin, turmeric, ginger, root crops, shoots, leaves and ferns from old *jhum* plot.
May	Start harvesting watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*), maize (*Zea mays*) from new *jhum* and continuing harvesting from old *jhum* field.
June	Celery leaves (Apium graveolens) and continues to harvest cucumber and watermelon. No further harvest from old *jhum* field.
July	Harvest maize, beans, millet, pumpkin (Continues for 10 months) and early rice.
August	Main harvest of rice (*Oryza sativa*) in some area. Continues to harvest vegetables, pumpkin etc.
September	Main harvest of rice in some area. Continues to harvest vegetables, pumpkin etc.
October / November	Harvest vegetables, pumpkin, beans, soybean (*Glycine max*) and turmeric

2. Impact of *Jhum* cultivation in on Natural resources

In *Jhum* cultivation practices, land is primarily cleared by cutting of the forests, bushes, *etc.* up to stump level during December-January, leaving the slashed materials for drying and final burning to make the land ready for dibbling of seeds of different crops before the onset of monsoon. After 2-3 years, the cultivated area is kept abandoned for natural built up of soil fertility and a new site is selected to repeat the same process. Initially, when the shifting cultivation originated, it followed the cycle of 15-20 years, enabling the soils to mine adequate nutrients from the sub-soil and enrich the surface soil through decomposition of the litter fall. But, over the past few decades, the region has experienced rapid population growth, which has resulted in expanding cultivation on to marginal land and the cycle reduced to 3-5 years, which hardly provide time for natural regenerated of soil fertility. Excessive deforestation coupled with shifting cultivation practices have resulted in tremendous loss of soil (50.74 to 70.12 t/ha/year), SOC (608.90 to 911.60 kg/ha/year) and available NPK nutrients (15.97 to 26.93 kg/ha/year) in 1st two years of *jhum* cultivation in Nagaland (Ray *et al.,* 2017). At present, 83.6% of soil pH value is falling below pH 5.5 as the consequences of faulty cultivation practice in Nagaland, now more than twenty nine (29) blocks of different districts are affected severely by soil acidity problems. Besides soil acidity, soils of different blocks of Nagaland are also deficient in N (1.8 to 34.4%), P (1.8 to 60.1%), K (0.2 to 56.5%) and Zn (1.1 to 37 %) nutrients (NBSS&LUP, 2014). The problems accentuated due to growing population pressure leading to reduction of *jhum* cycle to 3-4 years compared to 10-12 years in past. The ever shortened *jhum* cycle has put tremendous pressure on natural resources, resulted in drastic decline in soil productive capacity and has left several detrimental effects on both forest and environment (Toky and Ramakrishnan, 1981; Arunachalam and Pandey, 2003; Lele and Joshi, 2009). Of late, the system becomes unsustainable and non-profitable for overall improvement of livelihood and providing food and nutritional security (Mantel *et al.,* 2006). Because of that huge number of *jhum* farmer has now started adopting alternative livelihood occupations (Karim and Mansor, 2011) such as waging, animal rearing, cultivation of annual mono-crops, extraction and selling of forest products, etc.

3. Present issues of *Jhum* lands

Issue I: Reduction in *Jhum* cycle followed by degradation *Jhum* cycle reduced to 2-5 years from 20 - 30 years. However, 15-20 years of *jhum* cycle is sustainable.

Issue II : Heavy dependency on forest for livelihood.

Issue III : Soil acidity , Fe &80 % of the soil are acidic Al toxicity

Issue IV : Loss of soil health. Total soil loss from NEH region : 181 million tones /yr and it causes

Issue V : Low productivity

Issue VI Low crop intensity & reduced no. of crops : maximum area under monocrop (73%)

Issue VII: Lack of capital

Issue VIII : Land tenure system (MN & TR: 100 % by Forest Dept, NL & ML: >88 % by Individual, AP: 74 % by Civil Authority, MZ : 44 % by Civil Authority, AS : 39 % by Corporate Society)

Issue IX : Remoteness and Lack of market chain

3.1: Soil erosion calendar of shifting cultivation system

Month	Agricultural operation	Erosion problem	Soil erosion (t/ha)	
			Minimum	Maximum
January, February, March April	Plot selection, forest cutting, burning and clearing of hill slopes and sowing begins	Displacement of loose soil materials to downhill and rolling down of earthworm casting, soil erosion as above and wash due to rains	0.0	22.4
May	Sowing / weeding	Heavy soil wash, faint riling at foot hills on slit deposits	0.2	61.9
June	Weeding	Heavy wash of soil aggregates	0.2	45.4
July	Weeding, harvesting begins	Heavy wash of soil aggregates, crop root exposed, farm soil visible	1.8	21.9
August	Harvesting and occasional weeding	Soil wash continues	1.0	29.6
September	Harvesting	Soil erosion appreciably reduced	0.1	13.8
October	Harvesting	Soil erosion appreciably reduced	0.0	2.7
November	Harvesting	No erosion, moss turns brackish	0.0	0.0
December	Harvesting/threshing and carrying to home	No erosion	0.0	0.0
Whole year total	**Shifting cultivation on steep slope**	**Heavy soil wash**	**3.3**	**201.4**

4. Key determinants of *jhum* cultivation

Shifting cultivation practice is associated with a number of limitations and environmental implications but huge numbers of tribal farmers are still involved in this system. The cultivation on sloppy land traditionally with locally available seeds, tools and implements, without taking soil and water conservation measures are the reasons of low crop productivity. In spite of several limitations, complete eradication of this method of cultivation is practically impossible because of non-availability of effective livelihood

alternatives. The ongoing typical *jhum* farming operational systems *viz.* crops growing period, cultivar used, seed rate, methods of sowing, weed management and yield of the major growing *jhum* crops (paddy, maize, local beans, colocasia, ginger, soybean, ricebean, cucumber, topiocca and chilli)

5. Ongoing programmes on *jhum* improvement

- ✓ Integrated land development projects under DSCO, Govt. of Nagaland.
- ✓ Integrated watershed development project under DSCO, Govt. of Nagaland.
- ✓ Soil and water conservation programme under RKVY under DSCO, Govt. of Nagaland.
- ✓ ICAR- projects on *jhum* improvement under TSP project

6. Constraints and challenges in improving the *jhum* cultivation system

The *jhumias* are well aware of the major negative environmental consequences of *jhum* cultivation, but they are bound to continue *jhum* cultivation primarily due to their ethnic belief of cultural heritage and secondly and more importantly due to lack of alternate employment opportunities to sustain the family needs throughout the year (Paul *et al.,* 2017). Some of the tangible constraints in improving *jhum* cultivation are;

- ✓ Traditional mindset and ongoing cultivation with low yielding varieties in a unintelligent manner for different agriculture and horticultural crops.
- ✓ Undulating topography and poor economic status.
- ✓ Residue burning.
- ✓ Lack of alternative livelihood options
- ✓ Cultivation practice is still continuing with ineffective traditional tools and implements.
- ✓ Livestock are always considered as subsidiary income and mostly reared indigenous, poor productive livestock with poor feeding and management system.
- ✓ Lack of industry facilities, agriculture farming system is the only options of earnings for the farmers.
- ✓ Inadequate credit support. Inefficient marketing channels, lack of processing and value addition facilities and farmers are not getting any premium prices for their harvest though the product is like organic.

7. The identified Rehabilitation models to address *Jhum* cultivation:

1. SALT models (Sloping Agriculture Land Technology) / Contour Hedgerow Farming System Technology (CHFST) (by GBPIHED)
2. SWEET (Sloping Watershed and Environmental Engineering Technology) (SFRI, Itanagar)
3. Intensive watershed based livestock production system (ICAR)
4. ICAR 3-tier model (ICAR)

5. NEPED (Nagaland Environment Protection and Economic Development, Govt. of Nagaland)
6. Introduction of CASH CROPS: broom grass, beetle leaf and beetle nut, cinnamon, fruit orchards and floriculture by the farmers (by RCNAEB and SFRI)

8. Approaches to Improve Shifting Cultivation

- ✓ Integrated farming system
- ✓ Agroforestry
- ✓ Contour Bunding / Bench terrace / Contour drenching
- ✓ Toposequential Cropping
- ✓ Use of HYV with required PoP
- ✓ Better fallow management –Cover crops (velvet bean)
- ✓ In-situ composting / organic manures
- ✓ Crop rotation and introduction of nontraditional crops (wheat, barley, peas etc.) after traditional crops (rice, maize, millet etc.)
- ✓ High value, low volume crops
- ✓ Value addition
- ✓ Retaining valuable and immature trees / pruning of trees
- ✓ Afforestation / Reforestation with MPTs
- ✓ Micro enterprises (mushroom, bee-keeping, poultry, aquaculture, duckery, piggery, goatery, cattle etc.)

9. Improved Varieties for soil acidity:

9.1 Rice varieties :

Kharif : SARS 5, Bhalum 1, 2, & 3, 4 RC Maniphou 6 (Upland) RC Maniphou 7 & RC Maniphou 11, Lungnila (Lowland)

Pre-*kharif* : RC Maniphou 4 & RC Maniphou 5, Krishna Hamsha, IR-64

Boro : TRC Borodhan 1, Naveen, Ranjit, Krishna Hamsha

Cold stress - Megha Rice 1, Megha Rice 2, and Megha Rice 3

Iron Toxicity - Sahsarang 1 & Lampanah

Submergence :Swarna *sub 1*, Shambha mahasuri, IR64 *sub1,* FR13 A

Flood tolerant : Jalashree, Plaban

Drought : Sahabhagi, Vivek Dhan 82

9.2 Maize varieties : Maize RCM 1-1, Maize RCM 1-3, HQPM 1, RCM 75, 76, DA 61A

9.3 Fruit trees & crops

- **High Hills (900-2000m msl)**

  Fruits: apple, peach, pear, plum, apricot, kiwi and strawberry,

  Crops: potato, cabbage, cauliflower, radish and beans

- **Mid Hills (Below 800 m msl)**

  Fruits: citrus, banana, pineapple, papaya and guava,

  Crops: ginger, turmeric, chilli, brinjal, tomato, bean, sweet potato, tapioca and colocasia

- **Foot Hills (Bordering areas of hills)**

  Fruits: jackfruit, arecanut, black pepper

9.4 Prioritised medicinal plants for NE region for *Jhum* Improvement

1. *Aconitum heterophylum* (*Atees*)
2. *Saraca asoca* (Ashoka tree; "sorrow-less")
3. Swertia Chirata (Chirata)
4. *Nardostachys Jatamansi* (Jatamansi, Indian Spikenard)
5. *Picrorhiza Kurroa* (Picrorhiza, Kutki)
6. *Withania somnifera* (Ashwagandha)
7. *Rauwlfia serpendine* (snakeroot, sarpagandha)
8. *Tinospora cordifolia* (Giloe)
9. *Piper longum* (Long pepper, Pippali)
10. *Embelia ribes* (Vai Vidang)
11. *Aconitum ferox* (Vatsnabh, MeethaVish, Monks hood)

10. Significant achievements of the centre in the areas of *jhum* improvement

- ✓ Numbers of one day, three day, four day and seven days training programme were pertained to farmers, district officers of agri & allied departments and other extension workers to disseminate the suitable technologies for improvement of *jhum* farming.
- ✓ Development of location specific Agri-Horti-Animal based integrated farming system models has been developed at farmer's field through KVKs of the centre.
- ✓ Implemented technology mission for integrated development of horticulture in the state under HTM.
- ✓ Development of Non-Forest Wasteland Development through Agro-Forestry Model for 175 ha area .
- ✓ To harvest rainwater judiciously altogether one thirty numbers of silpaulin sheets (250 micron) were distributed under TSP and NICRA project to intensity the cropping during post rainy season.
- ✓ Promoted pulse production in *jhum* areas through Cluster Frontline Demonstration under NFSM & TSP.
- ✓ The centre continuously supplementing good quality disease free seeds of paddy, maize, soybean, mustard, lentil, linseed, rajmah, pea, etc. to enhance the productivity in *jhum* system.

- ✓ Planting materials of kiwi fruits, ramie, assam lemon, tree bean, alder, orange, litchi, peach, etc has been distributed every year for better management of *jhum* fallow by establishing orchards as sustainable venture.
- ✓ To boost up the production of organic input and promotion of organic farming in *jhum* areas earthworms culture and portable vermi-bag has been distributed time to time during the training cum demonstration programes.
- ✓ Good quality improved and cross breed chicks, piglets, duck, fish, and medicines of livestock were also supplied to the *jhumias* to integrate with *jhum* farming system to secure their livelihood.

11. Success stories of *jhum* improvement

Success Story-I

Livelihood Improvement of Tribal Jhumias through Integrated Farming System Approach-A Success Story : The intervention of integrated farming system (IFS) was made at Humtso village of Wokha district. The location of the site lies in between $26^0$06'437" N latitude and $94^0$12'810" E longitude and 727m above the mean sea level. The site is situated at 13 km North-Western side of the district head quarter. The intervention was made at the field of Mr. Atheyo Lotha; he is a youth aged 32 years from Humtso village, having 3.2 ha sloppy land and had been practicing low productive traditional *jhum* farming. Mixed *jhum* cropping system with locally available cultivars and poor soil and water conservation measures was identified the main constrains for his low farm income. He was not capable to integrate other agriculture and allied activities because of his limited scientific knowledge in modern cultivation practices and lack of proper water storage facilities. The IFS intervention was made with objectives; to improve the existing *jhum* practices through appropriate scientific interventions, to establish a suitable agricultural farming system model through sustainable use of natural resources and to promote integrated farming system (IFS) for enhancing productivity, improving livelihood and for maintaining soil health.

After giving him proper training at KVK, Wokha and ICAR Nagaland centre the interventions was made. Feasible soil and water conservation measures like terracing (Fig. 1), bunding, etc were taken up for 1.6 ha farm areas. Plantation of MPTs and fruits trees carried out following top to bottom system approach. Encouragement was given to adopt scientific packages and practices for cultivation of both the *kharif* and *rabi* crops/vegetables using improved crop varieties, to enhance crop productivity, cropping intensity and also for crop diversity. Two numbers of ponds were managed properly to promote integrated fish cum pig (12 nos.) and integrated fish cum duck (50 nos.) farming (Fig. 3 & 4) to obtain additional farm income. Vanaraja chicks (100 nos.) were also introduced as a component of IFS to meet the family egg and meat requirements. Cultivation of fodder crops like maize (HQPM1), cassava, colocasia were promoted to supplement feeding requirements for livestock. Emphasis was given on daily feeding of poultry and piggery by using both the commercial as well as local available feeds. Year round mushroom was taken up as

secondary agriculture to meet the family requirement. Low-cost portable vermicomposting unit was also demonstrated to recycle farm waste.

Fig.1 Construction of terraces for SWC. Fig.2 Cultivation of winter vegetable as 2nd crop in terraces

Fig.3 Promoted integrated pig cum fish farming **Fig. 4 Integrated duck cum fish farming.**

Crop productivity and cropping intensity increased significantly. Intervention of fodder crops reduced the feeding requirements by 31.6 to 44.7% for poultry and piggery. Overall interventions of crops, livestock, fishery and secondary farming increased employment opportunity (603 man-days) as compared to traditional *jhum* farming (72 man-days). Adoption of the soil and water conservation measures and better nutrient management practices improved soil health resulted in overall enrichment in soil organic carbon (SOC), available nitrogen and phosphorus status. Intervention of poultry, piggery, dairy, fishery, duckery, mushroom, vermicomposting and fruits in cropping cycle provided 6.54 times better income than traditional *jhum* farming. It could be concluded that promotion of integrated farming system (IFS) is a viable intervention for the tribal *jhumias* for overall improvement in productivity, income, employment, food, nutritional and ecological security through sustainable use of natural resources.

Success Story-II

Promotion of Artificial Rainwater Harvesting Pond Based Integrated Farming System for Tribal Jhumias-A New Initiative *:* The study was undertaken at three distinct *jhum* cultivating villages (yanthamo, Longsa and Riphyim) of Wokha district in Nagaland, India (Table 2). Acute scarcity of water during post-rainy season is one of the major constraints

for intensification and diversification of agricultural activities in *jhum* areas for overall livelihood improvement of the *jhumias*. Moreover, 78% of total rainfall concentrates during the four months (June-Sept.) of the year, leaving no or little rain during post rainy period. This calls for concretive efforts for massive rain water harvesting and its efficient utilization on improving the existing *jhum* practices through scientific interventions (water harvesting, crop diversifications, inclusion of animal and fishery components as well as secondary agriculture) for overall improvement in productivity, income, employment, food, nutritional and ecological security through sustainable use of natural resources.

Different interventions such as provisioning rainwater harvesting (8.75 lakh) structure (size; 35m x 10m x 2.5m), establishing suitable agricultural models (top to bottom approaches), involving planting of MPTs (tree bean, alder) at top hill, planting of fruits (litchi, Assam lemon, mandarin orange, papaya, banana) and cultivation of seasonal crops and vegetables in middle and bottom hill. Livestock components (poultry and piggery) and fishery was promoted along with secondary agricultural interventions of vermicomposting and mushroom for additional farm income. The interventions were replicated in three different *jhum* areas and soil tested before interventions made (Table 2).

Table 2. Interventional locations and soil characteristics.

Sites	Location		Altitude (m)	Tex-ture	pH	SOC	Initial soil status		
	Latitude	Longitude					N	P	K
Yanthamo	$26^0$03.753' N	$094^0$18.195' E	973	SL	SA	VH	L	L	MH
Longsa	$26^0$04.029' N	$094^0$14.936' E	1174	Si L	EA	VH	L	M	MH
Riphyim	$26^0$12.282‘ N	$094^0$15.748‘ E	536	CL	EA	VH	L	L	MH

SL= Sandy loam, Si L=Silty Loam, CL=Clay Loam, SA= strongly acidic, EA=Extremely acidic, L=Low, M=Medium, VH=Very high, MH= Moderately high.

The study clearly revealed the enhancement of yield of cereal (29%), oilseed (40.7%), pulse (15.1%), vegetable (298.4%), spice (53.6%) and fruit (9.92%) crops. Intervention of fodder crops reduced in feeding requirement of poultry (28.6%) and piggery (39.3%). Promotion of IFS increase overall net income (Rs. 2,46,160/-) as compared traditional income of *jhum* farming (Rs. 52,248/-). Overall interventions of crops, livestock, fishery and secondary farming enlarged employment opportunity (506 man-days) as compared to traditional *jhum* farming (72 man-days). Adoption of the farming system there was improvement in soil health resulted in overall enrichment in soil organic carbon (SOC), available N & P status but soil pH and available K content deceased or more or less remains unchanged. Therefore, promotion of rainwater harvesting, crop diversification, inclusion of animal and fishery components as well as secondary agriculture is viable intervention for the tribal *jhumias* for overall improvement in productivity, income, employment, food, nutritional and ecological security through sustainable use of natural resources.

Fig.5 Digging of artificial pond.

Fig. 6 Harvested water in artificial pond (8.75 lakh litre).

Significant achievements made by the institute:

- ✓ **Flagship programme on Jhum improvement** for food security of tribal farmers through sustainable agriculture has been undertaken in Nagaland. About 61% of the total households of the state practice shifting cultivation in about 1.00 lakh hectare of land annually thereby exposing about 5.65% of the total geographical area of the state to soil erosion hazards. The centre targets to improve *jhum* cultivation practices through inclusion of improved crop varieties, RCT and agro-forestry interventions in farmers participatory mode.
- ✓ **Popularization of location specific Integrated Farming System:** Based on the evaluation and profitability of the IFS model developed by the centre, the centre targets to replicate the models with appropriate modification suiting the location in other districts of Nagaland.
- ✓ **Promotion of rain water harvesting and its efficient utilization for higher water productivity :** In Nagaland, more than 75% of the rainfall (2000mm) is concentrated during the period of June-September which constraints crop intensification, diversification. Small and fragmented land holding, poor investment capacity and lack of adequate knowledge about improved agricultural practices further concentrate the problems of poor productivity and profitabilities of agriculture sector. Farm mechanisation is also yet to start for reducing dragger to the farmers and timely ensuring agriculture practices. To mitigate the problem, the centre envisaged blending technology demonstration, capacity building and linkage establishment in systematic and holistic approach to transform rural economy to a profitable enterprise. A such, ICAR Nagaland Centre conceived the training and demonstration programme under National Innovations on Climate Resilient Agriculture (NICRA) and Tribal Sub Plan (TSP)on promotion of water harvesting structures in Dimapur, Peren, Wokha, Longleng, Kiphire and Tuensang districts of Nagaland for increasing the cropping intensity, crop diversification and farm profitability. Around 3500 farmers from the different districts of Nagaland, Dimapur, Peren, Wokha, Longleng, Kiphire and Tuensang were trained for resource conservation technologies, water harvesting and its efficient utilization through

sprinkler and drip irrigation. A total of number of 15 large (8.75 lakh litres capacity), 3 Medium (2.0 lakh litres capacity), 52 Small (63,000 litres capacity) and 110 very small (30,000 lakh litres capacity) water harvesting structures were developed for demonstration at farmer's field. The impact for the development of water harvesting structures was most significant. In this programme all total 20.3 million litres of water was harvested and the farmers used the water during lean period (November- January) for multiple purpose like, production of winter vegetables, fishery, piggery etc. and could increase their farm income 200% over the previous years.

- ✓ **Promotion of secondary and tertiary agriculture including post harvest management:** The state is bestowed with indigenous fruits and vegetables which are having high medicinal values. The centre targets to improved secondary and tertiary agriculture includes postharvest management of crops for enhancing farm profitability through training and demonstration.
- ✓ **Distribution and popularization of mushroom spawn & cultivation, improved breed of piglets and chicks under pig farming and backyard poultry rearing in Nagaland:** Promotion of oyster mushroom cultivation for small and marginal farmers of Nagaland was undertaken by supplying quality mushroom spawn to SHGs/rural unemployed youths/NGOs. Dissemination of oyster mushroom cultivation technology through method demonstration was given to 577 numbers of farmers during which 14228 nos. of packets were supplied. The centre also guided one young entrepreneur in establishing spawn production unit to meet the spawn demand as secondary sources of income to Jumias. The scientific rearing of pig and poultry birds was popularized among the farmers of Nagaland as well as other north eastern states. A total of 241698 nos. of chicks and 2847 nos. of piglets were distributed from the centre. Scientific practice of AI in Pig enhanced the production of piglets from superior breeding stock available under Mega Seed Project on Pig is growing in popularity among the farmers.
- ✓ **Promotion of protected cultivation and value addition of Horticultural crops:** Scientific cultivation of various fruits and vegetable crops like Banana, Litchi, Arecanut, Guava, Pineapples, Citrus, Coconut, Kiwi, Tomato, Chilli, Cole crops, Large cardamom, Turmeric, King Chilli, etc have been taken up for orchard development as well as part of Inter cropping and multistoried cropping system models. Protected cultivation has been standardized for quality production of various vegetables and ornamental plants. Growing of high value crops like capsicum, king chilli, tomato, flowers like lilium, gerberas, anthuriums orchids and roses under naturally ventilated polyhouse and shadenet houses have been popularized. Black polythene mulch technology is gaining popularity among pineapple growers in Nagaland because of high productivity, quality produce and its economic viability. A number of value added products from Jackfruit, Citrus, Mango, different vegetables like tomato, chilli, tuber crops, mushroom etc. have been developed. For dissemination of technologies, region and crop specific training and

demonstration programmes are being taken up to enhance farm profitability on sustainable basis and to ensure nutritional security.

- ✓ **Production of quality seeds, planting materials and improved breeds of pig and poultry:** As availability of seed is the major constraint in the state, the centre targets to produce seed production programme in farmers' participatory approach to cater the needs of the seed in time. The centre targets to promote mushroom cultivation and AI in Pig on large scale. the centre also targets to increase the production of quality piglets and chicks so that more beneficiaries can be covered and trained on scientific rearing in the next 5 years.

12. Strategies

There is a need to support the *jhumia* families with some secondary employment opportunities, such that they can support their livelihood needs throughout the year. The same in turn will be a great stride towards curbing the menace of ever shortening of fallow period, and thus conserving forest and environment. Large scale government support and initial investment to integrate allied employed opportunities *e.g.*, scientific bee keeping, mushroom cultivation and commercial poultry farming may be of immense help. Promotion of bamboo and other abundantly available local resources based handicrafts may be a viable option for the same. Apart from utilizing to the highest extent alternate land use options including agroforestry and non-traditional land use practices, dedicated and structured educational drives, demonstrations and training efforts by the grassroots level organizations, like *Gram Panchayat,* KVK and Agricultural Technology Management Agency (ATMA) to explore allied and non-farm employment opportunities will add to the sustainability of *jhum* based livelihood and at the same time help in restoring the length of fallow, forest and environment.

Conclusion

The mountain eco-systems of these regions with shifting cultivation practice have to be made ecologically sustainable. Formulating an eco-development plan for the region with environmental sustainability, could consider for improving *jhum* practice and land use system. Unscientific agricultural practices are at the loss of biodiversity resources; estimates indicate that one unit of energy in agronomic production costs loss of greater energy from the forests. However, farmers Participatory and convergence approach with new land use policy for location specific and farmers centric technologies are required for rehabilitation the *Jhum* practice.

References

Statistical Handbook of Nagaland, 2015, Directorate of Economic and Statistics, Government of Nagaland

SHIFTING CULTIVATION IN TRIPURA: CHALLENGES, PROSPECTS AND ALTERNATIVES

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1. Introduction

Jhum or shifting cultivation is one of the primitive, rainfed and subsitance farming practices of tribals usually in the hills and slopes of tropical rainforest areas of the world including Central Africa, Central America and Southern Asia. The origin of shifting cultivatin can be traced back to Neolithic period (7000-8000 BC) when civilization gets transformed from hunters and gatherers to food producers. And at Tripura, Jhum farming was the only form of agriculture known till recently. Probably, plough cultivation was introduced in Tripura with migrant settlers from adjoining districts of Bengal during 15th century.

Jhumias are tribal's who practice shifting cultivation or *jhumming*. At present Tripura houses 19 tribal groups and has a big tribal population near about 31.1 % (census 2001) (Table 1). *Jhum* cultivation to the tribes of Tripura has over the years been not just an economic activity; rather it is a way of life. "The whole process of *jhumming* is clean and keeps the tribal in the open, enjoying the cool mountain breeze, singing and dancing. Over the years the *jhum* economy has undergone many changes as land available for *jhumming* has decreased; leading to a shortening of the *jhum* cycle and a fall in incomes.

In 1984, the Central Forestry Commission estimated that 6.7 million ha of cultivable area was affected by *jhum* in India. According to the Task Force on Shifting Cultivation, as many as 43000 families in Tripura practiced *jhum* cultivation bringing 22,300 ha under this method of cultivation annually (Table 2).

Table 1:Tribals in Tripura

SL. No.	Name of Tribe	Population	Percentage	SL. No	Name of Tribe	Population	Percentage
1.	*Tripuri*	250382	55.57	11	*Garo*	5559	1.23
2.	*Reang*	64722	14.36	12	*Munda*	5347	1.18
3.	*Jamatia*	34192	7.59	13	*Orang*	3428	0.78
4.	*Chakma*	28662	6.36	14	*Santal*	2222	0.49
5.	*Halem*	19076	4.23	15	*Khasia*	491	0.11
6.	*Noatia*	10297	2.28	16	*Bhil*	169	0.04
7	*Mog*	13273	2.94	17	*Chimal*	Nil	Nil
8	*Lushai*	3672	0.81	18	*Bhutia*	3	0.001
9	*Uchai*	1061	0.21	19	*Lepcha*	175	0.04
10	*Kuki*	7775	1.72		**Total**	**450506**	**100.00**

Source: Government of Tripura, Department of Tribal welfare

Table 2: Shifting cultivation in N.E. Region

States	Annual area under shifting cultivation (sq.km)	Fallow period (in years)	Minimum area under shifting cultivation one time or other (sq. km)	Families practicing shifting cultivation
Arunachal Pradesh	700	3-10	2100	54000
Assam	696	2-10	1392	58000
Manipur	900	4-7	3600	70000
Meghalaya	530	5-7	2650	52290
Mizoram	630	3-4	1890	50000
Nagaland	190	5-8	1913	116046
Tripura	223	5-9	1115	43000
Total	**3869**	-	**14660**	**443336**
	(1.5 Per cent)		**(5.7 per cent)**	

Source: RTFSC (1983), Basic Statistics of NER, 2002, Government of India, North Eastern Secretariat, Shillong. p. 42.

2. Status of *jhum* cultivation in Tripura

Shifting cultivation has been the main source of livelihood for most tribes of North-eastern hills including Tripura hills and a sizeable portion of population in the hills of Tripura still depending on *jhum* cultivation. Several agencies at different point of time presented variable *jhum* coverage in Tripura (Table 2 & 3). According to the Task Force on Shifting Cultivation, Ministry of Agriculture (1983), the annual area under shifting cultivation was 223 sq. km, fallow period is 5-9 years, minimum area under shifting cultivation one time or other was 1115 sq. km and number of families practicing shifting cultivation was 43000 but as per the estimates of Forest Survey of India (1999), the cumulative area (million ha) of shifting cultivation (1987 to 1997) was 0.06. The total area under shifting cultivation in Tripura in accordance to the survey conducted by National Remote Sensing Agency (2003) is 395.26 km^2. However National Forestry Commission (2006) opined that the 221 km^2 of dense forest and 163 km^2 of open forest area being used for jhum cultivation in Tripura.

Table 3: Area under shifting cultivation in Tripura

Survey Agency	Area (km^2)
1. Task-Force Ministry of Agriculture, 1983	223
2. Satpathy *et al*, Ministry of Rural Development, 2003	1080
3. National Remote Sensing Agency, 2003	395.26
a) Abandoned *jhum*	110.37
b) Operational *jhum*	284.89
4. Forest area under *jhum* (1987-1997), Forest Survey of India, 1999	600
5. Forest cover affected by *jhum*, State of Forest Report, 2003, National Forestry Commission, 2006	
a) Dense forest	221
b) Open forest	163

Source: Tiwari, 2005[3]

Almost all the hilly areas of the state fall within the Tripura Tribal Areas Autonomous District Council (TTAADC), which comprises 7132.56 sq km and form about 67.98% of the State. Of the total area ADC, as much as 5911 sq km (82.87%) is forest land under the effective control/ management of the State Forest Department. As per legal status, these forests comprise of (a) 3582 sq km of Reserved Forests (RF), (b) 258 sq km of Proposed Reserved Forests (PRF) and (c) 2071 sq km of Protected Forests (PF), re-designated as Unclassified Government Forests (UGF). The UGF outside the ADC area is only 125 sq km. On strict legal term, no one would be allowed to do shifting cultivation in forest areas, unless otherwise proven that it is needed as part of the forest management practice. On the other hand, the ADC is charged with the constitutional mandate of " Regulation of the practice of shifting cultivation"[4].There are 40,000 *jhumia* families within ADC areas, of which 21,099 families reside within the Reserve Forest areas (Table 4).

Table 4: *Jhumia* statistics of Tripura

Particulars	No. of families dependent on *jhum*		
	Fully dependent	Partially dependent	Total
Tripura state	21,677	33,372	55,049
ADC area	15,830	24,171	40,001
*O*utside ADC area	5,847	9,201	15,048
Reserve Forest (RF)	8,440	12,659	21,099
RF within ADC	5,622	9,082	14,704
RF outside ADC	2,818	3,577	6,395

Source: State Agriculture Research Centre, Department of Agriculture, Government of Tripura, Agartala (2005)

Studies by the Department of Agriculture, Government of Tripura[5] showed that the 40001 *jhumias* are practicing Jhum in 1,08,842 ha land and jhums are mostly concentrated in Dhalai and North Districts (Table 5).

Table 5: *Jhumia* and *jhum* area statistics in accordance to the districts of Tripura

Districts	Total *jhumia* population	Total *jhumia* households	*Jhum* area sown in 2004-05 (ha)	Total area affected by *jhum* (in ha)
West	38,723	7,569	2,397	15,120
South	65,485	12,713	4,448	28,080
Dhalai	63,568	11,824	5,008	32,400
North	41,424	7,895	5,272	33,242
Total	209,200	40,001	17,125	1,08,842

Source: State Agriculture Research Centre, Department of Agriculture, Government of Tripura, Agartala (2005)

3. Characteristics of *jhum* cultivation

In the local parlance of Tripura, a *jhumia* is a tribal who strictly follow shifting cultivation or *jhuming*. Under this form of cultivation hill slopes are cleared of their vegetable cover which is set on fire and several crops sown. After harvesting the crops from the field, *jhumias* shift to other land for cultivation. The essentials of *jhum* cultivation are clearing and burning of

surface vegetation before planting[6]. Plots located in hill forest lands are normally chosen for *jhum* cultivation. Shrubs and creepers are cleared, and smaller trees are cut. After the clearing process, which usually takes place in the month of April and May, the cleared jungle is left to dry under the sun, in order to be burned later on. The 'singing' raindrops thereof bring the villages into a state of activity for *jhum* cultivation. Each adult member carries to the field a small basket filled with mixed seeds of food grains, vegetables and cash crops. The above crops will be ready for harvesting from July to December.[7]

Jhumias adopt mixed cropping and the mixture of crops varies from tribe to tribe within a region. Among the food grains the coarse varieties of rice, maize, millet, and small millets are the principal crops while cotton, ginger, pigeon pea, rapeseeds, sesamum, pineapple and jute are important cash crops, and soybean, potato, pumpkins, cucumbers, yams, tapioca, chillies, beans, onion, arum are vegetables grown in *jhum* fields. In fact, the choice of crop is consumption oriented, and the *jhumias* aims at growing everything that he needs for his family consumption. These crops harvest at different periods, thereby providing the tribes with varied food for nearly six to nine months in a year (Table 6). In addition, soil exhausting crops, e.g., rice, maize, millets, cotton, etc., and soil enriching crops, e.g., legumes, are grown together. This practice has many direct and indirect advantages. The same *jhum* land is cropped by the community for two years, thereafter; the land is abandoned to recuperate. Occasionally, some residual crops are collected from the abandoned fields. Further, consecutive cropping is generally observed for two years in a cleared piece of land. As one patch every year is abandoned, a new patch is cleared. Thus, two patches are cultivated simultaneously every year, and these two patches are generally quite at a distance from each other.

Table 6: Rotation of crops in Tripura *jhum*[8]

	First Year		Second Year	
	Kharif	**Rabi**	**Kharif**	**Rabi**
(i)	Millets , maize, vegetables, cotton, sesamum, pigeon pea, ginger	---	Maize, paddy, jute, vegetables, ginger	---
(ii)	Paddy, vegetables, cotton	---	Millets, maize, vegetables	---
(iii)	Maize, millets, jute, vegetables	---	Small millets, vegetables	---

Rice is the predominant crop in jhums of Tripura. The percent share of the *jhum* rice area to the total rice area of the state during 2008-09 to 2012-13 increased from 5.9 to 7.2 (Table 7). The kharif rice area of the state for the period 2016-17 is 205.2 (000 ha) with 8.2 percent area for *jhum* rice. The advance estimate for the kharif rice area for Tripura for the period 2017-18 is 203000 ha with 7.8 percent shall be the share for *jhum* rice[9]. However, a gradual decline in the acreage but improvement in yield of *jhum* rice has been observed at Tripura (Table 8).

Table 7: Percentage of *jhum* rice area to total rice area[9]

Year	Total rice area (000 ha)	Percentage of *jhum* rice to total rice area
2008-09	243.0	5.9
2009-10	245.5	5.9
2010-11	264.6	6.2
2011-12	266.0	6.4
2012-13	254.7	7.2

Table 8: Area, production and yield of *jhum* rice during 2011-16[9]

Period	Area (000ha)	Production (000MT)	Yield (kg/ha)
2011-12	17.2	17.6	1020
2012-13	18.4	19.0	1035
2013-14	19.5	20.5	1050
2014-15	17.9	19.0	1066
2015-16	16.5	17.7	1072

The continuance of *jhum* in the state is closely linked to ecological, socio-economic, 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. Various religious ceremonies, based on traditional faith and belief of each tribe, are performed both prior to harvest and post-harvest. The practice of *jhum* is wide-spread among the *Reang*, *Tripuri*, *Chakma*, *Halam* and *Lushai* tribes in the state. (Table 9). *Tripuri* are the most dominant tribe to be involved among the five major tribes followed by *Reang*, *Chakma*, *Lushai* and *Halam.* Dhalai district houses 35 percent households of *jhumia* followed by North (26), West (23) and South (16) of the total *jhumia* households of the state maximum concentration of *jhumias* are seen in Chawmanu, Damboornagar, Mungiakami and Dasda RD Block. Some non-tribals of the West Tripura district have adopted shifting cultivation as a means of livelihood.

The *jhum* cycle is influenced by the pressure of population, nature and density of forests, terrain, angle of slope, texture of soil and the average annual rainfall. Areas of sparse population generally have longer *jhum* cycle (15-25 years), while areas with high density of population have shorter *jhum* cycle (5-10 years). The patches of land for shifting cultivation are not selected in any given order or sequence. There is always a room for choice. The period of consecutive cropping and fallowing differs from region to region and from tribe to tribe. Presently, with the increase in population and being somewhat staked down to smaller areas, a shifting cultivator has not got much choice left to shift about. His world has become small, he has to be content moving about in narrow circles and the circle is becoming increasingly smaller with the passage of time. In brief, in the earlier decades, the period before which the *jhumias* returned to cultivate the same plot was quite long. This

was partly due to the limited population and partly to the better fertility of soil which used to be rested for nearly thirty to forty years. The tribes in which the *jhum* cycle is around five years are facing serious problems of undernourishment and their ecosystems are fast losing their resilience characteristics.

Table 9: District wise distribution of *jhumia* households of different tribal communities during 2007

Tribe	North	Dhalai	West	South	Tripura
Tripuri	552	5197	5785	2024	13558
Reang	4518	3252	81	1328	9178
Noatia	0	21	59	47	127
Chakma	578	860	0	400	1838
Halam	269	236	182	399	1086
Jamatia	0	221	103	94	418
Mog	17	14	1	208	240
Garo	4	1	32	0	37
Lushai	1434	39	0	0	1473
Kuki	9	1	10	0	20
Munda	2	0	80	0	82
Uchai	0	0	0	12	12
Orang	4	0	20	0	24
Bil	1	0	0	0	1
Khasia	3	0	16	0	19
Santhal	0	2	1	6	9
Others*	1	10	149	2	153
Total	7392	9854	6520	4520	28286

*Includes non-tribals and unidentified groups

Source-Compiled from the survey undertaken by the Dept. of Forests, Govt. of Tripura[3]

4. Impact of shifting cultivation in Tripura

The impact of *jhum* is having good and bad aspects which are as follows-

Positive aspects of shifting cultivation

Shifting cultivation facilitates the tribal people to preserve their rich cultural traditions and diversity as *jhum* cultivation is interwoven into the cultural and tradition of near about 19 tribes those inhabit basically in the hilly parts of Tripura especially in Dhalai and North Tripura district. Shifting cultivation is a labor intensive and low subsidy based farming system, provides an assured source of food production and security to the nourishment level of the *jhumias* in the hilly parts of Tripura. Shifting cultivation in its traditional form may also put in towards the conservation of agro-biodiversity, principally the native food crops like rice, various vegetables and even different fruits. They usually cultivate 8-10 varieties of crop items in a particular *jhum* land, in that way they can produce more food in a single time-frame. Shifting cultivation practices in Tripura also reveals an effective form of landuse pattern as they are using limited space for optimum production in a specific time. In the process, a small piece of *jhum* land accomplishes almost all the needs of *jhumias* and

reduces his reliance with other allied activities or external inputs. Besides burning and slashing in the *jhum* plots, other cultural practices are followed like controlling the weeds, soil-borne pathogens and other diseases of crops. *Jhumias* also practice their indigenous religious customs like offering their Gods and Goddesses during harvest. Negligible interventions of synthetic fertilizers and pesticides by *jhumias* in Tripura may lead to protection of soil health partially. Therefore, *jhum* cultivation is having some positive aspects and Govt. of Tripura allows tribal people to do *jhum* to some extent but through improved and modern ways as *jhum* provides base for low external input agricultural technologies.

Negative aspects of jhum cultivation

Problems relating to shifting cultivation through slash and burn are not new in Tripura. As early as 1876, W.W. Hunter in his book, 'Statistical Account of the Hill Tipperah' had marked that the "regression of forests had already started in hills because of shifting cultivation practiced by almost the whole population numbering less than 50000 who were all tribals". *Jhum* cultivation starts with cutting and burning of trees and leads to degradation of forest or deforestation in the hilly areas where they used the land to do *jhum*. Deforestation has negative effects on the environment which ultimately leads to climate change which nowadays a matter of global concern. Deforestation may also affect the flora and fauna existing in the forest. One of the most vital negative environmental impacts of shifting cultivation is the damage that causes to the soil system. It accelerates the soil erosion and nutrient loss manifold. If the total area under shifting cultivation in Tripura is considered 67000 ha, the account of soil and nutrient loss in Tripura annually is presented in table 11.[11]Out of the available nutrients, the loss in thge available nitrogen constitute 40% and the total quantity from 67000 ha of land is 1662 to and such a huge qauntyty annually lost is valued as Rs. 216 lakh in terms of nitrogenous fertilizers. Erosion is slight in soils well covered by dense grasses or forest but is enormous from steep, poorly covered jhum lands as reported in Megaha;laya (Prasad and Sharma, 1994).

Table 10: Soil and nutrient loss in shifting cultivation site of Tripura[11]

Parameters	Soil/nutrient loss (ton)
Soil	49.6 lakh
Organic matter	1.42 lakh
Available nutrients	4154

The second year of *jhum* cycle is comparatively hazardous than the first year from the point of soil erosion. The possible implication of actual soil loss vis-a-vis productivity loss is given in Table 11 (Higgins et al. 1982). Normally soil loss tolerance ranges from 7.5 to 12 t/ha/. These ares are exposed to hazaerds odf intense rains and often on terrains which promotes erosion. However, most of the areas have been under use of centuries and are therefore, subjected to different degrees of degradation. Since 50 t/ha corresponds to a soil depth of reduction of only 3-4mm, soil losses of such magnitude as reported are hardly noticed by the shifting cultivator even they are convinced of their occurrence. The loss ofv 6the top few

millimetres of shallow depth soil, where organic carbon and biological activity are concentrated, may signioficantly decrease soil fertility and crop yield.

Table 11: Relationship between soil erosion and decline in land productivity[11]

Soil loss (t/ha)	Anticipated productivity losses
<12	No change in land productivity
12-15	50% of area of very productive land shows a diminishing trend to productive land, the remainder remains unchanged
50-100	100% of all productive land shows a diminishing trend by one productive class
101-200	50% of the area of all productive land is converted to suitable land, the remainder shows diminishing trend by one productive class
>201	The entire area of productive land is converted to not suitable class

The changes in the soil properties of shifting cultivation sites need to be documented and regularly monitored to bring about an improvement in the areas under the practice of shifting cultivation over the centuries. As such soil samples were collected over a period of 1-3 years in Tripura and were analysed (Datta et al, 2001). Soils were acidic with pH ranging from 4.5 to 5.1 (Table 13). A decline in 0.1 to 0.2 units was registered with the rise in shifting cycle from 1 to 3 years. The exchange acidity varying from 1.95 to 2.51 showed arise from 1st to 3rd year of shifting cycle. Due to the rapid mineralization over the shifting cycle, organic carbon underwent rapid oxidation as noted from the decrease in the values from 7.3 to 6.5 and 8.3 to 6.1 g/kg in soil sites under study. Bulk density remained unchanged but water holding capacity showed a decline from 34 to 32% and 40 to 35% probably to reduction in organic matter and erosion of soil finer soil fraction from the soil matrix. On the other hand, cation exchange capacity (CEC) showed a decreasing trend primarily due to erosive loss of soil clay and organic matter. Exchangeable cations underwent decline with the rise in shifting cycle owing to leaching losses. But base saturation showed an increasing trend mainly due to sharp decline in CEC.

Table 12: Effect of shifting cultivation on soil physic chemical properties[11]

Properties	West Tripura			South Tripura		
	I*	II	III	I	II	III
pH(H_2O)	4.70	4.60	4.50	5.10	5.10	5.00
Exchangeable acidity [c mol (p+)/kg]	2.33	2.30	2.46	1.95	2.31	2.51
Organic carbon (g/kg)	7.30	6.70	6.50	8.30	7.00	6.10
Bulk density (mg/m^3)	1.30	1.30	1.30	1.2	1.30	1.30
Water holding capacity (%)	34	32	32	40	35	35
Cation exchange capacity [c mol (p+)/kg]	4.22	3.86	3.38	4.29	4.20	3.33
Exchangeable cations [c mol (p+)/kg]	0.84	0.76	0.75	1.10	1.37	1.06
Base saturation (%)	20.40	19.90	22.40	25.80	32.10	34.40

*I, II, III, denote 1st, 2nd and 3rd year of shifting cycle

Data on nutrient availability in soils under shifting cultivation are presented in table 13. Available nitrogen status of which varied from high to medium showed a sharp decline with the rise in shifting cycle. Available phosphorus (Bray P/1) was low. Available potassium varying from low to medium also showed a decreasing trend in soils under shifting cultivation. The DTPA extractable Fe/Mn underwent a inconsistent variation but the soil s were found to contain adequate amounts of theses cations.

Table 13: Nutrient availability in soils influenced by shifting cultivation.[11]

Nutrient	West Tripura			South Tripura		
	I*	II	III	I	II	III
N (kg/ha)	589	561	522	567	558	511
P (kg/ha)	1.89	3.59	2.70	4.34	6.21	5.31
K (kg/ha)	150	125	134	259	319	203
Fe (mg/kg)	47	87	49	36	51	53
Mn (mg/kg)	23	20	21	20	20	21

*I, II, III, denote 1st, 2nd and 3rd year of shifting cycle

Besides causing air pollution due to burning, shifting cultivation is responsible for loss of useful soil fauna and microbes. Burning lowers soil acidity, organic matter and total nitrogen, but enhances phosphorus and cations. The maintenance of soil fertility in *jhum* area is a serious problem in places where jhum cycle is very short. These result in declining of *jhum* productivity. So ten years jhum fallow or 10 years cycle is vital for bamboo forest rejuvenation and helps to accumulate sufficient plant nutrients in the field. So minimum 10 years *jhum* cycle maintenance is most importance of recovery for forest eco-system.

5. Key determinants of *jhum* cultivation

Adjustment problem with non-tribes in the settled area: Since tribal are very much fond of God hence they face difficulty for building worship place of a particular religion when there is mixed population. The tribal of Tripura are Hindus, Christians or Buddhists besides other religious group where they live. Socio-economic conditions of the tribal also differ from the other neighbouring non-tribes.

Lack of sufficient attraction towards their colonial home: a. Colonies are not set according to the religion and culture of the tribes. b. Rehabilitation of the tribal family is far away from their original habitat c. Lack of social environment and freedom in the rehabilitation area. d. Lack of special training for plain land cultivation.

Financial problem: Government schemes are not enough to make them financially reliable to stay in the new colony for initial years. According to the rehabilitation schemes in the year 1953-54, each family was allotted 5 acres of arable land over and above a grant of Rs. 500/- for purchasing the essential requirements to support cultivation. Out of this cultivation later on rubber plantation was one of the significant cultivation which was provided to them. But it took at least 7-8 years to turn into a mature productive plant to provide the earning. But they were neither economically strong nor skilled enough to go for an alternative source of earning during that period.

Lack of Proper Education: Available data on dropouts of students in the state revealed existence of educational wastage both at the State and national level. Dropout rate at the primary stage was estimated to be significantly higher in schedule tribes than the general category of pupils and scheduled caste. Same trends were also observed in the middle and secondary stages. This proves the unsteady as well as pathetic conditions of the tribal communities in India.

6. *Jhum* developmental programmes in Tripura

Problems related to shifting cultivation through slash and burn are not new to Tripura. As early as 1876, W. W. Hunter[12] in his book 'Statistical Account of the Hill Tipperah" had remarked that the regression of forests had already started in hills because of shifting cultivation practiced by almost the whole population numbering less than 50,000 who were all tribals". Even successive Maharajas of Tripura were genuinely concerned that the practiced be continued or that the tribals should be drawn to settled agriculture in place of jhum.

Tripura has fairly long history of *jhum* control and *jhumia* rehabilitation programmes.[13] The first plan was drawn up 1953-54 in which each *jhumia* family was allotted 5 acres of arable land and a grant of Rs. 500/- for land development and purchase of essentials to support settled farming. From this period upto 1955-56, the *jhumias* were settled sporadically. From 1956-57 onwards, the approach of resettlement or rehabilitation was on compact colony so that other basic amenities can be provided. Tripura has implemented (and/or is implementing) the following various programmes and schemes for rehabilitation of *jhumias* and *jhum* land, involving at least 8 various departments or agencies of the government (Table 14). Computed from different sources to show indicative achievement. Infact official documentation regarding improved *jhum/ jhumming* for sustainability is meagre if not nil.

Table 14: Summary of *jhum* developmental programmes and achievements in Tripura[4]

Departments/agencies & Schemes/Activities	Achievements			
	Period/ Year	Outlay/ Amount spent (Rs. lakh)	Area covered (ha)	*Jhumia* families benefitted
A. Tribal Welfare Department				
(a) Rehabilitation of landless *jhumias* under settlement programme				
• Rs 500 per family scheme	1955-70	1058.15	--	21163
• Rs 1910 per family scheme	1970-77	1357.82	--	7109
• Rs 6510 per family scheme	1975-85	5724.89	--	8794
• Rs 8000 per family scheme	1985-88	1003.20	--	1254
• Rs 25000 per family scheme	1988-92	--	--	4268
• Rs 30000 per family scheme	1992-97	--	--	4079
• Rs 53000 per family scheme	1997-2000	--	--	904
***(b) Jhumia* settlement scheme based on**				
• Rubber plantation	1999-2004	368.10	--	1472
• Tea Plantation	1999-2004	203.80	--	514

• Coffee Plantation	1999-2004	36.00	--	120
• Horticulture Plantation	1999-2004	270.10	--	900
B. Forest Department				
Rehabilitation of shifting cultivators through				
• Soil and water conservation schemes	1974-83	--	--	641
• NEC assisted schemes	1975-79	--	--	400
• Rubber-based rehabilitation schemes	1983-85	--	--	1185
C. Agriculture Department				
Integrated scheme for improvement of production and productivity of jhum crops (supply of seeds, supply of fertilizer, horticultural plantation in homestead, training of jhumias)	1998-04	184.99	--	6379
D. Horticulture Department				
Watershed Development Project in Shifting Cultivation Areas				
• 8th Five Year Plan	1992-97	360.00	3665	1994
• 9th Five Year Plan	1997-02	649.71	10757	3000
• 10th Five Year Plan (only the first one year)	2002-03	247.40	2474	3635
E. Tripura Forest Development Plantation Corporation (TFDPC)				
Jhumia rehabilitation through rubber plantation (data provided by Tribal Welfare department)	2001-03	14.96	--	60
F. Tripura Rehabilitation Plantation Corporation (TRPC)				
Socio-economic upliftment of tribal jhumias through rubber plantation	--	--	5095.71	3977
G. Tribal Rehabilitation in Plantation & Primitive Group Programm (TRP&PGP)				
(a) Economic development through				
• Teak plantation	1986-02	--	14076	
• Bamboo plantation	2004-05	--	60	11530
• Cashew plantation	1986-98	--	7850	
(b) Intensive rehabilitation of primitive tribes (to wean away from *jhum*)	2004-05	116.30	--	95
H. Autonomous District Council				
(a) Assistance for upland (*jhum*) farming (land preparation, supply of *jhum* paddy seeds, sowing and weeding)	2000-04	497.80	--	*84000
(b)Integrated tribal jhumia rehabilitation through rubber plantation	1998-99	--	1500	1500

*It is likely that many family enjoyed the assistance more than once over the successive four years period under report

In 2007, the Forest Department completed a first-ever Census enumeration of hard core shifting cultivators and found 27,278 families (or 1, 36,000 persons) dependent on *jhum*. The total count shows a clear decline in the number of *jhumia* families. The following table shows a clear cline in the number of *jhumia* families though it has increased from 1968 to 1987 but after that it has declined due to varied Government schemes.

Table 15: Number of households and persons dependent on *jhum*, Tripura, 1968 to 2007

Year	Source of the estimate	No. of households	No. of persons (in lakh)
1968	J.B. Ganguly	25000	--
1978	Benchmark Survey (1978)	46854	2.59
1987	Benchmark Survey (1987)	55049	2.88
1999	Department of Tribal Welfare	51265	--
2007	Forest Department	27278	1.36

Source: TDHR, 2007; pp-37

7. Constraints and challenges in improving *jhum* cultivation system

Challenges of designing innovative programme components: The State Government in the Department of Agriculture is already implementing one model designed with the assistance of Prof. P. S. Ramakrishnan, former professor of Jawaharlal Nehru University (JNU), New Delhi and experts from International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu[4] through Integrated Jhum Development (IJD). However, the fruits of various IJD models continue to evade as many as 40000-55000 families in the State. This perhaps calls for a revisit to entire programme of IJD either lacking practical innovations in design components or delivery mechanisms of the agencies involved.

Challenges of working in an integrated fashion by different agencies: IJD requires a rather total package to address the 'human, social, physical, economical, financial and natural dimension from the perspectives of the jhumias and their livelihoods and livelihood strategies. Best intentions and programmes of the government have not yielded desired results as different departments or agencies involved have been looking the problems and their solution s from the prism of their own departmental perspectives.

Challenges of delivery and implementation strategies: Nearly 50 years of concerted government efforts to *jhumia* rehabilitation through several specialized departments/ agencies seemed to have not yielded the desired results at the pace required. Hence innovative options involving dedicated agencies including local NGOs may be instrumental in requisite delivery and implementation of IJD plans.

Challenges of building a dedicated and motivated team for delivery of IJD: The people and the professional working in the IJD require different mindset and set of orientation. Such kind of programme cannot be effectively and productively delivered through routine system of works and people. The IJD team would require a great deal of sensitivity and ability to put themselves along with the feelings and perceptions of the *jhumias*.

8. Success stories on *jhum* improvement

Under the ten year perspective plan Tripura government has targeted to achieve paddy cultivation in more than 17,000 hectares of hill land under improvised *jhuming* in 2011-12[14]. Before launching ten years perspective plan in the paddy production, *jhum* was only in 10,735 hectares in 1999-2000 and in 2009-10 it was raised to 14,535 hectares and in 2010-11 the *jhum* cultivation area had increased to 16,390 hectares because of modernisation and technological intervention. Besides, per hectare production in *jhum* has also increased to 1.02 MT in 2011-12 against the target of 1.2 MT, which was only 0.5 MT in 1999-2000. Additional production was increased because of the use of scientific methods and fertilisers as per requirement. Use of bio-fertiliser had also increased to 1500 MT in the state as a whole in 2011-12 against the target of only 1200 MT that was only 1.4 MT in 1999-2000.

The success of implementation of ten years perspective plan, which has also been expanded for two more years, the food grains production expected to be 7.52 lakh MT against the requirement of 8.56 lakh MT in 2011-12, which appeared to be a gap of 1.04 lakh MT between demand and supply that would be met up from import but the food grains production of Tripura has increased by 2.39 lakh MT over the past ten years.

9. Strategies and action points for *jhum* improvement

There can be two approaches to successfully manage the shifting cultivation in the states of north-east India. Tripura is a tiny state of north-east India and tribal people are practicing *jhum* cultivation in the hilly parts of Tripura. Considering the socio-cultural importance of *jhum* in the life of the people of Tripura, the befitted strategy could be to modify and improve the *jhum* cultivation in a scientific way using modern agricultural technology to enhance the productivity and meet the necessities of the *jhumias*. On the other hand, the existing forms of *jhum* cultivation may be replaced by new alternative schemes and programmes such as ideal agro-forestry, horticulture landuse, livestock farming, pisciculture, agro-industries, mushroom farming, sericulture, floriculture and piggery farming. While transforming and improving the existing *jhum*, the following aspects must be taken into consideration such as soil and water conservation, maintenance of soil fertility, crop diversity and high yielding seeds, food security, market linkages and deforestation as it is led to the climate change which nowadays a matter of global concern. Following are some of the strategic components with key interventions and activities:

***Jhum cropping phase/ cultivation phase*:**

a) Where *jhum* must continue, increasing the crop yield by providing good seeds/ high yielding seeds, maximizing the cropping period, adopting good agronomic practices along with soil and water conservation measures, etc.
b) Increasing cropping phase from traditional one year to two or more years through crop rotation/ crop manipulation/agronomic practices/green manure/ cover crop (State Agricultural Research Station, Mokokchung, Nagaland has successfully demonstrated that cropping can be carried out continuously for for years maintain both the yield and soil quality/ soil fertility).
c) Inducting Biofertilizer component comprising of Nitrogen Fixers- *Rhizobium*,

Azotobacter, *Azospirillum*, phosphate solubilizers and mobilizers including Arbuscular Mychorrizal Fungi (AMF) in the crop cultivation phases recurrently. Microbial cultures possessing stress tolerant (acid, water) and fire resistant attributes should be considered with priority in this regard.

***Jhum* fallow phase/ forest regeneration phase:**

a) Plantation of fallow areas with multipurpose and multispecies trees for timber, fuel wood, fodder etc.
b) Plantation with useful nitrogen-fixing species such as tree beans (*Parkia roxburghii*), Sajna or Drumstick, *Bahunia* sp., *Sesbania grandiflora*, etc.
c) Plantation with medicinal trees such as Arjun, Bahera, Palash, Hartaki, Amla, Neem, etc.
d) Plantation with NTFPs (primarily bamboo, edible plants, etc.)
e) Plantation with wild fruit trees
f) Development of permanent agroforests with combinations of the above species along with horticultural species/ fruits.
g) Promotion of perennial horticultural species.
h) Maximizing the fallow periods above 10 years.

Jhum homestead gardens:

a) Development of home gardens/ agroforest home (seasonal/off-season vegetables, domestication of wild edible plants, tuber crops for livestock/piggery, bamboo, fodder, firewood, medicinal plants, fruit trees, etc.)
b) Integration with livestock, fishery, apiculture, sericulture, etc.

Jhum lunga land development:

a) Development of valley or lunga land for wet rice cultivation.
b) Water/ rainwater harvesting for irrigation, aquaculture, ground water recharging, etc.
c) Infusion with high yielding paddy verities

Jhum micro-finance and non-farm sector with market linkage:

a) Development of microfinance/micro-credits (individuals or groups, particularly for women and youth for enterprise development, self employment, etc.)
b) Development of handloom, handicrafts, food processing, value chain development and market linkages, enterprise development, business development, etc.

Jhum institution development and capacity building:

a) Organizing the communities and building the social and human assets and capacities of the communities with special focus on women and youth
b) Training and skill development for different alternative livelihoods and livelihood strategies
c) Slaso awareness and capacity building of the traditional community leaders village councils etc. (social engineering)

Jhum knowledge management:

a) Innovations and lessons learned and unlearned must be constantly identified,

documented, shared and disseminated between/ among the communities, the programme implementers, government departments, development planners and practitioners, policy makers, academia, civil society organizations, media and various other stakeholders.

10. Conclusion

Programmes aimed at arresting or eradicating shifting cultivation in the Northeast had been underway since the start of the 20th Century. Initially these programmes were based on the assumption that the introduction of cash crops would help to wean people away from *jhum*. *Jhumias* were given planting material and financial help to switch over to these crops. Coffee, pepper, and rubber plantations achieved some success. However, it was soon realized that cash crop cultivation couldn't be adopted as an alternative to *jhuming* which people practice mainly to meet their essential food requirement.[15] Furhter, *Jhumias* are unable to shift overnight to plough agriculture from hoe agriculture, and only the better-off families can afford to hire the additional labour needed for transplanting and maintaining of terraces. Schemes to resettle *jhumias* by distributing marginal lands for permanent cultivation in Tripura have lead to greater indebtedness, land alienation and impoverishment of the resettled families.[17] A series of research projects on the agro-ecological systems of the Northeast has led to a shift in emphasis in recent years from *jhum* control to *jhum* management, more specifically, to the management of fallows.

The setting up of the task force marks a significant departure from the approach of earlier reports dealing with forests and shifting agriculture. It cites the unique socio-economic conditions of the different tribal communities as reasons for 'precluding uniform prescriptions and requiring the development of location-specific solutions' to deal with the problems currently affecting *jhum* cultivation.[18]

The major constraints identified by the report are: lack of coordination between different line departments and inexperience of extension staff in 'participatory development' techniques, lack of service facilities such as credit, input supply and marketing; and lack of scientific analyses of farming systems in different locations and micro-climatic conditions. It expressly seeks to dispel the notion that large-scale erosion is chiefly caused by shifting cultivation and takes the view that land use based on long periods of fallow rotation is a sustainable model. By stressing people's needs and avoiding the 'one size fits all' approach this report could well be a first step towards sensitizing governmental agencies to the special needs of the hill tribes and evoking better appreciation of the unique features of the various farming systems developed in the Northeast.

References:

1. Sharma, T.C. 1976. The pre-historic background of shifting cultivation. In Proceedings of Seminar on Shifting Cultivation in North East India. New Delhi: Indian Council of Social Science Research.
2. Saigal O. (1978) Tripura: Its History and Culture, Concept Publishing Company, New Delhi

3. https://www.slideshare.net/Indraneeltu/socioeconomic-profile-of-shifting-cultivators-of-tripura (Last visited on 10. 11. 2017)
4. Darlong V. T. 2012. Shifting paradigm on shifting cultivation: revisiting challanges and oiptions for transforming 'Lives, landscapes and livelihoods'in Tripura from the experience of NERCORMP-IFAD in Northeast India. In: Shifting cultivation in Tripura (ed. Devvarma NC), Tripura Research and Cultural Institute, Govt. Of Tripura, pp66
5. State Agriculture Research Centre, Department of Agriculture, Government of Tripura, Agartala (2005)
6. Bhattacharjee P.R. 'Sociological Aspects of Resource Use Pattern in Tripura: An Analysis in Historical Perspective', Tui (A Quarterly Research Magazine on Tribal Life and Culture), September- November, Vol.III, 1993.
7. Bhattacharjee, P.R. and Ganguli, J.B., 'Relative Economic Status of Social Groups: A Study in Inequality', Journal of North-East Council for Social Science Research, Vol. 17, No.2, October 1993.
8. http://www.yourarticlelibrary.com/cultivation/shifting-cultivation-cropping-patterns-jhum-cycle-and-problems (Last visited on 10. 11. 2017)
9. Personal communication with Department of Agriculture, Govt. Of Tripura, Agartala
10. http://agri.tripura.gov.in/APY(Last visited on 10. 11. 2017)
11. Datta M and Singh N. P. 2012. Shifting paradigm on shifting cultivation: revisiting challanges and oiptions for transforming 'Lives, landscapes and livelihoods'in Tripura from the experience of NERCORMP-IFAD in Northeast India. In: Shifting cultivation in Tripura (ed. Devvarma NC), Tripura Research and Cultural Institute, Govt. Of Tripura, pp66
12. Hunter W. W. 1876. Statistical Account of the Hill Tipperah (Reprint).
13. Dev Varman S. B. K. 1971. A study over the jhum and jhumia rehabilitation in the Union Territory of Tripura. Directorate of Research, Department of Welfare for Scheduled Tribes & Scheduled Castes, Government of Tripura, Agartala.
14. http://www.theshillongtimes.com/2011/12/07/tripura-practises-jhum-in-17000-hectares-for-paddy/
15. L. Rinjah, 'Land Use Pattern – Jhumming and Control, Settled and Terraced Cultivation with Related Problems,' in T. Mathew (Ed.), (1981), *North Eastern Hills Regions of India – Problems and Prospects of Development*. New Delhi: Agricole Publishing Academy
16. Anthony Patton (1981), '*Socio-Economic Impact Of Shifting Cultivation Control Schemes In Nagaland - A Case Study Of Baghty In Wokha District,*' Pp 38-40. in T. Mathew (1981, Ibid.)
17. Tripura Statistical Department: 18th Round of NSS (1963-64). Indebtedness of Scheduled Tribe Households in Tripura. In J.B. Ganguly, 'Progress of Jhumia Rehabilitation in Tripura: a critical review,' in T. Mathew (1981, ibid.)
18. MoEF 2003, p.10
19. Ibid, p.14

REJUVINATION OF *JHUM* LAND THROUGH AGROFORESTRY INTERVENTIONS

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Agriculture has evolved from hunting and food gathering to modern input driven intensive farming during the last 10,000 years. Hunting, shifting cultivation and pastoral nomadism preceded settled agriculture. Shifting cultivation is still prevalent in many tropical countries more particularly on the hills upto 1500 m above sea level. The core activities of shifting cultivation involves periodic shift to new land as the fertility of original patch is exhausted. The location specific variations in crop husbandry, cultivations practices, benefit sharing etc were deeply influenced by the local cultural values, production constraints, constraints of labour, capital and requirements, physiography, and associated ecological conditions. Most of the variants were aimed at making the food production sufficient to meet the demand of the surrounding population. It was practiced by our ancestor's 10-12 thousand years ago, but it is still source of food for millions of farmers from Asian, Africa and Latin America. Globally, over 300 million people practice shifting cultivation over more than 400 million hectares (cf Teegalapalli, and Datta, 2016). It has been a successful adaption in difficult environmental conditions in tropics particularly when the rotation is kept 15-20 years. This is a natural way of utilizing vegetative means for replenishing soil fertility instead of costly chemicals and organic matter applied externally in more developed settled agriculture. It was most naturally adopted and adapted farming in the limitations of communication, nonexistence of alternative means of soil nutrition like chemical fertilizers and compulsion of meeting all the food, fiber, fodder, fuel needs from the field itself and availability of forest land was plenty because of very low population density.

The local adaptations of the Shifting cultivations were heavily influenced by the community structure and cultural life of the tillers. Therefore it was an ecologically sustainable form of agriculture in the montane region of the tropics when population densities was low and fallow periods were long enough to restore soil fertility to support crop production for the community. These traditional food systems, previously existing in ecological balance with their environment, are now breaking down under pressure of population expansion and increasing demand. The immediate adoption of increasing population was area expansion and reduction of fallow period. Initially, when the population pressure increases, the fields are tilled more frequently reducing the fallow period as shifting of fields to distance from the habitation has a maximum limit beyond which it is not physically possible to continue access and do cultivation. Then starts the trend of cultivating more area having less soil fertility, so that the food demand of the community is met with. This cycle of fertility degradation leads to development barren and degraded land on which cultivation is no more economically viable. This was the major contributing factor for land degradation resulting in migration and threatening livelihood of the Jhumias. In the search for solutions to the problems of shifting cultivation, attention has turned to agroforestry. Since shifting

cultivation is a type of agroforestry, scientific agroforestry is not so much an 'alternative' to shifting cultivation as a systematic approach to the reintegration of its basic elements into more productive, sustainable and politically viable forms of land use, under pressure of population and competing uses for land and labour (Raintree and Warner, 1986).

Shifting cultivation in North Eastern Hill States of India

Northeast India is situated at the confluence of Indo-Malayan, Indo-Chinese and Indian biogeographical realms and as a result of this the region harbours rich and diverse culture and high biodiversity and endemism. It is one of 12 mega biodiversity hotspot of the world and represents 50 percent of Indian biodiversity (Mao and Hynniewta, 2000). Seven hill states that include Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura are collectively referred to as North Eastern Hill region. It is located between of 21°58' to 29°30'N latitude and 88°58' to 97°30' E longitude and is spread over 1, 83,741 km^2 area. Climate of the region varies from tropical to alpine type with very high range of variation in precipitation. Shifting cultivation is predominant in the midhills upto 1500 m altitude. It has been practiced over 9000 years and said to have been originated in the Neolithic era dated by the archeologists to 7000 B.C. (Maithani, 2005). The area under Jhum cultivation and its change in recent past is presented in Table 1

Table 1. Area (km^2) under shifting cultivation in different states of the NEH region

States	TGA (km^2)	1999	2003	2005	2008
Arunachal Pradesh	83743	2300	1613.13	1531.46	2039.56
Assam	78438	1300	--	239.56	395.19
Manipur	22327	3600	4816.68	852.2	471.63
Meghalaya	22429	1800	743.83	448.99	540.63
Mizoram	21081	3800	4017.41	2617.56	1662.08
Nagaland	16579	3900	1917.9	2827.74	2357.42
Tripura	10486	600	395.26	254.11	102.19
Sikkim	7096	0	0	0	0
Total	**262179**	**17300**	**13504.21**	**8771.62**	**7568.7**

Source: Wasteland Atlas of India 2005, 2011and SFR 1999

The region is inhabited by more than 200 indigenous tribes having diverse lifestyle, cultural ethos and multiple ethnicities resulting in multidimensional pressure on the natural resources. Some of the major tribes of North East Region of India are presented in Table 2.

Table 2. Major Tribes of the North Eastern Region of India

State	Tribes
Arunachal Pradesh	Adi (ashing, Bogun, Bokar, Bori, Botog, Gallong, Komkar, Karka, Lodung, Milang, Minyong, Padam, Pailibo, Pangi, Ramo, Shimong, Tangam), Aka, Apatani, Bangani, Khamba, Khuwa, Memba, Miji, Hillmiri, Mishing/Miri, Mishmi, Monpa, Na, Nishi, (Dafla) Nocte, Sherdukpen, Sulung, Singpho, Tagin, Tangsa, Wancho, Yobin, (Lisu) Zakhring (Meyor).

Assam	Chakma, Dimasa, Garo, Hajong, H'mar, Khasi, Jaintia, Synteng, Pnar, War, Bhoi, Lyngngam, Kuki tribes-including (biate, Changsan, Chongloi, Doungel, Gamalhou, Gangte, Guite, Hanneug, Haokip, Hampit, Lhonyen, Lhochwun, Lupheng, Mangje, Misao, Riang, Sairhem, Selnam, Singson, Hoalai, Hengna, Hoangsungh, Hrangkhwal, Raokhol, Tongpe, Khawathlang, Khothalong, Khawchung, Khelma, Kholhou, Kipgen, Kuki, Lengthang, Lhangum, Lihougem, Lhouvum, Misao, Sairhem, Selnam, Sitlhou, Sukto, Thasou, Thangngeu, Uibush, Vaiphei), Lakher, Man (Tai speaking), any Mizo (Lushai) Tribes, Mikir, Nay Naga tribes, Pawi, Barmans in Cachar, Boro, Borokachari, Deori, Hojai, Kachari, Sonowal, Lalung, Mech, Miri, Rabha
Manipur	Aimol, Anal, Angami, Chiru, Chethe, Gangte, H'mar, Kabui, Kacha Naga, Koirao, Koireng, Kom, Lamgang, Mao, Maram, Maring, Any Mizo (Lushai) tribe, Monsang, Monyon, Paite, Purum, Ralte, Sema, Simte, Suhte, Thangkhul, Thadou, Vaiphei, Zou.
Mizoram	Chakma, Dimasa Kachari, Garo, Hajong, H'mar, Khasi, Jaintia, War, Any Kuki (Biate, Changsan, Chongloi, Doungel, Gamalhou, Gangte, Guite, Hanneug, Haokip, Hanpit, Lhonyem, Lhocwun, Lupheng, Mangje, Misao, Riang, Sairhem, Selnam, Haolai, Hengna, Hongsunh, Hrangkhwal, Roakhol, Tongbe, Kghawathlang, Khothalong, Khawchung, Khelma, Khoihou, Kipgen, Kuki, Lengthang, Lhangum, Lhoujem, Lhouvum, Misao, Riang Sairhem, Selnam, Singsom, Sitlhou, Sukto, Thado, Thangngeu, Uibush, Vaiphel) Lekher, Man (Tai speaking), many Mizo (Lushai tribe), Karbi, many Naga tribe, Pawi.
Meghalaya	Bhoi, Boro, Chakma, Dimasa, Hajong, H'mar, Jaintia, Karbi, (Mikir), Khasi, Koch, Kuki, Lakher, Lyngngam, Man (Tai speaking), Naga, Pawi, Rabhi
Nagaland	Adi, Aka, Dimasa, Galong, Garo, Khasi and Jaintia, Khowa, Kuki, Karbi, (Mikir), Mizo, Any Naga tribe (Ao, Angami, Chakhesanf, Chang, Chiru, Khliemnungan, Konnyak, Lotha, Makwari, Phom, Rengma, Sangtam, Sema, Tikhir, Yimchungree, Zeliang, Synteng, Momba.
Tripura	Bhil, Bhutia, Chaimal, Chakma, Garo, Halam, Jamatia, Khasia, Kuki, including following sub-tribes (Baite, Belalhut, Chhalya, Fun, Hajong, Jangtei, Khareng, Khephong, Kuntei, Laifaung, Lentei, Mizel, Namte, Paitu, Paite, Rangchan, Rangkhole, Thangluya) Lepcha, Lushai, Mag, Munda, Kaur, Noatia, Orang, Riang, Santal, Tripuri, Tippera, Uchai.
Sikkim	Lepchas, Bhutias, Limbu

Jhum cultivation in the North East region is a complex system with wide variation that depends upon the ecological variation in the area and cultural diversity among various tribal clans. However, the basic cropping practice is quite similar. Usually all the essential crops such as paddy, maize, tapioca, colocasia, millets, sweet potato, ginger etc. are grown on the

same piece of land as mixed crop. Poor soil conditions, use of elementary tools such as axe and the hoe, low density of population in the region and low level of consumption are the distinctive feature of jhum cultivation. Generally shifting cultivation is characterized with low productivity, extensive land requirement and degradation of natural resources. This traditional system of farming is characterized by high crop diversity and good productivity especially in first two years.

Though jhum it is primarily an economic activity performed for production for crops, however, it is also integrated with socio-cultural and religious activities of tribal populations. Jhumias basically belief in spiritual quality of nature and they believe that supernatural power controls forest, land, soil, fertility and health of farmers as well as animals. They perform rites and ritual and offer animal sacrifice to please the spirit. Every stage of jhum cultivation is accompanied by ritual and feast. Even the major events of life such as marriage, festivals, house construction are directly or indirectly adjusted to jhum cultivation and villager's emotions and sentiments are interwoven with jhum. Before starting jhum, farmers perform rituals for seeking apology for damaging plant and animals in the process of burning of jhum field. This ritual shows the concern of farming community toward biodiversity conservation. Some areas with high endemic biodiversity are declared sacred groove and practicing jhum in these areas is totally prohibited. Nishis (a major tribe of Arunachal Pradesh), believe that Sengri and Sengne (*Ficus* sp.) are abode of Wiyus (spirit) and to cut them is tabooed. In some areas Meghalaya, during cleaning of forest vegetation is partial short tree stump and large tree bole are kept intact to stabilize the slope, reduce soil erosion and to be used as support for the climber crops. Trees belonging to *Schima wallichii, Calicarpa arborea, Castanopsis tribuloides, Gemlina arborea* and *Eurya japonica* are left over during cleaning the field. Bamboo used as soil binder facilities soil nutrient recovery and creates microhabitats of shade loving species (Rao and Ramkrishanan, 1989). In few instances farmers are planting *Bambus tulda*, *Toona ciliata*, *Duabanga grandifolia* and *Manihot esculenta* along the boundaries of shifting cultivation fields and fruit trees such as *Artocarpus chaplasha*, *Citrus* sp., *Litchi chinensis*, *Mangifera indica*, *Myrica esculanta*, *Prunus nepalensis* and *Musa* sp. in jhum plots (Deb et al, 2013). If we look at larger prospective, this traditional farming has allowed tropical forest to survive or at least regenerate where as settled agriculture has destroyed the forest completely.

In Garo tribe, more than 10 festival and rituals are associated with jhum cultivation (Marak, 2006) which starts from site selection to final harvesting and storing the produce. Similarly, in Khasi tribe, inhabiting khasi hills of Meghalaya, prayers are performed before burning the forest (Mini Rokime), during sowing to drive away crop diseases (Mi Amua), at the time of first harvest (Rongchu gala-fowl is scarified before deity), and after harvest of jhum field (Ja Megapa). In Jaintia tribe, inhabiting jaintia hills of Meghalaya, Longhai festival is celebrated during weeding period in millet. In all other states of north east India also various festivals are associated with jhum cultivation. In Nishis, a major tribe of Arunachal Pradesh, major festivals revolve around jhum. Before starting cultivation, Mnyokom- Yulo is celebrated and

vaiours deities such as Yapom (god of jungle), Yulo, Tangang-Yulo and Regeu-Yulo (gods of agriculture) are invoked to protect crops from diseases, insects and wild animals. After the harvest Sirom Molo Sochum festival is celebrated in the month of Rojo (December). Similarly, in kukis of Manipur KheLhai-Khai ceremony, Athusian ceremony, Tuilunta ceremony, Muchitu ceremony and Mim Kut, Lohan Kut and Chapchar Kut etc. are associated with jhum. This amazing and colourful traditional farming system is also associated with traditional knowledge of plants. Mao tribe inhabiting northern hills of Senapari districts of Manipur, are able correlate the flowing of different trees as indicator of seasons and accordingly important jhum activities are planned (Mao and Hynniewta, 2010). Rice, Millets etc. are planted in Jhum field with the onset of flowing in Kachnar tree (*Bauhinina purpurea*) locally known as camel foot in Mao tribe. Similarly, *Prunus carmesina* (wild cherry) and *Prunus persica* (peach) fruit trees flowers in March, and flowering of these trees is considered as appropriate time for direct sowing upland paddy in jhum field and lowland paddy in nursery. *Mantisia spathulata* plants, locally known as dancing girl, flower every year in May and flowering is not affected by environmental factors. Mao people consider flowering of dancing girl as right time for transplanting of rice seedlings in lowlands.

Therefore it is essential to give due consideration to the cultural values and local traditions of the Jhumias while devising any strategies to improve productivity of such lands. The approach should adopt *Integral* systems that should stem from a more traditional, year round, community-wide, largely self-contained, and ritually-sanctioned way of life.

Agroforestry Systems suitable for enhancing productivity and reducing fallow period of Jhum land

Alder based system in Nagaland

The Angamis tribe from Nagaland used to practice such a alder based sustainable jhum system that was developed in Khonoma village in Nagaland. It provides about 57 food crops to supplement the staple crop rice. The root nodules of the Alder (*Alnus nepalensis*) plants improve soil fertility by fixing atmospheric nitrogen into the soil through *Frankia*. The fallen leaves act as mulches and add humus to the topsoil. The wood is used as fuel-wood, for charcoal burning and in construction works. Alder saplings collected from nursery or wild forest are planted in a *jhum* field located in hills above 1000 m. In the first year in *jhum* plots, alder trees are pollarded at a height of 2 m from the ground before or after the slash and burn operation. Mixed cropping is repeated in the second year. The field is then left fallow for 2-4 years to allow the alder trees to grow for pollarding and cropping in the subsequent cycle. Young trees with bole circumference of about 50-80 cm are pollarded for the first time, usually at the age of 7-10 years. Cyclical/subsequent pollarding is performed after 4-6 years. During this operation, the pollarded stumps that coppice profusely are allowed to grow till the harvest of the first year's crop. On the second year, 4-5 selected shoots are retained and the rest is removed. These shoots are allowed to grow till the next *jhum* cycle and the same process is repeated. Thus with the incorporation of alder trees in their *jhum* lands, the fertility of the field is increased (Singh et al, 2013).

Tree based farming by Konyak Tribes in Nagaland

The Konyak tribes in Nagaland also have sound ecosystem knowledge which they use in their shifting cultivation practices. In a study in the Nganchin village of Mon district of Nagaland. It was observed that the tree-stand- density nowhere in the Naga system matches the Konyak system where at times about 3000 small saplings could be observed in 1 ha of land. They gradually reduce the density during the fallow period. They manage the seedlings and saplings of *Macanaga denticulata* on the Jhum field and do not uproot them unless the density is too high for cropping. The species grows in poor site conditions and has prolific regenerative activity. Konyaks and the other tribes of Nagaland also keep the trees such as *Trema orientalis*, *Sapium bacatum*, *Grewia spp*., *Quercus spp*., *Schima wallichii* and *Alnus nepalensis* in the Jhum fields. In the Konyak Jhum field about 42 species could be seen; rice and colocasia being the dominant ones. They have a sound knowledge of mixing rice and colocasia by which the slopy land is covered under vegetation for a greater part of the year i.e. from April to December. Mixed cropping of rice and colocasia is also practiced by Garo and Khasi tribes of Meghalaya and they cultivate colocasia as a supplementary crop. But, Konyaks grow both the crops as their main crop to meet their food requirements. The common rice varieties cultivated by the Naga tribes are Tangyu, Yamsam, Phuha (Brown rice), Yam, Wungshu, Seshu, Tangyu seshu, Tatak and Tanyak (Black rice). As much as thirteen types of colocasia such are grown by the Konyaks. Some of the importants ones are Isee, Maywu, Mukshung, Yangshing, Tungmi, Nyakha, Tung, Yakpe, Ngaktung, Tunglu, Tungyey, Tungshu and Tungkhan. However, with grater urbanization and changing food habit, the area under certain crops such as Jobstear and some varieties of rice like Yam and Phuwal. The Konyaks have a good sense of fallow management and aware that the leaves and twigs falling from the trees restores the fertility of the Jhum land. They count the number of leaf falls and believe that after seven times 'leaf fall' the land becomes mature enough to cultivate. That is why they keep the fallow period as seven years and deliberately keep the seedlings of tree species for establishment during the resting phase. They religiously protect the jhum lands from fire during the fallow period. If some accidental fire occurs, the fallow period is extended. This shows the great sense of ecosystem among the Konyak tribes (Bhan, 2009).

Bun System in Meghalaya

In Khasi hills of Meghalaya, shifting cultivation is known as "Rep Syrti". Shifting cultivation or Rep Syrti practices are of two types- jhumming and bun cultivation. Jhumming involves cutting and burning of forest vegetation on slopy lands and using the site for two to three year for growing rice, maize, millets, beans, cassava, yam, sweet potato, ginger, chillies, sesamum and vegetables in mixture thereafter moving to a forest site for repeating the same process . At times, a single crop of rice is grown in the second year of jhumming. In Bun cultivation, twigs and branches of forest trees species such as *Pinus kesiya*, *Schima wallichii*, *Michelia* species at lower elevations, and *Schima khasiana* in higher elevation along with weed biomass (*Artimisia vulgaris*, *Crotolaria mysorensis, Eupatorium odoratum*, *E. adenophorum, Imperata cylindrical*, *Inula capa*, *Lantana camera*, *Micania macarantha*,

Panicum khasianum, *Plectranthus coetsa*, *Rubus ellipticus*, *Saccharum spontaneum*, *Pteridium aquilinum* from the surrounding areas are kept in heaps at regular interval in the entire area. The buns are usually 2 to 4 m long, 1 to 2 m wide and 0.15 to 0.35 m in height. They are spaced at 1 to 2 m depending on the soil depth and are covered with a thin layer of soil in order to burn the whole biomass under anaerobic condition and finally the biomass is slowly converted into ash. The activity is usually done during Feb to March

Traditional Agroforestry systems

In the NEH region, trees are deliberately integrated with the crop and livestock production system. A number of crops like maize, ginger, pineapple, coffee, and vegetables are grown with tree species such as *Pinus kesiya*, *Alnus nepalensis*, *Schima wallichii*, *Pyrus communis*, *Prunus domestica*, *Areca catechu* etc. The choice of a particular tree species and intercrop depends upon the climatic conditions of the area and economic importance of the species. Some of the traditional agroforestry systems adopted in the various agroclimatic zones are given below in Table 3 .

Table 3. Common agroforestry practices of the NEH region

Agroclimatic zone	Agroforestry System	Components of Agroforestry	Remarks
Mild Tropical Hills to mid hill subtropical and Plains (200 to 900 m)	*Agri-horti system*	*Citrus grandis* +Maize	
		Orange with crops	Intercrops viz. beans/chillies/ginger /turmeric
	Agri-silvi	*Lagerstroemia speciosa* + Paddy	
		Bambusa pallida (boundary plantation) + Paddy	
		Schima wallichii + Paddy	
		Michelia oblonga + Paddy	
		Michilia champaca + Paddy	
		Pinus kesiya + Paddy	
	Agri-silvi-horti system	*Pinus kesiya* + Turmeric + Maize	
		Bambusa pallida + *Erythrina indica* + Maize + Sweet potato	
	Homestead gardens	Guava, banana and *Moringa*	Tree tomato (*Cyphomandra betacea*), guava, banana and *Moringa* are the fruit crops grown in kitchen garden or farm boundaries.
		Coconut, arecanut, jackfruit and banana etc. around fishponds near homesteads	-
	Horti-pastoral system	*Musa paridisica* + Broom grass	
		Musa paridisica + Citrus reticulata + Setaria + Broom grass	

	Horti-silvi	*Schima wallichii* + Ginger + Colocasia + Chilli + *Dioscoria* + Pumpkin + Sweet potato	
		Michilia oblonga + Ginger	
		Erythrina indica (boundary plantation) + Ginger + Colocasia + Lady's finger+ Sweet potato + Chilli + Perilla	
		Bambusa pallida (boundary plantation) + Paddy + Ginger+ sweet potato + Chilli + Tapioca + Lady's finger's + Colocasia + Perilla	
		Michelia oblonga + Pinus kesiya + Ginger + Chilli + Colocasia + Perilla + Maize + Turmeric	
		Erythrina indica with coffee and black pepper	-
		Terminalia myriocarpa with coffee and black pepper	-
		Schima wallichii + Ginger + Colocasia + Chilli + Dioscoria + Pumpkin + Sweet potato	
		Pinus kesiya + Ginger	
	Multi-tier horti system	Arecanut with betel vine	-
		Arecanut with pineapple	-
		Arecanut with pineapple and betel vine	-
		Arecanut with black pepper	-
		Arecanut with pineapple and black pepper	-
		Banana with pineapple	-
		Artocarpus heterophyllus + *Litchi chinensis* + Ginger + Colocasia + Maize + Bottle guard	
		Artocarpus heterophyllus + *Litchi chinensis* + *Areca catechu* + Betel vine	
		Musa paradisica + Pineapple	
		Areca catechu + Pineapple	
	Silvi-horti	*Acacia auriculiformis* + Pineapple	
		Acacia auriculiformis + Schima wallichii + *Musa paradisica* + Pineapple	
		Pinus kesiya + Ginger	
	Silvi-pastoral system	*Schima wallichii* + Broom grass	
		Michelia oblonga + Broom grass	
		Michelia champaca + *Schima wallichi* + *Pinus kesiya* + Broom grass + *Setaria*	

	Sericulture-based farming Bamboo-based farming	*Morus laevigata, Terminalia sp. Chimonobambusa sp., Dendrocalamus sp., Bambusa sp., Drepanostachyum intermedium, Himalayacalamus falcomeri, Phyllostachys bambusoides.*	Pulses, oilseeds, broom grass, millets oat. Tender bamboo shoots collected, ginger, turmeric, large cardamom, rice bean (up to 11 to 15 m from bamboo rows)
	Agri-horti system	Sikkim mandarin with field/vegetable crops	(i) Maize-wheat (ii) Maize + ginger/buck wheat/millet/pulses/ vegetable/beans/ radish/hara simbi/ricebean (iii) Maize+ soyabean/ millet (iv) Ginger/rice bean (v) Maize/sweet potato/millet/buck wheat/ vegetable beans/radish
		Pyrus communis + maize + cabbage + cauliflower	
		Citrus reticulate + Turmeric + Ginger + Mustard	
		Citrus grandis + Maize + Turmeric + Cauliflower + Mustard leaf + Potato	
	Agri-silvi-pastoral	*Alnus nepalensis, Schima wallichii, Prunus cerasoides, Terminalia myriocarpa, Castonopsis tribuloides, Litsea polyantha, Macranga denticulate, Ficus sp.*, broom grass.	Maize, wheat, pulses, buckwheat, oilseeds, beans, finger millet.
	Homestead	*Sikkim mandarin, lime Ficus sp., tree tomato (Cyphomandra betaceae), guava, pear, pomelo, papaya, pomegranate, avocado, banana, Urtica sp., Artemisia s*	Vegetables, passion fruit, gladiolus, tuberose, marigold, orchids, sugarcane, pig, poultry, cattle, goats, ducks, wild edibles-ferns, nettles, fishery, mushroom, apiary.

II. Sub-tropical Hills to sub temperate hills and Plains (900 to 1500 m)	Horti-silvi system	*Alnus nepalensis*/ *Schima wallichii* with large cardamom	-
		Schima wallichii with pineapple	-
		Schima wallichii with ginger/turmeric	-
		Alnus nepalensis, Schima wallichii, Macranga pustulata, Albizia sp., Machilus edulis, Saurauia nepalensis, Terminalia myriocarpa, Juglans regia	Large cardamom (Amomum subulatum Roxb.)
		Alnus nepalensis, Schima wallichii, Macranga pustulata, Albizia sp., Machilus edulis, Saurauia nepalensis, Terminalia myriocarpa, Juglans regia	Large cardamom (Amomum subulatum Roxb.)
	Multi-tier horti system	Khasi mandarin with pineapple/vegetable crops	Mandarin with pineapple/ beans/ radish / ginger/ turmeric/ cole crops etc.
III. Sub-temperate - Temperate (1500 to 2700 m)	Horti-Pastoral system	Pears with vegetables/beans / broom grass	Pears with cabbage, cauliflower, beans or broom grass.
	Horti-silvi- pastoral	Apple, *Juglans regia, Alnus nepalensis, Prunus nepalensis, Quercus* sp., *Betula alnoides, Acer* sp., *Hippophae salicifolia*	Maize, millets large cardamom, potato (table and seed), peas, cabbage, cauliflower, beans, radish.
	Horti-silvi system	Pine with field/vegetable crops	Pine trees with pea, radish, potato, sweet potato, cabbage, turnip, cauliflower, mustard or maize.
		Plums with vegetables	Plums with pea, radish, cabbage or cauliflower.
	Livestock-based mixed farming	*Betula uitlis*, *Acer* sp., *Imperata cylindrica*, *Arundinella* sp., *Avena* sp., *Eleusine* sp., *Setaria* sp., *Rubus* sp., *Viburnum erubescens*, *Berberis* sp., *Urtica* sp., *Artemisia* sp.	Goats, pig, sheep, poultry, nomadic herds of yak (dzo's)
	Multi-tier horti system	Apple with field/ vegetable crops	Apple + potato
Sub-alpine to Alpine (2700 to 4000 m)	Horti-pastoral-transhumance	*Quercus* sp., *Acer* sp., *Betula utilis, Sorbus* sp., *Carex* sp., *Trisetum* sp., *Eragrotis* sp., *Aralia* sp., *Allium* sp., *Iris* sp.	Radish, peas, potato, beans, maize, cabbage, cauliflower,

			Brassica juncea var. *ragosa*, yaks (dzo's) sheep, goats, mules
	Livestock-based mixed farming (beyond timberline) - transhumance	*Poa* sp., *Agrostis* sp., *Carex* sp., *Gentiana* sp., *Rumex* sp., *Phlomis rotate*, *Urtica dioca*	Potato, cabbage, peas, *Brassica juncea* var. *ragosa*, yaks (dzo's), sheep and mules.

Source: Chauhan and Dhyani (1990, 1991), Bhatt et al (2006);

Banana based agroforestry in Mizoram

Banana is a preferred crop in most parts of Mizoram. In the *Khumtung* and *Baktwang* village, people have a belief that planting banana would protect them against all the natural calamities and misfortune besides giving them good economic prosperity. Along with Banana other annual crops, leafy vegetables like Lai Pata are grown. Now a days, people are also raising few of the fruit crops like lemon and orange (Sahoo, 2007).

Some of the MPTs suitable for agroforestry systems of the north east region are listed below:

Table 4. Important multipurpose tree species suitable for farming in different agrforestry systems

Plant species	Altitudinal distribution (m asl)	Important uses
MPTs		
Aesculus assamica	500-900	Fuel, small timber, fast growing
Albizia chinensis	700-1500	Fuel, fodder, timber, N_2 fixing species fast growing
A. lebbek	350-800	Fuel, fodder, timber, N_2 fixing species fast growing
A.procera	400-700	Fuel, fodder, timber, N_2 fixing species fast growing
Alnus nepalensis	700-2500	Fuel, fodder, timber, N_2 fixing species fast growing
Altingia excels	750-2100	Fuel, fodder, timber, fast growing
Anogeissus acuminate	800-1300	Fuel, fodder, timber, slow growing
Anthocephalus chinensis	400-900	Fuel, fodder, timber, fast growing
Artocarpus chaplasha	500-1500	Fuel, fodder, timber, fast growing
Bauhinia variegate	650-1500	Fuel, fodder, ornamental, fast growing
Castonoptis indica	650-1950	Fuel, timber, slow growing
Chukrasia velutina	200-1400	Fuel, timber, fast growing
Cordial dichotoma	550-1500	Fuel, fodder, fast growing
Debregesia salicifolia	700-1800	Fodder
Duabanga grandiflora	150-800	Fuel, fodder, timber, fast growing
Exbucklandia populnea	900-2400	Fuel, fodder, small timber
Ficus altissima	700-1200	Fodder, fuel, fast growing
F.curtipes	600-1000	Fodder
F.cyrtophylla	500-900	Fodder
F.elmeri	600-1200	fodder
F.gibbosa	1000-1800	Fuel and fodder
F.glomerata	700-1800	Fuel, fodder, figs edible, fast growing

F.hirta	650-1350	Fodder, fast growing
F.hispida	600-1300	Fuel, fodder figs edible fast growing
F.hookerii	700-1500	Fuel, fodder, fast growing
F.oligodon	600-1400	Fodder, figs edible
Fraxinus floribunda	1500-2700	Light timber, ornamental, fast growing
Gmelina arborea	350-1200	Fuel, fodder, timber, fast growing
Kydia calycina	500-1200	Fuel, fodder, timber slow growing
Largerstroemia speciosa	250-1950	Fuel, fodder, timber
Litsaea polyantha	400-900	Fuel, fodder, small timber, fast growing
Livistonia jenkinsiana	500-1100	Leaves for roof making, new apical as broom, fruit pulp edible
Macaranga denticulate	800-1350	Fuel, fats growing
Mesua ferrea	350-1700	Fuel, fodder, timber, avenue tree
Michelia champaca	200-900	Fuel timber fast growing
M. doltsopa	1500-2400	Fuel, timber
Moringa oleifera	100-800	Fodder tender pods edible fast growing
Morus alba	250-1200	Fuel, fodder, sericulture, light timber, fast growing
Parkia roxburghii	500-1500	Tender pods edible light timber fast growing
Pinus kesia	800-2500	Fuel timber slow growing
Prunus cerasoides	800-1500	Fuel fodder fast growing
Prunus nepaulensis	1800-3000	Fuel fodder
Quercus griffithii	1500-2650	Fodder, fuel, timber, slow growing
Q.serrata	800-2500	Fodder, timber, slow growing
Q.semiserrata	600-1500	Fodder, timber, slow growing
Salix tetrasperma	1200-2100	Fuel, fodder, small timber fast growing
Sapindus mukorossi	150-1500	Fuel, fodder, timber, ornamental, soap nuts as detergents fast growing
Schima wallichii	350-1700	Fuel, fodder, timber fast growing
Shorea assanica	150-800	Fuel, timber
Sorbus cuspidata	120-450	Fuel timber
Tectona grandis	100-650	Timber
Terminalia bellirica	500-1500	Fuel, timber, fruit medicinal slow growing
T.chebula	450-1500	Fuel, timber, fruit medicinal slow growing
T.myriocarpa	300-1100	Timber slow growing
Toona ciliata	150-1050	Timber slow growing
Bamboo spp.		
Bambusa balcooa	10-1200	Young shoot edible, fodder, culm used for various household activities, fast growing
B.bambos	150-350	Live fencing, pole, agricultural implements
B.polymorpha	15-110	Young shoot semi edible, house roofing, partition wall
B.jaintiana	1100-1900	Live fencing, fishing rod, winnowing tray, etc.
B.khasiana	1100-1900	Live fencing, fishing rod, winnowing tray, etc.
M.muliplex	800-2100	Young shoot semi edible, live fencing, cane industry
B.nana	100-450	Construction purposes and cane industry
B. nutans	650-1700	Young shoot edible, fodder, construction purposes
B.tulda	10-850	Young shot semi edible, fodder, construction purposes
B.vulgaris	700-1700	Ornamental, construction purposes
B.wamin	550-1000	Ornamental, construction purposes
Chimonobambusa callosa	800-1300	Young shoot edible, construction purposes

C. hookeriana	500-2100	Young shoot edible, construction purposes
Dendrocalamus giganteus	35-1350	Young shoot edible, construction purposes
D. hookerii	1100-1900	Young shoot edible, fodder, construction purposes
D. longisphathus	600-1400	Young shoot edible, fodder, construction purposes
D. membranaceus	1350-1950	Young shoot edible, fodder, construction purposes
D. sikkimnensis	550-1150	Young shoot edible, fodder, construction purposes
Gigantochloa rostrata	1050-2000	Young shoot edible, construction purposes
Melocanna baccifera	10-1200	Young shoot edible, construction purposes
Phyllostachys bambusoides	850-1850	Young shoot edible, cane industry
Schizostachyum dullooa	15-250	Young shoot edible, live fencing, cane industry
Teinostachyum wightii	550-1100	Young shoot edible, live fencing, cane industry
Cane spp.		
Calamus spp	200-700	Furniture and various other household activities
Daemonorops spp	150-600	Furniture and various other household activities
Hedgerow spp.		
Cajanus cajan	150-950	Fuel, fodder, seeds edible, N_2 fixing, fast growing
Crotolaria pallid	150-960	Fuel, N_2 fixing, fast growing
Demodium rensonii	400-1000	Fuel, fodder, N_2 fixing, fast growing
Flemingia macrophylla	200-950	Fodder, N_2 fixing, fast growing
Indigofera tinctoria	250-1200	Fuel, fodder, N_2 fixing, fast growing
Milletia ovalifolia	500-1200	Fodder, N_2 fixing, fast growing
Tephrosia candida	300-1000	Fuel, fodder, N_2 fixing, fast growing
Thysanolaena maxima	500-1500	fodder, Spikes as broom, fast growing

Three tier agroforestry system in the NEH region

Alder (*Alnus nepalensis*-promising nitrogen fixing tree species) was introduced as a tree crop during 1987 and tea (*Camellia sinensis*) was planted in 1993 as second storey crop at a density of 12,350 plants ha^{-1}. The investment for Alder and tea was Rs 11,398 and Rs 36,035 ha^{-1}, respectively. Besides tea, large cardamom, turmeric, ginger, taro and black pepper were intercropped. Alder produced 8.5 q ha^{-1} biomass of pruned material and 24 q ha^{-1} biomass of foliage. Green bud production of tea ranged form 44 to 64 q ha^{-1} for a period of five years with an average production of 59 q ha^{-1}. Productivity of large cardamom was 6.4 q ha^{-1}. Ginger, turmeric and taro produced 79, 165 and 172 q ha^{-1}, respectively. Black pepper was found to be sensitive to frost injury. Therefore, no significant yield could be obtained from this crop. Among various crops, net benefit was maximum (Rs 33,111 ha^{-1}) through large cardamom, followed by tea and ginger. On an average, the multistoried agroforestry system could generate a net annual return of Rs 12,884 ha^{-1}.

Silvipastoral system

Som tree is suitable for raring of Munga silkworm. This tree attained average height of 6.75 m, 10.30 cm dbh and 0.046 cubic meter volume 5 years after plantation. Maize (*Zea mays*, cv. *Vijay* Composite) and broom grass were intercropped with it. Broom grass was cultivated on the terrace risers, covering total area of 480 sq m. Average grain production of maize was 11.98 q ha^{-1} in association with this tree crop as compared to 13.5 q ha^{-1} in control plots.

Broom produced 63 q ha^{-1} flower (most remunerative part of it), 86 q ha^{-1} of green fodder and 36 q ha^{-1} of dry fuel wood. This system generated net return of Rs. 23,444 per ha. Bhatt et al (2010) evaluated seven MPTs such as *Acacia auriculiformis*, *Alnus nepalensis*, *Bauhinia purpurea*, *Exbucklandia populnea*, *Ficus hookeri*, *Michelia champaca*, *Michelia oblonga* with broom grass in the understorey in the mid hill conditions of Meghalaya. After 10 years, highest standing volume was recorded in *Acacia auriculiformis* (220.28 m^3 ha^{-1}) followed by *Exbucklandia populnea* (120.08 m^3 ha^{-1}) and *Alnus nepalensis* (114.13 m^3 ha^{-1}). Yield of broom grass cultivated in the tree inter pasces varied from 3.817 t ha^{-1} dry biomass (under *Bauhinia purpurea*) to 2.361t ha^{-1} (under *Alnus nepalensis*). Non-arable hilly areas with high slopes (> 45 %) and low soil depth (<0.6 m) can be managed under suitable tree and grass combinations under livestock based silvipastoral system. In an experiment at I C A R Research Complex for NEH Region, Meghalaya, 13.54 t ha^{-1}(Dry Matter) forage yield was obtained from combination of stylo and setaria with alder. A combination of stylo and guinea grass with alder could produce 11.30 DM t ha^{-1}. In addition alder could provide 1.32 t ha^{-1} of fule wood from the pruned branches.

Sericulture based agroforestry system

Seven mulberry varieties, seven silkworm breeds including a bivoltine breed (NB-18) were studied for their yield and rearing performance. The results obtained are presented in the Table 5.

Table 5. Yield of mulberry and silkworm cocoon in sericulture based agroforestry system

Mulberry variety	Plant Height (m)	Yield (t ha^{-1} yr^{-1})			Net returns from cocoon (Rs ha^{-1})
		Leaf	Cocoon	Fuelwood	
TR-4	1.70	19.1	0.81	6.4	33,449
TR-10	1.69	16.6	0.70	6.3	27,125
BC-259	1.44	15.2	0.65	5.7	23,627
S-1635	1.51	18.2	0.77	6.1	31,085
C-7635	1.52	16.5	0.70	5.6	26,865
Kanva-2	1.43	14.1	0.60	5.7	21,715
Local	1.28	9.1	0.39	4.1	8,215

Source : Dhyani *et al* (1996)

Thus jhum cultivation, is perhaps, a sustainable way of farming in remote and inaccessible areas and infertile soil where heavy inputs cannot be used. Same farmer practice intensive farming in fertile lowland field and jhum farming in remote and infertile hilly areas. Moreover jhum is associated various rites, ritual and ceremonies and people are emotionally attached with jhum farming. However in recent past, due to rural depopulation, area under jhum is shrinking. Jhum cultivation should not be looked as only an economic activity, but it should be considered in the light of high agrobiodiverisy and rich culture associated with it. Jhum farming is the way of life for tribal population of North East India.

References

Bhan, S. 2009. A case study on shifting cultivation practices in Mon district of Nagaland. *Journal of Soil and Water Conservation*. 8(2): 8-13

Bhatt, B.P., Sachan, M.S. and Singh, K.2006. Production potential of traditional agroforestry systems of Meghalaya: A case study. . *In* Agroforestry in North-East India: Opportunities and challenges. Eds. B.P.Bhatt. and K.M. Bujarbaruah. I C A R Research Complex for NEH Region, Umiam, Meghalaya 337-349 pp

Chauhan, D.S. and Dhyani, S.K. (1990). Traditional agroforestry practices in north east Himalayan regions of India. *Indian Journal of Dry Land Agricultural Research and Development*. 4(2):73-81.

Chauhan, D.S. and Dhyani, S.K. (1991) Existing agroforestry practices of Meghalaya. *Journal of Hill Research*. 4(1):19-23.

Dhyani, S.K., Chauhan, D.S., Kumar, D., Kushwaha, V. and Lepcha, S.T. (1996). Sericulture based agroforestry system for hilly area of north-east India. *Agroforestry Systems*. 34:247-258.

Maithani, B.P. 2005. Shifting cultivation in the North-East India: Policy Issues and Options. Mittal Publications, New Delhi. 179 p.

Raintree, JB and Warner, K, 1986. Agroforestry pathways for the intensification of shifting cultivation. *Agroforestry Systems.* 4: 39-54

Sahoo, U. K., Rocky, P., Vanlalhriatpuia, K and Upadhyaya, K. 2010.Structural diversity and functional dynamism of traditional homegardens of north-east India. *The Bioscan*.1:159-171

Teegalapalli, K and Datta, A. 2016. Field to a forest: Patterns of forest recovery following shifting cultivation in the Eastern Himalaya. *Forest Ecology and Management* 364:173–182

Bhatt, B.P., Singha, L.B., Satapathy, K.K., Sharma, Y.P. and Bujarbaruah, K.M. 2010. Rehabilitation of shifting cultivation areas through Agroforestry: A case study in eastern Himalayas, India. *Journal of Tropical Forest Science*. 22(1):13-20

Deb, S.; Lynrah,M. M. And Tiwari, B. K. 2013. Technological innovations in shifting gricultural practices by three tribal farming communities of Methalaya, north east India. Tropical ecology. 54(2):133-148.

Lombi, P. and Riba, T. 2016. Declining shifting cultivation and loose of tribal culture: with special reference to tribes of Arunachal Pradesh. International Journal of Emerging Technology and Advanced Engineering. 6(5): 183-191.

Mao, A.A. and Hynniewta, T.M. (2000). Floristic diversity of North East India. *J. Assam Sci. Soc.*, 41 (4): 255-266.

Mao, A.A. and Hynniewta, T.M. 2011. Plants used agriculture season indicator by Mao tribe Manipur Meghalaya, India. Indian journal of Traditional Knowledge. 10(3): 578-580.

Marak, F. K. 2006. Major folk festivals of Garos with special reference to cultivation: a critical study. Ph. D. Thesis. Department of Garo, NEHU, Tura. 6-16.

Singh, A. K., Arunachalam, A., Ngachan, S.V., Mohapatra, K.P. and Dagar, J.C. 2013. From Shifting Cultivation to Integrating Farming: Experience of Agroforestry Development in the Northeastern Himalayan Region. In: (Eds) A. K. Singh *et al* (2013) Agroforestry Systems in India: Livelihood Security & Ecosystem Services. Advances in Agroforestry Volume 10, 2014, pp 57-86

ROLE OF HORTICULTURE IN JHUM IMPROVEMENT AND REHABILITATION

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The North-eastern region comprises of eight states viz., Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim lying between 21.5^{o} N - 29.5^{o} N latitudes and 85.5 ^{o} E - 97.3 ^{o} E longitudes. It has a total geographical area of 2,62,180 km^{2} which is nearly 8% of the total geographical area of the country. In the whole of NE region, about 35% area is plain and the remaining 65% area is under hills. Whereas in Assam, plains account for 84.44% of its total geographical area and the remaining 15.56% area is under hills. Net sown area is highest in Assam (34.12%) followed by Tripura (23.48%), however, Arunachal Pradesh has lowest net sown area in the region. Cropping intensity is highest in Tripura (173%) followed by Manipur (152.1%), Mizoram (136.36%) and Assam (123.59%). The region has unique weather and climatic condition because of its typical geographical location, physiography, highlands in the northern part and their syntaxial bend, presence of alternating pressure cells of North West and Bay of Bengal and presence of tropical maritime air masses (Barthakur, 2004).

Shifting cultivation: traditional landuse system in NE

Shifting cultivation or *Jhum* is the most primitive and popular farming practiced across the entire NEH region which is essentially an agroforestry system organized both in space and time (Ramakrishnan, 1992). Jhum is a way of life that is deeply entrenched in the artifacts, sociofacts and mantifacts of the tribal way of life in the north east. It is locally known as *Rep Sytri* in Khasi; *Lo* in Mizo etc. It has been practiced over 9000 years and said to have been originated in the Neolithic era dated by the archeologists to 7000 B.C. (Maithani, 2005). *Jhum* in the region is a complex system with wide variation that depends upon the ecological variation in the area and cultural diversity among various tribal clans. However, there are some commonalities in the basic cropping practice. Usually all the essential crops such as paddy, maize, tapioca, colocasia, millets, sweet potato etc. are grown on the same piece of land as mixed crop. *Jhum* in its most traditional form is not a very unsustainable land-use practice particularly when the *Jhum* cycle is more than 20 years. The soils get enough time to rejuvenate and restore their health and productive capacity. The Angami tribe from Nagaland used to practice such as alder based sustainable *jhum* system that was developed in Khonoma village in Nagaland. It provides about 57 food crops to supplement the staple crop rice. The root nodules of the Alder (*Alnus nepalensis*) plants improve soil fertility by fixing atmospheric nitrogen into the soil through *Frankia*. The fallen leaves act as mulches and add humus to the topsoil. The wood is used as fuel-wood, for charcoal burning and in construction works. Alder saplings collected from nursery or wild forest are planted in a *jhum* field located in hills above 1000 m.

The Konyak tribes in Nagaland also have sound ecosystem knowledge which they use in their shifting cultivation practices. In the Konyak *Jhum* fields about 42 species could be seen; rice and colocasia being the dominant ones. They have a sound knowledge of mixing rice and colocasia by which the sloppy land is covered under vegetation for a greater part of the year *i.e*. from April to December. Mixed cropping of rice and colocasia is also practiced by Garo and Khasi tribes of Meghalaya and they cultivate colocasia as a supplementary crop. But, Konyaks grow both the crops as their main crop to meet their food requirements. The Konyaks have a good sense of fallow management and aware that the leaves and twigs falling from the trees restores the fertility of the Jhum land. They count the number of leaf falls and believe that after seven times 'leaf fall' the land becomes mature enough to cultivate. That is why they keep the fallow period as seven years and deliberately keep the seedlings of tree species for establishment during the resting phase. They religiously protect the *jhum* lands from fire during the fallow period. If some accidental fire occurs, the fallow period is extended. This shows the great sense of ecosystem among the Konyak tribes (Bhan, 2009).

In Khasi hills of Meghalaya, shifting cultivation is known as "*Rep Syrti/Thangram*". Shifting cultivation practices are of two types- *jhumming* and *bun* cultivation. *Jhumming* involves cutting and burning of forest vegetation on sloppy lands and using the site for two to three year for growing rice, maize, millets, beans, cassava, yam, sweet potato, ginger, chillies, sesamum and vegetables in mixture thereafter moving to a forest site for repeating the same process (Singh and Dhyani, 1996). At times, a single crop of rice is grown in the second year of *jhumming*. In Bun cultivation, twigs and branches of forest trees species such as *Pinus kesiya*, *Schima wallichii*, *Michelia* species at lower elevations, and *Schima khasiana* in higher elevation along with weed biomass (*Artimisia vulgaris*, *Crotolaria mysorensis, Eupatorium odoratum*, *E. adenophorum, Imperata cylindrical*, *Inula capa*, *Lantana camera*, *Micania macarantha*, *Panicum khasianum*, *Plectranthus coetsa*, *Rubus ellipticus*, *Saccharum spontaneum*, *Pteridium aquilinum* from the surrounding areas are kept in heaps at regular interval in the entire area. The buns are usually 2 to 4 m long, 1 to 2 m wide and 0.15 to 0.35 m in height. They are spaced at 1 to 2 m depending on the soil depth and are covered with a thin layer of soil in order to burn the whole biomass under anaerobic condition and finally the biomass is slowly converted into ash. The activity is usually done during February to March.

At present, with increase in population pressure on land resources, the *Jhum* cycle is getting reduced very fast and reached at 2-4 years at present. This makes the system unstable and lead to severe land degradation as a result of soil erosion and associated factors such as reduction in soil organic matter, nutrients etc. Total area under shifting cultivation is highest in Nagaland followed by Mizoram and Arunachal Pradesh. In terms of percentage of the total geographical area, Nagaland (17.06 %) and Mizoram (12.42 %) are the most severely affected by *jhum* cultivation. However, there is decline in area under shifting cultivation in most of the north eastern hill states except Nagaland (Table 1). It has declined from 1.35 million ha in 2003 to 0.85 million ha in 2005 (excluding the state of Assam).

Table 1. Area (km^2) under shifting cultivation in different states of the NEH region

States	2005			2003			TGA (km^2)	Change
	Current Jhum	Abandoned Jhum	Total 2005	Current Jhum	Abandoned Jhum	Total 2003		
Arunachal Pradesh	1025.1	506.4	1531.5	1116.9	496.2	1613.1	83743	-5.06
Manipur	752.1	100.1	852.2	1119.5	3697.1	4816.68	22327	-82.31
Meghalaya	291.9	157.1	448.9	627.2	116.6	743.8	22429	-39.64
Mizoram	1028.5	1589.0	2617.5	1146.9	2870.4	4017.4	21081	-34.84
Nagaland	1239.1	1588.6	2827.7	1116.6	801.3	1917.9	16579	47.44
Tripura	89.3	164.8	254.1	284.9	110.4	395.3	10486	-35.71
Sikkim	0	0	0	0	0	0	7096	0
Total	**4425.9**	**4106.1**	**8532.0**	**5412.1**	**8092.1**	**13504.2**		**-36.82**

Source: Wasteland Atlas of India, 2010 (http://doir.nic.in/wasteland_atlas.htm)

Horticulture for *Jhum* improvement

Under the scenario of climate change and gradual degradation of natural resources including lesser per capita availability of land, there has been an urgent need for location-specific measures to conserve, utilize and manage these resources for optimizing production on sustainable basis without adversely affecting its quality. The age old practices of *Bari* (Backyard farming) system in Assam, *Zabo* system in Nagaland and *Apatani* system in Arunachal Pradesh are some of the glaring examples of effective utilization of the bio-resources in farming systems mode. The wide agro-climatic variation from subtropical to alpine provide enough scope for growing different horticultural crops with little modification in abandoned *jhum* lands and existing *jhum* fields based on the prevailing ecosystem. Development of horticultural based farming system in varying topography, soil and environmental conditions, is one of the viable options. Thus, horticulture can play a very viable option for *jhum* improvement and rehabilitation for ecological and economical sustainability. Besides improving the value of the fallow or a shift towards settled cultivation, horticulture can also provide the much needed capital with which further intensification of lands will be undertaken in many cases.

Although, enough efforts have been made to control the soil /land degradation but desired results are still awaited. The altitudinal, climatic, socio-ecological diversity within the region provided enough opportunities for the cultivation of large number of forest species, cereals, horticultural crops including fruits, vegetables, spices, flowers and large number of foliage ornamentals in the different agro-climatic zones. NE Region has a total area of 1.37 million ha and 11.50 million tones production of horticultural crops and contributes about 5.66% and 4.15% of national area and production, respectively (NHB, 2015).

The region is characterized by difficult terrain, wide variability in slope and altitude, land tenure system and cultivation practices and poor communication system making majority of the areas in the region still inaccessible. Majority of the population is dependent on agriculture, horticulture and allied land based activities. The agriculture production system

in the region is mostly rainfed, mono-cropped and subsistence type. The fruits grown in this region range from tropical and sub-tropical fruits like banana, papaya, pineapple, jack fruit and citrus to temperate fruits like apple, pear, peach, plum and even certain nut fruits. The region has rich diversity of different vegetable crops and both indigenous tropical vegetables and temperate vegetables are grown to a considerable extent. The major vegetables grown in the region are brinjal, cabbage, cauliflower, okra, onion, pea, potato, tomato, knol-khol, radish, carrot, French bean and different cucurbitaceous crops. Among the flowering plants special mention may be made about the orchids, where about 600 species are reported to occur in the region alone. The other commercial flowers of the region are marigold, tuberose, gladiolus and chrysanthemum. Tuber and rhizomatous crops like tapioca (cassava), sweet potato, *Dioscorea*, colocasia, ginger and turmeric grow abundantly in the region, while plantation crops like tea, coconut, areca nut, cashew nut have considerable impact on the economy of the tropical and sub-tropical parts of the region. Later on other plantation crops like rubber and coffee, medicinal and aromatic oil yielding plants like *Solanum spp.*, *Dioscorea spp., Cymbopogon spp., Citrunella spp.* etc. have been considered suitable for certain areas of the region (Deka *et al*., 2016).

Apart from these, there are certain underutilized or lesser-known horticultural crops, which are grown at large scale in some or other parts of the region by tribals. These underutilized crops include passion fruit, kiwi fruit, chow-chow, parkia, sweet gourd (kakrol) etc. These crops are grown in such a large scale that they are not only consumed by tribal / people of the region but are also exported outside the region.

Potential horticultural crops for NEH Region

Fruits	Pineapple, Khasi mandarin, Banana, Passion fruits, Assam lemon, Peach, Guava, Kiwi
Vegetables	Colocasia, Chow-chow, Tapioca, Potato, Pea, French bean Cabbage, Onion etc.
Flowers	Gladioli, Roses, Lillium, Carnation, Gerbera, Orchids, Chrysanthemum, Anthurium , Foliage plants
Spices	Ginger, Large cardamom, Turmeric, King chilli, Black pepper
Medicinal & Aromatic plants	Patchouli, Neem, Agar, Aloe-vera, Garcinia and Ginseng
Plantation crops	Arecanut, Coconut and Cashew

Selection of crops across the elevation

The different horticultural crops can be grown in different altitudes based on their climatic requirements in *jhum* or degraded lands.

Altitude (above msl)	**Suitable crops**
High hills (900 – 2000 m)	Apple, Peach, Pear, Plum, Apricot, Kiwifruit, Strawberry, Potato, Colocasia, Cabbage, Cauliflower, Radish, Beans, etc.
Mid hills (below 800 m)	Citrus, Banana, Pineapple, Papaya, Guava, Ginger, Turmeric, Chilli, Brinjal, Tomato, Bean, Sweet potato, Tapioca, Colocasia, etc.
Foot hills	Jackfruit, Arecanut, Cashew nut, Coconut, Black pepper, etc.

Horticulture based cropping systems to be followed for better income

The following cropping models/ techniques may be followed in the entire region based on the availability of lands suitable for the system.

A. Mixed horticultural land use for hilly slopes

- 2/3 areas from top towards lower hillside are converted into contour using logs/ bamboo.
- 3-4 fruit blocks may be developed i.e. Mandarin block, Peach block, Guava block, lemon block.
- The lower 3/4 contour may be utilized for cultivation of rhizomatous crops. After that 3-4 terraces may be completely utilized for the pure vegetable cultivation.
- The lower 1 or 2 contour may be utilized for strawberry under plastic mulch.
- The contour bunds may be utilized for planting of pineapple.
- Alternate contour bunds may be utilized for marigold, gerbera etc.

B. Multi-tier horticultural land use system for better income

- Horti-horti three-tier system: Areca nut + black pepper +ginger/ turmeric/ pineapple/Assam lemon
- Silvi-horti-three tier system: MPT + black pepper + ginger/turmeric/pineapple
- Silvi-horti-two tier system: Tree bean and pineapple
- Alder based farming system: Alder and vegetables like potato, cole crops or alder and cereals like maize, rice etc.
- Alder based large cardamom system
- MPT + Assam lemon

C. Horticulture based farming system for sustainable family income

Horticulture based farming system approach may be a sustainable option for abandoned/ existing *jhum*. ICAR Research Complex, Barapani has developed a model in 1 hectare area with the following components so as to get regular income throughout the year.

- Fruit crops: *Khasi* mandarin/ Sweet orange, Pineapple, Assam lemon, Guava
- Vegetable crops: As inter crops
- Protected cultivation of vegetable in polyhouse
- Flower crops: gerbera & marigold
- Vermicompost: 1 unit: 3 chambers
- Vermiwash: 2 units
- Water harvesting structure cum fish pond

Table 2. Income generation from horticulture based farming system within one year

Crops	Area (m^2)	Planting season	Gross income
Sweet orange	2000	July	
Pineapple + Assam lemon	1200	April	2000 (Pineapple)
Guava	500	July	

Polyhouse	100	Whole year	16000
Vermicompost unit	1 unit	October	Utilized for cultivation
Vermiwash unit	2 nos		
Turmeric, colocasia etc	200	April	9900
Water harvesting pond	1000		3000 (fish)
Flowers (Gerbera and Marigold)	Intercrop		3450
Cabbage, capsicum, brinjal	intercrop		2330
Pea, tomato, French bean	intercrop		1748
Broccoli, cowpea, okra	intercrop		2750
Total income	Nov, 08 – Dec, 09		41178

Source: Anon., 2010

A number of such other models have been developed and standardized across the region as per the need of the farmers and availability of the resources. The following are some of the models.

1. Tuber Crop Based Farming System

The *tilla* (moderate hillock upland) land is suitable for cultivation of tuber crops in Dhalai District of Tripura. As a portion of the land was *tilla* and without any source of irrigation, it was selected for tuber crop cultivation *viz*., Diascorea, elephant foot yam, tapioca, ginger, sweet potato etc. after cleaning land was divided in to plots of size 800m^2 each for the individual tuber crops. Boundary of each plot was planted with banana suckers. One unit pig (2 piglets) was integrated for fattening by utilizing tapioca, sweet potato etc as feed. The cost of production was Rs. 3,250 for 0.48 ha area for cultural practices & Rs. 5100/0.48 ha for planting material. The cost of pig rearing including piglets, feed etc was Rs. 9800/-. The total cost of production is Rs. 18,150.00 and farmers earn a gross return of Rs. 23,100 from crop component + Rs. 16,000 from livestock i.e. total Rs. 39,100/-. with a net return of Rs. 20,950 having a B:C ratio of 2.15 (Datta *et al.,* 2012).

2. Agri-hort-silvi-pastoral system

The system was standardized in 0.80 ha area in ICAR Research Complex for NEH Region, Umiam, Meghalaya. In this system 0.10 ha of foothills was used for agricultural crop, 0.25 ha for horticulture and 0.44 ha for silvi-pastoral crops. The Agri-horti-silvi-pastoral system produced 8344 kg REY (rice equivalent yield). The highest REY of 3000 kg was estimated with cow milk followed by Capsicum-Turmeric (2006.5 kg REY). The gross return of Rs. 94,781/-from the system while net return of Rs.45,092/- was obtained from one cow dairy unit. Vegetable component registered a net income ofRs.18365 while fruit orchard (guava and pineapple) gave a net income of Rs. 5071 amounting to a total net income of Rs. 45,092 from the system (Anon., 2016).

3. Silvi-horticultural system

The total area of Silvi-horticultural system was 3.13 ha with a forest land of 2.17 ha and planned land use of 0.96 ha of which 0.50 ha area was kept for system study. The average slope of the area was 53.18%. Lower terraces covering an area of 490 m^2 was utilized for growing spices and vegetables like turmeric +bottle gourd, turmeric + pumpkin and turmeric alone. The middle portion of the system was utilized for fruit crops such as guava. Upper portion of the system was covered with the forest tree spp. *Alnus nepalensis*. A gross income of Rs. 34,400.00 was recorded from this system (Anon., 2016).

4. Arecanut/ palms based farming system

Due to its height, crown shape and wide spacing, areca nut (*Areca catechu*) is amenable to intercropping with annual, biennial and perennial crops. Banana, black pepper, pineapple, tapioca, turmeric and ginger are grown successfully in the under storey of areca nut. In areca nut and palm nurseries, banana is also grown to provide shade to the seedlings. In intercrops with black pepper, areca palms of more than 10 years of age and 7-8 m tall serve as standard. This is very popular in homestead gardens mainly in valleys up to 400 m above mean sea level elevation.

Palms provide more than one economic products and can be considered as multipurpose. Leaves or petioles of palm are used as thatching, making hats, mats, baskets, ropes etc. Stems are used as pillars in construction of houses. Inflorescence and flowers are used for preparation of beverage. Fruits are edible. Palms are common in mixed small farming system. By virtue of canopy architecture, tree multiple economic / commercial products and their diverse uses, palms have immense potential in agroforestry system as a woody component. Techniques have been developed to cultivate hybrid napier under coconut based hortipasture system. The yield reduction in hybrid napier was observed up to 2.5 m distance from the base of the coconut plant.

5. Alder based FS

The main crop during the first year is usually upland rice in warmer areas and job's tear in cooler high altitude regions. Earlier the upper Konyaks, Chang, Yimchunger and Khiamungan tribes of Nagaland were using Chinopods and *Amaranthus* spp. as main crops in higher altitude ranges and later those were changed over by upland rice, job's tear and maize along with varieties of secondary crops being sporadically inter planted. It is recorded that as many as 45 crop species are grown in a single *jhum* field in Chujuyimlang in Mokokchung district. Many wild vegetables and fruit bearing plants, which are grown naturally, are also conserved in the fields. Plants for domestic requirement, such as *Livistona jenkinsiana* (thatching material, palm), various bamboos, *Caryota sp.,* perennial vegetable crops and fruits, medicinal and ornamental plants are also grown and conserved in the *jhum* fields, which lead to form a multistoried AFS.

One of the objectives of NEPED-II (Nagaland Empowerment of Poor through Economic Development Project) was to introduce shade loving cash crops to be grown under trees for value added agriculture. Almost six years after the introduction of trees as additional crop in

jhum fields, shade loving crops can be grown under the trees. Today Nagaland is providing cash crops like cardamom, ginger, passion fruit, black pepper and turmeric (Table 3).

The indigenous tribes used to collect large cardamom from natural forests, later on these were domesticated and now it has become the major plantation crop of the region. Among 30 shade tree species found in large cardamom plantation, alder is most abundant. Farmers have evolved a classical tree cutting schedule in plantation area to get continuous supply of fuel wood and fodder without affecting the shade requirement of large cardamom plants. It helps in preventing lifting of long large cardamom clumps by thick old roots; otherwise productivity of cardamom is affected. This is an economically viable and export potential system, which has great potential in farming systems of NEH region.

Passion fruit, a new introduction in the region, is grown under partial shade and has normally two harvesting seasons in a year. The first harvest is done in the month of May-June and continues up to Oct-Nov. The yield of passion fruit varies depending upon the age of the vine and the method of cultivation. Fruiting generally starts from second year and goes on increasing until the fourth year or more, provided pruning and manuring is done on time. Usually, a single plant yield 7-30 kg up to the fourth year.

Table 3. The details of under storey crops.

Crops	Seed/ planting material used	Time of sowing/ planting	Elevation (m)	Spacing (m)	Best suited soil	Yield (q/ha)	Degree of shade required
Cardamom	Rhizomes and suckers	April-May	600-1900	1.5 x 1.5	Loamy soil	10-15	50-75%
Betel vine	Cuttings of runners	May-June	200-800	Depending on support trees.	Clay to loamy soil	10-15	50-75%
Black pepper	Cuttings of runner shoots.	May-June	200-800	Depending on support trees.	Clay to loamy soil	10-15	50-75%
Passion fruit	Seed and vine cuttings	April-May	600-2000	4.5 x 6.0	All types of soil	45-50	25%
Turmeric	Rhizomes	March-April	200-1600	0.45 x 0.3	Loamy with rich organic matters	140-320	10-25%
Ginger	Rhizomes	March-April	200-1600	0.45 x 0.3	Sandy soil with rich organic matters	100	10-25%

6. Home garden for Biodiversity Conservation of Woody Perennials

Bamboo grooves on water springs and around the farm boundary shade the agricultural lands. Moreover, soil under the shade of bamboo remains saturated during most part of the monsoon. Studies to utilize shaded area under *Bambusa nutans* have revealed that the lands near bamboo grooves (11-15 m from grooves) should be utilized for growing ginger, turmeric, large cardamom and dinanath grass, depending upon the choice of the grower. The land beyond this zone may be put to suitable crops of farmers' choice. The associated broad leaved trees with some of the bamboo species grown in home garden have been shown in Table 4.

Table 4. Trees and agricultural crops associated with edible bamboo species in some states of NEH region

Bamboo species	Elevation (m asl)	Tree/ crop in association in Home garden	Natural/ plantation forest
B. balcoa	Lower (100-200)	*Artocarpus heterophyllus, Mangifera indica, Michelia oblonga, Bambusa tulda, B. nutans, Citrus* spp.*, Thysanolaena maxima, Areca catechu, Amaranthus* spp.	-
	Higher (250-450)	*Artocarpus heterophyllus, Mangifera indica, Bambusa tulda, B. nutans, Melocanna baccifera, Moringa olifera, Citrus* spp.*, Thysanolaena maxima, Areca catechu, Amaranthus* spp.	-
D. hamiltonii	Lower (100-250)	*Mangifera indica, Litchi sinensis, Artocarpus heterophyllus, Bambusa tulda, B. nutans, Areca catechu, Anacardium occidentalis*	*Ficus religiosa, Terminalia* spp.*, M. baccifera, Artocarpus lakoocha*
	Higher (450-1400)	*Michelia champaca, Citrus* spp.*, Musa* spp.*, Areca catechu, Piper beetle* and seasonal vegetables.	*Tectona grandis, A. lakoocha, Pterospermum* spp.*, Duabanga* spp. and wild banana
Melocanna baccifera	Lower (150-650)	*Bambusa cacharensis, Areca catechu, A. heterophyllus, Citrus reticulate, Piper* spp.*, Dioscorea bulbifera, D. alata, Gingiber* spp.*, Cucurbita* spp.	*A. lakoocha, Tectona grandis, Toona ciliata, Terminalia* spp. *Schizostachyum dulloa, P. acicularis*
	Higher (800-1200)	*Cinnamomum sp., Ananas comosus, Piper beetle, A. heterophyllus, Colocasia* spp.*, Gingiber* spp.*, Schium edule*	*Syzyzium* spp.*, Pterospermum acicularis, Tectona grandis, Morus* spp.

C. hookeriana	Higher (1000-1300)	*Alnus nepalensis, Ficus hookerii, Albizzia chinensis, D. hamiltonii, Pyrus communis, Prunus persica,* seasonal vegetables.	*Duabanga sp., Terminalia sp., Pterospermus sp.*
D. hamiltonii	Lower (300-600)	*Bambusa tulda, B. wamin, Mangifera indica,* vegetables.	-
	Higher (1000-1300)	*D. giganteus, Pyrus communis, Prunus persica, C. hookeriana,* seasonal vegetables including *Amomum subulatum.*	*D. hamiltonii, Ficus* spp.

7. Potentialities of indigenous fruit crops in AFS

A large number of wild plants or their parts still supply food to a large section of population in the entire Himalayan and Northeastern region of India. For years, man has relied on nature to provide wild fruits without managing or taking any effort to propagate them. This, coupled with lack of *ex-situ* conservation strategies has led to loss of indigenous fruit tree species in the natural forests. Introducing such trees on farm through suitable agroforestry model not only has the potential for improving food security in hilly areas but it will also conserve the biodiversity on farm. A few examples of indigenous fruit tree species that can be fitted in various agroforestry models in this region are mentioned in Table 5.

Table 5. Indigenous fruit tree species of NEH region with their state of occurrence and relevant potentialities.

State	Indigenous fruit tree species	Potentialities
Arunachal Pradesh	*Actinidia sp.*	Wild relative of kiwi fruit (*A. chinensis*)
	Dendrobenthamia capitata	A wild fruit grows in temperate region
	Illicium griffithii	Famous 'Star Anise' species occur in temperate hills.
	Fragaria spp.	Variability may be used for production and processing industries.
	Rubus spp.	Variability may be used for production and processing industries.
Assam	*Artocarpus lakoocha*	Unripe fruits used for medicinal purpose and ripe fruits used for edible purpose.
	Dillenia indica	Mature fruits are used for pickling and canning purpose
Manipur	*Parkia roxburghii*	Tree bean of Manipur with substantial nutritive value.

Meghalaya	*Prunus nepalensis*	Fruits are processed for soft drinks
	Myrica esculenta	A potential semi-domesticated fruit needs proper commercial exploitation.
	Elaegnus latifolia	A potential semi-domesticated fruit needs proper commercial exploitation.
	Morus acidosa	A potential semi-domesticated fruit needs proper commercial exploitation.
	Citrus indica	A wild relative of orange
Mizoram	*Mangifera sylvatica*	A wild relative of cultivated mango.
Nagaland	*Citrus ichangensis*	A Wild relative of orange
	Malus baccata	A wild relative of cultivated apple
Sikkim	*Musa sikkimensis*	A frost resistant banana species
Tripura	*Psidium guinensis*	A wild relative of cultivated guava
	Zizyphus mauritiana	Extensive diversities are available within the state.
	Citrus megaloxycarpa	An endemic species and wild relative of cultivated orange.

Source: Hore, 2006.

Constraints

1. Planting material

The importance of type and quality of planting material in horticulture needs due attention. Several initiatives have been taken both at national and state level; as a result, there is now a chain of measures at ICAR Institutes, SAUs, State Dept of Horticulture, Commodity Boards and in private sector. However, the quality of planting material still remains to be regulated. Several other inadequacies also exist in production and supply of planting material as detailed below:

- Acute shortage of mother plants of recommended varieties particularly of new varieties.
- Absence of suitable mechanism to ensure quality.
- Acute gap between demand and supply in several crops.
- Micro-propagation protocols are not available in many crops for large scale production of planting material.
- The dispersal of public sector hybrids of vegetable crops has been rather slow.
- Seed and nursery registration acts are not being implemented in letter and spirit.
- Most of the existing nurseries lack modern infrastructure.

2. Connectivity

The main problems confronting to the farmers are the remoteness from the market outlets and of poor road connectivity from the place of production to market outlet. Products often have to be transported by means of head load thereby increasing the cost of production.

The perishability of fruits possess special problem, though attractive markets make it worthwhile especially if the appropriate infrastructure can be put into place.

3. Extension System

Role specificity of extension system in promotion of horticultural crops has remained unattended because of skewed primacy of food grain by extension workers. Some of the crucial inadequacies identified include:

- Extremely weak horticulture extension system due to lack of extension professionalism as well as lack of trained manpower.
- Lack of linkage, coherency and co-ordination among different extension agencies.
- Lack of centers of capacity building for farmer on advanced/ modern practices.
- Lack of mobility of the field functionaries of line departments.
- Low budgetary allocation on TOT of horticultural crops.

4. Land use planning and development strategies

The ideal alternative to *jhum* on hill slopes requires a total change of cultivation practice. Plantation and horticultural crops must be simultaneously cultivated with forestry species to ensure permanent plant cover. Cereal crops should be confined to the valleys. Two factors, however, make this an unrealistic prospect in the near future. First, the isolation caused by topographical distance from urban centres cannot be countered except through extensive networks of roads. Importing cereals into the region on a large scale to compensate for reduced local production thus is not feasible. Second, social and cultural changes have to take place before such a system will be adopted. For immediate future, an improved *jhum* cycle must be the focus of development.

The north eastern hill region can support a variety of tropical and temperate fruit trees besides plantation crops such as tea, coffee and rubber. Planting suitable crops on a cooperative basis among a number of contiguous villages in an area of 100-200 ha with each family in a village being a unit, will ensure continued independence of family units, promote economic viability and reduce the pressure on the land from *jhum*.

Conclusion

Although the region is very rich with respect to natural resources and biodiversity but their exploitation and extraction with poor replenishment has become a point of concern for their sustainability. The large scale interference due to shifting cultivation and increased population pressure has enhanced the process of degradation. Development of horticultural based farming system in varying topography, soil and environmental conditions, is the need of the hour. While devising any such programmes, social, economic and cultural traditions of the *jhumias* have to be introspected. Moreover, priority should be given to techniques and practices that can enhance production and productivity with regular income at farm level. Besides improving the value of the fallow or a shift towards settled cultivation, horticulture has also provided the much needed capital with which further intensification of lands can be undertaken. Horticulture can play a pivotal role for *jhum* improvement and rehabilitation for ecological and economical sustainability.

Development packages must be specially designed for a given cluster of villages, taking into consideration the microenvironment and the socioeconomic condition and cultural background of the people. The aspiration of the tribal people are unique because of their independent nature and closeness to the forest ecosystem, provisions to protect these unique characters need to be established during the planning process. Scientists, planners and administrators often have tried to impose plans for development that they consider good for the people in the region without trying to understand the process that operate in the traditional ecosystems. Rather, the strategy for development should be one with which the people themselves can identify. Traditional value systems should be incorporated as much as possible rather than ignored or even undermined. Development packages of this type not only will find ready acceptance by tribal societies but also will ensure participation of the people in the development processes.

References

Anonymous. 2010. Annual Report (2009-10), ICAR Research Complex for NEH Region, Umiam.

Anonymous. 2016. Annual Report (2015-16), ICAR Research Complex for NEH Region, Umiam.

Barthakur, M. (2004). Weather and climate. *In* Brahmputra basin water resources. (eds.) V.P. Singh, N. Sharma, S. Shakhar and P. Ojha. Kluwer Academic Publisher: Netharlands. pp. 17-30.

Bhan, S. 2009. A case study on shifting cultivation practices in Mon district of Nagaland. *Journal of Soil and Water Conservation*. 8(2): 8-13

Datta, M., Das, A. and Ngachan, S. V. 2012. Innovations in Agroforestry based Farming System for Sustainable Land Use and Rural Livelihood in Tripura. In: *Innovations in Integrated Farming System for Livelihood Improvement.* Book of Extended Summaries of the National Seminar On Livelihood Options for Small and Marginal Farmers Livelihood Options for Small and Marginal Farmers in Fragile Ecosystems, 9-10th August, 2012. pp 58-64.

Deka, B.C., Rymbai, H., Deshmukh, N.A. and Talang, H.D. 2016. Horticulture based Farming System: The Engine for Prosperity in Northeast India. Souvenir cum Invited Paper Abstract of the Platinum Jubilee of HIS, the 7th Indian Horticulture Congress, Doubling Farmers Income through Horticulture, New Delhi, November 15-18th, 2016 pp. 264-265.

Hore, D. K. 2006. Potential of minor forest produce and other economic plants in socio-economic development of NER. In*. North East Emerging Horizons in Agribusiness* (eds. Akali Sema, Amod Sharma, A.K.Jha and Imti Naro L.). Published by Seminar Organizing Committee N.E. Agri Expo 2006.pp125-139.

Jha, A.K., Verma, V.K., Deshmukh, N.A., Rymbai, H., Assumi, S.R., Devi, M. B. and Talang, H.D. 2017. Spices for income enhancement in NE Region: Needs and focus. (*in*) Theme 4: Horticulture for Nutrition and Assured Income. National Seminar on 'Smart Farming for Enhancing Input Use efficiency, Income and Environmental Security' organized by Indian Association of Hill Farming in collaboration with ICAR Research Complex for NEH Region during 19th -21st September 2017. Pp 109-118.

Maithani, B.P. 2005. Shifting cultivation in the North-East India: Policy Issues and Options. Mittal Publications, New Delhi. 179 p.

Ramakrishnan, P.S. 1992. Shifting agriculture and sustainable development: An interdisciplinary study from North-Eastern India. UNESCO-MAB series, Paris, Parthenon Publications, Cornforth, Lancs, UK.424p.

Rathore, S.S., Karunakaran, K. and Prakash, B. 2010. Alder based farming system, a traditional farming system in Nagaland for amelioration of Jhum land. *Indian Journal of Traditional Knowledge* 9(4): 677-680.

Singh, B.P. and Dhyani, S.K. 1996. An appraisal of indigenous landuse systems in Meghalaya for developing sustainable rainfed hill agriculture. *In*. Proceedings IUFRO-DNAES International Meet on Resource Inventory Techniques to support Agroforestry and Environemntal activities. Eds. R.K. Kohli and K.S. Arya. DNAES, Chandigarh. Oct 1-3, 1996. Pp. 61-72.

Singh, J. S. and Singh, S. P. 1992. *Forests of Himalaya*, Gyanodaya Prakashan, Nainital, p. 294.

Singh, A and Singh, M.D. 1981. Effect of various stages of shifting cultivation on soil erosion from steep hill slopes. *Indian Forester* 106(2): 115–121.

OPTIONS FOR NATURAL RESOURCE CONSERVATION FOR *JHUM* IMPROVEMENT IN NEH REGION

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India's North Eastern Region consists of eight states–Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura–occupying 262,179 square kilometres and with a population of over 45.58 million (Census 2011) which is 3.77% of India's population. The North Eastern Region is socially, culturally, and politically very complex and contains great environmental and natural resource diversity. More than 200 dominant tribes and many sub-tribes reflect the complex social structure of the region. Agriculture is the mainstay of the economy of northeast India, where more than 80 percent of the total population is rural. *Jhum* (shifting) cultivation is the predominant land use system in the hilly states of the region. A lack of enterprise and the decline in local income generation in the once fairly self-sufficient villages resulted in large-scale migration of young people to cities and other urban areas, including outside the region. Consequently, the decline in the number of young people in the villages makes it more difficult to meet the labor-intensive requirements of most agricultural practices in the hilly regions. Further, poor market access and lack of opportunities for value addition for cash crops and locally abundant horticultural crops hinder the tapping of alternative sources of income.

Natural resources

In terms of its natural resources, the region is identified as one of the world's biodiversity hotspots, with species-rich tropical rainforests supporting diverse flora and fauna, and is the center of origin of several species, including citrus, cereals, and orchids. The North Eastern Region has abundant water resources accounting for 34% of the country's water resources and almost 40% of India's hydropower potential. One-third of India's runoff flows from the Northeast through the Brahmaputra and Barak rivers. The abundant surface water resource imposes severe distress and costs on the region through frequent flooding and erosive processes. The region also has a substantial unutilized groundwater resource. The total forest cover in the region 171,964 sq km which is 65.59 percent of its total geographical area (TGA) in comparison to national forest cover of 21.34%. Recent assessment (ISFR, 2015) shows a decrease of forest cover to the extent of 628 sq km (0.37%) in the NE region. The reason behind such decrease is attributed to the biotic pressure and shifting cultivation in the region. State wise forest cover along with the changes as compared to previous assessment (2013) is given in Table 1. The quality of land in the region is favourable for a wider range of crops livestock-forestry-fishery activities. Furthermore, there are large reserves of petroleum and gas in the region, which constitute a fifth of the country's total potential. Industrial raw materials such as coal, hydrocarbons, and mineral resources, including thorium and limestone, are also abundantly available

Table 1. Status of forest cover in North Eastern states (ISFR, 2015)

States	TGA (Sq km)	Forest cover in 2015 (Sq km)	% of TGA	Change w.r.t. 2013 (Sq km)	% Change over 2013
Arunachal Pradesh	83,743	67,248	80.30	-73	-0.11
Assam	78,438	27,623	35.22	-48	-0.17
Manipur	22,327	16,994	76.11	+4	+0.02
Meghalaya	22,429	17,217	76.76	-71	-0.41
Mizoram	21,081	18,748	88.93	-306	-1.63
Nagaland	16,579	12,966	78.21	-78	-0.60
Tripura	10,486	7,811	74.49	-55	-0.70
Sikkim	7,096	3,357	47.31	-1	-0.03
Grand total	**266,179**	**171,964**	**65.59**	**-628**	**- 0.37**

Shifting cultivation

Shifting cultivation (*jhum*) is believed to have originated during 7000 BC. A considerable portion of the landmass of the North East is under shifting cultivation (Table 2). This practice of food production is refined and intensely associated with tradition and socio-cultural values that the people perceive towards livelihood sustenance in the hills. There are different arguments with regard to the impacts of shifting cultivation on forest cover, soil and environment; however the practice in present form with very short cycles is shown to be affecting the forest cover and soil fertility. Though, this practice has been projected as harmful, no good alternatives such as agro-forestry or horticultural intervention could infiltrate into the *jhum* areas substantially. The traditional lifestyle, culture and resistance to government policies by the local inhabitants have led to non-adoption of any suggested alternatives to *jhum* cultivation. Since complete eradication of shifting cultivation is practically impossible, research for prescribing resilient shifting cultivation for sustainable development is needed. The existing scenario of shifting cultivation practice and its impact on livelihood has been studied during the past several years. Effort to develop strategies for resilient shifting cultivation with a goal of sustainable development and livelihood security is the need of the hour.

Table 2 : Area under current and abandoned jhum land in North East

State	Abandoned *jhum*		Change (sq km)	Current *jhum*		Change (sq km)	Total *jhum*		% change*
	2005-06	2008-09	2005-06	2005-06	2008-09		2005-06	2008-09	
Ar. Pradesh	**506.39**	1078.52	+572.13	**1025.07**	961.04	-64.02	1531.46	2039.56	+33.2
Assam	79.41	136.33	+56.92	160.15	258.86	+98.71	239.56	395.19	+65.0
Manipur	100.10	201.32	+101.22	752.10	270.31	-481.79	852.2	471.63	-44.7
Meghalaya	157.12	268.11	+110.99	291.87	272.52	-19.35	448.99	540.63	+20.4
Mizoram	1589.03	1049.37	-539.66	1028.53	612.71	-415.82	2617.56	1662.08	-36.5
Nagaland	1588.65	842.47	-746.18	1239.09	1514.95	+275.86	2827.74	2357.42	-16.6
Tripura	164.83	68.99	-95.84	89.28	33.20	-56.08	254.11	102.19	-59.8
Total	**4185.53**	**3645.11**	**-12.9%**	**4586.09**	**3923.59**	**-14.4%**	**8771.62**	**7568.70**	-13.7%

***change in total *jhum* area during 2008-09 over 2005-06**

Natural resource conservation options for *jhum* improvement

Jhum lands are classified into two categories i.e. current jhum land and abandoned jhum land. Current jhum lands are the area that are used for cultivation by the process of *jhuming* which are clearly perceptible on the current season satellite image that are in pre-burnt/post-burnt condition. Abandoned *jhum* lands are the areas that were under shifting cultivation, left idle for more than one year but less than 5 years thereby giving a scope for the regeneration of secondary vegetation, especially bamboo or grasses. This category has a tendency to get mixed with forested areas. The area under current and abandoned jhum land in the North East are given in Table 2. Keeping in view of the diversity in bio-physical conditions and resource availability, the approaches for natural resource conservation in two different categories of jhum lands will be different. Some of the approaches for conserving natural resources for *jhum* improvement are highlighted:

Current *jhum* land situation:

- The jhum is a unique agro-ecosystem having distinct agro-biodiversity, considered to be an important natural resource, adapted only to the fragile hill ecosystem and maintained through the tribal communities. Biodiversity in this jhum agro-ecosystem comprises of cereals, millets, tuber crops, vegetables, oil seeds, spices, condiments and culinary herbs, floricultural and medicinal plants. Farmers cultivate more than 40 species in the jhums. There also exists wide genetic diversity within the species. Besides the agrobiodiversity farmers also use wild plant species as food plants linked with food security. Traditional cultivars of these crops have been conserving from time immemorial through *jhum* practice. These traditional cultivars are either fertilizer non-responsive or very less responsive. There is little scope for replacement of these cultivars with fertilizer responsive HYVs of crops. The farmers are reluctant to apply fertilizers in the jhum fields, so HYVs can't give expected yield. Moreover, the fertilizer use efficiency will not be encouraging since most of the applied fertilizers will be lost from the system through surface runoff because of high rainfall in the region. Therefore, effort to develop varieties having good yield potential with low inputs using existing genetic pools of traditional cultivars has merit. It will also help in conserving diversity of traditional cultivars and protecting soil and water resources from degradation. Tagging of products of jhum field as organic will fetch higher prices for which policy intervention is needed for developing market linkages for such products. Expansion of trade to South East Asia under Act East Policy, GOI may provide ample opportunity for marketing of such product.
- Maintenance of high species diversity contributes to the agro-ecosystem stability. With high crop diversity it would be possible to achieve high productivity thorough maintaining high organic biomass content in the system as a whole. Maintenance of higher level organic matter in soil of jhum field (organic by default) helps crops to overcome moisture stress particularly during winter months. High organic matter in soil also prevents soil loss due to erosion. Due to burning, the biomass availability in jhum

field for soil application is less and therefore, farmers need to be motivated for collection of biomass from adjoining forests. Integrated farming system (IFS) is a production system being followed in the entire north east and livestock/birds component of IFS may serve as an important source of manures for jhum fields. Motivation of farmers to dig compost pit adjacent to jhum field for utilization of biomass from crop and non-crop areas for production of manures should be given due importance.

- Microbial diversity is an unseen natural resource that deserves greater attention. Microorganisms are essential for the earth to function. They play many roles both on land and in water, including being the first to colonize and ameliorate effects of man-made disturbed environments. As the jhum is virtually organic production system, bio-fertilizers can play significant role in managing soil nutrients in jhum fields. Microbial biodiversity of jhum field should be exploited for production of biofertilizers. Biofertilizers produced from native strains of microbes will be far more effective than that of commercial biofertilizers produced elsewhere.

- **Replacing slash-and-burn with slash-and-char can improve the quality of *Jhum* field soils** (Hazarika, 2014)**.** Slash-and-char is a carbon and nutrient conserving alternative to existing slash-and-burn technique. Carbon will rather be retained in the system compared to slash-and-burn, since only biomass from the same cropping area will be used for producing the charcoal. A global analysis revealed that up to 12% of the total anthropogenic C missions by land use change (0.21 Pg C) can be off-set annually in soil, **if slash and burn is replaced by slash and char**. The production of charcoal for soil amelioration purposes could establish a C sink and could be an important step towards sustainability and soil organic matter conservation in *jhum* agriculture. To popularize the slash-and-char practice among the hill farmers of North East, research focus and policy initiatives on popularizing low-cost *biochar* production technologies is urgently needed.

- The shifting cultivation adversely affects soil fertility of *jhum* fields due to soil erosion, loss of organic matter and leaching of plant nutrients. Studies on steep slopes (44–53 %) have indicated soil loss to the tune of 40.9 t/ha, and corresponding nutrient losses per ha are 702.9 kg of organic carbon, 63.5 kg of P and 5.9 kg of K (Ram and Singh 1993). The soil loss from hill slopes (60–79 %) under first year, second year and abandoned jhum was estimated to be 147, 170 and 30 t/ha/year, respectively. Soil loss can be suitably minimized through adoption of soil conservation measures such as contour trenches, contour bunds, vegetative bunds, grass water ways etc. Introduction of leguminous cover crops in current *jhum* field will minimize soil loss, improve soil health, suppress weed, provide food to human and feed to animal besides adding cash incomes. Bio-terracing of *jhum* field with fast growing hedgerow species like *Tephrosia candida, Crotalaria tetragona, Crotalaria juncea, Indigofera tinctoria, Flemingia macrophylla and Cajanus cajan* has scope for minimizing soil loss and improving the productivity of the soil of current *jhum* fields. Hedgerows alone abridged soil loss by 94% and runoff by 78

%. Use of twigs and tender stems of hedge plants as mulch conserved ~83% of soil and 42% of rains water. In an experimental trial conducted at Changki, Nagaland, soil loss was abridged by 22% with integration of hedgerow species in jhum plots as compared to traditional jhum site (38.1 t/ha/year). Therefore, contour hedgerow technology provides an alternative farming on hill slopes on a sustainable basis. Alegre *et al.* (1996) reported that combined use of earthworm inoculation and organic inputs is an efficient way to improve the fertility of jhum fields.

- Crops in *jhum* field suffers from severe moisture stress particularly during winter months that drastically reduce the productivity of the crops. Despite having heavy monsoon rainfall in North east region, there is acute shortage of water in winter months. The geological formation does not permit water retention; run-off is quick and springs and small streams dry up when there is no rain. In order to improve the *jhum* productivity, water/moisture conservation options suitable for sloppy land need to be explored. Construction of low cost micro water harvesting structures with minimum seepage and evaporative losses (*Jalkund* 30,000 l capacity) depending on availability of suitable space in sloppy land will be a viable option for life saving irrigation of crops. Harnessing perennial spring water, if available near *jhum* field, through diversion channels hold promise to overcome the water scarecity problem in jhum fields. In-situ conservation of soil moisture through organic mulch may be one of the ideal options. Forest biomass of adjoining *jhum* field may provide source of availability of organic mulch. Vegetative barrier with hedge row species in jhum field may provide alternative source of biomass for organic mulch.
- Adoption of Alder based jhum system, wherever possible, should be encouraged because it is an outstanding model of sustainable land use system for hilly ecosystem evolved through numerous years of testing. Alder based jhum fields are managed typically in four year cycles, with two years of cropping between the alder trees fallowed by two more years while the soil is rested and the coppices allowed to grow.

Abandoned *jhum* lands situation:

The declining productivity of *jhum* lands is the main threat for sustainability of shifting cultivation. One of the main reasons for rotation of land in shifting cultivation is exhaustion of soil fertility and search for new fertile land. To make the abandoned *jhum* lands fertile and less prone to soil erosion, following intervention can be made for its improvement for sustainable agriculture.

- Adoption of soil fertility restoration measures through recommended practices viz. cover cropping, introduction of legume in cropping system, carbon management through manure/compost application, green manuring etc.
- Adoption of suitable crops and cropping sequence for soil improvement. Raising of close growing crops like grasses and good canopy-producing crops like legumes controls soil erosion and improves soil structure due to good canopy, higher root mass and root

secretions helping in binding soil particles. Cropping sequences that provide early and continuous ground cover permit less erosion. A suitable cover crop such as pigeon pea (*Cajanus cajan*), stylo (*Stylosanthes guianensis*) and velvet beans (*Psophocarpus palustris*) used in crop rotation helps to improve soil properties.

- Nutrient management through conventional sources of nutrients (organic manure, green manure, crop residue, compost etc) should be given due emphasis since the farmers are reluctant to use chemical fertilizers.
- The SALT approach (Sloping Agriculture Land Technology) when suitably adapted to the local conditions has the potential to offer the hill tribes with an alternative method of agriculture, which while being climate smart, will also provide the farmers with a means of sustainable livelihoods.
- Soil and water conservation through adoption of site specific land use systems viz. horticultural based land use system, horti-silviculture based land use system, agri-horti-silvi-pastoral land use system, agro-forestry based land use system etc. Agroforestry has been a long-standing custom in the region, where cereals, rhizomes, pineapple, coffee, tea, spices and vegetable crops are grown along with fruits and other trees such as pine, pear, plum, areca nut, mandarin, guava, coconut, jackfruit, banana and large cardamom with alder trees.
- Adoption of soil and water conservation measures through bio-terracing, contour trances, vegetative bunds etc.
- Terracing of hills with abandoned jhum land. Creation of micro water harvesting structures in steep hill slope of jhum fields is difficult for rain water harvesting. Terracing not only helps in reducing hill slopes but also provide platform for creation of micro water harvesting structures. Terraced land could be used for planting commercial crops like tea, rubber etc. Terracing of hill is a costly affair and so concerned government should introduce land use policy for terracing of *jhum* lands for enhancing agricultural productivity and livelihood security. For example Government of Mizoram has introduced New Land Use Policy (NLUP) for conversion of hill slopes in to terraces.
- Development of the abandoned *jhum* land following watershed approach.

Conclusion

As the *jhum* system has cultural linkages with the traditional communities, improvement of *jhum* is the only option left out with the researchers and developmental workers for motivating people to mitigate the ecological degradation of the production system.

Literature cited

Alegre *et al.* (1996). Dynamics of soil physical properties in Amazonian agroecosystems inoculated with earthworms. Soil Science Society of America Journal 60(5): 1522-1529.

Hazarika, S. (2014). Abstract of National Seminar on Shifting Cultivation (*Jhum*) in the 21st Century: Fitness and Improvement November 28-29, 2014 at CPGS, CAU, Umiam, Meghalaya, India

ISFR (2015). Indian State of Forest Report 2015 published by Forest Survey of India, Ministry of Environment & Forests, GOI, New Delhi.

Ram and Singh 1993. Ram, Munna and Singh, B.P. (1993). Soil fertility management in farming systems. Lecture notes. Off-campus training on farming system, Aizawl. 5-7 October, pp. 46-50.

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