# Addressing Driver of Deforestation and Forest Degradation in Mizoram through Sub-National REDD+ Action Plan

*Nabin Bhattarai[1], Nemit Verma[2], R.S. Rawat[2], Bhaskar Singh Karky[1], VRS Rawat[2]*

[1]International Centre for Integrated Mountain Development (ICIMOD), Nepal

[2]Indian Council of Forestry Research and Education (ICFRE), India

Corresponding author: nabin.bhattarai@icimod.org

**Abstract**

Knowledge and understanding on drivers of deforestation and forest degradation (D&D) plays a vital role in development of policies and measures in countries moving ahead with REDD+ (Reducing Emissions from Deforestation and Forest Degradation) implementation at national as well as sub national level. The conference of Parties (COP) 15 also inspires the non-annex countries to identify drivers of D&D and means to address them in addition to stabilisation of forest carbon stocks. A National REDD+ Strategy (NS) or National REDD+ Action Plan (AP) is mandatory under the United Nations Framework Convention on Climate Change (UNFCCC) for any country wishing to receive international funding under the REDD+ payment. Forest ecosystems and drivers of D&D vary across countries and regions (within individual countries) and this type of plan which are developed at sub-national level in consultation with local stakeholders will support in REDD+ readiness as well as implementation at the local level. In addition, addressing drivers of D&D following this sort of process plays a bridging role between the local and national level for the implementation of REDD+ activities. This study primarily identifies the drivers of D&D in Mizoram State of India. Methods for this research were adopted from "Developing Sub-National REDD+ Action Plans: A Manual for Facilitators" published by the International Center for Integrated Mountain Development (ICIMOD) in 2017". It was observed that, shifting cultivation is the main driver of D&D in the study area. To address the main driver, settled cultivation or permanent cultivation supported by horticulture crops should be adopted for better livelihood options.

**Key words**: Drivers of deforestation and forest degradation, intervention packages, Mizoram, shifting cultivation, strategies

## INTRODUCTION

Globally, deforestation and forest degradation (D&D) has become one of the major causes of greenhouse gas (GHG) emissions besides burning of fossil fuels. According to the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC), annual GHG emission flux from land use and land-use change and forestry activities accounted to approximately 4.3-5.5 $GtCO_2eq/yr$ or about 9-11 per cent of total anthropogenic greenhouse gas emissions (Smith *et al.* 2014). The overall contribution from agriculture, forestry and other land use (AFOLU) sector is around one quarter of the global anthropogenic GHG emissions (Smith *et al.* 2014). Broadly, forests are known as source as well as sink of carbon. Deforestation and forest degradation leads to the release of carbon in the form of carbon dioxide which has been stored in the tree biomass. Therefore, in order to address D&D as a part of integrated strategy to reduce global GHG emission, the concept of REDD+ (reducing emissions from deforestation and forest

degradation in developing countries) as climate change mitigation option was first introduced during the 11th session of the Conference of Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) in Montreal in 2005. Further in COP 13 held in Bali, the concept of REDD was promoted to REDD+ with inclusion of the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries and finally recognized by the Paris Agreement during the COP in 2015.

Understanding drivers of D&D is fundamental for the development of policies and measures (PAMs) that aim to alter current trends in forest activities towards a more climate and biodiversity friendly outcomes. The 15th session of COP, decision 4/CP.15 encourages the non-annex countries "to identify drivers of D&D resulting in emissions and also the means to address these and to identify activities within the country that result in reduced emissions and increased removals, and stabilisation of forest carbon stocks". Further the issue of identifying drivers and activities causing change in forest carbon stock in the context of monitoring and implementation of REDD+ at national level had received wide attention at the international level.

In order to achieve the above REDD+ goals, the initial step is to understand the drivers of D&D at the sub-national as well as national level. To design effective REDD+ policy, National REDD+ Strategy and Implementation Plans, there is a need to assess the forest dynamics (Boucher 2011; Rudorff *et al.* 2011). Forest Reference Level (FRL) can be estimated, if drivers as well as the activities addressing the drivers of D&D are identified at the regional level (Huettner *et al.* 2009). As a result, for implementation of REDD+ activities, there is a need of database at sub-national as well as country level on drivers of D&D along with the information on change in forest cover and forest carbon stocks.

More than 60 per cent population in rural areas of Mizoram depends on the agriculture for their livelihood. Shifting cultivation is an age-old practice of farming in all the Northeastern states of India in which each family clears a patch of forest by cutting down whatever is growing in that patch and later dry and burn whatever has been cut down on the ground. The ashes left behind act as fertilizer and this cleared and burnt patch of land is used for the cultivation of rice and other subsidiary crops such as tobacco, cotton, chili and vegetables followed by fallow period to regain the soil fertility (Conklin 1961; Ramakrishna 1984). The cycle of the shifting cultivation in Mizoram used to be 8-10 years in past but due to population growth, decrease in productivity and limited land availability, this cycle has be shortened to 4-5 years (Ramakrishna 1984). In addition, new patch of land has been cleared to practice shifting cultivation, ultimately resulting in D&D. Mizoram lacks researches on drivers of D&D though there are studies showing that North-East States are practicing shifting cultivation and it is the main cause for D&D.

This study was carried out in the State of Mizoram, India, aiming to 1) identify the direct and indirect drivers of D&D; 2) prioritize the main driver; and 3) develop intervention package and activities to address the driver of D&D.

## WHY SUB-NATIONAL REDD+ PLANNING?

According to paragraph 71 of the decision 1/CP.16, National REDD+ Strategy (NS) or National REDD+ Action Plan (AP) is mandatory under the UNFCCC for any country wishing to receive international REDD+ payments. This accreditation is vital because inappropriate policies, measures and governance arrangements, across several sectors, must be addressed for REDD+ to be successful. In most countries, there are significant sub-national differences in forest ecosystems and drivers of deforestation & forest degradation (D&D) that make it important for REDD+ planning and implementation at the sub-national and local level.

Sub-national REDD+ Action Plan (SRAP) responds to the challenge of operationalising an NS or AP and its component PAMs by tailoring them to address locally specific drivers of D&D and barriers to expanding (forest carbon) enhancement activities.

Sub-national planning also allows local stakeholder participation in the planning process, which will increase the transparency, ownership and social sustainability of REDD+ programs. If possible SRAPs should be undertaken after a detailed NS process so that the SRAP process can build on and complement the national PAMs, and because this sequencing should result in a more streamlined and cost-effective SRAP process while ensuring the overall national coherence of REDD+.

Globally, over a period of 130 years i.e. from 1850 to 1980, it was found that about 15 per cent of the world's forest and forest resources were cleared out of which 43 per cent constitute from Asia (WRI 1987; Sharma *et al.* 1992). NRSA (1982) recorded the rate of forest depletion in Northeast India to the tune of 1865 sq km per year. According to the latest India State Forest Report, 2017 (FSI 2017) there is a decrease of 531 sq km of forest area in the region as compared to India State of Forest Report, 2015. Socio economic conditions at national or sub-national level and structural problems related to the international economic regime are the major causes of forest degradation particularly in developing countries (Tarasofsky 1995).

### Study Site

Mizoram state is among the seven sister's states in the North-Eastern part of the India. Geographically it lies between 21°58' to 24°35'N latitudes and 92°15' to 93°29' E longitudes. It shares interstate border with states of Assam, Manipur and Tripura along with the international borders of Myanmar and Bangladesh. Total geographical area of the state is 21,081 sq km which constitutes 0.64 per cent of the total geographical area of the country. The state has 8 districts viz. Aizawl, Champhai, Kolasib, Lunglei, Mamit, Lawngtlai, Saiha, and Serchhip and 23 sub-divisions. The total population of Mizoram is 10,97,206 (GoI 2011) with overall density of 52 persons per sq. km. Population of Mizoram has increased by 23.48 per cent between 2001 to 2011 compared to 1991-2001 period. The literacy rate of the state is 91.58 per cent which is the 3rd highest in the country.

Forests are one of the important natural resources in the state which constitute 18653 sq km of area under total forest

and tree cover, and comprises 88.48 per cent of the total geographical area of the state (FSI 2017). Overall, state of Mizoram contributes around 2.33 per cent in the total forest and tree cover of the country. As per India State of Forest Report (2017) the per capita availability of the forest and tree cover in the state is 0.017 sq km.


**Figure. 1. Map of Study Area**

## MATERIALS AND METHODS

The forest dynamics and transitions can be studied well by understanding the drivers of D&D at sub-national as well as national level. The method for the identification of drivers of D&D was guided by Richards *et al.* (2017). In order to identify the drivers of D&D in the study area, two days consultation workshop was conducted with the government agencies, community members, civic societies, academia and reporters. A total of 44 participants were present for this workshop. The main objective of organising this workshop was to identify the drivers of D&D. During this workshop, all the participants were divided into two different groups to work separately on drivers of D&D. The drivers of D&D were listed on the meta cards. All the listed direct and indirect drivers were differentiated. Before separating direct and indirect drivers, knowledge regarding direct and indirect drivers were explained. Direct drivers or proximate drivers of deforestation are anthropogenic activities that directly affect the loss of forest, which can be grouped into different categories such as agriculture expansion, expansion of infrastructure and wood extraction (Geist and Lambin 2001). Agricultural expansion has been identified as a key driver of deforestation in the tropics (Gibbs *et al.* 2010), drivers vary regionally and temporally (Boucher *et al.* 2011). Whereas indirect drivers or underlying drivers are complex interactions of social, economic, political, cultural and technological processes that affect the proximate drivers to D&D (Rawat *et al.* 2017). In addition, all the participants were requested to identify the areas having D&D in the maps which later on was termed as hotspots.

After, having list of direct drivers, participants were again requested to prioritise the drivers by providing ranks to each on the basis of importance. Once, the ranking was completed, their highest ranked driver was selected to develop the cause and effect of the particular driver via problem trees. Once, the problem trees were formulated, solutions for those problems were developed by using the help of solution trees. Following the consultation workshop, field verification of the hotspots was carried out by the team members in different locations. A total of 15 different locations were visited and this was supported by focus group discussion with the local communities residing near to the hotspots to gather detailed information of the area.

To formulate the intervention packages (IPs) from all gathered information and solution trees, one day expert level consultation workshop was organised. This workshop was attended by 23 participants from government institutions and academician in the state which are actively involved in forest management and conservation. Finally, strategies and detailed activities for REDD+ implementation in the state were developed for all the IPs.

## RESULTS

### Historical Forest Trend Evaluation of Mizoram

In the state of Mizoram, the area under very dense forest cover is increasing while the moderately dense forest (MDF) and overall forest cover is decreasing (Table 1). Since 2009, MDF and overall forest cover of the state is decreasing. During 2013, the area under all the forest cover classes' i.e. very dense forest, moderately dense

forest and open forest is decreased which resulted in overall decline in 306 sq km of forest land in the State. Table 2 represents the historical land use statistics in the state of Mizoram from last two decade, which clearly shows that on an average there is the 0.45 sq km of current fallow land in the state of Mizoram per year.

**Table 1: Historical Trends in Different Forest Types of Mizoram (sq km) from 2003-2011 as per India State of Forest Reports from 2005 Onwards**

| Year | VDF | Change in VDF | MDF | Change in MDF | OF | Change in OF | Forest Cover | Change in Forest Cover |
|---|---|---|---|---|---|---|---|---|
| 2005 | 133 | 1 | 6173 | 78 | 12378 | 477 | 18648 | 592 |
| 2009 | 134? | 0 | 6251 | -165 | 12855 | 42 | 19240 | -123 |
| 2011 | 134 | 4? | 6086 | -186? | 12897 | 119? | 19117 | -63 |
| 2013 | 138 | 4 | 5900 | -186 | 13016 | 119 | 19054 | -306? |
| 2015 | 138 | 0 | 5858 | -42 | 12752 | 0 | 18748 | -306 |
| 2017 | 131 | -4 | 5861 | 61 | 12194 | -588 | 18186 | -531 |

Source: FSI (2005, 2009, 2011, 2013, 2015, 2017)

**Table 2: Land Use Statistics of Mizoram (Area in Ha)**

| S. No. | Year | Not available for cultivation | | Other uncultivated Land excluding follow Land | | | Follow Land | |
|---|---|---|---|---|---|---|---|---|
| | | Land put to Non Agricultural use | Barren and Inculturable Land | Permanent Pasture and other Grazing Land | Land under Miscellaneous Tree Crops and Groves not included in net Area sown | Culturable Waste | Follow Land other than current Follow Land | Current Follow Land |
| 1 | 1997 - 98 | 1.218 | 0.086 | 0.225 | 0.306 | 0.053 | 1.558 | 0.363 |
| 2 | 1998 – 99 | 1.227 | 0.078 | 0.106 | 0.192 | 0.051 | 1.633 | 0.358 |
| 3 | 1999 - 00 | 1.252 | 0.082 | 0.131 | 0.273 | 0.095 | 2.157 | 0.414 |
| 4 | 2000 - 01 | 1.250 | 0.089 | 0.057 | 0.151 | 0.060 | 1.944 | 0.384 |
| 5 | 2001 - 02 | 1.255 | 0.085 | 0.053 | 0.102 | 0.050 | 1.812 | 0.500 |
| 6 | 2002 - 03 | 1.254 | 0.086 | 0.053 | 0.102 | 0.052 | 1.972 | 0.410 |
| 7 | 2003 - 04 | 1.254 | 0.086 | 0.052 | 0.688 | 0.052 | 1.661 | 0.415 |
| 8 | 2004 - 05 | 1.254 | 0.086 | 0.052 | 0.667 | 0.052 | 1.660 | 0.449 |
| 9 | 2005 - 06 | 1.240 | 0.090 | 0.053 | 7.948 | 0.270 | 1.709 | 0.301 |
| 10 | 2006 - 07 | 0.934 | 0.088 | 0.053 | 0.322 | 0.067 | 1.808 | 0.660 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11 | 2007 - 08 | 0.950 | 0.083 | 0.053 | 0.375 | 0.067 | 1.823 | 0.666 |
| 12 | 2008 - 09 | 0.950 | 0.083 | 0.053 | 0.409 | 0.067 | 1.831 | 0.612 |
| 13 | 2009 - 10 | 0.950 | 0.083 | 0.053 | 0.411 | 0.067 | 1.940 | 0.504 |
| 14 | 2010 - 11 | 0.995 | 0.083 | 0.053 | 0.734 | 0.067 | 1.611 | 0.471 |
| 15 | 2011 - 12 | 0.686 | 0.063 | 0.111 | 0.413 | 0.074 | 1.268 | 0.466 |
| 16 | 2012 - 13 | 0.764 | 0.069 | 0.138 | 0.412 | 0.090 | 1.252 | 0.318 |
| 17 | 2013 - 14 | 1.218 | 0.086 | 0.225 | 0.306 | 0.053 | 1.558 | 0.363 |
| 18 | 2014 - 15 | 1.227 | 0.078 | 0.106 | 0.192 | 0.051 | 1.633 | 0.358 |
| 19 | 2015 - 16 | 1.252 | 0.082 | 0.131 | 0.273 | 0.095 | 2.157 | 0.414 |

Source: Government of Mizoram (n.d.)

## Identification and Priority of Drivers of D&D

Mizoram State having the highest forest cover has been facing high rates of D&D. From the consultation workshop several drivers were identified which later on was differentiated as direct and indirect drivers (Table 3).

**Table 3: Direct and Indirect Drivers of D&D**

| | Deforestation | Forest Degradation |
|---|---|---|
| Direct drivers | • Topographic factors<br>• Traditional farming methods-expansion of shifting cultivation<br>• Limited livelihood options | • Shifting cultivation<br>• Forest fire<br>• Firewood and NTFP collection |
| Indirect drivers or underlying causes | • Limited flat land<br>• Unavailability of irrigation<br>• No alternative for shifting cultivation<br>• Income generation<br>• Food security<br>• Lifestyle of Mizo<br>• Lack of awareness<br>• To meet domestic demand | • Low socio-economic status<br>• Abiotic factors (soil, rainfall, temperature, topography, slope and terrain)<br>• Remoteness<br>• Lack of awareness<br>• High livelihood dependency on forest resources<br>• Weak government policies and poor law enforcement<br>• Land and revenue policies<br>• Traditional practices<br>• Lack of viable income opportunities |

As REDD+ only can't address all the above mentioned drivers so, prioritisation of drivers for both D&D was carried out. Prioritisation was carried out on the basis of ranking and importance of these drivers. The direct driver getting the maximum votes/rank was selected for further evaluation. For both D&D, shifting cultivation was found to be the major issue in Mizoram. To get the root cause of shifting cultivation, problem tree was developed.

## Problem and Solution Analysis of Shifting Cultivation

Problem and solution tree analysis used "participatory theory of change" approach for mapping out the main problems, along with their causes and effects, to come up with clear and manageable goals and the strategy of how to achieve them. Two main stages were followed in this process: (1) identification of negative aspects of existing situations (or key challenges) in the form of problem trees (involving the analysis of causes and effects of D&D or barriers to forest carbon enhancement); and (2) the inversion of the problems into objectives leading to solution trees or "results chains" showing potential solutions or strategies that respond to the drivers or barriers.

To develop the problem tree, shifting cultivation is taken as key challenge. Main reason behind practicing shifting cultivation was found to be Topographic factor, traditional method of farming and limited livelihood options were found out be the major reason behind the practice of shifting cultivation (Figure 2).

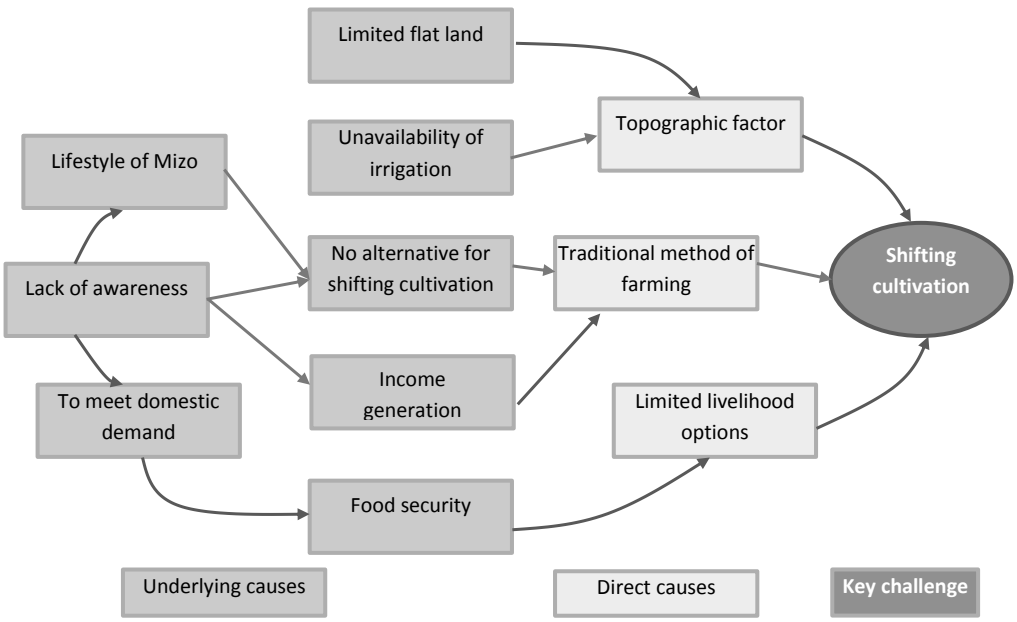


**Figure 2: Problem Tree for Shifting Cultivation**

To address shifting cultivation as a driver of deforestation, the desired outcome in the solution tree (Figure 3) was formulated as 'Reduced D&D from shifting cultivation". From the solution tree, four key results were identified for achieving this desired outcome: development of hill terracing and contour farming; promotion of horticultural crops; promotion of permanent farming systems; and development of a habitat mosaic for biodiversity.

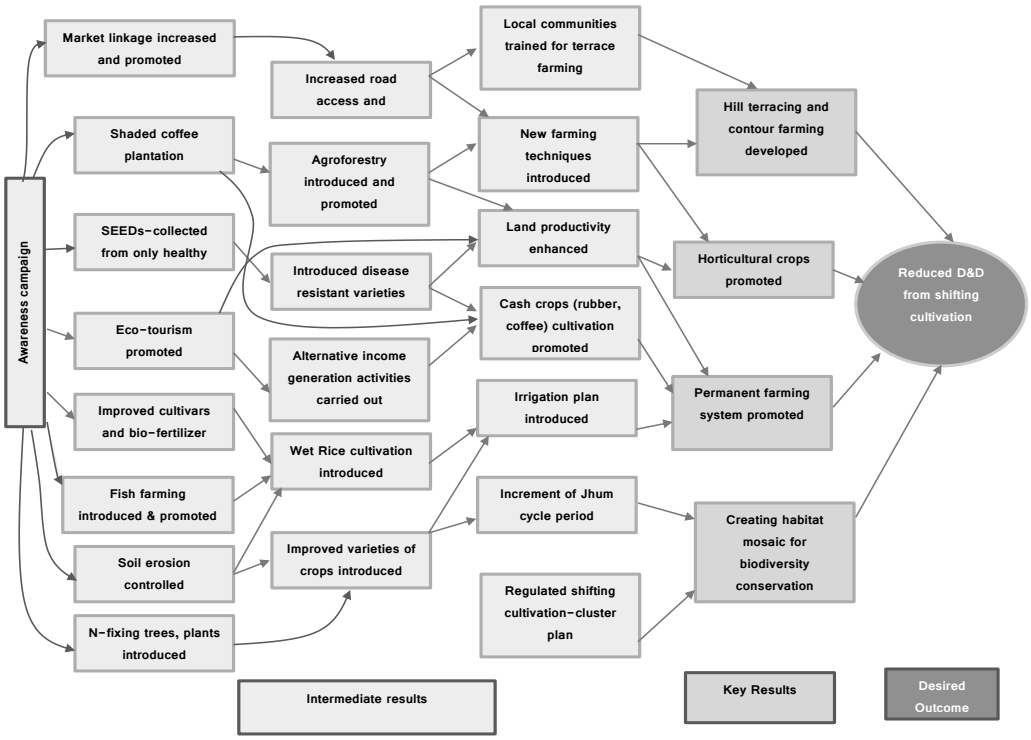


**Figure 3: Solution Tree for Reduced D&D from Shifting Cultivation**

## Development of Intervention Package with Strategies and Activities

The key results from the solution tree were used as the basis for strategies in the IPs. This workshop was attended by 13 experts to formulate the IPs. A total of three IPs were formulated to address shifting cultivation. To come up with the key IPs, feasibility analysis for all IPs were carried out on the basis of implementation cost, cost effectiveness, implementation risk, opportunity cost and incentives measure (Table 4).

**Table 4: Feasibility Analysis of the IPs**

| Intervention Packages (IPs) | Implementation Risks/ Obstacles L-3, M-2, H-1 | Cost-effectiveness of risk reduction measures H-3, M-2, L-1 | Implementation Cost L-3, M-2, H-1 | Opportunity Cost L-3, M-2, H-1 | Incentives measures L-3, M-2, H-1 | Total Score |
|---|---|---|---|---|---|---|
| Increased employment alternatives/ opportunities | 2 | 3 | 1 | 2 | 2 | 10 |
| Improved crop productivity | 3 | 3 | 2 | 3 | 2 | 13 |
| Sustainable cropping pattern and land management | 2 | 3 | 1 | 2 | 3 | 11 |

Among three IPs, experts decided to consider two key IPs, improved crop productivity and sustainable cropping pattern and land management. This exercise was followed by developing strategies and activities for the selected IPs. For each IP, one strategy was developed supported by numbers of activities (Table 5).

**Table 5: IP, Strategies and Activities**

| Intervention Package | Strategies | Activities |
|---|---|---|
| Improved crop productivity | Promotion of high yielding crops and management of soil to maintain the soil fertility | • Procurement of improved cultivars<br>• Mass multiplication of the cultivars<br>• Supply to farmers for plantation<br>• Demonstration to farmers and polarisation<br>• Contour banding<br>• Construction of terraces for farming<br>• Sod culture<br>• Mulching to maintain the soil fertility<br>• Plantation of soil binders<br>• Raising of nursery having horticulture, crops and trees seedlings<br>• Plantation of seedlings<br>• Promotion of horticulture<br>• Creating awareness and training programs |

| | | |
|---|---|---|
| Sustainable cropping pattern and land management | Adoption and expansion of settled hill farming system | • Site survey, selection and preparation of land.<br>• Capacity building, training on terracing/ contour and permanent farming system<br>• Promotion of Sloping Agriculture Land Technology (SALT)<br>• Development of irrigation channels<br>• Construction of vermi-compost/manure collection tank (pit-holes etc.)<br>• Awareness campaigns of agroforestry systems<br>• Development of nurseries to promote agroforestry and enrichment plantation<br>• Selection of appropriate paddy varieties<br>• Financial and technical support for the establishment of WRC cum fish farming |

## DISCUSSION

Forest ecosystem plays an important role in providing various environmental benefits and life support systems to maintain ecological balance between various anthropogenic activities and natural phenomena. Carbon sequestration, nutrient cycling, watershed protection, abatement of pollution along with the micro-climatic regulation are the important processes provided by forests of a particular area towards its environmental benefits. Broadly the term "degradation of forests" has emerged as a result of various anthropogenic activities that deteriorate the quality of forests. Clearing of forests was not only confined to the settlement of villages but also used for cultivation and expansion of pastures. Further it has caused over exploitation of land and water resources, and ultimately disrupting the forest quality. Hence the extent of forest degradation can be easily observed at the sub-national level (Hosonuma *et al.* 2012).

Several drivers of D&D in Mizoram were identified but the most alarming drivers were found to be Shifting cultivation. The government and scientific establishment has long considered Jhum to be destructive to environment due to removal and subsequent burning of vegetative cover from the selected Jhum area. Increased air pollution, soil erosion and landslides have been attributed to Jhum. Government of Mizoram in 1984 launched a programme called New Land Use Policy (NLUP) with an objective to put an end to Jhum practice by providing alternative land based permanent farming and sustainable income to the Jhum cultivators (Garbyal 1999). Despite the introduction of NLUP, the problem of D&D due to shifting cultivation is still prevalent as it was not able to make significant changes in the quality of life of the beneficiaries (Garbyal 1999). In line to the findings of this paper, Rawat *et al*. (2017), have identified the direct drivers of D&D including shifting cultivation, fuelwood collection, timber harvesting and NTFP's extraction. The main alternatives put forth in this study is by converting Jhum area to settled agriculture through terrace construction

or establishing plantations and orchards. The success of these alternatives has been limited since they are cost intensive and dependent on external inputs and technology, beyond the reach of the hill farmers. The farmers use the specific allocated area for a period of 2-3 years following which further exacerbates those areas are abandoned. Farmers shift to new forest area which land. People perceive that the solution to abate the extent of shifting cultivation is the wet rice cultivation. The rice is the major crop of the state and WRC with appropriate paddy varieties is the most favorable type of cultivation technique to increase the production of rice. The total area under wet rice cultivation in the state has also been increased from last few years which have also increased the rice production in the state (GoM 2014). Introduction of fish farming in WRC can be a good option for increasing in income of the farmers.

Further, it was suggested that terrace farming and permanent farming can also decrease the extent of shifting cultivation in the state. Terrace farming and allotment of land on permanent basis to the farmers can increase their interest and responsibility towards it. Restoration of the shifting patched can also play an important role, as the famers give attention to land for 2-3 years following which there is no provision towards the maintenance of that particular patch. The area has been left abandoned by the local communities without using any scientific method of eco-restoration. Hence at the village council level, a team with active participation of local communities can be formed which can work towards restoration of that abandoned patches of land under the guidance and support of State Forest Department and other forestry research organizations working for the local communities at national as well as sub national levels. In addition, due to short Jhum cycle, production and per ha yields of crops has largely been decreased (Prasad *et al.* 2014) thus demanding for, higher yielding crops. To have better outcome, introduction of improved cultivars, which then should be multiplied in huge numbers and need to be supplied to the farmers for cultivation.

In terms of decreasing the extent of shifting cultivation as well as to increase economic status at household level, it has been found that introduction of horticultural crop can also play an important role. Promoting horticultural crops can increase income from a particular patch of land. This can further encourage farmers for a regular source of income. Oil palm, ginger, turmeric, coffee and tea plantation can play an important role in reducing the extent of shifting cultivation in the project area (Rawat *et al.* 2017).

Employment opportunities are also an important determinant of D&D. The employment opportunities are very less and most of the people depend on farming practices and collection of forest produces. It has been found that majority of farmers (72%) are involved in farming practices and only 13 per cent of the population are in Government and private jobs (Rawat *et al.* 2017). Agriculture in Mizoram, though being a major economic source, have been affected due to ragged terrains, which are not so conducive for the cultivation of crops. In addition, distribution of erratic and prolonged rainfall is creating problem for soil fertility. So, it is very important to develop irrigation channels and also

soil mulching with the plantation of soil binders should be implemented for the conservation of soil and to increase soil fertility.

It has been found that some of the farmers are converting farms to coffee garden which is providing an alternative source of income. Coffee plantation has proved to play an important role towards generating alternative employment opportunities for local communities as well as reduce the extent of shifting cultivation. Hence, by acknowledging the traditional knowledge and skills of the local communities, emphasis should be laid on promoting various livelihood activities based on traditional and indigenous system. (Kesavan and Swaminathan 2008).

There is also a significant area of Jhum land that has been abandoned and degraded in Mizoram. This practice is mainly prevalent in slopy terrains. This land could be restored by carrying out plantation activities or can be used for agriculture or agroforestry, which helps in reducing pressure on the natural forests and other ecosystems. For this to happen, effective collaboration and coordination with other forest related organisations/agencies should be in place. In addition, for effective outcome, it is important to consider issues and coming up with the interventions at local level to address that particular issue. For instance, SALT concept has not been introduced in Mizoram. This technology can be a good option for the Government of Mizoram to achieve the objective of NLUP in abolishing Jhum cultivation by providing sustainable livelihood options.

## CONCLUSION

This paper examines the drivers of D&D in Mizoram, North-Eastern state of India. A total of six direct drivers were identified. Among them, the drivers shifting cultivation was the most significant drivers of D&D. Root causes of shifting cultivation were identified through problem analysis followed by potential solutions. Challenges to shifting cultivation include unseasonal and erratic rainfall, reduction in duration of fallow period due to pressure on land, reduction in yields due to decline in soil fertility, low income generation, lack of interest among the younger generation in practicing it among others. To address this problem two IPs were proposed supported by several activities like promotion of agroforestry, management of land for agriculture, promotion of WRC cum fish farming, and others. Introduction of SALT in areas where shifting cultivation is practiced will be the best option for permanent farming. In addition, this technology has 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. Introduction of agroforestry species which have the potential to reduce the soil erosion can also help to reduce the extent of shifting cultivation and also increase the productivity of the farmland. Hence, introduction of area specific agro-forestry models as well as motivation and capacity building can encourage the local communities towards adopting the concept of Agroforestry in the state.

Overall, considering the economic, ecological and social condition of the state, there is a need to find a suitable solution and to implement best practice model for providing economically viable alternatives to reduce the extent of shifting cultivation. REDD+ mechanism can provide a stable platform to the local communities to participate and get reap benefits by means of income generation activities and also reduce the extent of shifting cultivation. That would ultimately lead towards addressing the drivers of D&D in the state and overcome adverse impacts of climate change by means of adaptation and mitigation.

## ACKNOWLEDGEMENTS

Authors are thankful to the Director General of ICIMOD and Director General of the Indian Council of Forestry Research and Education, Dehradun, India for their support towards implementation of REDD+ Himalaya Project in the state of Mizoram, India. The field assistance and support provided by Advance Research Centre for Bamboo and Rattan Aizawl, Mizoram and Mizoram State Forest Department for carrying out the study in district Mamit is highly acknowledged.

## REFERENCES

**Boucher D., Elias P., Lininger K., May-Tobin C., Roquemore S. and Saxon E. 2011. The Root** of the Problem: What's Driving Tropical Deforestation Today? Union of Concerned Scientists, Cambridge, Massachusetts.

**Conklin, H.C.** 1961. *The Study of Shifting Cultivation. Current Anthropology*, **2**(1): 27–61.

**FSI.** 2005. India State of Forest Report 2005. Forest Survey of India, Government of India, Dehradun.

**FSI.** 2009. India State of Forest Report, 2009. Forest Survey of India, Government of India, Dehradun.

**FSI.** 2011. India State of Forest Report, 2011. Forest Survey of India, Government of India, Dehradun.

**FSI.** 2013. India State of Forest Report, 2013. Forest Survey of India, Government of India, Dehradun.

**FSI.** 2015. India State of Forest Report, 2015. Forest Survey of India, Government of India, Dehradun.

**FSI.** 2017. India State of Forest Report, 2017. Forest Survey of India, Government of India, Dehradun.

**Garbyal, S. S.** 1999. Jhuming(Shifting Cultivation) in Mizoram (India) and New Land Use Policy-how Far it has Succeeded in Containing this Primitive Agriculture Practice. *Indian Forester,* **125**(2): 137–148.

**Geist, H. and Lambin, E.** 2001. What Drives Tropical Deforestation? A Meta-analysis of Proximate and Underlying Causes of Deforestation based on Subnational Case Study Evidence. Land-Use and Land-Cover Change (LUCC) Project, International Geosphere-Biosphere Programme (IGBP). LUCC Report Series: 4.

**Gibbs, H.K., Ruesch, A.S., Achard, F., Clayton, M.K., Holmgren, P., Ramankutty, N. and Foley, J.A.** 2010. Tropical Forests were the Primary Sources of New Agricultural Land in the 1980s and 1990s. *PNAS*, **107**(38): 16732-16737.

**GoI.** 2011. Census of India 2011. Government of India, India.

**GoM.** 2014. Mizoram Economic Survey 2014-2015 (Vol. 19). Government of Mizoram, Mizoram, India. http://mizofin.nic.in/file/b 15-16/Mizoram Economic Survey 2014-15.pdf accessed July 25, 2018.

**Government of Mizoram.** n.d. Report on Economic Survey of Mizoram, 2016-17. Planning & Programme Implementation Department, Government of Mizoram, India.

**Hosonuma, N., Herold, M., De Sy, V., S De Friess, R., Brockhaus, M., Verchot, L., Angelsen, A. and Romijn, E.** 2012. An Assessment of Deforestation and Forest Degradation Drivers in Developing Countries. *Environmental Research Letter*, **7**(4): 4009.

**Huettner, M., Leemans, R., Kok, K. and Ebeling, J.** 2009 A Comparison of Baseline Methodologies for Reducing Emissions from Deforestation and Degradation. *Carbon Balance Management,* **44**.

**Kesavan, P.C. and Swaminathan, M.S.** 2008. Strategies and Models for Agricultural Sustainability in Developing Asian Countries. *Philosophical Transactions of the Royal Society B: Biological Sciences,* **363**(1492): 877–891.

**NRSA.** 1982. Change in Forest Cover in India. National Remote Sensing Agency, Department of Space, Hyderabad.

**Prasad Sati, V. and Rinawma, P.** 2014. Practices of Shifting Cultivation and its Implications in Mizoram , North-East India : A Review of Existing Research. *Nature and Environment*, **19**(2): 179–187.

**Ramakrishna, P.** 1984. The Science behind Rotational Bush Fallow Agricultural System (Jhum): Proc. *Indian Academy of Sciences (Plant Science)*, **93**(3): 379–400.

**Rawat, V. R., Rawat, R.S. and Verma, N.** 2017. Drivers of Deforestation and Forest Degradation in Mizoram. A Synthesis Report for REDD+ Policymakers . Biodiversity and Climate Change Division, Directorate of Research Indian Council of Forestry Research and Education. Dehradun, India.

**Richards, M., Bhattarai, N., Karky, B. S., Hicks, C., Ravilious, C., Timalsina, N., Phan, G., Swan, S.; Vickers, B.; Windhorst, K. and Roy, R.** 2017. Developing Sub-National REDD+ Action Plans: A Manual for Facilitators. ICIMOD Manual 2017/13. International Center for Integrated Mountain Development, Kathmandu, Nepal.

**Rudorff B.F.T, Adami M., Aguilar D.A., Moreira, M. A., Mello, M. P.,Fabiani, L., Amaral, D. F. and Pires, B. M.** 2011. The Soy Moratorium in the Amazon Biome Monitored by Remote Sensing Images. *Remote Sensing*, **3**: 185–202.

**Sharma, N.P., Rowe, R., Openshaw, K. and Jacobson, M.** 1992. World's Forests in Perspective. In: N.P. Sharma, Managing the World's Forests (Ed.). Kendall /Hunt Publishing Company, Iowa, USA.

**Smith, P., Bustamante, M., Ahammad, H., Clark, H., Dong, H., Elsiddig, E.A., Haberl, H., Harper, R., House, J., Jafari, M., Masera, O., Mbow, C., Ravindranath, N.H., Rice, C.W., Robledo Abad, C., Romanovskaya, A., Sperling, F. and Tubiello, F.** 2014: Agriculture, Forestry and Other Land Use (AFOLU). In: O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. MinxClimate (Eds), *Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

**Tarasofsky, P.** 1995. Man and the Forest. Duke University Press, Durham.

**WRI.** 1987. World Resources 1987. Basic Books, New York.