Identification and Adoption of Appropriate Technology for REDD+ Implementation in Mizoram

ICIMOD

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

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Indian Council of Forestry Research and Education

(An Autonomous Body of Ministry of Environment, Forest and Climate Change, Government of India)

P.O. New Forest, Dehradun - 248006 (INDIA)

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Abbreviation Used

BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
COP	Conference of Parties
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIZ	Deutsche Gessellschaft fur Internationale Zusammenarbeit
ICFRE	Indian Council for Forestry Research and Education
ICIMOD	International Centre for Integrated Mountain Development
ICS	Improved Cook Stoves
LPG	Liquefied Petroleum Gas
NDC	Nationally Determined Contributions
Rs.	Rupees (Indian)
IPCC	Intergovernmental Panel on Climate Change
km^2	Square kilometer
MoEF&CC	Ministry of Environment, Forest and Climate Change
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

A feasibility study for identifying and adopting appropriate technology for introduction of improved cook stoves, solar energy, agroforestry and livestock management in the Mamit District of Mizoram was undertaken. The objective of this study was to identify the potential activities for addressing the drivers of deforestation and forest degradation which provides the ecological and economic benefits to the local communities.

During the survey, it was found that major population (95.74%) of local community are dependent upon traditional type of cook stoves whereas only 3.09 % percent are using improved cook stoves (ICS). This results into high pressure on forest resources and further becomes a driver for forest degradation. Moreover, the majority of population has limited sources of income (53.09%) and agriculture practices mainly shifting cultivation is the main source of their income. Shifting cultivation is practiced by majority of individuals (75%) on the fragmented land. The local communities are mainly dependent on electricity for lightening their houses, however, 29.63% of population is also using solar energy as an alternative source for lightening purpose.

The study has identified an appropriate feasible technology for the local communities which provide capability to improve the ecological and economic benefits. This includes improved cook stoves, solar energy, agroforestry, and livestock management. Out of this, improved cook stoves scored maximum for adoption. Other technologies scored less due to the high implementation risk involved and less awareness in comparison to ICS.

Feasibility study showed that adoption and implementation of technologies/ activities of such as promotion of agroforestry, shaded coffee plantations, improved cook stoves, solar energy etc. can address the drivers of deforestation and forest degradation as well as also enhance the income of the local communities which will eventually be helpful in implementation of REDD+ activities in the Mamit District of Mizoram.


AARTI SURAKSHA
AARTI SURAKSHA

1

Introduction

Reducing emission from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forest and enhancement of forest carbon stocksin developing countries is known as REDD+. It has been well recognized as a climate change mitigation mechanism under United Nations Framework Convention on Climate Change (UNFCCC). In accordance to Decision 1/CP.16 of UNFCCC, there are three phases of REDD+ implementation i.e. readiness, implementation and result based action. The paragraph 73 of decision 1/CP.16 also defined the initial step for REDD+ implementation is the development of national strategies or action plans, policies and measures, and capacity-building, followed by the implementation of national strategies or action plans, policies and measures that could involve further capacity-building, technology development and transfer, results-based demonstration activities and evolving into results-based actions that should be fully measured, reported and verified.

Indian Council of Forestry Research and Education (ICFRE) in collaboration with International Centre for Integrated Mountain Development (lCIMOD) implemented a trans-boundary landscape project titled "REDD+ Himalaya: Developing and using experience in implementing REDD+ in the Himalaya". District Mamit of Mizoram has been selected as a project area for implementation of the project activities.
Mizoram i.e. the 'Land of Mizos' was earlier known as the Lushai Hills District of Assam before it was renamed the Mizo Hills District in 1954 and received the status as 23rd state of India in 1987. Total geographical area of Mizoram state is 21,081 sq km which is 0.64% of the geographical area of the country. As per Indian State of Forest Report 2017, Mizoram has the forest cover of 18,186 sq km which is 86.27% of its geographical area. The state has 131 sq km under very dense forest, 5861 sq km under moderately dense forest and 12194 sq km under open forest. Mizoram comprises of the total forest carbon stocks of 95.041 million tonnes i.e. 348.484 million tonnes of CO_2 equivalent which is 1.34% of the total forest carbon stocks of the country (FSI, 2017).

The rich forest diversity of the Mizoram includes tropical semi-evergreen forests, tropical moist deciduous forests, sub-tropical broadleaved hill forests and sub-tropical pine forests. Bamboos has the highest percentage cover (45.41%) hence making its occurrence most common in the forest types of the state. It is found in association with other species. However, it has been observed that the state has shown highest decrease in the bamboo recorded forest area (5,978 km^2) in 2017 as compared to the previously recorded bamboo forest area (9,245 km^2) in the Indian State of Forest Report 2011 (FSI, 2017).

Shifting cultivation, fuel wood collection, unemployment, excessive extraction of non-timber forest products, lack of industries and lack of knowledge & awareness have been reported the major drivers of deforestation and forest degradation in the state of

Mizoram. (Rawat *et al.*, 2017). Permanent farming practices along with alternate income generation activities can be a suitable option at community level for addressing the shifting cultivation. Hence, the concept of agroforestry can be a part of REDD+ project activity in the region. On the other hand, fuelwood collection is the second major driver of deforestation and forest degradation. Introduction of improved cook stoves in the project area along with the solar energy can play a major role in decreasing the extent of fuelwood collection from the forests. Livestock rearing in the project area can be one of the options for alternate income generating activities to the local communities. In terms of climate change mitigation and adaptation, REDD+ implementation involves the prioritization of project activities that are necessary for climate change mitigation and adaptation.

A feasibility study for identifying and adopting appropriate technology for introduction of improved cook stoves, solar energy, agroforestry and livestock management in the state of Mizoram was undertaken under the REDD+ Himalaya project. The main objective of this study is to identify the potential activities for addressing the drivers of deforestation and forest degradation which provides the ecological and economic benefits to the local communities. Feasibility study also aims to identify the gaps in local knowledge for promoting the improved cook stoves, solar energy, agroforestry and livestock management in the project area in order to achieve the carbon benefits and develop the capacity of the local communities and other stakeholders for implementation of REDD+ activities.

2

Distinctiveness of Mizoram State

2.1 Background

Mizoram state is among the seven sisters states lies in the Northeastern part of the country. Geographically it lies between 21°58' to 24°35'N latitudes and 92°15' to 93°29' E longitudes. Total geographical area of the state is 21,081 sq km which constitutes 0.64% 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 (Census of India, 2011) with overall density of 52 persons per sq km.

2.2 Climatic Conditions

State has typical monsoon type of climate. The climate is also influenced by the periodic cyclonic disturbances, local mountains and valley breezes and extensive forest cover. The state receives rainfall from both northeast and southwest monsoons. The climate is humid tropical, characterized by short winter, long summer and heavy rainfall. Temperature (on an average) ranges from 25°C to 30°C during summer, 18°C to 25°C in autumn and 11°C to 23°C in winter season. The average rainfall in Mizoram ranges between 200 to 300 cm per year. Generally, it rains during May to September, July and August being the rainiest months. November to January is the dry period with minimum rainfall.

2.3 Land Tenure System

In Mizoram, the majority of the land comes under the customary rights of the local

communities which provide a significant land for shifting cultivation to the local communities. Shifting cultivation is a most common form agriculture practice in the state. The communities involved in this practice are known as *Jhumias*. In every village of the Mizoram, there is Village Council (VC) which has full control over the complete village land and VC is only responsible for the allotment of land for shifting cultivation, for construction of houses and for taking up other farming practices etc. to the villagers.

2.4 Shifting Cultivation

More than 60 per cent population in rural areas of Mizoram depends on the agricultural practices for their livelihood. Shifting cultivation is an age-old practice of farming 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, chilli and vegetables etc. Shifting cultivation is also known as jhum cultivation/ jhumming or slash burn agriculture practice. Over the time, the productivity of the land diminishes and left as fallow land. So a new patch of land has to be cleared and burnt year after year. This unscientific farming system has resulted in patchy deforestation, soil & nutrient loss, moisture loss, and loss of indigenous biodiversity.

2.5 Other Sources of Income

Apart of the agricultural practices, piggery and poultry are the alternative sources of income generation in the state of Mizoram. It provides the economic support for the rural people of the state and has become one of the important sources of their income. Along with the economic gain from livestock, Mizoram is dominated by bamboo in terms of natural resource which has proved a major contribution towards the socio-economic development in the state and covers around 31% (about 6,446 sq km) of its geographical area.

2.6 Forests of Mizoram

Forests are the one of the important natural resource 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, 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 1.71 ha.

Six forest types have been identified in the state of Mizoram representing the four major type groups of Champion and Seth (1968) Classification of Forest type i.e. Group 2- Tropical Semi-Evergreen Forests, Group 3- Tropical Moist Deciduous Forests, Group 8- Subtropical Broadleaved Hill Forests and Group 9- Sub Tropical Pine Forest (FSI, 2011). The northern part of the state is dominated by Secondary Moist Bamboo Brakes along with the different species of trees and plants while on the other side eastern and southern part of the state is dominated by the East Himalayan Moist Mixed Deciduous Forest.

3

Methodology and Site Description

Implementation of the activities under REDD+ Himalaya project in the state of Mizoram has been focused in the pilot site which consists of 12 villages under district Mamit. The project area comprises of 1,583 households with the total population of 8,174 (Table 1). Map of the project area has been given in Figure 1.

Table 1: Population status in project area (District Mamit, Mizoram)

S. No.	Name of Village	Number of Households	Total Population	Male Population	Female Population
1	Reiek	360	1627	786	841
2	W.Lungdar	109	668	340	328
3	Lengte	88	406	211	195
4	Nghalchawm	60	302	161	141
5	Rulpuihlim	78	392	233	159
6	Chungtlang	54	327	174	153
7	N. Kanghmun	166	858	432	426
8	Khawrihnim	128	789	401	388
9	Ailawng	104	510	267	243
10	Rawpuichhip	241	1244	620	624
11	Tuahzawl	80	381	198	183
12	Hruiduk	115	670	356	314
	Total	**1,583**	**8,174**	**4,179**	**3,995**

(Rawat *et al*., 2017)

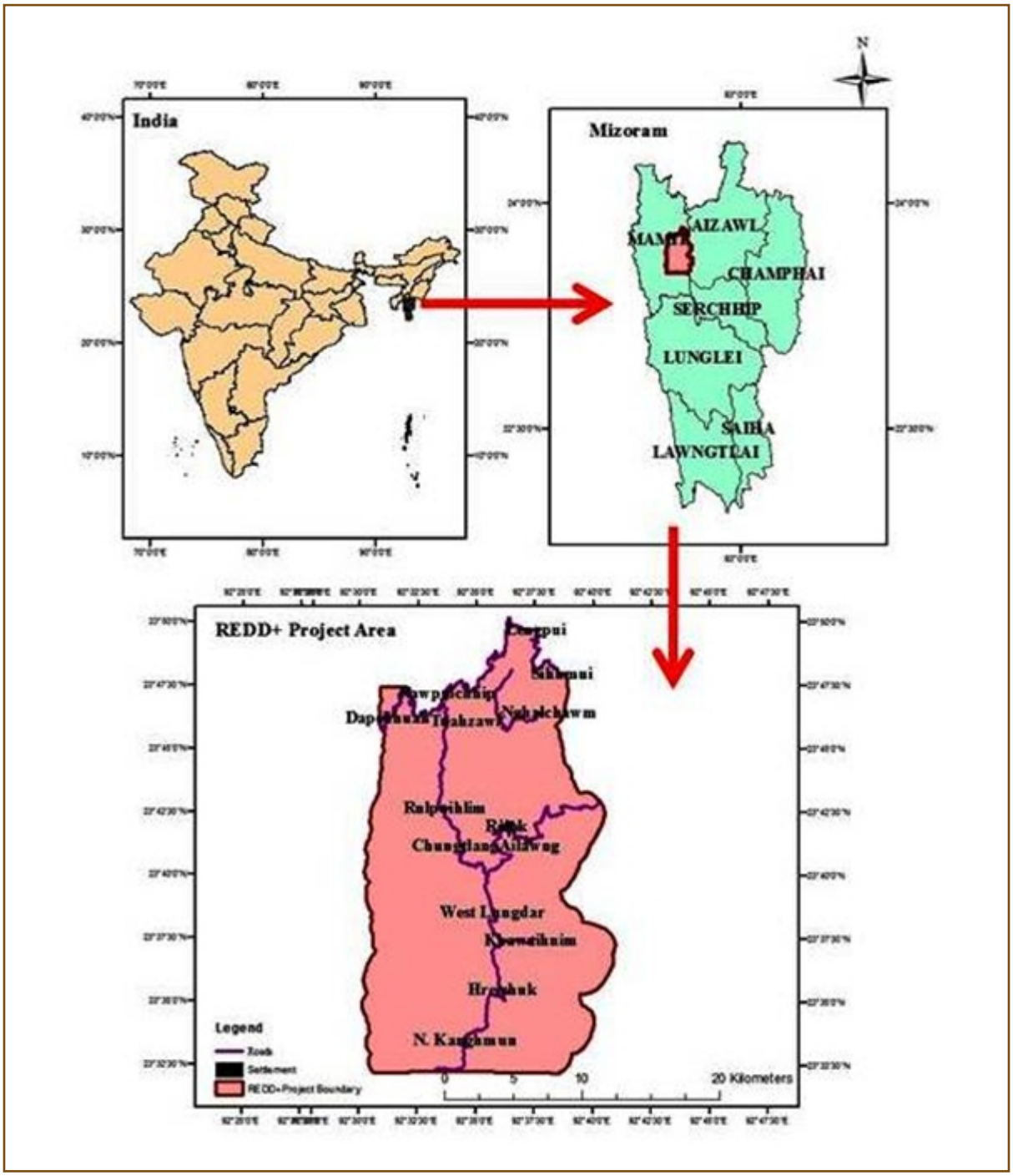

Fig 1: Villages selected for household survey under Mamit District, Mizoram

3.1 Methodology

A study was conducted to determine the feasibility for identifying and adopting appropriate technology for introduction of improved cook stoves (ICS), solar energy, agroforestry and livestock management in REDD+ project area under Mamit district of Mizoram through detailed household socio-economic survey. All the relevant data were collected on the basis of pre-tested questionnaire (Annex 1) which covered all the data needed to identify and adopt appropriate technology for ICS, solar energy, agroforestry and livestock management. Twelve villages of the project area were selected for conducting socio-economic survey in the project area (Table 2).

Table 2: Selected villages in the project area

S. No.	Name of Village	Number of Households	Total number of households surveyed
1	Reiek	360	37
2	W. Lungdar	109	11
3	Lengte	88	9
4	Nghalchawm	60	6
5	Rulpuihlim	78	8
6	Chungtlang	54	7
7	N. Kanghmun	166	18
8	Khawrihnim	128	13
9	Ailawng	104	10
10	Rawpuichhip	241	24
11	Tuahzawl	80	8
12	Hruichhuk	115	11
	Total	**1583**	**162**

Out of the total 1,583 households of the project area, 162 households were randomly selected for collection of the relevant data (Annex 2). About 10 per cent sampling was done which includes the personal responses in view to adopt the modern technology and captured their current status on which their livelihood depends upon. Microsoft excel and Statistical Package for the Social Sciences (SPSS) software have been used for the analysis of the collected data.

4

Results

During the household survey it has been observed that 53.09% of population of local community in the project area falls under the annual income class of Rupees 0-60000 followed by 27% in the income class of Rupees 60001-120000 which shows that majority of population has very limited source of annual income. Agricultural activities i.e. shifting cultivation is the main source of their annual income (Table 3). Overall 78.64% of the total households under project area are involved in agriculture practices out of which 62.03% of the populations are dependent on agriculture as a primary source of their income (Table 4) with average landholding of 2.00 ha per household. The total land acquired by a household may vary, depending on the number of total individuals in each household.

Table 3: Income status of household in the project area

Income Class (in Rs.)	≥60000	60001 - 120000	120001 - 180000	180001 - 240000	240001 - 300000	Above 300000
Percentage of population	53.09	27.16	4.32	2.67	4.94	3.70

Table 4: Profession wise percent distribution of population in the project area

Profession	Agriculture	Govt. Jobs	Business	Others	Agriculture + Govt. Jobs	Agriculture + Business + Others	Agriculture+ Others	Business+ others
Percentage of Population	62.03	11.22	7.48	19.25	5.10	2.30	9.21	6.00

Source of energy for cooking by households: In the project area, it was found that majority of population (61.73%) of local community are using fuelwood as a primary source of energy for cooking purpose (Table 5). They collected fuelwood from their own lands, community land and nearby forest areas. The majority of fuelwood comes from their shifting cultivation areas. Although 90% of the households have LPG connections but they are using LPG as secondary source of energy. Only 36.42% households are using LPG as primary source of energy for cooking purpose. Instead of fuelwood and LPG, 0.62% of households are using electricity (induction plates and electric heaters) as a primary source of energy for cooking purpose. Overall, it has been found that the LPG is the major secondary source of energy for cooking purpose. Irregularities in the supply of LPG cylinders and low annual

income of the households are the main reason for using LPG as a secondary source. The total number of LPG cylinders used annually in all villages is 1,168 with the highest consumption (335) in Reiek village and lowest consumption (12) in Nghalchawm village. Thus, the estimated data explains the need of introduction of appropriate technologies in the project area so that the consumption of fuel wood can be reduced and cleaner form of energy can be promoted by adopting feasible technology.

It has also been found that about 95.74% of the local communities are using their traditional type of cook stoves (*chullah*) with average daily consumption of 16.13 kg of fuel wood per household. Only 3.55% of the households are having and using improved cook stoves (ICS) due to which fuel wood consumption has been reduced (Box-1).

In all villages, it was noticed that traditional cook stoves were more in use for cooking purposes whereas modern and improved cook

Table 5: People's perception on source of energy for cooking

S.No.	Source of Energy for Cooking	Type of Source	Percent of Individual Dependent
1.	Primary source	Fuel wood	61.73
		LPG	36.42
		Electricity	0.62
	Secondary source	Fuelwood	29.63
		LPG	43.83
		Electricity	1.85
2.	Sources for fuelwood collection	Type of Source	Percent of Individuals
		Own Land/Shifting Cultivation areas	46.10
		Forests	7.14
		Community Land	9.74
		Own Land + Forest	13.64
		Own Land + Community Land	12.99
		Forest + Community Land	4.55
		Own Land + Forests + Community Land	4.55
3.	Type of cook stove	Type of cook stove	Percent
		Traditional	95.74
		Modern	0.71
		Improved cook stoves	3.55
4.	Average amount of fuelwood collected in a day by each individual (kg)		16.13
5.	Average annual expenditure by each individual for fuelwood collection (Rupees)		2027
6.	Willingness to adopt Improved Cook stoves (ICS)		60%

Box 1: Improved Cook Stove used by the local community

During interaction with the villagers of Chungtlang (District Mamit, Mizoram) Pi Lalremtluangi informed that the consumption of fuel wood has been drastically reduced from about 20 pieces to 5 to 6 pieces daily after using ICS (Improved Cook Stove) which is provided by FRCBR (centre of ICFRE)under REDD+ Himalaya Project. ICS is safe and food is cooked in clean environment. Since it produces more heat thus, food cooking and water boiling is done in much shorter time.

Pi Lalnunthari of Chungtlang village informed that ICS is found to be very good as it consumes less firewood and cooks food faster. For one time cooking, in traditional *chullah* about 5-6 pieces of woods were used whereas in ICS about 2-3 pieces of woods are used. ICS produces less smoke and occupies less space thus, maintenance is much easier. It is very useful and we are really grateful to FRCBR (centre of ICFRE) for distribution of ICS.

During the survey, it has been found that the Mizoram State Forest Department has also distributed ICS in N. Kanghmun village for about 30 households. A woman named Pi Esther Lalhmingmuani told that they are using only ICS in their house. It has reduced the consumption of fuelwood by 60% and has also overcome the problem of smoke inside the house which is produced by the use of traditional cook stoves. They are fully satisfied with the use of ICS and they have advised their relatives to use ICS.

stoves are very less in use. Further, in a detail discussion at household level, it has been found that about 60% of the local communities are willing to adopt the ICS out of which 50% of household asked for some financial assistance from the government for buying the ICS. About 34% of individuals suggested that the motivation and awareness regarding the use of ICS and consequences of use of traditional cookstoves are needed so that maximum number of households can prefer ICS over traditional cook stoves for cooking purpose. About 16% of the household preferred to have some recommended source for the purchase of ICS in the local market. This clearly showed the readiness of local communities to adopt ICS and its less usage are mainly due to lack of awareness and knowledge, and non-availability of ICS in the local markets.

Source of energy for lightening of houses: As per Economic Survey 2017-18 of Government of Mizoram "the present peak demand of electricity is 102 MW but the department can generate only about 15 MW from the installed capacity of 29.35 MW as the generating stations are rain fed run-off the river hydroelectric project". The state is dependent on other various out sources from Central Sector Utilities like North Eastern Electric Power Corporation Limited, National Hydroelectric Power Corporation Limited, National Thermal Power Corporation, etc. to fulfill the overall energy demand in the state. Hence, introduction of solar energy as an alternative source of energy in the state can provide the financial as well as social benefits in the state. Because of heavy rain, the state undergo discontinuity in the power supply in its remote areas and the houses remain in dark for many days if there will be a disturbance in power line by rain.
It was found that 100% of the population is dependent on electricity for lightening their house as a primary source of energy and only 29.63% of the population is having solar energy as an alternative source of energy. Further, the individuals having solar panels are only those whose economic status is quite high in their locality. The local communities are very much interested for the use of solar

energy but 60% of the individuals highlighted the problem of their low economic status by means of which they could not afford the cost of the solar panels whereas 90% of the overall population is willing to adopt the solar energy as an alternate source of energy (Table 6). Further, introduction of solar energy as a part of project activity can help the local communities to overcome their financial burden on power supply and will ultimately save energy in terms of state overall power supply budget. Although the state has initiated solar power plants and there are various policies measures in the state for promoting solar energy. The convergence of those activities can provide a better synergy in terms of power saving and promoting renewable source of solar energy in the state.

Current agricultural practices and scope of agroforestry: The agriculture is the main occupation of the majority of the population in the state of Mizoram. About 85.80% of the population in the project area is involved in

Table 6: People's perception on source of energy for lightening of houses

S.No.	Source of Energy	Type of Source	Percent of Individual Dependent
1.	Primary source	Electricity	100
	Secondary source	Solar energy	29.63
		Inverter/Batteries etc.	43.83
		Others (candle/chargeable emergency light/kerosene lamp)	1.85
	Total expenditure (Rupees/Month)		280
2	Having source of	Yes	28.40
	solar energy	No	71.60
3	Willing to adopt	Yes	90.12
	solar energy	No	9.88

agricultural practices with average annual income of Rupees 16973.12 and the average land holding under agricultural practices is 1.56 ha per household. The majority of population are involved in traditional cultivation i.e. rice cultivation (27.16%), seasonal vegetables cultivation (43.21%) and ginger cultivation (25.93%). The hilly terrain is one of the geographic limiting factor in the state for permanent cultivation and wet rice cultivation. Hence, the majority of individuals are involved in shifting cultivation i.e. 75% (Table 7). In consultation with the local communities, it has been found that the local communities really want to overcome the extent of shifting cultivation but the technical knowledge for developing terraces or permanent cultivation farms is one the limiting factor. Only 5% of the local communities have knowledge of agroforestry and only 3% of the local communities are involved in double cropping system. Hence, promotion of site specific and landscape wise agroforestry models in the project area can be a better option for increasing the income of local communities from agricultural source which will ultimately catch the interest of local communities towards agroforestry.

The state government is also promoting number of schemes and policy such as wet rice cultivation, implementation of oil palm development program, sugarcane cultivation program, *Rashtriya Krishi Vikas Yojana*, New Land Use Policy, Rainfed Area Development etc. to overcome the extent of shifting cultivation and to increase the agricultural production in the state. Introduction of agroforestry models and capacity building of the local communities should be a priority

Table 7: People's Perception on introduction of agroforestry

S.No.	Activities and Scope of Agroforestry		
1.	Agricultural practices	Whether Yes/No	Percent of Individual Dependent
		Yes	85.80
		No	14.20
2	Average annual income (Rupees)	16973.12	
3	Average agricultural land (including shifting cultivation areas)		1.56 (ha.)
4	Willing to adopt agroforestry		51.85
5	Willing to adopt agroforestry with shaded coffee plantation		37.65

activity for motivating the agricultural dependent local communities to adopt the agroforestry models which will ultimately divert the local communities towards permanent types of cultivation practices. Table 8 represents the common agricultural / horticultural crops grown by the local communities in the project area.

The average annual income of all the villages from agriculture has been calculated to be Rupees 15,510 whereas village wise average agricultural income has been found to be highest in Rulphuihlim (Rupees 46,250) followed by Reiek (Rupees 18,918.92) and lowest in Lengte (Rupees5,388.89). Thus, if appropriate techniques in agriculture sector

Table 8: Type of agricultural/horticultural crops grown by the local communities

S.No.	Type of Crop	Percentage of Individual
1	Pineapple plantation	4.94
2	Banana	10.49
3	Rice	27.16
4	Turmeric	16.05
5	Ginger	25.93
6	Mustard (winter crop)	0.62
7	Oil palm	4.32
8	Orange	15.43
9	Mango	0.62
10	Others [Cucumber, Maize, Potato, Onion, Pumpkin, Brinjal/ Samtauk, Corn, Aieng, Barikbawn, Phuihnam (winter crop), Chilli, Beans (winter crop), Danya, Lemon, Chiryit, Chhawhchhi, Bal, Oil Palm, Pan leaves, Soyabean, Kawnglaung, Tomato (winter crop), Olive, Vegetables, Behlawi, Bahkhawi, Thinfanghma, Lengser, Lemon]	43.21
11	Sandalwood, Agarwood	1.23
12	Betel nut	7.41
13	Rubber	1.85
14	Papaya	4.32
15	Sugarcane	1.85
16	Tea	1.85
17	*Parkia roxburghii*	9.88
18	*Khangu* (*Rhus* spp.)	4.94

are introduced such as agroforestry etc. may result in better yield and income of the people of the project area. However, the survey of all villages showed that 51.85% respondents are ready to adopt agroforestry. Whereas village wise observations have marked the highest percentage (100%) in village Chungtlang and Rulphuihlim, respectively. The second highest percentage (81.82%) has been observed in Hreichhuk village whereas the lowest percentage for willingness to adopt agroforestry has been observed in Rawpuichhip village (33.33%).

The survey also showed the willingness of respondents to adopt shaded coffee plantations. The results also showed that only 20.37% respondents from whole project area are willing to adopt this new technique and local community of village Hreichhuk showed maximum willingness (36.36%) in adoption of shaded coffee plantation. The observations from the survey showed that the people are less aware about the modern technologies.

Livestock Management: The majority of individuals in the project area are involved in piggery (51.85%) and poultry (32.72%). Overall 66% of the total individuals are involved in rearing of cattle with average expenditure of Rupees 5014.00 per month and annual average income of Rupees 23117.56 per individual from cattle rearing (Table 9) which clearly showed that the rearing of livestock is contributing significantly towards overall average income at household level. On the other hand rearing of cattle for dairy production is very less in the project area. Local communities are mainly dependent on packed milk products commonly available in their local markets. The exposure visits, trainings and piloting of dairies at local level can catch their interest towards rearing of cattle for milk production. This will provide an alternate source of income and cattle's dung can be used as a source of organic manure.

The results showed that maximum respondents (66.67%) rear livestock for meeting their daily requirements. The maximum livestock rearing has been observed in Nghalchawm village (100%) and least in Hreichhuk village (27.27%). Among the livestock, pigs are reared by about 51.85% households, poultry farming by 32.72% households, cows by 4.94% households and others such as goat by 1.85% households. The maximum pig rearing has been observed in village Khawrihnim village (69.23%) and lowest in Lengte (11.11%) village. Similarly, the maximum hen production has been observed in Nghalchawm village (100%) and lowest in Rawpuichhip village (8.33%). It has been observed that the percentage of people rearing cow are very less as compared to rearing of pigs and poultry. The cow rearing has been observed in only two villages i.e. Nghalchawm (16.67%) and Rawpuichhip (4.17%). Similarly, other livestock such as goat rearing has also been observed in only three villages i.e. Lengte (11.11%), Ailawng (10%) and Kanghmun (5.56%), respectively.

Table 9: People's Perception on Rearing of Livestock

S.No.	Status on Rearing of Livestock	
1	Rearing of livestock	66.05%
2	Type of livestock	
	Cow	1.23%
	Pig	51.85%
	Hen	32.72%
3	Average expenditure by each individual per month on rearing of livestock (Rupees)	5013.49
4	Average annual income excluding all expenditures (Rupees)	23117.56

The average monthly expenditure on livestock rearing in the study area has been estimated to be Rupees 2,683.34 per month with the highest expenditure recorded in village Ailawng (Rupees 7,365 per month) and lowest in village Lengte (Rupees 988.89 per month). Similarly, in case of income from livestock rearing, the average income in the study area has been estimated to be Rupees 1,281.22 per month, with the highest income in village Ailawng (Rupees 2,841.67 per month) and lowest (Rupees 507.58 per month) in village Hreichhuk.

As far as source of collection of food for the livestock is concerned, 43.21% respondents of the project area buy livestock's food from market, 29.01% respondents collect it from agricultural lands and 18.52% from forests. In context to availability of fodder for livestock, 49.38% respondents agreed for easy fodder availability whereas 17.9% respondents of the study area stated that fodder is not easily available. This may be due to the fact that 48.15% livestock's fodder is collected from forests, 45.06% from agricultural lands, 8.64% from market. Introduction to improved livestock management techniques can be helpful in meeting the daily animal products requirement as well as helpful in increasing the income of the local community which will be ultimately addressed the drivers of deforestation and forest degradation.

Feasibility Analysis: Feasibility analysis has been done for ensuring that which technologies are better for adoption in terms of implementation risk, cost effectiveness, implementation cost, opportunity cost and incentive measures. It provides a basis for deciding that which activity or technique is more practical as well as cost-effective. Table 10 shows the feasibility analysis of the appropriate technologies selected for the study area.

Table 11 shows the overall feasibility of selected technologies in the study area. The main purpose of the feasibility study is to assess the current situation of the study area and to identify, adopt and develop appropriate technology for sustainable management of resources in Mizoram. Based on five factors that is implementation risks/ obstacles; cost-effectiveness of risk reduction measures; implementation cost; opportunity cost and incentive measures the appropriate technologies selected for feasibility for a study area implies the greater feasibility of ICS technology over other technologies.

The reason involves incentives provided by the various government agencies, reduction in consumption of fuel wood and its combustion which works as a cost effective measure to reduce the risk bearing capacity. Solar energy have obtained the scoring 12 and is considered less feasible technology based on

Table 10: Feasibility Analysis of appropriate technologies selected for study area

Outputs/ Activities	Risks/ Obstacles	Risk Reduction Measures	Risk Reduction Targets	Indicators
Promotion of ICS	Lack of adequate supply; Remoteness; Topography	More programmes on sustainable energies targeted to rural areas	60% of households used sustainable energy sources programmes	Number of households using sustainable energy
Utilization of Solar Energy	Lack of market, Economic inability of inhabitants	Improved market linkages, Improved income opportunities	2 awareness campaigns per year on solar energy utilization; 3 capacity building programmes per year	Number of solar energy users, Number of people trained
Introduction to Agroforestry	Fragmented land holdings; Unwillingness, Existing Traditional Practices	Awareness campaigns and training programmes; Demonstration plots of appropriate agroforestry models; Exposure visits for farmers; Identification of gaps and constraints	5 awareness campaigns per year on adoption of agroforestry; 1 study for identification of gaps and constraints	Number of awareness campaigns on agroforestry and studies done for identification of gaps and constraints
Introduction to Livestock Management & Rearing Practices	Fodder unavailability	Adoption of better livestock management practices	3 awareness campaigns per year for better implementation of livestock practices	Number of awareness campaigns on livestock management & practices

high implementation cost and risk based on the economic inability of inhabitants. Agroforestry is given least scoring (10) on the basis of its high implementation costs based on the fragmented land holdings, supporting traditional practices (shifting cultivation), less awareness and no successful agroforestry models developed which automatically becomes less cost effective in order to reduce the risk bearing capabilities even if high incentive measures are provided.

Table 11: Overall feasibility of selected appropriate technologies

Technology	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	Incentive Measures H=3/M=2/ L=1	Total Score
ICS	3	3	1	3	3	13
Solar Energy	3	3	1	2	3	12
Agroforestry	1	2	1	3	3	10
Livestock Management Practices	2	2	2	2	3	11

*H-High; M-Medium; L-Low

Gap Analysis

Introduction of Improved Cook Stoves: Overall, it has been found that there is huge consumption of fuelwood in the project area and this demand is increasing day by day with the increase in population from last few decades. Approximately 60% of the local communities are willing to adopt improved cook stoves; however, there are some gaps and constraints in context of adopting ICS in their routine life. Necessary actions required to be implemented for addressing the identified gaps and constraints are given in Table 12.

Introduction of Agroforestry: Agricultural practices are major source of income of all households. Agroforestry can be a best option to multiply the output as well as to increase the economic status of each household. However, majority of population is involved in shifting cultivation and hence the introduction of agroforestry can motivate the local

Table 12: Gaps & constraints and actions required for introduction of improved cook stoves

Gaps & Constraints	Actions Required to be Implemented
• Lack of suitable market and certified/Government approved vendor for distribution of ICS • High rates of ICS • Motivation and awareness • Monitoring at local level	• Identification of suitable models and training for local vendors so that ICS can be made available at local level • Provision of providing subsidies/convergence with related initiatives started by state/central government. • Documentation and distribution of success stories and organization of awareness campaigns • Maintenance and periodic updates of fuelwood consumption by all beneficiaries. Provision of rewards for the significant household.

communities for its adoption and will ultimately helpful in reducing the extent of shifting cultivation from the project area. The abandoned shifting cultivation areas can be the potential sites for the project proponents to develop pilot sites for agroforestry. Those sites can provide motivation to the local communities and will help to develop area specific agro-forestry models. The constraints and actions required to be implemented for introduction of agroforestry as a part of REDD+ implementation in the project area is given in Table 13.

Table 13: Gaps & constraints and actions required for introduction of agroforestry

Gaps & Constraints	Actions Required to be Implemented
• Lack of technical knowledge • Lack of suitable agro-forestry models • Motivation and awareness	• Development of pilot sites for agroforestry. • Development of agroforestry models. • Awareness campaigns and exposure visits.

Introduction of Solar Energy: The Mizoram State Solar Power Policy was introduced in 2017, which aimed at ensuring reliable power supply and a sustainable energy mix for the state. According to this policy, the state aims to reduce the 10.5% of overall expenditure on energy consumption by the use of renewable source of energy. Hence, by motivating the local communities for using the solar energy and promoting the renewable source of energy can reduce the overall consumption of electricity and also help in reducing the cost of electricity bills at household level. This will ultimately be helpful in achieving the concept of eco-village with low carbon footprint. The constraints and gaps identified, and actions required to be implemented for introduction of solar energy as a part of REDD+ implementation in the project area are given in Table 14.

Table 14: Gaps & constraints identified and actions required to be implemented for introduction of solar energy

Gaps & Constraints	Actions Required to be Implemented
• Low economic status • Lack of suitable market	• Distribution of solar panels/lights at subsidized rates or standardization of rates. • Provision of recycling of old unused solar lights/panels. • Convergence with the schemes like National Solar Mission *Deendayal Upadhyaya Gram Jyoti Yojana* etc.

Livestock Management: To raise the socio-economic status of local communities, the introduction of livestock farming by using the traditional knowledge can play an important role. The concept of dairy farming is very rare in the state of Mizoram. The per capita availability of milk in the state is low. Hence, the awareness campaigns, exposure visits and introduction of successful livestock management models can motivate the local communities to adopt the dairy farming practices. The various training programs on stall feeding, preparation of green and dry fodder etc. can be initiated to get better yield from this practice. On the other side, the concept of backyard poultry farming can also help to increase the income from the poultry farming. Backyard farming is a low investment method, which includes the traditional method to improve the production comprising of rearing the indigenous poultry. The local breed are generally in high demand and can fetch comparatively high rate in comparison to improved breeds because they are developed under natural conditions without any artificial environmental stress. The constraints and gaps identified, and actions required to be implemented for livestock management as a part of REDD+ implementation in the project area are given in Table 15.

Table 15: Gaps & constraints identified and actions required to be implemented for livestock management

Gaps & Constraints	Actions Required to be Implemented
• Lack of motivation • Availability of fodder	• Introduction of dairy farming at community level or developing dairy societies to be owned by local communities. • Backyard poultry farming.

Recommendations

Following recommendations have been made to address the drivers of deforestation and forest degradation after identifying appropriate technologies:

Improved Cook Stoves (ICS): Traditional types of cook stoves consume more fuel wood and create smoke related health problems. Thus, ICS has been chosen as *chullah* one of the appropriate technologies which is not only cost effective but also reduce the fuelwood consumption as well as minimize the release of toxic gases by complete combustion of fuel wood. There is a need to create more awareness about the use and promotion of ICS and made its easy availability of cost effective ICS in the local markets.

Solar Energy: The cheapest, efficient and most conventional form of energy i.e. solar energy has been chosen as an appropriate technology for the people of the REDD+ project area. Since the use of this technology is very cost effective than electricity as well as has no emissions, it is the best practice which can be applied for lightening the houses. Thus, there is a need to create more awareness about the use and promotion of solar energy and made its easy availability of cost effective solar energy devices in the local markets.

Agroforestry: The adoption of agroforestry will not only increase crop production but will also increase the annual income of the farmers belonging to the project area. There is need to develop some demonstration plots of agroforestry models such as shaded coffee plantations etc. which will be a show case for the local communities for adopting the agroforestry.

Livestock Rearing and Management: The adoption of feasible livestock rearing and management techniques will increase the production of animal products as well as also increase the annual income of the farmers of the project area. There is need for introduction to improved livestock management techniques and capacity building of the local communities on livestock rearing and management practices.

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Annex 1

Questionnaire for feasibility study for identifying, adopting and developing an appropriate technology for improved cookstoves, solar energy and agroforestry practices in Mizoram under the REDD+ Himalaya Project

Questionnaire No. : .....

Village Name : ..... Latitude : ..... Longitude : .....

1) Name of Respondent : .....

2) Qualification : ..... 3) Age : ..... 4) Gender : .....

5) Profession (Please tick) :
Government Service : ..... ; Agricultural Practices : ..... ; Business : ..... ; Other : .....

6) Annual Income from all sources (Rupees) : .....

A) Source of energy for Cooking

a) Primary Source : ..... Secondary Source : .....

b) Fuel wood (Please tick if yes) : ..... Source of Fuelwood collection : .....
Amount of Fuelwood used in a month(kg) : .....
Expenditure if any (Rupees/month) : .....
Type of cookstoves used for cooking purpose (Traditional/modern/Improved) : .....

c) LPG (Please tick if yes) : .....
Number of cylinders used in a month : ..... Expenditure (Rupees/month) : .....

d) Other source of energy if any : ..... Expenditure(Rupees/month) : .....

e) Have you ever used improved cookstoves, if yes, then what are the reasons for abandoning : .....

f) Are you still using improved cookstoves (Yes / No) : .....

g) If yes, from how long : .....

h) Is there any scheme by Government of India/Mizoram for distribution of improved cookstoves (Yes / No) : .....

i) If yes, Please elaborate : .....

j) Are you willing to adopt fuel improved cookstoves .....

k) Are you aware of any local market/technology/government department for providing improved cookstoves (Yes / No) : .....

l) If yes, please mention : .....

m) Personal opinion towards the adoption of improved cookstoves whether it will be successful (Yes / No) : .....

n) If yes what are the efforts required to make it success and if no, then what are the responsible reasons : .....
.....

o) What will be the overall benefits after adopting improved cookstoves : .....
.....

p) Do you know about biogas plants (Yes / No) : .....

q) If yes, Please elaborate how : .....

r) Willing to adopt biogas : .....

s) Are you aware of any local market/technician for developing biogas plants : .....

t) If yes, please mention : .....

B) Source of energy for lightening of houses

a) Primary Source : ..... Secondary Source : .....
b) Total Expenditure (Rupees per month) : .....
c) Do you have any solar light : .....
d) Have you purchased it from market or it was distributed under some government scheme : .....
e) If purchased, what was its cost : .....
f) If distributed under any scheme, mention the name of scheme : .....
g) Willing to adopt the alternative source of energy to reduce the cost of energy consumption (Yes / No) : .....
h) Preferred source of alternative energy : .....
I) What will be the overall benefit by adopting the alternative source of energy for lightening the houses in your opinion : .....
.....

C) Adoption of agroforestry practices

a) Are you involved in agricultural practices : .....
b) If yes, how much of land do you have for this practices : .....
c) What are the main crops grown by you (Please elaborate season wise) : .....
Summer Crops : .....
Winter Crops : .....
d) Total annual income from agriculture : .....
e) Do you know about agroforestry : .....
f) If yes, how do you know : .....
g) Have you planted any tree species with the agricultural crops in your farm land (Yes / No) : .....
h) If yes, how much of total land is under agroforestry : .....
I) Any income generation from agroforestry (Rupees) : .....
j) What are the major crop along with tree species in agroforestry farms : .....
Tree species : .....
Agricultural Crops : .....
k) Are you willing to adopt agroforestry : .....
l) What is your personal opinion about adopting agroforestry system : .....
.....
.....
m) Are you willing to adopt shaded coffee based agroforestry system : .....
n) If yes, what will be the potential agricultural crop along with shaded coffee plantation :
.....
o) What is the best combination of agricultural crop along with tree species for promoting agroforestry in the region : .....
.....
p) What will be the overall benefits after implementing agroforestry practices : .....
.....

D) Rearing and Management of Livestock Management

a) Do you have any livestock (Yes / No) : .....

b) Number of Livestock do you have:

   I. Cow : .....

   ii. Pigs : .....

   iii. Hens : .....

   iv. Any other (specify its name and number) : .....

c) Do you have local breed or any other improved breed : .....

d) What is the total expenditure in rearing of livestock (Rupees) : .....

e) Overall annual income from all the livestock : .....

f) Source of food for the livestock : .....

   .....

   .....

g) Do you have any linkage with any government/local agency for providing improved variety of livestock : .....

h) What is their perception about rearing of animals and their income status, how it can be increased : .....

i) Is fodder readily available for the livestock (Yes / No) : .....

j) Source of fodder : .....

k) What is their perception about fodder species for their livestock, how it can be increased and fulfill their demand in sustainable and cost effective manner : .....

   .....

Any other comment/opinion on Improved cookstoves, Biogas, Solar energy and Agroforestry system :

.....

.....

.....

Respondent Signature : .....

Date : .....

Name of Interviewer : .....

Interviewer's Signature : .....

Annex 2

List of Respondents

Name of Village	Name of Respondents
Chungtlang	C. Lalbiaktluanga Laibata Lalramchuana C. Liandawla H. Ullunla Lalenguara Lalmalsauma
Kanghmun	Lalhruaii Lalawmpuia M. Lalrinliani Laldirmaurii Lalthanliani L. amliana Vanlalliana Hmuakhiana Zadingluaia Denglungi Lallawmawma Lalnuntluargi Saizikpuii Kaphleia Rosangpuii Esther Lalhmingmuani Vanramthlira Chhuannwnii
Hreiduk	Zoramthangi Lalrinmanui Vanlaldika C. Lalthangkhuma C. Lalsangliana C. Lalrinawma Lalthanpuii Vanlaldika Remsangpuii Isaac Lalrgurliana Lalramtiani
Nghalchawm	Lalhawaka Lalnammuana Lalnunpuia R. Lalrinthanga F. Lalbiakltuiya C. Thanchhuiya

Name of Village	Name of Respondents
Ailawng	Lalduhsanga Losanghawii R. Lalsiama Lalhmangaihzuali C. Lalhlimpwi Lallawmzuali Eric Zoruamawia Ngurnunthangi Sailtuanja Lalbiakveli
Reiek	Lalmalsawmi Laldinpeni Raldangliani Lalremuati Robert Lalhauinjltaya Zolawni Lalrinnunga Lalmuanpuia Lalenkawli Brenda Lalrinnungi Lalrengpuii Zarzokima Lalrinmauri Lalrinkimi LalrinkimiKhiangte Zargokimi Sawtthanji V.L. Chhanhimi R. Lalduhawma Vanlalzawma Lalthanpurii Rohlupurii Pahbia Thankimi Zarzohiami Lalremruata Lalchhewrliami R.K. Chhandama Lalramumwana Lalnipari Lalhmachhuana

Lengte	C. Zothanzami Lalmawii Vanlalchhuanawma Lalhmangaihzuali Lianzami Vanlalmawria Zarzokima Vanlalruati
Rawpuichhip	Saikhuma Thanglura Ngurthansiami Lalchasyliani Ngaikimi Esther Rolowmsanji Zahmingthaiya Lalzikpeii Ngurdungu Lalthangdiana Lalhlenipeii Vanlalauva Lalawmpuia Sangkhunui Laikunga Lalbiabakthanga Tlanglawma Lalhumgmauria H.Sanglura Lalzingi K. Lalthianjkliia Lalbiakehhungi Lalzana Lalhmuchhuaki
Khawrihinim	Rammawri Zirthuangi R. Lalthanmanlia Vanlalchhuanga R. Laihwengthanga C. Lalveuthuang Lalrewprii Lalenkawli Lalzamliana Zachhingpeni Ramdinsanga Vanlalhriati N.G. Singh Jhaunqura
	P.C. Nghakliana Lalthangliana Lalthasanga Lalmunmawia Rodawla
Tuahzawl	Beki Lalengmauri R. Lalremlthangi Biokeiya Lalthanzuava Chawitheng Lalhriatpuwa Rohmingliana
Rulpuihlim	R. Lalruatkimi Lalkulhpenii Chhuanvawra Lalfakawmi Lalhwingthanga Lalhluipuia Laldawngwana Rochhingpuia Thanmauia
W. Lungdar	Zotaona Paukunga Darilianchhya C. Lalrokhawma V.L. Chhungi Lalhmingmawia C. Lalbiakthanga Nunsangi Lalsawmliona Lalttanchhungi Lalhruaimawii

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