An Assessment Report On

The Forest Restoration with Locally Important Species (FORLIS) System in Manipur

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Introduction:

Indigenous communities in Northeast India have a deep and intricate relationship with the forests they inhabit. Their lives are closely intertwined with the forest ecosystem, and this connection is manifested in various aspects of their culture, livelihoods, and belief systems. Such communities in the hills of Manipur have developed interdependent system of agriculture and forestry that are best suited to the topographical terrain of the region and also established a deep understanding of local ecosystems and the species within them.

However, lately implementation of infrastructural projects like railways and highways and activities such as landscape clearing to make up for increased population, market forces, lack of employment and livelihood opportunities continue to threaten as serious factors of forest degradation in the hills. Timber collection, slash and burn agriculture for cash crops and reckless collection of NTFP also continue to address precarious economic needs. These have led to the decrease in the forest cover of all the hill districts in the state (FSI Report 2021).

Deforestation and forest degradation has threatened biodiversity conservation, ecosystem goods and services, and forest-based livelihoods around the world (Chazdon et al., 2015). According to FAO (2018), the continuous reduction of global forests by 3% between 1990 and 2015 has forced the need for enhanced forest conservation and restoration. Additionally, naturally regenerated forest has 32% greater carbon storage, which led to a more positive conservation narrative, with a greater emphasis on forest restoration rather than tree planting. And therefore, forest restoration is now regarded as a cornerstone of global biodiversity conservation and sustainable development (Aronson and Alexander, 2013; Suding et al., 2015).

Planting native species in forest restoration activities has helped restore ecosystem functions, conserve biological diversity, cultural preservation, livelihood support, food security and diversify forest products (Elliott et al., 2003; Miyawaki, 2004; McNamara et al., 2006; Hall et al., 2011). Native shrubs, herbs, and climbers, in particular, provide habitat and food resources for wildlife, facilitate nutrient cycling, and contribute to the overall structural diversity of forests (Holl & Aide, 2011; Rey Benayas et al., 2009). Moreover, they often serve as pioneer species that colonize degraded areas, paving the way for the establishment of late-successional species (Capers et al., 2005). Additionally, these plant groups have been found to aid in erosion control, soil stabilization, and the suppression of invasive species (Martínez-Garza & Howe, 2003).

Forests are integral to many communities around the world, providing not just resources but also cultural and spiritual sustenance. They possess valuable traditional ecological knowledge (TEK) about native species, including their growth habits, medicinal uses, and associated folklore (Berkes et al., 2000). These plant species often have cultural significance and can contribute to the revitalization of cultural practices (Pretty et al., 2009). They also often have economic value, providing resources for food, medicine, and craft materials. Furthermore, the process of forest restoration can provide employment opportunities and foster community cohesion (Menz et al., 2013). There is also evidence that restored forests can contribute to improved mental and physical health within communities, a concept known as 'ecotherapy' (Burls, 2007).

Culturally, the indigenous people of this state possess a wealth of undocumented traditional knowledge that has been accumulated over generations through their close relationship with their local environment. This knowledge is often passed down orally, through stories, rituals, customs, and practices, encompassing various aspects of their lives, including agriculture, medicine, resource management, and social organization, however, it is gradually getting lost which was realised to be documented. Such existing traditional ecological knowledge of the tribals can be invaluable in guiding forest restoration efforts. They can identify locally important species, as well as understand their ecological roles, growth patterns, and cultural significance. By incorporating this knowledge into restoration projects, the initiatives become more effective, sustainable, and culturally appropriate.

With the intervention of NGOs like RNBA, Village Development Committees were established, women, youths and Self-help Groups were informed of their rights, entitlements and their abilities to strive for sustainable development and generate income for their community through Nature-based Solutions (NbS).

The organization also observed the value of a sustainable forest management system which is practiced by the tribal communities and the need to create a multi-functional outlook that sustains both people and nature. With the thought to maintain, conserve and restore forest lands to support and accelerate the function of the wide range of ecological services that forests provide, the Forest Restoration with Locally Important Species (FORLIS) System was initiated.

FORLIS as a model works on the trifecta of preservation and conservation of forest by restoring its cover; livelihood sustainability and; documentation of culture and indigenous knowledge systems. The goal of the FORLIS system is to promote rural resurgence where community and local economy thrive by restoring locally important species while keeping the community's native forest intact.

Objective:

To restore forest cover while providing sustainable livelihood opportunities and preservation of culture.
Primary focus area – Livelihood, Environment, Culture

Methodology:

Household Survey - Closed-ended questionnaires were collected using Kobo app in mobile phones to understand the household dependency on FORLIS/forest products.

Forest PRA – FGDs and key informant interviews were conducted in the sampled villages to understand the relevance and process of FORLIS in the village, resource mapping, seasonality mapping, and documentation of traditional knowledge in respect to ethno-medicine and resource management.

Vegetation analysis – Two plots (FORLIS site and Control site) were sampled in each village. Within each sample plot, one 30x30 m, four 5x5 m and five 1x1 m quadrat were laid for vegetation analysis.

The height (m) and diameter at breast height (dbh) of all tree species with height > 1.5 m was measured in 30x30 m quadrat. In 5x5 m quadrat, shrub and climber species were identified and in 1x1 m quadrat, herb and regenerating species were identified. All plants were enumerated and analyzed in each sample quadrat.

Carbon stock estimation – The above ground biomass (AGB) of every tree species was calculated using an allometric model developed by Nath et al., (2019):

$$AGB = 0.18D^{2.16} * 1.32$$

The AGB for those individuals with dbh<5 cm was derived by using the equation developed by Ali et al. (2015):

$$Ln(AGB) = -3.23 + 2.17 * ln(dbh)$$

The above ground carbon stock of the species with dbh < 10 cm and ≥ 10 cm were calculated as 46% and 49% of the ABG respectively (Hughes et al., 2000).

A detailed representation of the tools and methods implemented for the study is presented in Table 1.

Tool	Sub-tool	Tool delivery method	Data collected
Survey	HH Survey	Closed-ended questionnaire	HH characteristics, products collected from FORLIS/forest, time/season of collection, dependency in terms of consumption and economic return,
Forest PRA	Resource mapping	Key informant interview	Draw a map of the village and the surrounding forest areas, highlighting the FORLIS sites, roads, settlements, agriculture area, community land, reserve forests, water bodies etc
	Seasonality mapping		Gather information about months in which the product is available for harvesting, identify the peak time of collection
	Documentation of TEK	Focus group discussion	Document information of traditional practices on resource management, soil and water conservation, pest management, harvesting and storage, enhancing shelf life, listing ethno-medicinal plants and its usage
Ecological analysis	Vegetation analysis	Quadrat method	Species identification, species count,
	Carbon stock estimation	Allometric equations	dbh and height measured for tree species

Table 1 Data collection approach for FORLIS study

Study area:

Sl.No	*Village Name*	*Cluster*	*District*	*Vegetation analysis*	*Forest type (Champion & Seth, 1968)*
1	Jolzam	Tuibong	Churachandpur	Yes	Tropical Moist Deciduous forest
2	Haotak Tampha Khunou	Kumbi	Bishnupur	Yes	
3	Taodaijang	Tamenglong	Tamenglong	Yes	
4	Rangkekiulong	Duilon	Noney	No	
5	Rangkhung	Tousem	Tamenglong	No	Tropical Dry Evergreen forest

Figure 2 Herb and Creeper species counting

Figure 1 dbh measuring

Results

FORLIS/Forest dependency

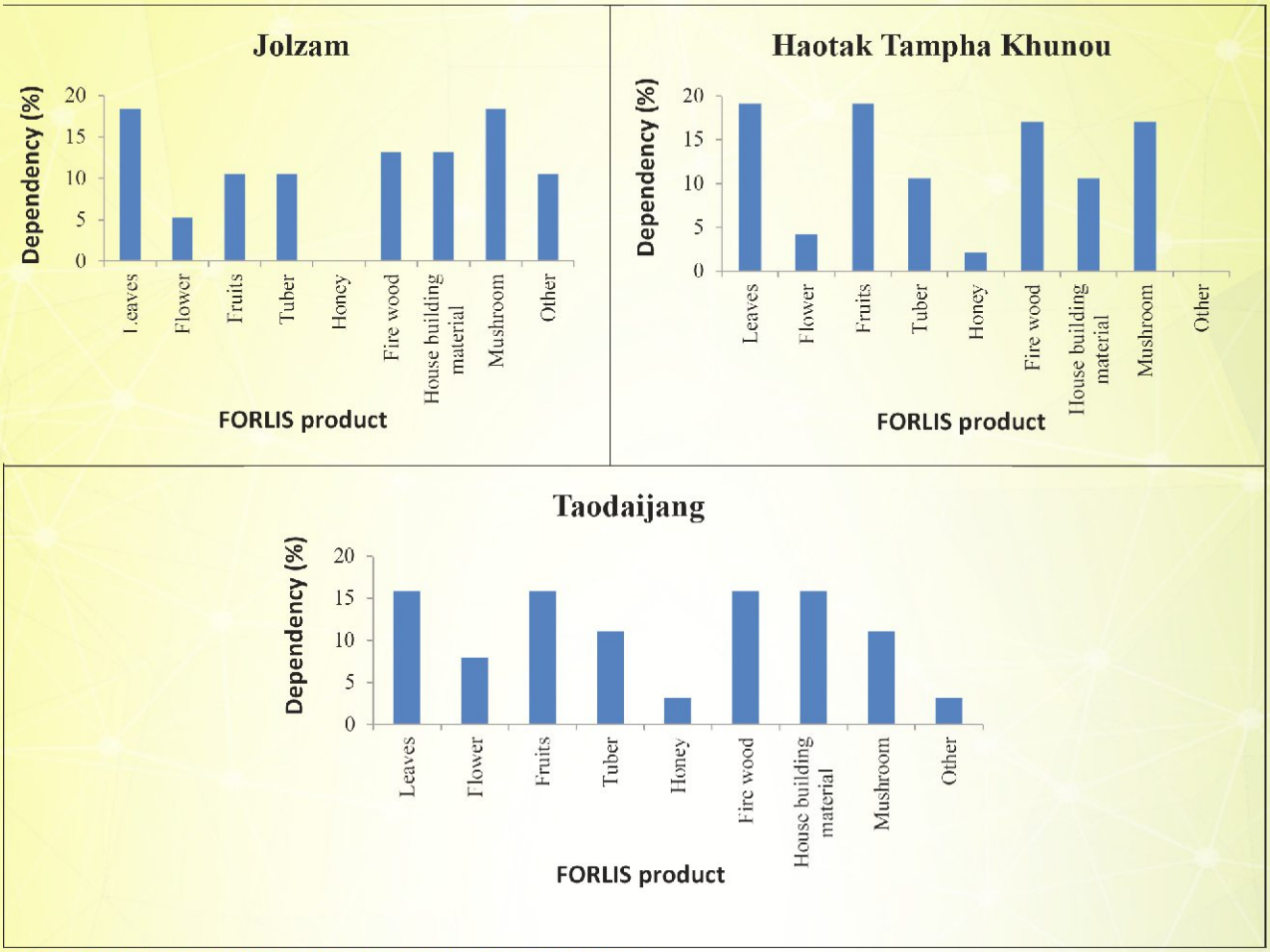

Figure 3 Percentage of dependency on products from FORLIS site

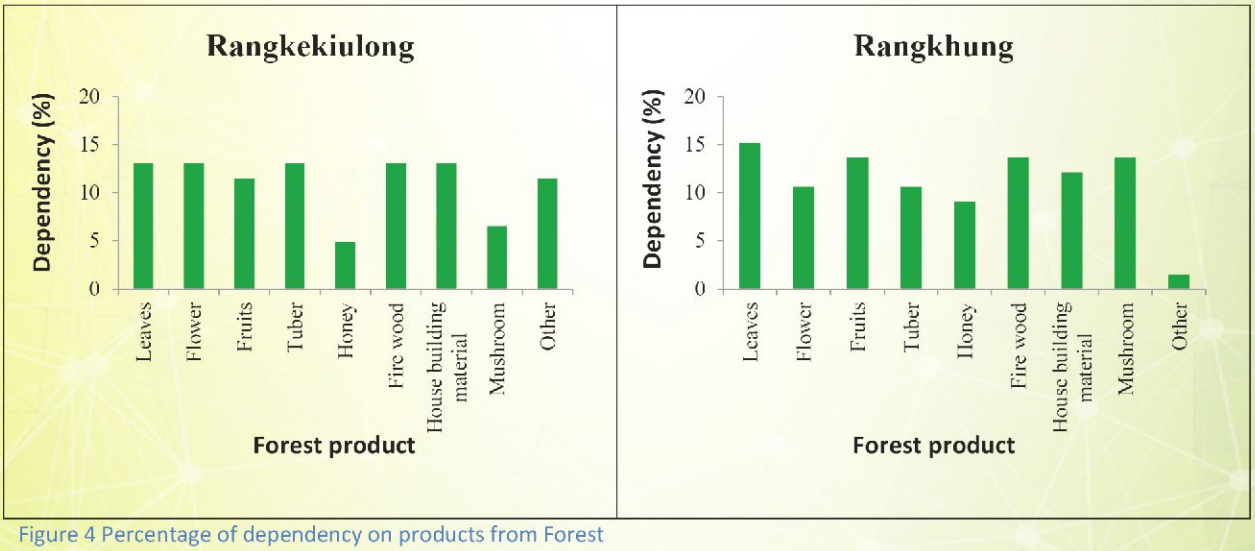

Figure 4 Percentage of dependency on products from Forest

Overall, more than half of the respondents (53.4%) were dependent on leaves followed by mushrooms (46.6%) in FORLIS site while in forest the villagers were most dependent on leaves and firewood.

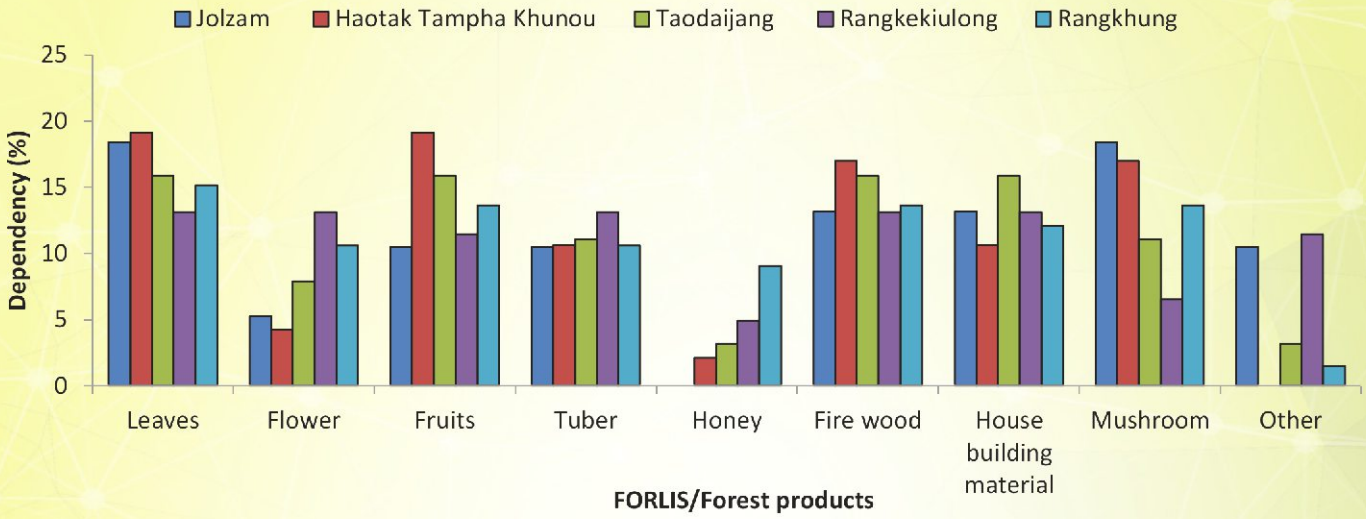

Figure 5 Percentage of Dependency on FORLIS/ Forest Products

In terms of economic returns, larger number of respondents generates highest income by selling mushrooms followed by leaves (Fig. 4).

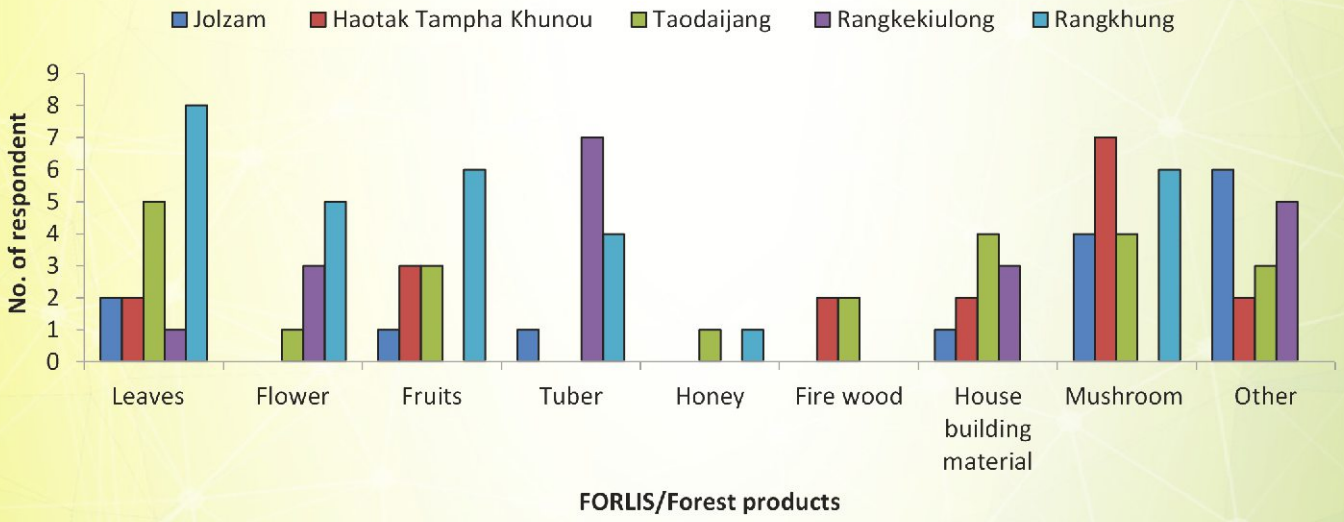

Figure 6 Percentage of dependency on FORLIS/ Forest products in terms of economic returns

Seasonality mapping of FORLIS/ forest products:

Index	Peak collection time	Collection period

Products	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Leaves												
Flower												
Fruits												
Tuber												
Honey												
Fire wood												
House building material												
Mushroom												

Table 2 Broad classification of products harvest from FORLIS site in Jolzam village

Products	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Leaves												
Flower												
Fruits												
Tuber												
Honey												
Fire wood												
House building material												
Mushroom												

Table 3 Broad classification of products harvest from FORLIS site in Haotak Tampha Khunou village

Products	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Leaves												
Flower												
Fruits												
Tuber												
Honey												
Fire wood												
House building material												
Mushroom												

Table 4 Broad classification of products harvest from FORLIS site in Taodaijang village

Products	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Leaves												
Flower												
Fruits												
Tuber												
Honcy												
Fire wood												
House building material												
Mushroom												

Table 5 Broad classification of products harvest from forest in Rangkekiulong village

Products	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Leaves												
Flower												
Fruits												
Tuber												
Honey												
Fire wood												
House building material												
Mushroom												

Table 6 Broad classification of products harvest from forest in Rangkhung village

Relevance and process of FORLIS

JOLZAM VILLAGE

FORLIS was initiated in 2020 with only women as beneficiaries (30% of the total village household). It was initiated in community land demarcated by the village chief but the plantation was conducted individually. Some FORLIS sites are individual land and homestead.

Community perception on FORLIS

1. Difficult to go to jungle regularly and hence the products including medicinal species are easily accessible
2. High market value of the species planted and helps generate income by selling the products (particularly wild vegetables)
3. Has improved the dietary intake
4. Do not extract/disturb the forest like previous times

Process of land preparation The men are involved just in clearing the forest and burning while the women plant, weed, harvest and sell in the market.

Planting method For majority of species under FORLIS, it was propagated through stem cuttings, only tubers for wild cardamom.

Income The produce are sold by themselves in the local market once in a week which is at the distance of about 14 km for which the transportation cost them Rs 100 per head (to the market

and return). The produce are sold as raw/freshly harvested from the site, however, in case of turmeric it is dried, crushed and sold in powdered form.

Species sold from FROLIS sites (till date)

Sl no	Name	Plantation Method	Fruiting Period	Harvested Period	Use	Medicinal use	Economic REturn
1	*Aralia sp.* (Kuki: Chonbeh)	Planted as stem cuttings in April	Blooms in December	January - March	Sell the inflorescence, fruit and is consumed as vegetable.	No medicinal use	Rs 50 per bundle (weighing about 350 g)
2	*Clerodendrum sp.* (Kuki: Anphui)	Planted as saplings and root cuttings in April		March - May	Sell the tender leaves and flowers while the seed is for self-consumption	The leaves of this plant is used for controlling high BP	Rs 20 per polythene (Leaves + flowers)
3	Wild Cardamom	Propagated from rhizome in March - April		May	Sell the stem as well as bulb. Generate higher income from selling the bulb		Rs 20 per bundle of stem Rs 30 - 50 per bundle of bulb (weighing about 350g)
4	Wild Coriander/Burmese Coriander	Planted as saplings after the first rainfall (March – April		June - July	Sell the whole plant	The root is used for treating dysentery	Rs 20 per bundle
5	*Houttuynia cordata* (Common name: Heart leaf)	Planted as saplings, root cuttings near the streams in March - April		June - July	Sell the leave as well as root. Generate higher income from selling the root		Rs 20 - 30 per bundle
6	Wild banana	Propagated from rhizome, suckers in April		Harvest at 12 - 18 months after planting	Sell the leaves and flowers while the stem is self-consumed	Leaves are used as wrapping material and harvested during the month of October - November	Rs 20 - 50 per banana flower

Table 7 Species sold from FROLIS sites

Species which they want to introduce in the FORLIS site and its reason

1. *Dregea volubilis* (Kuki: Thingthupui)
   This species has high market value and the leaves are consumed for controlling high BP and treating cold,cough.
2. *Senegalia pennata* (Kuki: Khamkhur)
   This species has high market value and the leaves are used for treating pile.
3. Ginger
   The soil type is suitable for growing ginger and also every part of the plant is edible.

Village	JOLZAM	
Sl No	**Disease name**	**Species name (Flower- FL, Fruit- F, Tuber-T, Leaves- L, Steam –S, Bark –B, Root- R, Seed-Sd, Whole plant-WP, Rhizome-Rz, Vine-V)**
1	Toothache	Phoi (grass) mixed with garlic is used for treating toothpain/ cavity, Bolje (raw L)
2	Dysentery	Tender Gauva (L), Tree bean (B), Heimang (L)
3	Blood Pressure (High)	Papaya (L), peel of the fruit of tree bean,
4	Tapeworm	Paste of mature black papaya seed (Sd) is consumed
5	Jaundice	Sugarcane juice
6	Diabetes	Tender mango (L) is boiled and the decoction is consumed after food
7	Wound	Croftonweed (L) is made into paste and applied on wound, Bolje (L) paste applied topically on livestock, Ailaidum (Rz),
8	Cough, Fever	Nongmangkha (L)
9	Body ache	Nongmangkha (L) is boiled and the steam is pressed on the area with the help of a cotton cloth,
10	Cancer	Bolje (L) decoction helps in treating throat cancer,
11	Ulcer	Bolje (raw L) helps in treating mouth ulcer,
12	Muscle Cramp	Common plantain (WP) is made into a paste and applied on the area,
13	Piles	Common plantain (WP) is boiled and taken orally,
14	Gastritis	Common plantain (WP) is boiled and taken orally,
15	Stomach ache	Ailaidum (Rz)
16	Post delivery	Bastard oleaster (L) is boiled and the steam is pressed on lower abdomen area with the help of a cotton cloth
17	Acidity/heart burn	Indian nightshade (F) consumed raw,
18	Kidney stone	Touch-me-not (R), Acmella sp. (WP) boiled and taken orally to break kidney stone. Longchang (Sd) is mixed with lemon and kept in a dark room and is consumed when the seed disintegrates in the lemon juice, this dissolves the kidney stone.
19	Head lice and nits	Tender Koini (V) is smashed and applied on the head for about 30 minutes and washed
20	Ring worm	Bagalen (L)
21	Anti-danruff	Acmella sp. (WP) boiled and used for washing hair
*** Poklou (WP) and Ailadum (Rz) are also used to ward off evil spirit**		

Table 8 Ethno-medicinal use of plants in Jolzam village

HAOTAK TAMPHA KHUNOU VILLAGE

FORLIS was initiated in 2021 in community forest of about 50 acre with women SHGs as beneficiaries. Besides, some homesteads also comprise FORLIS sites where gooseberry trees are planted.

Community perception on FORLIS

1. Traditional medicinal species easily accessible
2. Source of fodder namely the leaves of Tairen (*Toona ciliata*), bamboo, local banana
3. Provide construction material such as timber, bamboo
4. Generate income from selling the produce
5. Improve the dietary intake

Site selection: Selection as per the vegetation already growing in the area.

Process of land preparation: Since it was an existing forest stand, the ground was cleared and not burnt which was followed by plantation of the preferred species.

Planting method: Species such as Heikru (*Phyllanthus emblica*), heimang (*Rhus chinensis*) and Usoi (*Schima wallichii*) were propagated from seeds while heibam (*Ficus palmata*) and Nongmangkha (*Phlogacanthus thyrsiformis*) through stem cuttings.

Income*:* The men as well as women are involved in clearing the forest and planting while the women harvest and sell in Kumbi and Moirang market which is at a distance of about 15-17 km.

Products extracted from FORLIS sites (till date)

1. Heikru (*Phyllanthus emblica*): For selling the fruit in the market. Rs 20-30 per can (weighing about 500 g)
2. Nongmangkha (*Phlogacanthus thyrsiformis*): The leaf and flower of this plant are consumed as vegetable and medicinal use for cough.
3. Mukthrubi (*Zanthoxylum alatum*): The leave is consumed as vegetable and the seed is used for the treatment of cough.
4. Naosek manbi (*Aralia sp.*): The inflorescence, fruits are consumed are vegetable
5. Shahi (*Lithocarpus dealbatus*): The trunk/branches of the tree is used in construction, firewood and for making charcoal.
6. Heirit (*Ficus semicordata*): Fruits are consumed, tender leaves are used in eromba and trunk/branches used as firewood
7. Heimang (*Rhus chinensis*): Fruit is used for treating indigestion and loss of appetite.
8. Bamboo: For construction and edible bamboo shoot

In terms of preference, Bamboo > Heikhu > Heirit > Nongmangkha > Heimang.

There is no limit to extract from FORLIS site, however, cutting down of trees are not allowed.

Figure 7 Collected Product from FORLIS site

Resource management practice/methods

1. Planting heirit (*Ficus semicordata*) and heibong (*Ficus racemosa*) increases the water level in perennial steams
2. Planting of bamboo increases the soil holding capacity preventing soil erosion and landslides.
3. Drain and bund method of soil conservation in hilly terrain:
   Drains are dugged in the slopes and the soil dugged out are used for making bunds. As the top soil (with debris) gets deposited in the drain after rain, it is drag out and added to the bunds. The financial assistance for making the drains and bunds is obtained from the village MGNREGA fund.
4. As the village is situated in the foothill, the villages constructed a water storage pond in the community land which provided for the daily use of the villagers throughout the year, especially during the dry season.
5. Insect and pest management:
   Nongbanlei (*Lantana camara*) leaf is dried for 5-7 days and grind into powdered form. Seeds are stored mixed with the leaf powdered which act as a repellent against seed bores and fungal attack. Also, the powered leaf is spread in the field to protect the paddy and vegetables from wahik (aphids) infestation.
6. Storage/ to increase the shelf life:
   - Yongchak (*Parkia timoriana*) pods are half boiled (about 5 minutes) and sun dried for 10-15 days until its fully dried. It is then stored in plastic containers for almost one year.
   - Leaves of sorrel, mustard and mushrooms are sun dried and can be stored upto 5-6 months.

- Forest products such as heimang, heikru and yaipan (*Curcuma augustifolia*) are sun dried and can be stored upto one year.

Figure 8 Resource mapping of Haotak Tampha Khunou village

Ethno-medicinal use

1. Leaves
    - Nongmangkha (L) is boiled and the steam is inhaled for corona while the decoction is taken orally for cough. (Jan-March)
    - Kongouyen (*Cissus adnata*) leave is boiled and the decoction is taken to break kidney stones. (April-May)
    - Ningthoukhongli (*Tinospora cordifolia*) leave is boiled and the decoction is taken orally for treating cancer and arthritis. (April-May)
    - Yenpon (L) is used to improve blood circulation and also to remove poisonous substances from pregnant women.
    - Hanurei (*Mussaenda frondosa*) leave is used as a stress relive and for treating headache. (March-May)
2. Fruits
    - Heikru is consumed raw for treating cold and cough. (Nov-Dec)
    - Heimang is consumed for proper digestion, enhances appetite and also decoction is fed to dogs when it is sick. (Nov-Dec)
    - Heirit is used as an anti-acid and also good for treating constipation. (June-July)
    - Heining (*Spondias pinnata*) is consumed raw to treat dysentery. (Nov-Dec)

3. Flower
    - Nongmangkha is boiled and the decoction is used for treating cough and lowering BP. (Feb-April)
    - Nungthabi (*Acmella oleracea*) is boiled and taken orally to treat mouth ulcer and break kidney stone while it taken raw for treating toothache. (April-May)
    - Wild banana flower is consumed for treatment of malaria, high BP, gastritis, sore throat. (All year round)
    - Leihao (*Michelia champaca*) is used for treatment of sore throat, mouth and stomach ulcer. (March-April)
4. Tubers
    - Khutchapei (*Anotis foetida*): The root are smashed and applied to fractured bones for setting and healing. Same is also applied to boils. (April-May)
    - Yendang (*Cycas pectinata*) : The root is consumed raw for constipation. (April-May)
    - Sabanpuron: The root of this plant is boiled and consumed for treating UTI. (April-June)
    - Tabopi : The root is boiled and the decoction is taken orally for treating gastritis. (April-May)
5. Climbers
    - Moirambi: The vine is used for the treatment of piles and fractured bones.
6. Bark
    - Usingsha (*Cinnamomum zeylanicum*) is used for treatment of oral problem. (March-April)

TAODAIJANG VILLAGE

FORLIS was implemented in 2020 (May-June) with all the villagers as the beneficiaries in five (5) communal land sites. In addition, every household plants the indigenous species in their homestead.

Community perception on FORLIS

1. Increases the forest cover in the village vicinity
2. High market value of the species planted and helps generate income by selling the products (particularly resin and mantribi)

Site selection: As per the vegetation already growing in the area and accessibility.

Process of land preparation: Activities such as clearing and planting in the sites were carried out through mass participation, while monitoring was conducted by the VDC under the supervision of village authority.

Planting method: Species such as mantribi (*Homalomena aromatic*) was propagated through rhizome while resin (*Canarium strictum*), yongchak (*Parkia timoriana*) and mango (*Mangifera indica*) were replanted in the sites as saplings from personal nursery in addition to tapiakthai (*Baccaurea ramiflora*).

Interestingly, it was observed that mantribi showed the highest surviral rate and tapiakthai showed the lowest. In general, the reason for low survival rate of species were planting in the wrong season, soil type, dense canopy leading to retarded growth and seeds are eaten by the animals after sowing.

In future they desire to introduce sandalwood in FORLIS site as its economical value is very high in the market.

Except Mantribi, there is no limit to extraction from FORLIS site, however, cutting down of trees are not allowed.

Resource management practice/methods

1. Soil conservation measures:
   Wood logs are placed in the sloppy land. When it rains, the top soil gets accumulated in the log bund which enhances the moisture level and improves the health and yield of paddy plant.
2. Water conservation measures:
   - Preserve and avoid cutting down forest in the vicinity of spring source
   - Also plant wild banana to retain the moisture and hence store water
3. Planting flowers such as marigold not only is believed to increase the yield of paddy but also protects from insects and pests.
4. Storage:
   - The best seeds are selected for next year's cropping which is store in a container made from banana leave. The paddy is stored as a whole plant.
   - Cowdung mixed with mud is used to cover the outer area of the barn to protect from pests and insects.

Traditional knowledge which has been replaced my modern technologies/equipment

1. Insect and Pest management: In the past, paddy straws were burned and the ash was spread in the field to protect against pest and insects, Cow urine was also directly sprinkled to the infested crop. Neem is boiled in water and the decoction is used as insect repellent. All these practices are now replaced by chemical pesticides and insecticides.
2. Harvest: In the past, they used sickle to cut and stick to thrash the paddy which is replaced by machine.

Village	**TAODAIJANG**	
Sl No	**Disease name**	**Species name (Flower- FL, Fruit- F, Tuber-T, Leaves- L, Steam –S, Bark –B, Root- R)**
1	Fever	Nongmangkha (L), Raphai (L), Talang (L), Thangni (L), Thingbanam (L), Thalang (B)
2	Cough and cold	Nongmangkha (L), Ivy (L), Heimang (L), gooseberry (FR), Pongring (R)
3	Dysentery	Syang (L), yongchak (B), Guava (L), Ngang (B)
4	Blood Pressure (High)	Chlorodendron (L), Aralia (L, FR), Khang (L,S), Ganluak (L), Puking (L)

5	Blood Pressure (Low)	Khubuttti (L,S, FR)
6	Sugar/ diabetic	Ash Gourd (FR), Betel nut (FR), gooseberry (B), Khuang Bongthai (FR), Apeinuang (L)
7	Arthritis	Banamauai (L,T), Pudi (L), Talang (L), Karai (L is made into a paste and tied with a soft cloth above the joints)
8	Vomiting	Lemon(FR), Goose berry (FR)
9	Eye problem	Tupit (L), Kuang sing (L,R), Tamjinha(L), Mustard (L)
10	Head ache	Mustard (L), Honey Hive
11	Tooth Ache	Khubuti (L,S), Thangehag (Resin),
12	Stomach Ache/ pain	Chameiga (Black Turmeric), Kham (L), Thingkhump(R)
13	Removing Kidney stone	Touch Me not (Root), Flying squirrel urine
14	Clot bleeding	Chromolaena (L), Bamboo (B), Japan roof (L), Nagapuluai (L), Charcoal, Maikhutdui , Wild Pepper (L)
15	Snake Bite	Tamarind (T), Earth Worm, Colocasia (S)
16	Cancer	Meanuaru (Resin), Pukeamei (L), Leibaklei (R), Luikhummiumei (R), Garimmai
17	Hair Fall	Khui (S), Tajeihei (FR)
18	Bone Fracture	Ndun (L), Thingjikhengnei (L)
19	Gastric	Turmeric juice

Table 9 Ethno-medicinal use of plants in Taodaijang village

Figure 11 Haobumluia leaf

Figure 10 Tangaeng leaf

Figure 9 Khonthaipu Leaf

RANGKHUNG VILLAGE

Figure 12 Resource mapping of Rangkhung village

Village	RANGKHUNG	
Sl No	**Disease name**	**Species name (Flower- FL, Fruit- F, Tuber-T, Leaves- L, Steam –S, Bark –B, Root- R, Seed-Sd, Whole plant-WP)**
1	Cold, Cough and Fever	Bitter leaf (L) + Honey Raphai (L) + Banam Luai (L) creeper + Horim (L) creeper Tangang (L) + Lemon juice + Honey
2	Dysentery	Guava (L), Pomegranate (L), Tree Bean (B), Unripe Banana (F), Pegion Pea (L), Paitanam (B)
3	Blood Pressure (High)	Ganmakhui (L), Ganpuinu (L), Lemon + Honey
4	Blood Pressure (Low)	Local egg
5	Diabetes	Guaidaleinui (L)
6	Arthritis	Ladies Finger (Veg)
7	Sinus	Gankapei (L)
8	Stomach ache	Local Ginger (Black & Reddish Colour)
9	Blood clotting	Nagapuloi (L) creeper, Turmeric (T), Khuithing (L)

10	Snake Bite	Tamarind (Sd), Tobacco (Khaini)
11	Bee sting	Colocasia (S)
12	Cancer	Haobumluai (WP) creeper
13	Bone Fracture	Banamluai (L) + Egg is made into a paste and applied on the area, Karingpu (L)
14	Gastric	Tamik (L) is boiled and taken orally

Table 10 Ethno-medicinal use of plants in Rangkhung village

Sl No	Products	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Mushroom												
2	Banana Stem And Flower												
3	Resin												
4	Black Pepper												
5	Biusi Bark												
6	Thingni bark												
7	Bamboo												
8	Cane												
9	Sugandh Mantri												
10	Fruits												
11	Diff Veg												
12	Honcy												
13	Galuak Leaf												
14	Gankariak Leaf												
15	Ganmakhian Leaf												
16	Bamboo Shoot												
17	Fire Wood												
18	Ganmachiang Leaf												
19	Ru Yam (Tuber)												
20	Colocasia												
	Index	**Peak Collection Period**							**Collection Period**				

Table 11 Seasonality mapping of particular forest products in Rangkhung village

Vegetation analysis

JOLZAM VILLAGE

A total of 6 tree species was found in FORLIS site with Chonbeh (*Aralia sp.*) as the most dominant species. 2 climber, 15 shrub species and 9 species as recruits were also encountered where the most abundant species was thatch grass.

HAOTAK TAMPHA KHUNOU VILLAGE

Tree	FORLIS	Control
Total species	25	19
Total stem	69	53
Most dominant sp	Chingthrao (*Bauhinia sp.*)	Shahi (*Lithocarpus dealbatus*)
2nd dominant sp	Urcirom (*Mallotus philippensis*)	Naosek manbi (*Aralia sp.*)

Table 12 Tree species richness and dominance in 30x30 m quadrat

Shrub/Climber	FORLIS	Control
Total species	20	15
Total individuals	128	207
Highest abundance	Fern	Nongbanlei (*Lantana camara*)
Highest frequency	Nongbanlei (*Lantana camara*) and Alaigi achouba (*Amomum subulatum*)	Nongbanlei (*Lantana camara*)
Highest dominance	Fern	Nongbanlei (*Lantana camara*)

Table 13 Shrub/Climber species abundance, frequency and dominance in 5x5 m quadrat

	FORLIS	Control
Total species	9	18
Total individuals	166	67
Highest abundance	Waana maanbi (*Capillipedium sp.*)	Waana maanbi (*Capillipedium sp.*)
Highest frequency	Waana maanbi (*Capillipedium sp.*)	Tabopi
Highest dominance	Waana maanbi (*Capillipedium sp.*)	Waana maanbi (*Capillipedium sp.*)

Table 14 Herb/Regeneration species abundance, frequency and dominance in 1x1 m quadrat

TAODAIJANG VILLAGE

Tree	FORLIS	Control
Total species	65	45
Total stem	177	106
Most dominant sp	Chesnut (*Castanopsis hystrix*)	Karaibang
2nd dominant sp	Nthui and Tha	Thingdiak

Table 15 Tree species richness and dominance in 30x30 m quadrat

Shrub/Climber	FORLIS	Control
Total species	14	43
Total individuals	133	472
Highest abundance	Tiannicna	Tamlai
Highest frequency	Cane, Wild pepper, Nrih and Shaengluang	Cane, Fern, Ganmakhen, Sumatiang and Wild pepper
Highest dominance	Tiannicna	Ganmakhen and Sumatiang

Table 16 Shrub/Climber species abundance, frequency and dominance in 5x5 m quadrat

Herb/Regeneration	FORLIS	Control
Total species	19	25
Total individuals	70	162
Highest abundance	Kahuv thingtan	Tabeng
Highest frequency	Sugandh mantri	Wild pepper
Highest dominance	Kahuv thingtan	Tabeng

Table 17 Herb/Regeneration species abundance, frequency and dominance in 1x1 m quadrat

AGB Carbon stock estimation

Village		FORLIS	Control
Jolzam	AGB	3.39	No data
	AGB C	1.56	
	Highest C sp	Aralia sp	
Haotak Tampha	AGB	77.37	7.56
	AGB C	37.80	3.66
	Highest C sp	Tera (*Bombax ceiba*)	Shahi (*Lithocarpus dealbatus*)
Taodaijang	AGB	90.94	148.50
	AGB C	44.09	72.50
	Highest C sp	Chesnut (*Castanopsis hystrix*)	Karaibang

Table 18 AGB and carbon stock of trees (Mgha-1) in the sampled villages

Discussion

Forest restoration with locally important species is highly relevant for the lives of indigenous tribal people for several reasons:

- Cultural significance: These forests often hold spiritual, historical, and cultural significance for the community. Restoring forests with locally important species helps preserve and strengthen these cultural ties and enables the continuation of traditional practices, beliefs, and customs.
- Livelihoods: Many indigenous tribal people depend on forests for their livelihoods. Sustainable management of these restored forests aids to generate income from the collection and sale of non-timber forest products.
- Ecosystem services: Forests restoration supports the health and well-being of indigenous communities, helps maintain essential ecosystem services and ensures the long-term sustainability of the ecosystem.
- Climate change adaptation and mitigation: Restoring forests with locally important species can help indigenous communities adapt to climate change by enhancing the resilience of ecosystems and reducing the risks associated with natural disasters like floods, landslides, and droughts. Moreover, forests play a critical role in mitigating climate change by sequestering carbon dioxide from the atmosphere.
- Food security: The diversity of food sources ranging from edible plants, fruits, and nuts, as well as habitats for animals that are hunted or fished can improve the nutrition and overall health of indigenous communities.
- Land rights and self-determination: Forest restoration initiatives involving indigenous communities can contribute to the recognition and protection of their land rights and empower them to make decisions about the management and use of their resources.

With women being the major beneficiaries in this project, relationship between women and forests represents a prevailing interaction, rather than an externally imposed intervention. This assertion is rooted in the acknowledgment of the longstanding, reciprocal relationship that women have historically shared with forests, particularly within traditional societies (Agarwal, 2009). In the present context, the women folk possess indigenous knowledge about medicinal

plants, food sources, and sustainable harvesting techniques which showcases their roles as knowledge keepers and caretakers of forest resources (Howard, 2003; Gadgil et al., 1993). These knowledge systems have passed down through generations, and have often led to sustainable forest management practices that promote biodiversity and resilience while providing for human needs. However, as per Nightingale (2006) these interactions with forest can be influenced by numerous factors including socioeconomic status, caste, and ethnicity.

However, the rapid advancement of modern technology has shifted traditional knowledge towards technology-based solution which could result in:

- Erosion of cultural identity as communities may lose their unique customs, practices, and beliefs that have been passed down through generations.
- Environmental impact: The production and use of modern technologies can contribute to environmental degradation, pollution, and climate change, which may have long-term negative consequences for communities and ecosystems.
- Disregard for local context: Modern technologies may not always be suitable for local contexts, as they can be designed with different environmental, social, and cultural conditions in mind. In contrast, traditional knowledge is often adapted to local needs and circumstances.

Higher tree species richness generally indicates a more diverse ecosystem, which often suggests greater ecological health and stability (Tilman, 1999). In this study, FORLIS site has higher tree species richness than control site. There could be several potential interpretations, such as:

- The FORLIS site, due to more effective protection and conservation measures, has experienced fewer disturbances than the control site allowing for a greater number of tree species to establish and thrive (Sousa, 1984).
- The project site could have a wider variety of microhabitats and resource availability which provide different conditions suitable for different species (Tews et al., 2004; Huston, 1979). For instance, variations in soil type, light availability, moisture levels, nutrients, space can all contribute to higher species richness.
- Lastly, the difference could also be due to a successful implementation of a reforestation project which aimed at increasing the variety of tree species/ forest cover in the project site (Carnus et al., 2006).

It's important to note that while high tree species richness is generally a positive indicator of ecosystem health, the presence of invasive species should also be taken into consideration when evaluating an ecosystem's health (Naeem et al., 1994). And therefore, dominance of invasive species *Lantana camara* in control site at Haotak Tampha resulted in lesser tree and shrub species. *Lantana camara* alters the habitat and soil properties, releases allelopathic chemicals which impair and inhibit the germination and growth of other species (Day et al., 2003; Sundaram & Hiremath, 2012; Sharma & Raghubanshi, 2009; Appavu et al., 2008).

Higher richness of herb and regeneration species in the control sites could be indicative of the presence of mature trees and other plants that contribute to soil fertility through leaf litter and root activity, more available nutrients and effective nutrient cycle (Wardle et al., 2004).

In tropical moist deciduous forests, the AGB carbon stock values can be quite substantial due to the high productivity and biodiversity of these ecosystems. Literatures on AGB carbon stock of such forest type in North-East India is estimated to range from as low as 7.8 $Mgha^{-1}$ and escalates to 118.3 $Mgha^{-1}$ (Devi & Yadava, 2015; Thong et al. 2020; Chaudhury et al., 2022; Deb et al., 2020; Kushwaha & Dadhwal, 2013). However, the specific values can vary widely depending on many factors, including the age of the forest, the tree species present, the local climate, soil conditions and forest management practice (Luyssaert et al., 2008; Clark et al., 2001; John et al., 2007; Nabuurs et al., 2007). In addition, the values can vary substantially depending on the methods used to estimate the biomass namely direct and indirect method, choice of allometric equations and remote sensing techniques (Chave et al., 2005; Brown, 1997; Lu, 2006).

Conclusion

The whole concept of FORLIS is based on the participation of local communities as key component of forest restoration projects. This approach, known as participatory forest restoration or community-based forest restoration, recognizes the crucial role that local communities play in forest management and conservation namely identifying the locally important and native species that should be prioritized in the restoration project, collecting seeds and propagating in their private nurseries and planting them in restoration sites, monitoring the growth and health of the plants and determining when and where to initiate the restoration activity, how to manage and utilize the restored forest. The involvement of local communities not only helps ensure the success of forest restoration projects but also provides social and economic benefits for the communities, such as enhanced livelihoods, improved ecosystem services, and strengthened cultural ties to the land.

Despite the clear benefits, occasional land right disputes, insufficient funding, and a lack of recognition of traditional knowledge may hinder progress of such restoration project. However, these challenges can be addressed through collaborative approaches that involve indigenous communities in decision-making processes, recognize and respect their land rights, and value their traditional knowledge.

Therefore, forest restoration with locally important species, guided by the expertise of indigenous communities, offers a promising approach to reviving degraded ecosystems and supporting the well-being of the people who depend on them.

Recommendation

1. It would be suitable to record not only the names of the species but also the quantity of each species planted in every plot. This information will enable the calculation of the survival rate for every species planted within the FORLIS project.

2. It would also be fitting to establish certain limits on resource extraction from the FORLIS site, as over-extraction could deplete resources and also potentially lead to conflicts among beneficiaries concerning income generation.

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