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Ethnobotanical Study of Plant Resources and Identification of Reasons for Degradation of Vegetation by using Matrix Ranking and Paired Matrix Comparison on Lamdeng Forest Area under Langol Reserve Forest, Manipur, India

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ABSTRACT

Lamdeng Forest in Imphal West District, Manipur, India had severely degraded due to overexploitation. At present, the forest is rejuvenated with constant efforts to revive it by the joint approach of the State forest department and the nearby inhabitants of the forest. A paired comparison matrix study was undertaken to identify the possible reason for the loss of the vegetation in which setting fire on the forest for hunting wildlife emerged as the top reason. There were other five reasons which contributed to the loss of vegetation in the past. The study also documented 37 important trees, bamboo, and shrub species by using the matrix ranking method on the basis of 6 identified utilities provided by them. Among all the plant species, the highest point was assigned to *Castanopsis hystrix* with 273 points attributed by the 20 respondents. From the utility points, it had also 5 numbers of applications. Other important species were *Lannea grandis, Mesua ferrea*, *Meyna spinosa,* and *Vitex negundo.*

Key words: *Rejuvenated forest, Paired matrix comparison, Forest fire, Matrix ranking*

Introduction

Forest provides important services which can't be replaced by anything on this planet. The survival of all the existing live forms itself depends on it. Humans derive food, medicines, and a number of ecosystem services such as air purification, origin, and recharge of water bodies, nitrogen fixation, cycling of nutrients as well as many more other products from plant biodiversity (Larios *et al.* 2013; Kidane *et al.*, 2018). More than 86 million green jobs are directly involved through forest-related activities. An estimated 880 million people worldwide spend part of their time collecting fuelwood or producing charcoal, many of them women (FAO & UNEP 2020). With the rapid increase in human population, deforestation has increased in the past centenary on an unprecedented scale. Despite a number of measures taken up to stop forest decline, the world continues to lose some 15 million hectares of forests every year (Arnoldo, 2000). It becomes imperative how and what we do with the natural resources we have at

the moment. Ecological restoration is no easy task, but with resilient efforts, things can be improved. In India, afforestation programs had to make several pit stops (Bhatnagar, 1991) before achieving little success lately (Chaturvedi *et al*. 2008). Manipur, one of the Northeastern states of India although located in Indo-Burma hotspot is facing problems related to the degradation of its natural forest at an alarming rate. There are very few incidents in which the afforestation program could succeed. One such example is at Lamdeng forest under Langol reserve forest. Decades ago the forest had lost its vegetation due to exploitations by the surrounding inhabitant. So, it is important to identify the major reasons for the complete loss of vegetation in the area so that it should not repeat again in the future. It again demands a careful approach to know how the forest is reshaping by identifying the important plant species on basis of the utilities provided by them towards the people surrounding them. Relatively it also can determine the types of potential threats subjected towards any species.

Materials and Methods

Lamdeng is located in the Imphal West district of Manipur, under the Lamphelpat subdivision (Fig. 1 and Fig. 2A). The village is situated around 11km away from the city centre. It lies between 24°.83° N, and 93°.87^ E with an altitude range from 600m at the foothill to 1050m at the peak. In general, the climate of the District under which the study area is located has a subtropical humid climate. The average annual rainfall of the area is 1259 mm, ranging between 1085 mm min to 1434 mm max. The district gets rainfall from the South-West monsoon. About 60-65 % of annual precipitation is received during the South-West monsoon from June to September. Temperature ranges from a minimum of 0 °C to a maximum of 36 °C (Anon. 2020). The type of forest of the Lamdeng area is tropical moist deciduous forest. The population of the area surrounding the village is nearly 1700.

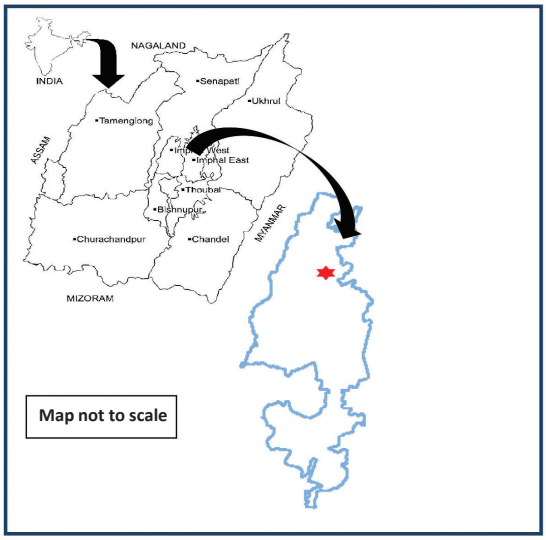

Fig. 1. Map showing study area

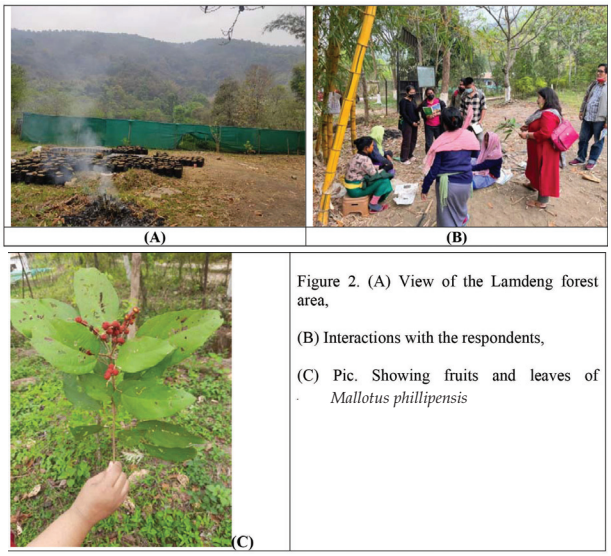

Figure 2. (A) View of the Lamdeng forest area,

(B) Interactions with the respondents,

(C) Pic. Showing fruits and leaves of *Mallotus phillipensis*

The Langol Hill Range area towards Lamdeng was highly degraded once due to various factors. The local people had first-hand experience of the consequences due to the damage to the forest caused by the falling of trees. Mudslides, water shortage and rise in temperature are some of the problems faced by the people due to deforestation. Today, with the help of the state forest department under the flagship plan of the National Afforestation Programme and constant efforts by local communities, the forest area is rejuvenated. A total area of 360 hectares of the forest area has been restored and renewed so far. From Lamdeng Mayai Leikai, the area recovered is 140 hectares, Lamdeng Awang Leikai is 110 hectares and Lamdeng Makha Leikai is 110 hectares (Devi, 2021).

Ethnobotanical data collection

Matrix ranking

A direct matrix ranking was conducted to discover local attitudes on species preference for multiple uses adopting methods described by (Kidane, *et al*.

2010; Kidane, *et al*., 2018). A total of 20 respondents were selected. From the present study, the 37 most important tree, bamboo and shrub species were recorded, based on recommendations of local guides and key informants to determine the range of uses obtained from each tree, bamboo and shrub species (Fig. 2 B.). The following categories were considered for enumerating the analysis:

1. Farming tools
2. Construction material
3. Firewood
4. Medicine
5. Human food
6. Animal fodder

A matrix table was prepared in which the list of plants was placed on the rows and use categories

Table 1. List of the plants with their utilities

Sl. No.	Species	Local name	Farming Tool	Construction Material	Medicine	Fire Wood	Human Food	Animal Fodder	Total uses
1	*Adhatoda vasica* Nees.	Nongmakhaangouba	0	0	x	0	x	0	2
2	*Albizzia procera*	Khal	x	x	0	x	0	x	4
3	*Amoora rohituka*	Heirangoi	0	0	x	x	x	x	4
4	*Azadarichta indica* L.	Neem	x	0	x	x	0	0	3
5	*Bambusa arundinacia*	Saneibi	x	x	0	x	x	x	5
6	*Bambus apallida*	Wanan	x	x	0	x	x	x	5
7	*Bauhinia purpurea* L.	Chingthraoangangba	0	0	x	x	x	0	3
8	*Castanopsis hystrix*	Shei	x	x	x	x	0	x	5
9	*Cedrelatoona*	Tairel	0	x	x	x	0	0	3
10	*Celtis cinnamomea*	Heikreng	x	x	0	x	0	0	3
11	*Cinnamomumtamala*	Tejpata	0	0	0	x	x	0	2
12	*Clerodendrum siphonanthus* L.	Charai-utong	0	0	x	x	0	0	2
13	*Clerodendrum tragraus*	Kuthab	0	0	x	x	0	x	3
14	*Dendrocalamus longipasthus*	Meirabobtujombi	x	x	0	x	x	x	5
15	*Dendrocalamus strictus*	Khokwa	x	x	0	x	0	x	4
16	*Eugenia precox*	Gulamjat	0	0	x	0	x	x	3
17	*Ficus semicordata*	Heirit	0	0	x	0	x	x	3
18	*Ficus hispida*	Ashiheibong	0	0	x	0	x	x	3
19	*Gmelina arborea*	Wang	x	x	0	x	0	0	3
20	*Lannea grandis*	Akman	x	x	x	x	0	x	5
21	*Litsae apolyantha*	Tumitla	x	x	0	x	0	0	3
22	*Mallotus philippensis*	Ureiromlaba	x	0	x	x	0	x	4
23	*Melanorrhoea usitata*	Kheoo	x	x	0	0	0	x	3
24	*Mesua ferrea* L.	Nageshor	x	x	x	x	0	0	4
25	*Meyna spinosa*	Heibi	x	0	x	x	x	0	4
26	*Oroxylum indicum*	Shamba	x	x	x	x	0	0	4
27	*Pinuskesia*	Uchan	0	x	x	x	0	0	3
28	*Psidium guajava*	Pungdol	x	0	x	x	x	0	4
29	*Quercus serratus*	Uyung	x	x	0	x	0	0	3
30	*Schimawallichii*	Ushoi	x	x	0	x	0	0	3
31	*Spondias mangifera*	Heining	0	0	0	x	x	0	2
32	*Stereospermum chelonoides*	Missi	x	0	x	x	0	0	3
33	*Terminalia myriocarpa*	Tolhao	x	x	0	x	0	0	3
34	*Terminalia citrina*	Manahi	0	0	x	x	0	0	2
35	*Thevetia peruviana (Pers.)*	Utonglei	0	0	x	0	0	0	1
36	*Vitex negundo L.*	UrikShibi	x	x	x	x	0	0	4
37	*Zanthoxylu malatum*	Mukthrubi	0	0	x	x	x	0	3

along the columns as given Table 1. and it was handed out to 20 respondents. Each respondent was given a task to rate the plants proportional to the importance of each species for each use (four for very good, three for good, two for fair and one for not good), moving across one entire horizontal row at a time to emphasize comparing the different uses of a single tree/shrub species. After the task was completed, whole points given by the respondents were counted and a preference list of plant species was made in ascending order or ranked them purely on the basis of the points assigned to them (Table 2).

Paired comparison

As mentioned earlier, activities that lead to devastating consequences of the Lamdeng forest area during past decades were listed out as perceived by the nearby inhabitants. Following Kidane *et al.* (2018), the possible reasons were listed down. Accordingly, the following categories of activities were established:

1. Forest fire for hunting
2. Construction material
3. Farming tools
4. Fuelwood collection
5. Grazing
6. Charcoal making

Then numbers of pairs of activities were established as described by Komiyama and Takeuchi, (2006) from the relation n (n-1)/2 where n is the number of activities. Thus 15 pairs were obtained serially, i.e., 1, 2; 1, 3; 1, 4; "-6. Then a pair matrix table was prepared (Table 3) and accordingly handed it out to 20 respondents who were again given the task to compare between the pairs to identify which category has relatively more accountable for loss of the vegetation in the reserve forest.

Results

Ethnobotanical study

The results obtained during the investigation have been organized into two sections. The first section deals with the findings related to knowledge of local people on the value of plants. This is followed by a section, where threats to forest resources of the study area are presented.

Knowledge on the value of plants among local people

The relative uses of 37 tree, bamboo and shrub species were assessed on the basis of their applicability fromsix utilities given (Table 1). Then a preference list of top 20 species was then made putting the specimens with highest score first by using direct matrix ranking method (Table 2). Interestingly, all the species have at least one use, though most of the species are used for multiple purposes (Table 1).

Table 2. Total score and rank of 20 important plants by direct matrix ranking

Sl. No	Scientific names	Local name	Points	Rank
1	*Castanopsis hystrix*	Shei	273	1
2	*Lannea grandis*	Akman	255	2
3	*Mesua ferrea* L.	Nageshor	198	3
4	*Meyna spinosa*	Heibi	187	4
5	*Vitex negundo L.*	UrikShibi	160	5
6	*Amoorarohituka*	Heirangoi	150	6
7	*Oroxylum indicum*	Shamba	133	7
8	*Mallotus philippensis*	Ureiromlaba	128	8
9	*Dendrocalamus longipasthus*	Meirabobtujombi	122	9
10	*Bambusa arundinecia*	Saneibi	118	10
11	*Albizzia procera*	Khal	116	11
12	*Cedrelatoona*	Tairel	109	12
13	*Psidium guajava*	Pungdol	102	13
14	*Azadarichta indica* L.	Neem	98	14
15	*Terminalia citrina*	Manahi	97	15
16	*Celtiscinnamomea*	Heikreng	93	16
17	*Terminalia myriocarpa*	Tolhao	92	17
18	*Quercus serratus*	Uyung	90	18
19	*Schimawallichii*	Ushoi	87	19
20	*Gmelina arborea*	Wang	85	20

Majority of plants i.e. 31 (83.78%) out of 37 (Table 1) were found to have three or more than three use values and 5 (13.51%) species had two use values whereas only1 plant (2.7%) contributed for only one type of use. Few important species utilised for 6 purposes isas given below.

Tree and shrub species use for farming tools

Castanopsis hystrix, Bambusa pallida, Gmelina arborea, Oroxylum indicum and *Celtis cinnamomea* are among the top plant species which remains the most popular choices among the farmers. Tree woods are preferred for making carts, ploughs etc. these species provide advantages as they are strong and light in weight. Bamboo is an inseparable plant species for especially North Eastern Indians when it comes to multipurpose utilisation, from fencing to making each tool; it remains an integral part of everything.

Tree and shrub species preferred for construction material

Several species identified during the study were found to be utilised by the local people for construction material. Important tree species including *Quercus serratus*, *Melanorrhoe ausitata*, *Gmelina arborea*, *Lanneagrandis*, *Albizzia procera*, *Mesua ferrea* and bamboo species *Dendrocalamus longipasthus* were most sought after for the said purpose.Any kind of extraction activity for wood and timber is strictly prohibited at present. This list was prepared solely looking at the knowledge possessed by the respondents on the basis of importance of the tree and bamboo species.

Species used for the medicinal purposes

High number of plants were recorded which possessed medicinal property. Among them *Azadarichtaindica, Amoorarohituka*, *Castanopsishystrix, Clerodendrumtragraus*, *Mallotusphilippensis, Meyna spinosa*, *Terminalia myriocarpa*, *Terminalia citrina, Vitex negundo* and *Zanthoxylum alatum* can be mentioned as some widely used species for treating several ailments ranging from skin disorders to neuropathic disorders. All sorts of plant parts were found to be utilised by the nearby inhabitants namely; leaves, rhizomes, fruits, tubers, barks, stems and roots etc.

Tree and shrub species use for firewood

Firewood collection from the forest is prohibited by the authorities at present. Base on the knowledge of the informants, the popular firewood species were documented. Species like *Castanopsis hystrix, Gmelina arborea*, *Pinuskesia,* and *Albizzia procera* served as excellent firewood. Other species preferred as firewood were *Mesua ferrea*, *Celtis cinnamomea, Stereospermum chelonoides* and *Lannea grandis*.

Species preferred as human food

Many of the species that listed out have utilisations as human food in the forms of fruit, leaves and shoots. Important tree and shrub species that gives edible fruits and leaves are *Adhatodavasica, Cinnamomum tamala*, *Eugenia precox*, *Ficus semicordata, Ficus hispida, Meynaspinosa*, *Psidium guajava*, and *Zanthoxylum alatum.* Bamboo shoots are also most sought after food at Manipur irrespective of tribe dwelling in the region. Out of the four bamboo species recorded, tender shoots of *Bambusa arundinacea* (Saneibi) is favourites among the people which is judiciously sold at a very lucrative price in the markets of Imphal.

Species preferred as animal fodder

Majority of domesticated grazing animals were cows (*Bostaurus*). Water Buffalo (*Bubal usarnee*) was also found to be domesticated by few farmers. In

Table 3. Matrix paired comparison: FF= Forest fire, CM= construction material, FT= Farming Tools, FW=Fuelwood, G= Grazing and C= Charcoal making (One sample from the 20 individuals in which he rated FF activity as the highest with 5 points and G activity as the least reason for the destruction of forest).

X	FF	CM	FT	FW	G	C	TOTAL PTS.
FF	X	1	1	1	1	1	5
CM	0	X	0	0	1	1	2
FT	0	1	X	0	1	0	2
FW	0	1	1	X	1	1	4
G	0	0	0	0	X	0	0
C	0	0	1	0	1	X	2

recent past, animals were left to the forest as a ranching ground. So these animals graze upon whatever was available and suitable for them to reach. Now, there are restrictions applied by the JFCs and Forest authorities as these will severely effect on the regeneration ability of the forest. Out of the 37 species recorded 14 species were found to be preferred by the aforementioned animals. Bamboo leaves appeared to be particularly attracted by the cows.

Paired comparison on the degradation of Lamdeng Forest

The exercise was carried out with 20 participants (Table 4). Out of these, 18 persons (90%) strongly voted forest fire for hunting as the main reason for the devastating loss of forest years ago. The total score attributed to this activity was 98 pts. (32.6%) followed by utilization of woods for construction material (75 pts.), farming tools (52 pts.), fuel wood collection (41 pts.), charcoal making (22 pts.) and least by grazing (12 pts.) from the overall score of 300 pts.

Table 4. Showing major activities rank in percentage wise for destruction of forest

Sl. no.	Activities	Points	Percentage (%)	Rank
1	Forest fire	98	32.67	1
2	Construction material	75	25.00	2
3	Farming tools	52	17.34	3
4	Fuelwood collection	41	13.67	4
5	Grazing	12	04.00	6
6	Charcoal making	22	07.34	5
	Total	300	100	

Discussion

The present study area has had shared its own misfortune subjected by different anthropogenic activities during the past decades (Devi, 2021; Sadananda *et al.,* 2022). During the study, it was observed that several important tree species regenerated and replanted *in situ* with great success. The key information shared by the local inhabitants provided deep insights into the nature of exploitation which lead to complete destruction of the Lamdeng area under Langol reserve forest in the recent past (Devi, 2021). From the documented 37 important trees, bamboo, and shrub species highest point was assigned to *Castanopsis hystrix* with 273 points attributed by respondents (Table 2). From the utility points, it had 5 uses. Likewise, other species followed the pattern of having higher scores with higher utility numbers given within the study. It may be also noted that species like *Cedrelatoona* and *Terminaliacitrina* outscored among the species having only 3 utilities. The reason may be attributed to their value associated with the religion and ritual practices of the surrounding community. This may also draw a similar conclusion to the findings of several workers (Lohidas *et al*., 2014; Upreti *et al.,* 2017). Some species had very important values but cannot be determined within the predefined parameters as it will not be applicable to other species, e.g. *Mallotus philippensis* is used for dyeing for cloths and has great economic values (Figure 2C). It can be mentioned that indigenous people throughout the world have their own distinct linguistic, cultural values, and beliefs preferences (Furze *et al.,* 1997).

The paired comparison exercise for degradation of Lamdeng forest revealed that forest fire was the main reason (37.67%). Similar results had been observed in the global trends (Tyukavina *et al.,* 2022). It can be explained as there are recurring problems of wild forest fires set out by the miscreants in the whole state and not just in Lamdeng area. The nature of forest fire in Lamdeng area can be treated differently in that it was not done for shifting cultivation which is a major reason for setting fires in the forest of North eastern India. The fire set out is purely done for the purposes of hunting wildlife. Control forest fire for game hunting had been described well in Colorado, USA, Spain (Cabrera, 1991), and Siberia (Shishikin and Ivanova, 1998). But setting fire without any control measures tends to end in devastating consequences on the vegetation. This has remained as one of the most challenging aspects for the safeguard keepers of the forest at the moment. Next was followed by the extraction of plant materials for construction purposes which contributed about 25% to the loss of vegetation. The other remaining defined activities also contributed to the loss of flora and fauna biodiversity. It was observed that the least destruction was done by the grazing animals as only a handful of people were involved in this activity.

Conclusion

Through the present study, it can be concluded that

the true value of a forest can be realised as the inhabitants of the area have already suffered after completely losing it for a decade and half. The newly rejuvenated forest started giving spring water on its foothill which was unheard of for two long decades. The true essence of losing ecological services from a forest is realised by the inhabitants of the area. This recently found value ingrained in the people is an important lesson to be learned by the generations to come. The main reason for losing the forest was solely due to the ignorance of the people and taking actions that meet their very short-term requirements without paying any deliberate attention to the probable consequences. It can be well observed that there also requires stringent laws to empower those people in the charge of the safeguarding of forests to take quick actions and can intervene whenever required. There are also reports on spotting of long-lost wildlife in the region which is a very welcoming sight. The newly rejuvenated forest already started to give its priceless ecological services; food. A more careful approach is required now than ever before as the new forest is steadily approaching a stable community, any unwanted invasive species may disturbed its natural ecosystem. Indeed it is the hard work of surrounding Inhabitants of Lamdeng area and the strong will of State Forest Department, Manipur that yielded such a rare result.

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