Chapter

Non-Timber Forest Products: Diversity, Utilization, and Dependency in Fringe Areas of Jaldapara National Park in Indian Sub-Himalayan Region

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Abstract

Non-timber forest products (NTFPs) greatly contribute to livelihood, development, and poverty alleviation across the tropics. We also assumed that the fringe communities inhabiting Jaldapara National Park (JNP) of Indian eastern sub-Himalayan region largely rely on the NTFPs for their livelihood due to its remote and isolated location with no physical infrastructure and facilities. Multistage sampling technique was used for the study. The sample size was 205 households selected randomly from a sample frame of 10 villages. Descriptive statistics was employed to analyze and summarize the data. A total of 146 NTFP species was documented. The communities relied on their NTFP collection/harvest for food, medicine, firewood, fodder, and other socio-cultural items for household use and cash income. The documented species were further categorized into plant, fish, fungus, and insect. The relative frequency of citation (RFC), value ranged from 0.2 to 0.96 for all categories of NTFPs with average 0.78. Income from NTFPs contributed on an average 45% of the total annual household income of the households. NTFPs provided a natural insurance to households especially during the periods of scarcity. Focused interventions with technical and financial support are recommended to uplift the livelihood of the communities in JNP.

Keywords: forest fringe community, NTFP, livelihood, sustainable development, eastern Himalayas

1. Introduction

Any biological products and services collected mainly from forests and other associated tree-based land use systems are known as non-timber forest products

(NTFPs) [1–4]. Most of the rural and indigenous communities residing in and around forests rely for their livelihood on NTFPs socioeconomically and culturally [2, 3, 5–14]. Non-timber forest products (NTFPs) along with the tradition of plants-based knowledge is distributed among the vast number of indigenous and rural communities [15, 16]. NTFPs provide natural insurance against hunger and malnutrition during scarcity and even during famines [5]. NTFPs are thus vital for the social development of the indigenous/forest fringe and rural communities [17]. In spite of the "right of ownership, i.e., access to collect, use and dispose of minor forest produce by the 'Forest Rights Act, 2006'" to the indigenous communities dependent on forest or forest dwellers, they still remain underprivileged and impoverished [18]. Having potential to address poverty, sustainable development, and tropical forest conservation without competing with agricultural activity, NTFPs is now receiving more academic and policy attention [2, 3, 19, 20].

The dependency of the indigenous forest and rural people on NTFP continues today because of their poor economic conditions and non-empowerment toward socioeconomic development [21] through its use in food, medicine, fiber, fuelwood and sale [2–4]. Plant and animal resources and their value as NTFPs are rich among the ethno-cultural groups [22, 23], but potentialities of many of these resources and valuable plants are yet to be explored [2, 3]. Unfortunately, till now, there are no serious efforts either to document the NTFP resources or to analyze their utilization and socioeconomic aspects [5]. Additionally, due to deforestation, modernization, unsustainable development, and ignorance of younger generation toward NTFPs, the traditional knowledge associated with them and their utilization is gradually eroding through acculturation and the loss of plant biodiversity [24–26]. Awareness, research, and education are needed to protect this diminishing knowledge of NTFPs and conserve bioresources for the benefit of our future generations [27].

Dependence on NTFP collection and utilization is still a crucial livelihood strategy for forest dwellers in the Terai foothills of eastern Himalayas in West Bengal [11, 24, 28–31]. Unfortunately, now the traditional knowledge associated with NTFPs in these regions is found mostly confined to the older generation of these communities, which is consequently in the verge of extinction [24]. Hence, identifying and documenting the diversity of NTFP resources with their utilization is important to conserve and manage these resources sustainably while also being helpful for restoration and preservation of their associated traditional knowledge [25, 26, 32–34]. More importantly, promoting the NTFPs-based activities has now become a crucial policy action of any developmental strategy for uplifting and empowering the rural and indigenous communities [35]. Such documentation will provide baseline data and information for conservation and sustainable utilization of the NTFP resources. Additionally, these documentations will be a proper testimony from specialists, which will also popularize the NTFPs to be introduced into the present-day farming systems and also get acceptance for utilization by the urban population [25, 26, 35, 36]. Therefore, the present study was conducted in the forest fringe villages in the Terai region of West Bengal with the following objectives:

- Documentation/enlistment of NTFPs used by forest fringe communities.
- Traditional uses and utilization pattern of NTFPs by these communities.

2. Methods and materials

2.1 Study area

JNP is a part of Himalayan Biodiversity Hotspot [15]. It is situated on the foothills of the eastern Himalayas, India [37]. The park is mainly savannah, containing giant grasses along with mixed deciduous, wet monsoon, tropical moist deciduous, tropical semievergreen, and riverine forests [38]. The region is subtropical, receiving average annual rainfall of 250–300 cm from south–west monsoon of which 80% is received from June to August. The summer and winter temperatures are mild with 34°C as the highest in the month of May, while the lowest temperature is 7.5°C in the month of January. The study area as measured by GPS (Germin- 72) was between 25^0 58′ N and 27^0 45′ N latitudes and 89^0 08′ E and 89^0 55′ E longitudes with an elevation of 47 m above mean sea level.

The forest is inhabited by divergent Indo-Mongoloid communities of Mech, Ravas, Totos, Uraons, Tamang, Toppo, Lepcha, Rajbangsi, and Mundas, making it bioculturally diverse with varied socioeconomic conditions. These indigenous people are permanently settled in and around the national park. Each indigenous community has its own distinct culture and beliefs (www.alipuarduar.gov.in). The primary livelihood activity of these communities is subsistence farming and NTFP collection. Their standing crop is frequently decimated by wild elephants. Further, the habitations are remotely located and isolated with no physical infrastructure and facilities like limited accessibility by good roads, making the whole area underdeveloped. The inhabitants of the area thus depend on NTFPs to meet their income and daily needs. The forest resources are locally managed by Forest Protection Committees under the Joint Forest Management Scheme controlled by the State Forest Department [39].

2.2 Sampling procedure

Multistage sampling procedures were applied in this study. JNP and the villages were selected purposively, while the respondents were selected randomly. The selection of the study area was purposive because it is a national park important for its rhinoceros conservation and inhabited by the indigenous communities depending on it for NTFP resources. The villages were located in the designated forest area and are termed as forest villages. The Indian Forest Act permits the inhabitants of these villages access and resource use rights over the collection of NTFPs from the park as the country is a signatory of the United Nation Convention on Biological Diversity of 1992 [40]. Major ten villages located in and around the national park that has more than 50 households were also selected purposively and from the each village; one tenth of the total households (205) were randomly selected [3].

2.3 Data collection

The data were collected from the sampled households by the lead author assisted by a trained enumerator with the help APRE-tested structured questionnaire through personal interviews and focus group discussions (FGD) guided by a checklist of questions [41–43]. The questionnaire was pretested for elimination, addition, and

alteration with non-sample respondents of the study area. In pretesting, care was taken not to include respondents who were selected as sample for final interview. On the basis of experiences in pretesting, appropriate changes in the construction of item and their sequence were made. Prior to starting the interviews, a few days were devoted in each selected village to establish rapport with the respondents. The questionnaire was administered to the respondent in the local language, and the responses were recorded in English. On the basis of the objectives of study, the questionnaire was designed with two sections. The first section was on socioeconomic attributes of the respondents like literacy, occupation, and total monthly household income, while the second section was on the collection and utilization including processing of NTFPs, value of NTFPs consumed and sold by the households, and contribution of NTFPs to total monthly household income.

Occupation indicates the economic activity of a household and thus is a source of income. We hypothesized that as our study villages are remotely located and isolated with no or very little basic infrastructure facilities, there will be limited or no livelihood options except dependency on forest resources or subsistence farming as was also reported in earlier studies [44]. The limitations of our study area mentioned above also led us to hypothesize that the inhabitants will be mostly illiterate and thus will have no other livelihood options except for relying on subsistence farming or on forest resources. Studies have shown that education results in lesser dependency on forest or farming activity and more inclination toward alternative employment opportunities [45]. Our last hypothesis was that the study area would have very low or marginal total household monthly income because of illiteracy and limited livelihood options rendering the inhabitants with no other livelihood options other than to depend on subsistence farming and NTFP collection from the forest [46].

Generally, the head of the household was taken as the respondent. The society of the study area is patriarchal, so the husband is the head of the family. In case when the husband is absent, the wife, eldest son, or the daughter was interviewed on behalf of the head. A total of 10 FGDs were conducted, one in each selected village. There were about 15–20 participants in the discussions, which included the village chief, senior citizens of the village, some prominent NTFP collectors, members of Forest protection committee, and representatives of the State Forest Department. The information gathered from these discussions supplemented the household surveys, which were finally used for interpretations of the results.

2.4 Data analysis

Data collected were statistically analyzed using a descriptive technique (frequency, percent and bar chart). We classified our respondents as literates and illiterates. According to Indian standards, a person who has only basic "3Rs" knowledge, that is, can read and write his/her name and can perform simple arithmetic, is literate and otherwise not. Literacy of the respondents is expressed as per cent of the total respondents. Monthly total household income is calculated as the sum total of income a household was earning from different sources (if any). Generally, the total household income (THI) is the summation of agricultural (AI), nonagricultural (NAI), and forest income (FI) or THI = AI + NAI + FI [5]. The households were classified as low-, medium-, and high-income group [47] based on their total monthly household income and then expressed as per cent of the total respondents. USD to Indian rupee exchange rate during the study period was USD1 = INR60.

2.5 Relative frequency of citation (RFC)

Relative frequency of citation (RFC) implies in this study to finding out the most collected NTFPs by the forest fringe people [48]. The RFC value is "0" when no one refers to the plant as being useful and "1" when all the participants refer to the plant as being useful. RFC is calculated as

$$\mathrm{RFC} = \frac{FC}{N}$$

Where "FC" denotes the number of participants who mention the collection and use of the species, and N denotes the total number of participants.

3. Results

3.1 Socioeconomic attributes

The main occupation of the indigenous communities of the sampled villages in and around JNP is subsistence farming and collecting/harvesting NTFPs supplemented with some temporary activities like daily paid manual labor or petty business. According to our classification made on the basis of total monthly household income, there were only two income groups. Almost all the respondents, that is, 95.33%, were in the low-income group living on USD 2–10 daily, and the rest were in the medium-income group living on 10–20 USD daily. The contribution of NTFP toward the total monthly household income varied widely in the range of 1–70% with an average of 45%. Around 60% of the respondents in the study area were literate, had spent at least two years in formal education, and had a tendency to search for an alternate occupation other than farming or collecting NTFP.

3.2 NTFPs diversity/richness

Documented NTFPs were listed as plant, fungus, and animal origin. A total of 146 NTFP species representing 126 genera and 76 families were documented, which were used by the indigenous communities of JNP (**Figure 1**; **Table 1**). Of these documented species, 95 were collected from the wild, 24 were cultivated, and 27 were either collected from the wild or cultivated (**Table 1**). Out of these documented NTFP species, 125 were plants, 14 animals, and seven fungi. Among the plants, trees dominated the list with 70 species, followed by herbs with 32 species, shrubs with 16 species, and climbers the least with seven species. Fishes with 13 species dominated the list of animals with one species of honeybee. Family *Fabaceae* among plants dominated the list with six species and six genera followed by *Euphorbiaceae* and *Malvaceae* each with five genera and five species. In animals, family *Cyprinidae* dominated with five genera and five species. In fungus, *Pleurotaceae* and *Lyophyllaceae* dominated with two species each.

Sn- scientific name; Vn- vernacular name; F- family; Lf- life form (C- climber; Fi-fish; Fu- fungus; H- herb; I- insect; S- shrub; T- tree); Is- IUCN status (DD-Data deficient; NA-Not yet assessed; LC-Least concern); Toc- time of collection (Whole year- Wy); Pu- part used (B- bark; Br- branch; Ds- dry seed; Fl-flower; Fr-fruit;

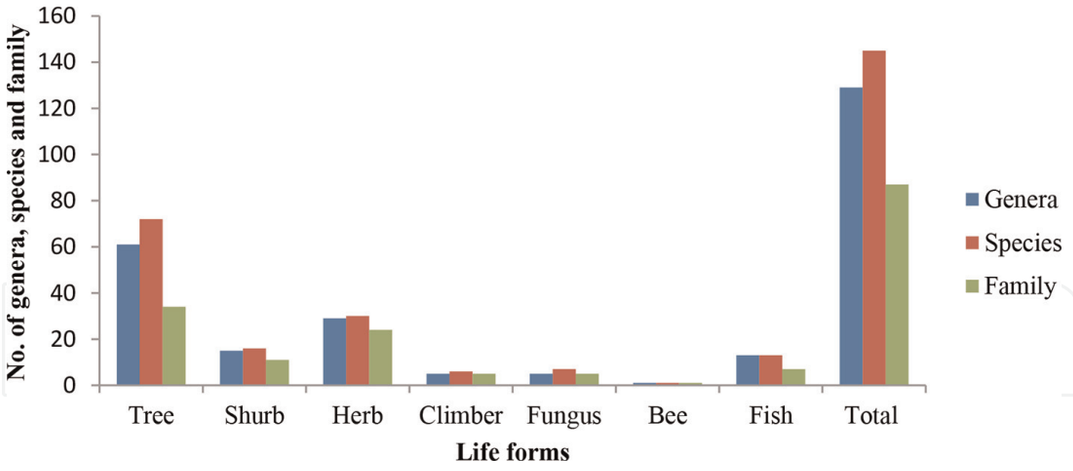

Figure 1.
NTFP diversity/richness used by fringe communities of JNP.

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
Animal origin- fish					
1	*Channastriatus* (Bloch) *Sole*; Channidae	NA	Wy	Cooked and consumed	0.73
2	*Catlacatla* (F. Hamilton) *Katlay*; Cyprinidae	NA	Wy	Cooked and consumed	0.94
3	*Cirrhinusmrigala* (Hamilton) *Mrigal*; Cyprinidae	LC	Wy	Cooked and consumed	0.94
4	*Clariasbatrachus* (L.) *Magur*; Clariidae	LC	Wy	Cooked and consumed	0.76
5	*Garragotyla* (Gray.) *Buduna*; Cyprinidae	LC	Wy	Cooked and consumed	0.86
6	*Gudusiachapra* (F. Hamilton) *Chipla*; Clupeidae	LC	Wy	Cooked and consumed	0.87
7	*Heterepneutesfossiles* (Bloch) *Sangri*; Heteropneustidae	LC	Wy	Cooked and consumed	0.94
8	*Penaeusmonodon* *Chingri*; Clupeidae	NA	Wy	Cooked and consumed	0.94
9	*Labeo rohita* F. Hamilton *Rahu*; Cyprinidae	LC	Wy	Cooked and consumed	0.94
10	*Mystusvittatus* (Bloch) *Tangra*; Bagridae	LC	Wy	Cooked and consumed	0.92
11	*Psilorhynchussucatio* (Ham.) *Chepti*; Psilorhynchidae	LC	Wy	Cooked and consumed	0.91
12	*Pethiaticto* (Hamilton) *Punti*; Cyprinidae	LC	Wy	Cooked and consumed	0.88

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
13	*Rita rita* (Ham.) *Rita*; Bagridae	LC	Wy	Cooked and consumed	0.93
	Animal origin- insect				
14	*Trigona Sp.* *Putka*; Apidae	—	Sep-Jan/ Ho	Cooked and consumed as medicine.	0.92
	Plant origin- climber				
15	*Coccinia grandis* (L.) Voigt *Telakucha*; Cucurbitaceae	NA	May-Aug/ L, Fr	Cooked as vegetable	0.82
16	*Cissusrepanda* Vahl. *Panilahara*; Vitaceae	NA	Wy/Tw	Whole plant is used to make rope and as fodder.	0.88
17	*Dioscorea bulbifera* L. *Githa*; Dioscoreaceae	NA	Wy/B, L	Dried powder of tuber is applied to cure ulcer and cooked as vegetable.	0.73
18	*Dioscorea pentaphylla* L. *Bhegur*; Dioscoreaceae	NA	Jun-Jan/ Rh	Extract is applied on infected portion to cure boil and cooked as vegetable.	0.73
19	*Momordicadioica* Roxb. Ex willd. *Ban karela*; Cucurbitaceae	NA	May-Jul/ Fr, R	Fruits cooked as vegetable and also consumed to cure stomach disorder. Leaf extract administered orally (250 ml) twice a day for two days during fever.	0.72
20	*Piper thomsonii* Linn. *Pipla*; Piperaceae	NA	Nov-Mar/ Fr	Fruits are boiled in water with salt. This mixture is consumed to cure cough & cold.	0.96
21	*Plumbagozeylanica* L. *Chita*; Plumbaginaceae	NA	Wy/L, R, B	Leaf extracts are mixed with rice for making rice beer. Rhizomes are crushed and boiled and consumed empty stomach during early morning to treat fever.	0.71
Plant origin- herb					
22	*Achyranthusarpera* L. *Apang*; Amaranthaceae	NA	Jan-Dec/R, Sd	Root powder mixed with black salt or root and seed crushed together and consumed with water to get relief from indigestion and dysentery.	0.44
23	*Ageratum conyzoides* L. *Bhusuri*; Asteraceae	NA	Wy/L	Fresh leaf extracts are applied on cut and wound and bandaged to stop bleeding and for healing.	0.82
24	*Artemisia vulgaris* L. *Titepate*; Asteraceae	NA	Wy/L, Fl, R	Leaves, flowers, and roots are crushed together with fresh water and consumed to control dysentery.	0.20
25	*Asparagus racemosus* Willd. *Satamuli*; Asparagaceae	NA	Jan-Dec/Fl, R	Dried root powder is consumed to get relief from diabetes and dysentery. Leaves are eaten to get relief from fever.	0.60
26	*Bambusa bamboos* (L.) Voss *Bans*; Poaceae	NA	Wy/Wp	Used for fencing and making small bridge and ladder.	0.83
27	*Bambusa vulgaris* Schrad ex J.C Wendl. *Baans*; Poaceae	NA	Wy/Ys, L, St	Young and tender shoots are cooked as vegetable and processed as pickle. Leaves are used as fodder and clumps as fencing.	0.09
28	*Basella alba* L. *Pui sag*; Basellaceae	NA	May-Jul/L	Decoction of root relieves vomiting. Tender twigs are used as vegetables.	0.22

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
29	*Bryophyllumpinnatum* (Lam.) Oken *Partharkurchi*; Crassulaceae	NA	Wy/L, Wp	Leaf paste is applied on burnt skin and on swelling for relief. Whole plant is used for decoration.	0.10
30	*Calamusrotang* L. *Bet*; Palmae	NA	Oct-Jan/ L, Fr	Leaves are used for home decoration, and fruits are edible.	0.49
31	*Cardamine hirsute* L. *Simrayo sag*; Brassicaceae	NA	Oct-Feb/L	Leaves with small twigs are cooked and used as vegetable	0.16
32	*Cassia tora* L. *Chakunda*; Caesalpiniaceae	NA	Jul-Dec/ L, Sd	Leaf extract is applied against rashes and allergies. Seeds are consumed to get relief against cough and cold.	0.61
33	*Centellaasiatica* Linn. *Gortapre*; Apiaceae	LC	Jan-Dec/L	Leaves are consumed as vegetables, which also ease body pain and fever. Leaf extract in water solution is also administered orally during early morning in empty stomach to heal wounds.	0.48
34	*Chenopodium album* L. *Bethusaag*; Chenopodiaceae	NA	Sep-Jan/ L	Tender leaves are cooked as vegetable.	0.35
35	*Cissusquadrangularis* L. *Harjora*; Vitaceae	NA	Jan-Dec/Wp	The plant is grinded and fried in mustard oil along with onion and then applied and messaged to get relief from fracture.	0.40
36	*Colocasia esculenta* (L.) Schott *Ban-Kuchu*; Araceae	LC	May-Aug/ Rh	Cooked as vegetable.	0.19
37	*Cynodondactylon* (L.) *Dubbaghass*; Poaceae	NA	Jan-Dec/Sh	Shoot extract is applied externally to cure skin disease and taken orally to cure vomiting and leprosy. Entire plant is fed to cattle for increasing lactation.	0.19
38	*Cyprus rotundus* L. *Mutha*; Poaceae	LC	Jun-Nov/Rh	Powdered and administered orally against dysentery, fever, and ulcer.	0.46
39	*Daturametel* L. *Dhutra*; Solanaceae	NA	Wy/L, Fl, Sd	Flowers and fruits are offered during religious ceremony. Mixture of leaf and seed is used to treat asthma, cold, and cough.	0.12
40	*Dendrocalamus strictus* (Roxb.) Nees *Male bans*; Poaceae	NA	Wy/Wp	Leaves are used as fodder for goat. Clumps are used as pole.	0.84
41	*Desmodiumgangeticum* (L.) DC *Salpani*; Fabaceae	NA	Sep-Dec/ Wp	Plant extract is consumed to get relief from rheumatism. Root is fed to post-labor woman.	0.53
42	*Dichroafebrifuga* Lour *Vasak* Hydrangeaceae	NA	Wy/L, R	Root extract consumed to control cough & cold. Fresh leaf and root exudates are consumed to control vomiting and blood pressure.	0.35
43	*Diplazium- esculentum* (Retz.) Sw. *Dhenkisaag*; Athyriaceae	LC	Apr-Oct/ Ys, L	Tender leaves are used as vegetable and whole plant as fodder.	0.96
44	*Drymariavillosa* Cham &Schlecht *Abijalo*; Caryophyllaceae	NA	Dec-Feb/L	Whole plant is consumed to cure jaundice and cold.	0.36

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
45	*Euphorbia thymifolia* Linn. *Dhudiya*; Euphorbiaceae	NA	Wy/Br	Leaf and tender stem decoction is consumed to treat cystitis and kidney problems.	0.38
46	*Ficuscunia* Buch. -Ham. Ex Roxb. *Khaniyun*; Moraceae	NA	May-Nov/ Wp	Used as green fodder.	0.70
47	*Fumaria indica* Pugsley *Ban dhania*; Fumariaceae	NA	Mar-Jul/ L	Leaves are used as spice.	0.41
48	*Hedyotisscandens* Roxb. *Koaru*;Rubiaceae	NA	May-Aug/L	Tender leaves with twigs are cooked as vegetable.	0.18
49	*Lycopodiumclavatum* L. *Nagbeal*; Lycopodiaceae	NA	Wy/R, L	Young root and leaves are consumed to treat sexual disorder and also used for decoration.	0.82
50	*Phyllanthus fraternus* G.L Webster *Bhuiamala*; Phyllanthaceae	NA	Wy/Wp	Plant extract is externally applied to cure skin infections. Plant exudates are externally applied on sores and ulcers or mixed with oil to cure conjunctivitis	0.17
51	*Saussurealappa* C. B. Clarke *Kur*; Compositae	NA	Wy/R, Fl	Dried roots are powdered with black pepper and administered orally to cure asthma, cold and cough. Flowers are used during religious ceremony.	0.40
52	*Solanum nigrum* L. *Kakmachi*; Solanaceae	NA	Wy/Fl, Fr, Sh	Animal feed, leaves with flower are cooked as vegetable and ripe fruits as dessert.	0.51
53	*Vernoniacinerea* (L) Less. *Chotokuksima*; Asteraceae	NA	Wy/Wp	Fever, hiccups, nerve disorders, kidney disease, and stomach discomfort.	0.26
			Plant origin- shrub		
54	*Abroma augusta* (L.) L. f. *UlatKambal*; Sterculiaceae	NA	Jan-Dec/R, L	Root powder is used to control urine infection. Leaf extract is useful for diabetes.	0.04
55	*Ageratina Adenophora* (Spreng.) R. King & H. Rob. *Banmara*; Asteraceae	NA	Wy/L	Leaves soaked in water for bathing to cure skin infection.	0.14
56	*Capsicum annum* L. *Jeray chili*; Solanaceae	NA	Apr-Jul/ Fr	Used as spice.	0.02
57	*Cinchona officinalis* L. *Cinchona*; Rubiaceae	NA	Wy/B, R	Root and bark decoction is orally administered against malaria and dysentery. Bark is also used as spice.	0.86
58	*Dendrocnide sinuate* (Blume) Chew *Moringe*; Urticaceae	NA	Apr-Oct/Ys	Young shoot cooked as vegetable.	0.31
59	*Lantana camara* L. *Ban-tulshi*; Verbenaceae	NA	Wy/Sh	Leaf extract is applied on ring worm and administered orally to get relief from cold and cough. Used as fencing and fuel wood.	0.27
60	*Melastomamalabathricum* L. *Dantrangi*; Melastomataceae	NA	Aug-Feb/Fl, L	Consumed to cure cholera, diarrhea, fever and dysentery.	0.10
61	*Meyna spinosa* Roxb. Ex Link *Kalomaney*; Rubiaceae	NA	May-Jun/L, Tu, Fr	Fruit are used as vegetable. Tuber and leaves are consumed to cure boil, dysentery and indigestion.	0.21

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
62	*Mussaendatreutleri* Stapf. *Tamba*; Rubiaceae	NA	Wy/Ys	Cooked as vegetable.	0.85
63	*Rauvolfiaserpentina* (L.) Kurz. *Sarpagandha*; Apocynaceae	NA	Oct-May/R, L	Half teaspoon root and leaf powder is consumed thrice a day to get relief from hypertension and control blood pressure. Root extract is taken orally to cure jaundice.	0.16
64	*Sida cordifolia* Wight &Arnott *Berela*; Malvaceae	NA	Wy/Wp	Consumed as energy vitalizer.	0.10
65	*Sidafallax* L. *Sida*; Malvaceae	NA	Wy/Br	Used as fuel wood.	0.12
66	*Tetracerasarmentosa* (L.) Vahl *Rikang*; Dilleniaceae	NA	Wy/R	Consumed to control diarrhea. Paste is applied to get relief from burn. Extract is applied to cure mouth ulcers.	0.35
67	*Urticadioica* L. *Sisnoo*; Urticaceae	LC	Wy/L, Fl, Ys	Cooked as vegetable.	0.66
68	*Vitexheterophylla* Roxb. *Panchpattay*; Lamiaceae	NA	Wy/L	Used as fodder.	0.51
69	*Vitexnegundo* L. *Nisinda*; Verbenaceae	NA	Wy/Wp	Consumed during morning to cure rheumatism and fever.	0.36
Plant origin- tree					
70	*Acacia catechu* (L. f) Wild. *Khayer*; Mimosaceae	NA	Wy/Br, Hw, B	Branches and twigs are used for fuel wood. Heartwood is processed as *Khatta* and consumed with betel leaf to cure indigestion. Bark powder is consumed to cure rheumatism.	0.30
71	*Aeglemarmelos* (L.) Corr. *Bel*; Rutaceae	NA	Dec-May/ Fr, L	Pulp is used to make health drink as body coolant during summer and to cure dysentery. Leaves are used during religious ceremony.	0.29
72	*Aglaiahiernii* Visal. Ramach *Lali*; Meliaceae	NA	Mar-May/ Br, Ds, L	Branches are used as fuel wood. Dry seeds are decorative. Fresh leaves used as fodder during summer.	0.30
73	*Albizia lebbeck* (L.) Benth. *Siris*; Mimosaceae	NA	Jan-Dec/Br, Sd, B, L	Seed powder is administered orally to get relief from pile and body pain. Bark is boiled and extract is consumed orally to control cold. Leaves are used a fodder and twigs as fuel wood.	0.41
74	*Alstoniascholaris* (L.) R. Br. *Chhatian*; Apocynaceae	NA	Jan-Dec/B	Bark paste is applied to cure skin disease. One tea spoon of bark extract is administered orally during early morning once a day to in empty stomach to cure jaundice and get rid of stomach worms.	0.32
75	*Amoorarohituk* (Roxb.) Wight &Arn. *Lasuney*; Meliaceae	NA	Wy/Br	Twigs are used as fuel wood.	0.55
76	*Anthocephalus cadamba* (Roxb.) Wight &Arn. *Kadam*; Rubiaceae	NA	Wy/Br	Twigs are used as fuel wood and to make agriculture implements. Fresh leaves are used as fodder.	0.16

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
77	*Artocarpus chama* Buch-Ham. Ex. Wall *Latore*; Moraceae	NA	Jan-Dec/L	Fresh leaves are used as goat fodder during lean period.	0.21
78	*Artocarpus heterophyllus* Lam. *Kanthal*; Moraceae	NA	Jan-Dec/Fr, L Lt	Fruit consumed as dessert and processed to pickle. Leaf is goat fodder, and latex is used as gum.	0.89
79	*Artocarpus lakoocha* Buch-Ham *Bore*; Moraceae	NA	Jul-Dec/ Fr, L, B	Fruits consumed as dessert. Leaf and bark are used against skin disease.	0.29
80	*Azadirachta indica* A. Juss. *Neem*; Meliaceae	LC	Apr-Dec/L, Sd, B	Fried leaves are consumed to cure mouth ulcers mouth. Leaves are boiled in water for bathing to cure small pox. Leaf extract is consumed orally to cure pneumonia and also used as appetizer. Twigs are used as tooth brush.	0.40
81	*Baccaureasapida* (Roxb.) Mull. Arg. *Latka*; Euphorbiaceae	NA	Jul- Sep/ Fr	Fruit are eaten as dessert.	0.91
82	*Bauhinia malabarica* Roxb. *Tanki*; Fabaceae	NA	Wy/L, F, Sh	Leaves are boiled and cooled solution is consumed daily to get relief from stomach pain. Fresh leaves are used as fodder. Flowers are cooked as vegetable. Branches are used as fuel wood.	0.72
83	*Bauhinia purpurea* L. *Devakanchan*; Caesalpiniaceae	NA	Wy/L, Fl, B, R	Leaf is boiled and solution is consumed to control jaundice. Bark paste is applied to heal wounds. Flower is used as vegetable and for decoration. Root paste is consumed to control ulcer.	0.76
84	*Bauhinia variegata* (L.) Benth. *Raktokanchan*; Caesalpiniaceae	LC	Jan-Dec/Fl, B, R	Decoction of bark and root is applied to cure mouth ulcer and skin disease. Flowers are used as vegetable.	0.69
85	*Beischimedia roxburghii* Nees. *Tarsing*; Lauraceae	NA	Wy/L	Leaves are used as fodder during lean season.	0.80
86	*Bombax ceiba* L. *Simul*; Bombacaceae	NA	Wy/Br, Fr, R, Sd,	Roots extract is consumed to treat diarrhea. Twigs are used as fuel wood. Seed and fruit floss is used to make pillow and blanket.	0.90
87	*Bridelia- retusa* (L.) A. Juss. *Gayo*; Euphorbiaceae	NA	May-Nov/L	Fresh leaves and small twigs are used as fodder.	0.76
88	*Buteamonosperma* (Lam.) O. Kuntze *Palash*; Papilionaceae	NA	Wy/B, Sd, L, Fl	Flower and leaf infusion is orally administered against diarrhea. Seed powder is consumed to kill stomach worms.	0.21
89	*Careya arborea* Roxb. *Kumbhi*; Lecythidaceae	NA	May-Dec/ Fr, L, B, Fl	Bark extract is consumed in empty stomach to cure dysentery. Flowers are used for decoration and branches are used as fuel wood.	0.61
90	*Cassia fistula* L. *Bandarlathi*; Caesalpiniaceae	NA	Wy/Fr, Fl, R, B	Dried Fruit and fresh flower are used to decorate the household. Root and bark are used to control asthma, fever, and cold &	0.20

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
				cough. Root is also used to control skin disease.	
91	*Castanopsis indica* (Roxb. exLindl.) A. DC *Kattus*; Fagaceae	NA	Wy/Sd, L, Br	Fruits & seed are cooked as vegetables and also to control blood pressure. Leaf paste in solution form is consumed to cure gastric problems. Twigs are used as fuel wood.	0.83
92	*Chukrasiatabularis* Juss. *Chikrashi*; Meliaceae	LC	Jun-Jan/ Br	Branches are used as fuel wood, agriculture implements, and for construction purposes.	0.18
93	*Cinnamomum camphora* (L.) J. Presl *Dalchini*; Lauraceae	NA	Wy/B, R, Tw	Dried bark is used for aroma in tea or hot water. Dried barks or leaves are consumed for stomach disorder and diabetes and to check reduced body weight. Root is burnt with fuel wood to repel mosquito.	0.21
94	*Cinnamomum tamala* (Ham.) Nees & Eberm. *Tejpata*; Lauraceae	NA	Jan-Dec/L, B	Leaf and bark is consumed with food to control hypertension and diarrhea.	0.21
95	*Dalbergia sissoo* Roxb. Ex DC *Sissoo*; Fabaceae	NA	Wy/L, Br	Leaves are used as fodder and branches as fuel wood and handles of agricultural implements.	0.40
96	*Delonixregia* (Hook.) Raf *Gulmohar*; Caesalpiniaceae	NA	Dec-Feb/P	Dried pods are used to decorate home.	0.44
97	*Dillenia indica* L. *Chalta*; Dilleniaceae	NA	Jan-Feb/ Fr, L	Leaves and fruits are elephant feed. Raw fruits are processed to pickle.	0.41
98	*Dilleniapentagyna* Roxb. *Tantari*; Dilleniaceae	NA	Sep-Nov/L	Leaves are used as fodder, decoration, and making plates.	0.50
99	*Elaeocarpussikkimensis* Roxb. *Bandarey*; Elaeocarpaceae	NA	Wy/Br	Braches are used as fuel wood.	0.53
100	*Elaeocarpus sphaericus* (Gaertn.) K. Schum. *Rudraksh*; Elaeocarpaceae	NA	May-Jul/Fr, Sd	Fruit and seed are consumed to control blood pressure and diabetes.	0.19
101	*Emblica officinalis* Gaerth *Amlakhi*; Euphorbiaceae	NA	Aug-Feb/Fr	Ripe fruits are consumed as dessert and with sugar to get relief from cold and stomach pain. Fruits are also processed to make pickle and candy.	0.84
102	*Erythrinastricta* Roxb. *Faledo*; Fabaceae	NA	Wy/L, B	Bark paste is consumed to cure liver problems, fever, and rheumatism.	0.55
103	*Ficuselastica* Roxb. *Laberay*; Moraceae	NA	Jun-Oct/L, Lt	Fresh leaves are used as goat fodder. Fruit latex is used in making gum.	0.23
104	*Ficusracemosa* L.f *Dumri*; Moraceae	NA	Fr, L	Leaves are used to cure mouth disease of domestic animals and as fodder. Ripe fruits are used as dessert.	0.19
105	*Ficus religiosa* L. *Peepal*; Moraceae	NA	May-Nov/ L, Wp	Sacred and religious plant.	0.22
106	*Garungapinnata* Roxb. *Dabdebay*; Burseraceae	NA	Sep-Dec/L, Fr	Used as fodder	0.28

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
107	*Gmelina arborea* Roxb. *Ghamari*; Verbenaceae	NA	May-Oct/L, R, Fr	Used as fodder during summer.	0.24
108	*Lagerstroemia parviflora* L. *Jarul*; Lythraceae	LC	Wy/Br, Sh, F, Fr	Small branches are used as fuel wood and to make handles of agriculture equipment. Flowers are used for decoration.	0.60
109	*Litsea monopetala* (Roxb.) Pers. *Kutmero*; Lauraceae	NA	Wy/B, R, Tw	Leaves cure arthritis. Bark and root powder is applied externally against bruises and pains. Tender twigs with leaves are used as fodder.	0.55
110	*Mallotus philipensis* (Lam.) Muell. Arg *Sindure*; Euphorbiaceae; T	NA	Jun-Sep/L	Used as fodder.	0.18
111	*Mangifera indica* L. *Aam*; Anacardiaceae	DD	Wy/Fr, Br, L	Ripe fruits are consumed as dessert, and raw fruits are processed to pickle and drinks. Leaf is sacred. Branches are used for agri. Implements and as fuel wood.	0.58
112	*Magnolia pterocarpa* Roxb. *Patpatay*; Magnoliaceae	DD	Wy/L, Br	Fodder and fuel wood.	0.46
113	*Michelia champaca* L. *Champ*; Magnoliaceae	LC	May-Dec/L, Sd, Fl	Leaf and seed are consumed to control fiver and eye disease; fuel wood; flowers are used for decoration.	0.51
114	*Murrayakoenigii* (L.) Sprengel *Karipata*; Rutaceae	NA	Wy/L	Leaf extract is consumed to control black fever and diarrhea. Leaves are used as spice and aroma or consumed in empty stomach to cure gastroenteritis.	0.14
115	*Oroxylum indicum* (L.) Benth. *Totola*; Bignoniaceae	NA	Nov-Feb/Fl, Sd, Fr, B	Bark is boiled with sugar, and the solution is consumed thrice a day to control jaundice. Flowers are cooked as vegetable to maintain blood pressure and also used as house decoration.	0.74
116	*Phanera variegata* (L.) Benth *Koinar*; Fabaceae	NA	Wy/Fr, Br	Bark and fruits are consumed to treat diarrhea and indigestion.	0.30
117	*Pongamiapinnata* L. *Karanj*; Fabaceae	LC	May-Jun/ Br, F	As tooth brush to cure dental pain and small ones as fuel wood.	0.25
118	*Premnabengalensis* C.B. Clarke *Gidary*; Lamiaceae	NA	Wy/L	Used as fodder.	0.33
119	*Pterospermumacerifolium* (L.) Wild *Parari*; Sterculiaceae	NA	Oct-Nov/L, Br	Used as fodder and fuel wood.	0.64
120	*Pterygotaalata* (Roxb.) R. Br *Narkeli*; Sterculiaceae	NA	Jan-Mar/Fr, L	Fruits with leaves are used for decoration.	0.72
121	*Sapindus rarak* DC. *Ritha*; Sapindaceae	NA	Oct-Dec/Fr	Used as soap and shampoo.	0.60
122	*Schimawallichii* (DC.) Korth. *Chilaune*; Theaceae	LC	Wy/Br, B	Branches as firewood and bark for dyeing and treating urine infection.	0.53

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
123	*Schleicheraoleosa* (Lour.) Oken *Kusum*; Sapindaceae	NA	Apr-May/ Br, Fr	Ripe fruits are consumed as desserts, and branches are used as fuel wood.	0.77
124	*Shorea robusta* Gaertn. f. *Sal*; Diterocarpaceae	LC	Apr-Oct/Br, L, Rs, S	Bark powder is applied on burns; leaves are used in plate-making; flower, bark, and leaves are used during festivities, and branches are used as fuel wood.	0.19
125	*Spondias mangifera* Willd. *Amara*; Anacardiaceae	NA	Apr-Jun/Fr	Fruits are used as vegetable and processed to make chutneys and pickles.	0.57
126	*Sterculiavillosa* Smith *Odal*; Sterculiaceae	NA	Feb-Mar/Fr, Fl	Used for decoration.	0.81
127	*Syzygium cumini* (L.) Skeels *Jam*; Myrtaceae	NA	Jul-Dec/ Fr, Sd, L, B	Branches are used as fuel wood, fruits as dessert, and leaves as goat fodder. Seed powder mixed with table salt is consumed with water to control indigestion and dysentery.	0.63
128	*Tectona grandis* L.f. *Shegun*; Lamiaceae	NA	Wy/Br, L	Construction, furniture, agriculture equipment. Branch and leaves are used as fuel wood.	0.55
129	*Tremaorientalis* (L.) Biume *Kuail*; Ulmaceae	LC	Wy/L	Used as fodder.	0.15
130	*Terminaliachebula* Retz. *Harra*; Combretaceae	NA	Jan-Mar/Br, L, Fr, Sd	Fruits, seed extract, and flowers are consumed with water against cold and cough. Flowers vegetable, branches, fuel wood and leaves fodder.	0.86
131	*Terminaliaalata* Roth. *Panisaj*; Combretaceae	NA	May-Jul/Fr	Fruit are used for house decoration during marriage.	0.16
132	*Terminaliaarjuna* (Roxb.) Wight &Arn *Arjun*; Combretaceae	NA	Wy/B, Br, L	Bark extract in water solution is consumed to cure heart problem and powder to control diabetes. Leaves and branches are used as fuel wood.	0.14
133	*Terminalia belerica* Roxb. *Barra*; Combretaceae	NA	Wy/Br, L, Fr, Sd	Fruits and seed are used consumed to cure cough and stomach ailments. Leaves are used as fodder and branches as fuel wood.	0.88
134	*Terminaliapaniculata* Roth *Kainjal*; Combretaceae	NA	Wy/L, B	Bark and leaf decoction controls diabetes. Leaves are fodder.	0.19
135	*Tetramelesnudiflora* R.Br *Maina*; Tetramelaceae	LC	Wy/Br	Used as fuel wood and handles for agriculture implements.	0.12
136	*Tinospora cordifolia* (Willd) *Gulancha*; Menispermaceae	NA	Wy/B, Sh, L	Roots in water solution after overnight soaking are consumed empty stomach in early morning to cure diabetes and stomach pain.	0.89
137	*Toonaciliata* Roem. *Toon*; Meliaceae	LC	Wy/L, Fr	Hut construction, furniture, fuel wood, & agriculture equipment.	0.33
138	*Trewianudiflora* L. *Pitali*; Euphorbiaceae	NA	Wy/Br, L	Shoot and leaf decoction controls excessive bile and leaf paste applied on wounds. Leaves are fodder and branches are collected for fuel wood.	0.24

Sl. No.	Sn/Vn/F/Lf	Is	Toc/Pu	Mou	RFC
139	*Ziziphus- mauritiana Lam. Kul*; Rhamnaceae	NA	Jan-Mar/Fr, L,	Leaf is goat fodder. Fruit and seed with salt control vomiting.	0.96
			Fungus		
140	*Pleurotusostreatus* (Jacq.) P. Kumm. *Chamray Chew*; Pleurotaceae	NA	Jun-Sep/Mu	Consumed as vegetable and processed to pickle.	0.94
141	*Pleurotus* sp. *Kaney*; Pleurotaceae	—	Jun-Sep/Mu	Consumed as vegetable	0.86
142	*Armillariamellea* (Vahl) P. Kumm. *Cheplay chew*; Phylsalacriaceae	NA	Jul-Nov/Mu	Boiled mushroom is consumed directly.	0.74
143	*Cantharelluscibarius* Fr. *Girolle*; Cantharellaceae	NA	Jul-Oct/ Mu	Consumed as vegetable and processed to pickle and snacks.	0.78
144	*Lentinussquarrosulus* Mont. *Kath chattu*; Polyporaceae	NA	Jun-Nov/ Mu	Consumed as vegetable.	0.73
145	*Termitomycesclypeatus* R. Heim *Kalunge Chew*; Lyophyllaceae	NA	Jun-Sep/ Mu	Consumed as vegetable.	0.64
146	*Termitomycesmammiformis* R. Heim *Jauri Chew*; Lyophyllaceae	NA	Jun-Sep/ Mu	Consumed as vegetable and processed to pickle.	0.80

Table 1.
Utilization pattern of NTFP species in JNP.

Ho- honey; Hw-Hardwood; L-leaf; Lt-latex; Mu- mushroom; P- pod; R- root; Rh- rhizome; Rs- resin; Sd- seed; Sh-shoot; St-stem; Tu-Tuber; Tw-twigs; Wp- whole plant; Ys- young shoot); Mou- mode of utilization; RFC- Relative Frequency citation.

3.3 Relative frequency citation

The RFC value ranged from 0.2 to 0.96 for all categories of NTFPs with an average of 0.78. In overall categories, the NTFP species collected most were *Piper thomsonii*, *Diplazium esculatum*, and *Ziziphus mauritiana*. All most all of the respondents (96%) cited these species. This is because these plant species have higher sale value in the local market. Among the 13 fish species, the RFC value ranged from 0.73 to 0.94 and the most collected fish species were *Heterepneutesfossiles, Penaeus monodon,* and *Labeorohita*and *Catla- catla* (0.94) and the least collected species was *Channa strictus* (0.73). Among fungus, the value ranged from 0.64 to 0.94 and the most collected species was *Pleurotusostreatus* and and the least was *Termitomycesclypeatus*, while the RFC value for single species of Bee *Trigona Sp.* was 0.92 (**Figure 2**).

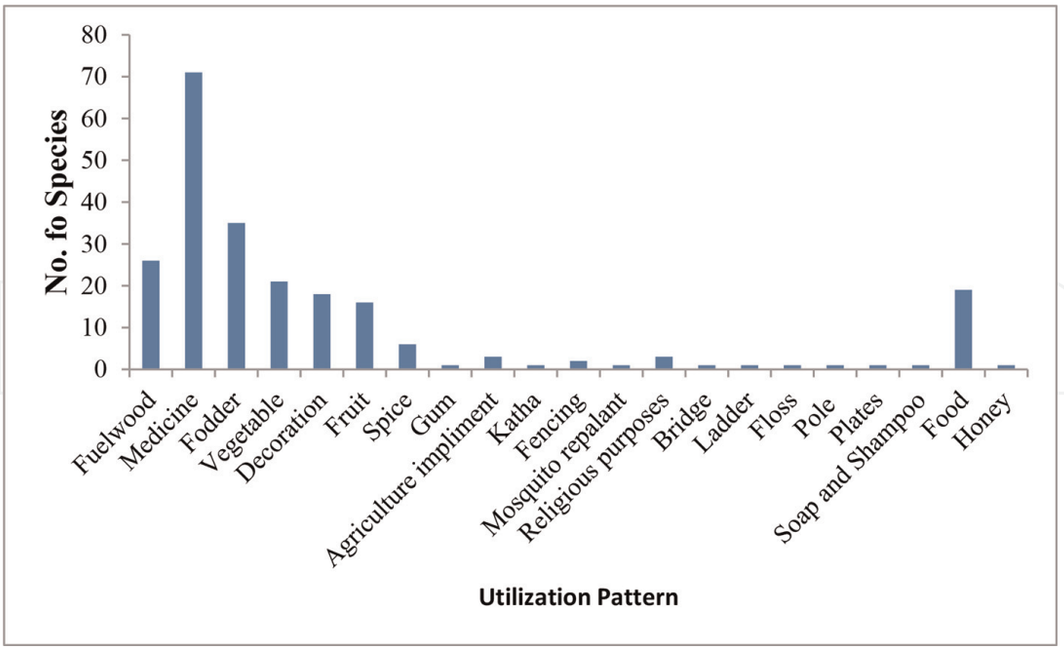

Figure 2.
Mode of NTFP use.

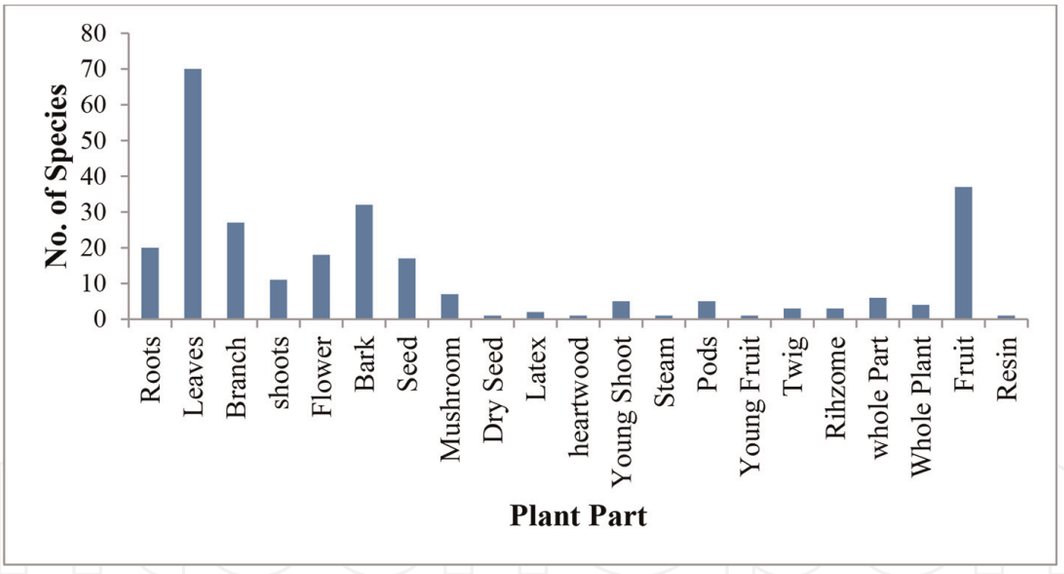

Figure 3.
Plant parts used.

3.4 Parts used, harvesting pattern, and time

Plant parts of NTFPs used by the indigenous communities of JNP and their mode of harvesting and utilization pattern are presented in **Table 1** and **Figure 3**. It was recorded that leaves/foliage were the most used plant part harvested/collected from 70 species, followed by fruits of 36 species, branches of 30 species, barks of 23 species, roots and rhizomes of 21 species, flowers of 17 species, seeds of 16 species, and shoots, twigs, and tender stem of 10 species. Latex and resin were extracted from three plant species. More than 60% of the documented NTFP species were collected or harvested throughout the year, and prominent among these is fuel wood. About 25% species

were collected or harvested during the rainy season, which include fodder, wild vegetable, medicinal plants, mushroom, honey, and fish. Fourteen species were collected or harvested during winter season, and the rest of the species were collected or harvested during the summer season. Generally, leaves were harvested during the profuse growth period of plant, that is, rainy season, which included fodder and leafy vegetable.

3.5 Utilization

The various uses of the NTFP species are for medicine, food, fruit, vegetables, spice, fodder, fuel wood, decoration/craft, fencing, and religious purposes as well as for construction, agriculture implements, soap/shampoo, rope, furniture, plate, and mosquito repellent (**Table 1** and **Figure 4**). The maximum number of species were documented with single use (75 species), and *Mangifera indica* is used for six purposes.

3.6 Medicine

Of the total documented NTFPs, 73 species were used for ethnomedicinal purposes, and among these species, 28 species were solely used for medicinal purpose (**Table 1**). The important species used as medicine are *Acacia catechu, Azadirachta indica, Aegle marmelos, Artocarpus lakoocha, Bauhinia malabarica, Bauhinia purpurea, Bombax ceiba, Castanopsis indica, Oroxylum indicum, Syzygium cuminii, Terminalia chebula, Terminalia bellerica, Trewianudiflora*, *and Ziziphus mauritiana*, which are usually administered against bleeding, urine infection, indigestion/stomach disorder, diarrhea/dysentery, diabetes, ulcer, gastroenteritis, rheumatism, fever, control body temperature, skin disease, allergy, stomach pain, jaundice, cuts/wound, could, cough, vomiting, nausea, and blood pressure. *Azadirachta indica*was is used round the year for treating various diseases like eye infection, allergy, and skin infection and also used as tooth stick. *Oroxylum indicum* is also used round the year to control jaundice and blood pressure.

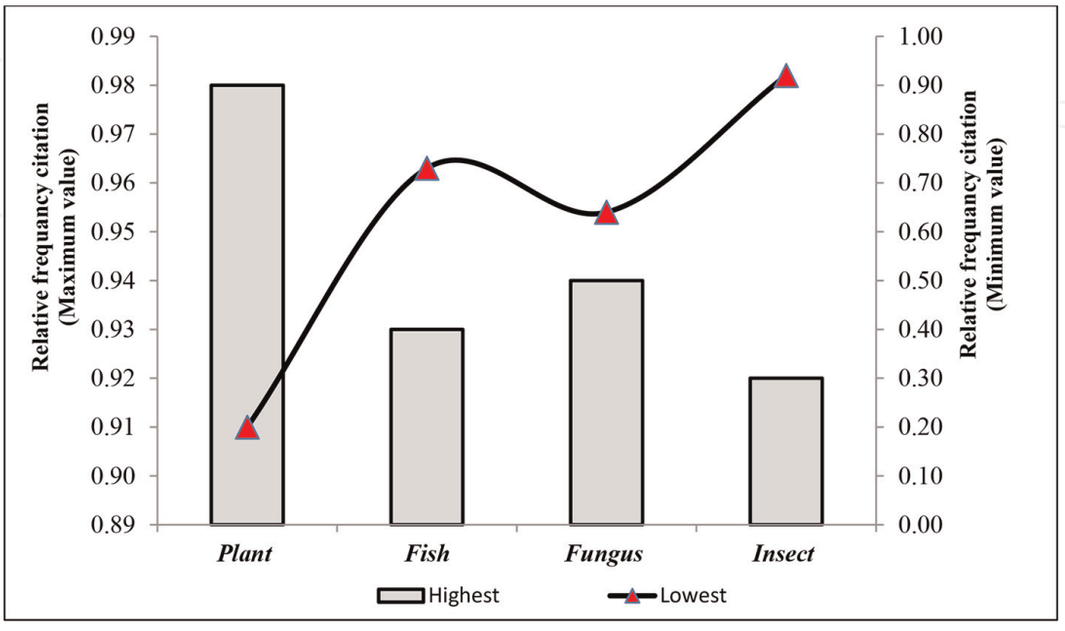

Figure 4.
Relative frequency citation (RFC) value.

The indigenous communities of JNP were rich in ethnopharmacological knowledge to properly use NTFPs. A total of 49 diseases/ailments were cured with the help of locally available plant resources. Fever, cough, and cold were documented as the most common disease suffered by the community. For remedy, the community used 12 different plant species. Another common disease was dysentery, and 10 plant species were used for its treatment. Skin and stomach problems were treated with eight and seven species, respectively. Diabetes, vomiting, and diarrhea were treated with five species each, while four species each were used for treating indigestion, mouth ulcer, rheumatism, and blood pressure. Similarly, three species each were used to treat asthma and allergy, while two species each were used as remedy for urine infection, jaundice, kidney problem, heart problem, eye problem, and burns. Treatment of cut and wound, snake bite, fracture, swelling/pain, body pain, arthritis, pneumonia, loss of appetite, liver aliments, stomach worm, cholera, gastroenteritis, ring worm, boil, sexual disorder, hypertension, conjunctivitis, tooth pain, small pox, reducing weight, leprosy, bleeding control, cystitis, hiccup, and nerve disorder was done by using only one plant species. Young twigs of *Azadirachta indica* and *Pongamia pinnata* are used for dental care. Honey secreted by *Trigona* spp. is mixed with black pepper powder and consumed for relief against cold and cough. Even mouth disease of domestic animals was documented to be treated, and *Ficus racemosa* was used for it.

Proper selection of species, parts, as well as preparation and administration methods was very important in traditional healthcare systems. Generally, fresh part of the plant is used for the preparation of medicine except for the underground parts, which were used in dried form. Ethnomedicinal formulations were administered both externally (skin, nasal, eye, and dental) and internally as oral doses. Most of the preparations were a mixture of different plant species, and in a few cases, only one plant species was used. Different parts of a single species were also used to cure different diseases. Almost all plant parts were used to prepare different medicinal formulations: roots, rhizomes, tubers, bark, leaves, flowers, fruits, seeds, young shoots, whole plants, and gum and latex. Doses of these preparations were not standardized but administered on the basis of age, physical appearance, and intensity of the illness. Children were usually administered with smaller doses than adults. The course of frequency of treatment is decided by the type of disease and its severity. The majority of formulations were prepared as juice followed by paste and decoction. The mode of preparation included juice, paste, decoction, powder, infusion, and chewing raw plant parts. The administration of the therapy is done as a raw, dried form in small pieces or powder, solution, or mixed with water/milk/honey and paste/lotion. Roots and rhizomes were preferred to prepare traditional remedies.

3.7 Food and nutrition

Many plant-, animal- and fungus-based NTFPs were collected by the indigenous communities from JNP for food and nutrition (**Table 1**). Plant-based resources used for food and nutrition was represented by 42 species. Animal-based resources used for food were represented by fish with 13 species and a honey bee species. Fruiting bodies of seven species of fungus were also used as food. Among the plant resources, more than 50% of the species were used as vegetable and fruits. Honey and fungus collected were mostly used for food and medicine purposes. All the mushrooms were used for culinary purposes and sometimes as snacks and added value to pickle as well. Fish supplements protein in the diets of the collectors. Leaves/foliage, root, rhizome, tuber, fruit, and flower/inflorescence of the plants were collected from the forest and either

cooked or consumed fresh. The communities were collecting these plant resources round the year or when available. Fruits are also consumed ripe as dessert or as vegetable and also processed as pickle or chutney. Herbs are generally consumed as leafy vegetables. Some tubers, rhizomes, pods, and fruits are also consumed as vegetable. Edible plants are generally important for both humans and domestic animals during the time of scarcity.

The indigenous communities of JNP were collecting different type of wild edible and cultivated fruits from the forest for both self-consumption and sale for cash income. The community collects fruits of 17 species for food, vegetable, and spice and also add value to products like pickles (**Table 1**). The maximum amount of fruits collected were consumed directly either raw or ripe. Fruits of *Artocarpus hetrophyllus* were either used as vegetable and pickle or consumed ripe. Fruits of *Mangifera indica* were also consumed as both ripe and raw after preparation of chutney. Fruits of *Syzygium cuminii*, *Baccaureasapida, Aegle* marmelos, and *Artocarpus lakoocha* were consumed as ripe only, whereas *Ziziphus mauritiana* and *Dillenia indica* were used for the preparation of pickle or "*chutney*".

Wild vegetables were collected for self-consumption and also sold in the local market to earn cash income. A total of 26 NTFP species were used as vegetable (**Table 1**). Among these, 19 were plants and seven mushrooms. NTFPs for vegetable purpose were daily collected for household needs. Leafy parts of the species were mostly preferred by the communities as vegetable and collected round the year from the forest. Some of the common species used as vegetable for both home consumption and sale were *Diplazium esculentum*, *Basella alba*, *Mussaendatreutleri*, and *Colocasia esculenta*. Rhizome and tender shoots of the *Colocasia* and *Basella* were collected during the rainy season for self-consumption, and a bulk of the amount was sold at the local market. Flower of *Mussaendatreutleri* is used for culinary purposes and consumed with rice. This cuisine is locally known as "*Mocha*" and consumed for supplementing the iron deficiency. Tender upper leafy part of *Chenopodium album* is cooked as vegetable and consumed with "*chapatti*" during winter season. Young shoots of *Bambusa vulgaris* were either consumed as vegetable or processed as pickle.

Products from six species of plants were used as spices or aroma for the preparation of locally made pickles for either self-consumption or sale (**Table 1**). These species are *Capsicum annum*, *Cinchona officinalis*, *Cinnamomum camphora*, *Cinnamomum tamala*, *Flumaria indica*, *and Murrayakoenigii*. Leaves of *C. tamala* and bark of *C. camphora* are used for making black tea and also used with rice. Leaves of *M. koenigii* were used for aroma and as condiment. Fish and mushroom were collected for both self-consumption and sale. Fishes like *Cirrhinamrigala*, *Labeorohita*, *Mystusvittatus*, and *Puntius ticto* were caught from the river, ponds, and other perennial water sources round the year except *Catlacatla*, which is caught during the rainy season only. The species is costly and used generally during ceremonial occasions. The fringe communities are highly dependent on these fishes for nutrition and energy along with cash income from sale in the local market. Seven types of mushrooms were also collected from the forest during the rainy season to prepare different culinary items for consumption with rice.

3.8 Animal feed

Plant leaves/foliage, fern, herb, and leaves of shrubs are collected from the forest as a supplement to the conventional fodder for domestic animals, and for this

purpose, 36 plant species were used (**Table 1**). Some of the preferred species as fodder were *Artocarpus*, *Ficus*, and *Dillenia sp*. as these species are available almost round the year. Leaves of *Ziziphus mauritiana* and *Syzygium cuminii* were also used as fodder, especially for goat. Leaves and foliage were mainly collected as fodder during summer and winter seasons when there is acute shortage of normal fodder. Fruits of *Dillenia indica* were also collected as feed for animals.

3.9 Other uses

The inhabitants of JNP largely depend for their domestic energy consumption on fuel wood collection from the forest, and they mainly use dead and dried wood of 26 species collected from the forest (**Table 1**). Apart from using it as domestic energy, firewood is sold in the local market and is a major contributor in the household income. The maximum consumption of firewood was documented during winter and rainy seasons as compared to during summer season. The area experiences cold temperature during the winter season, which necessitates firewood burning for heat. The firewood species preferred were *Albizia lebbeck*, *Anthocephalus cadamba*, *Pongamia pinnata*, *Schima wallichii*, *Lagerstroemia parviflora*, and *Mangifera indica* as compared to other documented species. Dried leaves of *Tectona grandis* are also collected during summer and used as fuel.

The fringe communities also make different types of craft and decorative items from the plant resources for decorating houses during festival, marriages, and other traditional rituals. Eighteen plant species were listed that were in use for this purpose (**Table 1**). The decorative or craft items were also sold in the local market for earning money. Some of the common species for this purpose are *Cassia fistula*, *Delonix regia*, *Oroxylum indicum*, and *Sterculia villosa*. Leaves, foliage, flowers, fruits, and twigs of six plant species were used for religious purposes (**Table 1**). Leaves of *Aegle Marmelos* and *Mangifera indica* were sacred and used as offering to God during rituals. Fruits of *Datura metal*, *Saussurealappa* flower, and seeds of *Elaeocarpus sphaericus* were also used while performing a religious ritual. *Ficus religiosa* is considered sacred by the fringe community. Three plant species were used to fence the homestead for protection against stray animals (**Table 1**). *Bambusa vulgaris* and *Bambusa bamboos* and *Lantana camara* were used for fencing around the animal shed and in crop fields. Bamboo thatching is also commonly used for fencing the house and animal shed.

NTFPs were also used for other purposes like agricultural implements, construction work (bridge, house, and animal shed), furniture, flosses, gum, honey, katha, ladder, pole, mosquito repellent, plate, rope, soap, and shampoo (**Table 1**). The branches of *Tetramelesnudiflora* and *Anthocephalus kadamba* were used for making small agricultural implements (handle of spade, plow). *Shorea robusta* is used for furniture and house construction, while its dried leaves are burned as mosquito repellent. Its leaves are also used for making plates. Small root pieces of *C. camphora* are also burned along with firewood as mosquito repellent. B*ambusa bamboos* and *Dendrocalamus strictus* are used for making ladder and construction of small temporary bridge. Twigs of *Cissus repanda* are used for making rope, heart wood of *Acacia catechu* for katha, and leaves of *Dilleniapentagyna* for plate, *Ficus elastica* for gum, *Bombax ceiba* for floss (floss of *Bombax* is locally known as "*Tula*"), and *Sapindus rarak* for soap and shampoo.

4. Discussions

4.1 Socioeconomic attributes

Socioeconomic profiling of forest-dependent communities helps in understanding their dependency on NTFP resources [2, 3, 13, 49, 50]. The settlement of the villages is in the designated forest area of JNP for past many generations with marginal land holding granted to the settlers in recognition of their traditional right to natural resources by the Forest Department. The villagers do not have any additional land to till except for the land around homestead where subsistence farming is practiced, that is, homegarden agroforestry. Rural livelihood is linked to socioeconomic characteristics of households as well as physical factors [51, 52]. Literacy level of the respondents indicates their progressiveness [3], and more than half of the respondents in this study were literates, ranging from illiterates to graduates. The total monthly income of the households surveyed in the study varied from INR ₹ 1000 to ₹ 30,000. The contribution of NTFP toward household income also varied widely from 1–70%.This is because the households earn income from NTFPs after their household needs are fulfilled [3, 53]. Similar variations in income from NTFPs were also reported by many earlier studies [21, 54–56]. Earnings from NTFPs vary from region to region [57, 58] depending on ecological settings, income level, and caste/community [59]. The entire household also had alternate income options. A majority of the households were engaged in daily paid manual labor and as vendors. NTFPs ensure year-round income to the households, and thus, the reliance of the households is more on them than on other livelihood options. This indicates that NTFPs are satisfying multiple needs of food, shelter, medicines, fibers, energy, and cultural artifacts and thus supporting the well-being of the indigenous people of JNP [2, 3, 39, 60].

Due to the availability of limited livelihood options to earn for a decent living and low development in the study area, the indigenous communities living in and around JNP were collecting NTFPs from the forest to meet their daily needs though their cash income varied widely from NTFPs. The cash income from NTFP sale is highly skewed because only the NTFPs that remain unused after satisfying their needs are subjected to sale in the local market and very less to the traders or vendors. It was reported that 43 NTFP species were sold by the fringe communities of JNP but in unprocessed form [3] and thus were undervalued, fetching only the collection charges of NTFPs to the collectors [3, 56]. Deprived of the fair prices of their product, the community is forced to spend more time on its collection, leading to unsustainable harvesting [61]. An absence of fair price mechanism and regulated market links in JNP was reported to be the cause of deprival of fair prices of NTFPs to its fringe communities [3].

Moreover, remoteness and absence of good roads make it very rare to approach the study area by the traders/vendors from outside for trading NTFPs. Several other studies though had also reported a wider range (10–60%) in the contribution of NTFPs to the total household income but ascertained that NTFPs do ensure a permanent source of income year-round [3, 62]. Distribution, collection, and contribution in household economy of these NTFPs vary from region to region and forest to forest due to change in locality factors including sociocultural domains [1]. Studies have also indicated that due to poorly developed market network, transportation absence of quality assurance, price-fixing mechanism and processing, most of the NTFPs are

consumed in household to satisfy daily needs [63]. It is reported that the more isolated and remotely located the area is, the higher is the contribution of NTFPs to noncash income [5]. The economic, livelihood, and ecological benefits of NTFPs can only be realized when their collectors are benefitted fully [5, 12, 13, 17].

4.2 Relative frequency of citation (RFC)

The relative frequency of citation (RFC) indicates that most cited species were collected abundantly in their respective season for the household consumption or marketing. Several studies suggested that a marketing of NTFPs leads to their competitive exploitation, followed by biological degradation [3, 64, 65]. Therefore, to study the diversity of NTFPs, the time of collection, utilization, and marketing channel are pivotal for the sustainability.

4.3 NTFP diversity

Documentation of 146 NTFP species indicates that the JNP is a rich reservoir of NTFP species of immense potential for human well-being. This documentation of NTFP species from JNP may play a pivotal role in the utilization and conservation of this natural wealth. Further studies on phytochemical principles including extraction of different active constituents on a scientific scale will lead to the recognition and preservation of the NTFP species unknown to the outer world. Among the enlisted 146 NTFP species, 116 were not assessed or not evaluated, 26 species falls under least concern and two species were under data deficit category in the IUCN priority list of species, [66]. Enlisting the species compared with the IUCN priority list indicates the status of the population of a particular species in an area. Such documentation will ensure future conservation of these species in the wild through their sustainable utilization and promote their domestication. The IUCN status of the JNP NTFP species warrants more vigorous and systematic research to gather accurate and complete information on the population status of the species in the area for their sustainable management and conservation for their continuous exploitation.

The ethnobotanical plant species that were documented as cultivated (24 species) or both cultivated and wild (27 species) were actually been planted by the respondents in their home garden, and it was found during the survey that almost all the respondents were maintaining a home garden contributing to the conservation of the species they were using. Indigenous people of JNP domesticating/cultivating ethnobotanical plants in their home gardens clearly indicate the community consciousness on the conservation values of these ethnobotanical species. This means that the inhabitants of JNP have switched to sustainable harnessing their valuable natural resource through domestication of some valuable wild species and leaving these species intact in the wild. There is a need to plant and domesticate the NTFP species of JNP through formulating local missions supporting indigenous strategies of food security. Similar report on home gardens maintaining rich biodiversity of ethnobotanical plants was also reported in earlier studies [11, 67]. There is relevance of man-made environments as a prominent source of ethnobotanical plants for both indigenous and non-indigenous agricultural societies for their conservation [68]. Home gardens serve as refuge for legacy species, with forces of family tradition and bonds that promote knowledge transmission and conservation [67, 69].

4.4 Plant part use/harvesting time

Most of the species were harvested year-round, while those used as fruits, vegetables, and fodder were harvested during the rainy season. Destructive harvesting was done in case of whole plants, roots, tubers, and rhizomes. Harvesting bark and seeds was also destructive as this can affect the survival of the plants. Harvesting patterns of leaves or foliage, root, rhizomes, and tubers indicate their possibility of vulnerability for becoming endangered and ultimately extinction [11]. Earlier studies also documented similar time of harvest or collection of NTFPs [4, 13]. The uses of various plant parts of these documented NTFP species in traditional uses were similarly reported by many workers [29, 70]. Genetic biodiversity of NTFP species gets threatened or vulnerable because of destructive harvesting techniques mainly done for commercial exploitation along with other causes like grazing, loss of habitat, and unmonitored trade [71]. NTFPs are freely harvested by users either for their own use or for trade [72]. The harvesting of these multiple-use species can put them under threat [73] but can also lead to better chances for their conservation [74], especially through home gardens.

4.5 Utilization

The acquaintance of forest flora and fauna and their importance are rich among the indigenous communities as they are traditionally integrated in the traditional lifestyle of these people, and this traditional knowledge system was accumulated and passed on from one generation to the other orally [4]. NTFPs collected were of multipurpose nature and were mostly used to supplement daily food and nutritional and health requirements of the households and domestic animals as well [1, 13, 24, 28–30, 50, 75–77 27]. There is much documentation of use ethnobotanical plants other than medicines and food [70, 71, 78].

Generally, NTFPs collected were consumed fresh either as food or for treating ailments traditionally [79] except for underground parts, which when used for medicinal purposes were dried [80]. Rarely the collected NTFPs were value added with exceptions for domestic consumptions that too very crudely [4, 81, 82]. Using roots and rhizomes to prepare traditional medicinal formulations has an advantage that these underground organs generally contain high concentrations of bioactive compounds [83]. Many studies also have made such observations [5, 12]. Proper selection of species, parts, as well as preparation and administration methods was very important in traditional healthcare systems [29, 30, 77].

Identification, documentation, collection/extraction, and conservation of indigenous traditional knowledge about the plants are very essential to be used in the near future for the ever-increasing population to ensure food and nutritional security [84]. No new food, particularly the wild food, will be accepted by the urban population without proper testimony from specialists. It will be no wonder if some plants used by the indigenous community as food may on analysis prove rich in nutrition. Others however may come out to poorer or even nutritionally almost useless. But that too would not minimize the utility of recording whatever information can be gathered on the botanical folklore of these fast-disappearing cultures [5].

Information generated from this study will be helpful to understand the human–forest relationship in terms of livelihood options and scheduling sustainable harvest procedures for the indigenous communities and thereby increasing their participation in the conservation and sustainable management of these natural resources [14, 84]. Such documentation will also aid in the preservation of traditional

conservation practices and framing management strategies, whereas utilization pattern can be helpful in transferring the traditional knowledge to younger generations and appreciating its value for human welfare and thus conservation of these ethnobotanical plant species. However, for the development of indigenous people and to conserve their knowledge under intellectual property right, a vast effort is needed [85].

Revitalizing the principles of traditional and religious practices where modern conservation programs could integrate traditional knowledge systems of indigenous communities into their conservation and management activities of natural resources is needed [86]. Ethnobotanical studies have reported resource management by the local people utilizing the principles of traditional knowledge in light of today's modern conservation principles [25–27, 87]. Institutional intervention was recommended to protect the rights and empower the JNP fringe community to access information on policy, market, and value addition of their products with capacity-building, financial, and infrastructural support [3]. Additionally, such missions will rejuvenate the sociocultural heritage and traditional food market circuits of JNP, which will conserve and replenish the NTFP resource to uplift the socioeconomic status and livelihood of indigenous communities at JNP [87–91].

5. Conclusion

The indigenous fringe communities of JNP with their traditional lifestyle relied on NTFPs for their daily subsistence needs and also for permanent source of cash income. The sale of NTFP was contributing 45% on an average to the total annual household income. NTFPs also provided a safety net particularly during the periods of scarcity and filled the gap of food deficit, especially when their subsistence standing crops were destroyed by wild elephants. We documented 146 NTFP species from our study area. In this list, 95 were wild, 24 were cultivated, and 27 species were both wild and cultivated. Some wild plant species were also grown in home gardens, thus aiding the conservation of these species. However, there is very less or no information available for these documented species as 116 species were not assessed or not evaluated, 26 were least concern, and two species were under the data deficit category in the IUCN priority list of species. More research is required to update information on the population status of these NTFP species. Systematic accounting the volume of NTFPs collected/harvested along with cash and noncash income should be initiated. Policies supporting *ex situ* conservation programs through capacity building the communities with improved cultivation techniques of commercially viable NTFP species and value addition of NTFP products will enhance their income and relieve pressure from the forest. Storage, grading, processing, and value addition through linking with existing development schemes should be created or promoted. Institutional intervention is required to empower the communities with information on policy, finance, markets, and products to enable them to trade NTFPs with better returns. Diversification of livelihood options along with education, skill, and basic infrastructure development is also recommended.

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Authorship contribution

Lakpa D. Lepcha: Data collection, analysis of data, and writing first draft; Gopal Shukla: Conceptualization of study and finalizing the draft MS; Biplov Ch. Sarkar: Data Collection and analysis; and Sumit Chakravarty: Conceptualization of study and final editing of MS.

Data availability

All the data are included in the paper.

Conflict of interest

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work presented in this paper.

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