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Species composition and structure of non-timber forest products in the Sirsi forest range, central Western Ghats, Karnataka, India

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Abstract
In India, it is estimated that 275 million people are from the rural background, which is 27 percent of the total population, depend on Non-Timber Forest Products (NTFPs) for their subsistence and livelihoods. NTFPs play a vital role in the social and cultural values of millions of rural and tribal populations. The Uttara Kannada district, situated in the central Western Ghats, is home to one of the region's most biodiverse forest zones. Although sustainability concerns and challenges are becoming increasingly prevalent in policy debates worldwide, NTFP harvesting practices in the Western Ghats have rarely been examined. Developing long-term management regimes for these products is critical. In this context, the present experiment was carried out to study the tree diversity and ecology of NTFP-yielding species in the study area, which is essential for understanding the population status of these species. A total of forty quadrats of 20 × 20 m (400 m²) dimensions were laid out using a compass, tape, and rope as per standard procedures. All woody species above 30 cm GBH (girth at breast height) at 1.37 m height were enumerated. Among NTFP species, the Sirsi forest mainly consisted of *Caryota urens*, *Aporosa lindliana*, and *Syzygium cumini* communities. It was found that among the dominant species, *Olia dioca* and *Aporosa lindliana* had wider adaptability. The family composition of the Sirsi forest range was dominated by members of the family Euphorbiaceae (FIV=24.86), Among the NTFP species, Anacardiaceae (19.26) was highest. The total tree density in Sirsi was 155 m²/ha. This variation might be due to the basal area contribution, which is highly dependent on the presence of large individual trees within the sample areas. The study provides useful information on the current state of woody species diversity and structure, which can help formulate management policies for forestry practices.

Keywords: Non timber forest products (NTFPS) species, family value index (FIV), Sirsi range

Introduction
Non-Timber Forest Products (NTFPs) consist of goods of biological origin other than wood and fuel wood derived from forests, other wooded lands, and trees outside forests (Anon, 1999) [1]. The term 'Non-Timber Forest Products (NTFPs)' encompasses all biological materials other than timber and fuel wood which are extracted from forests for human use (de Deer and Mcdermott, 1989). In India, there are about 15,000 plant species, out of which nearly 3,000 species (20%) yield NTFPs. However, only about 126 species (0.8%) have been commercially developed (Murthy *et al.*, 2005; Hanumantha *et al.*, 2019) [10, 6]. It is estimated that 275 million poor rural people in India, which is 27 percent of the total population, depend on NTFPs for their subsistence and livelihoods. This dependency is particularly intense for half of India's 89 million tribal population. According to an estimate, the NTFP sector alone can create about 10 million workdays annually in the country (Bhattacharya, 2009) [3].
NTFPs play a vital role in the social and cultural lives of millions of rural and tribal populations. NTFPs provide nutrition and supplemental income to about 400 million Indians who live in and around forests. They contribute considerably to the income of almost 30 percent of rural residents. Several findings suggest that NTFPs provide 20-24 percent of rural households' income (Kaushal and Kala, 2004) [8]. About 67 percent of all NTFP gatherers are women and 13 percent are children (Prasad and Bhatnagar 1991) [11].

The Uttara Kannada region is Karnataka's northernmost coastal district and is home to one of the Western Ghats' most biodiverse forest zones. Its total geographic area is 10,291 km², making up 5.4 percent of the state's overall geographical area. The total forest cover is 781,600 ha, which accounts for about 76 percent of the district's total terrestrial area. Sirsi, Siddapura, and Hulekal ranges have 72.87 percent, 73.36 percent, and 87.70 percent forest cover, respectively. Tropical wet evergreen forest, semi-evergreen forest, moist-deciduous forest, and dry deciduous forests are the most common forest types found in the study area.

While commercial exploitation causes changes in species composition, density, abundance, and regeneration capability of the species, the declining stocks of NTFPs that follow are anticipated to impact indigenous peoples' livelihoods. Although sustainability concerns and challenges are becoming increasingly prevalent in policy debates around the world, NTFP harvesting practices in the Western Ghats have rarely been examined (Kumar *et al*., 2001) [9]. It is critical to develop long-term management regimes for these products. Therefore, with this background, the study is undertaken in the Sirsi range of Uttara Kannada district in the central Western Ghats of Karnataka to determine the Structure and composition of Non Timber Forest Products (NTFPs) species in Sirsi Forest Range

Material and Methods

The study site is in the Western Ghats (14°23' N to 14°23'38" N and 74°48' E to 74'38" E), in the Uttar Kannada district of Karnataka, it falls under the administrative jurisdiction of Canara Forest Circle. The altitude varies from 0 to 750 m above sea level. The wet season lasts from May to October, with most rainfall occurring in July. The study area forms the northern limit of the evergreen forests of plains and low elevations. The forest in the study site is classified as “West coast tropical evergreen forest” with a Low-Level type floristic (Champion and Seth, 2005) [4].

An experiment was carried out to study the tree diversity of the study area, which is crucial for understanding the population status. To study the ecological parameters, forty quadrats of 20 × 20 m (400 m²) dimensions were laid out using a compass, tape, and rope in each range. All woody species above 30 cm GBH (girth at breast height) at 1.37 m height were enumerated. The enumeration included taking the girth and height of the trees. The height of the trees was measured using a Ravi Altimeter, standing 20 m away from the tree.

Results and Discussion

The Sirsi range primarily consisted of a community dominated by *Olia dioca*, *Hopea ponga*, and *Aporosa lindliana*, with a total of 58 species belonging to 30 families (Table 1). Among the NTFP species, the Sirsi forest consisted mainly of *Caryota urens*, *Aporosa lindliana*, and *Syzygium cumini*. It is clear that among the dominant species, *Olia dioca* and *Aporosa lindliana* had wider adaptability across all forest ranges. Similar studies conducted by (Bhat P R and Shivkumar, 2002) [2] in the Uttar Kannada rainforest support the current findings. According to their study, the adjacent vegetation of the current study area is primarily dominated by *Hopea ponga*, *Holigarna arnottiana*, *Bischofia javanica*, *Mappia foetida*, and *Alsodaphne semicarpifolia*. The floral species assemblage in the study area suggested certain ecological relationships in terms of environmental components and species composition. The dominant species exhibited preferences for specific climatic, edaphic, and topographic conditions.

However, the family composition of the Sirsi forest range was dominated by members of the Euphorbiaceae family (FIV=24.86), followed by Anacardiaceae (FIV=23.40) and Lauraceae (FIV=22.25) (Table 2). Among the NTFP species, Anacardiaceae (FIV=19.26) was followed by Arecaceae (FIV=35.95) and Clusiaceae (FIV=27.33) (Table 2). The findings are consistent with those of Sharma *et al.* (2017) [12], who studied the ridge tops of four different mountain ranges in the Garhwal Himalaya and discovered the presence of 69 species from 39 families, with Pinaceae and Fabaceae dominating the vegetation.

Density is the number of individuals per unit area. The average number of individuals per hectare is a parameter used to designate the density of forests. The stand density exhibited a range of variations among the communities of the forest ranges in the study area. The total tree density in Sirsi was 155 m²/ha. This variation might be due to the basal area contribution, which is highly dependent on the presence of large individual trees within the sample areas. Similarly, these results are in line with Inamati *et al*. (2005) [8], who recorded that basal cover and species richness were highest in the fourth altitudinal zone (401-500 m MSL).

Table 3 presents the key diversity values of NTFP species in the Sirsi forest range. The species richness is 20.00, the number of individuals per hectare is 382.00, the Shannon-Weiner index is 2.59, and the Evenness index is 0.72. Additionally, the total basal area per hectare is 60.46 sq.m. Similar findings were reported by Shastri *et al.* (2002) [13] in their study on tree species diversity in the village ecosystem of Sirsimakki village in Sirsi Taluk. They found the highest tree density per hectare in the areca boundary (735), followed by Soppina betta land, with the highest Shannon (H) diversity observed in the stream boundary.

Table 1: Vegetation structure of Non-timber forest product tree species in Sirsi forest range

Sl no	Species	No. of stems	Density/ ha	Basal area (m²)	BA (m²/ha)	Frequency (%)	Relative Frequency	Relative Density	Relative Dominance	IVI
1	*Caryota urens*	56.00	35.00	15.76	9.85	55.00	14.01	15.05	16.75	45.81
2	*Aporosa lindiana*	42.00	26.25	11.96	7.48	50.00	12.74	11.29	12.71	36.74
3	*Syzygium cumini*	40.00	25.00	11.83	7.39	45.00	11.46	10.75	12.57	34.79
4	*Cinnamon zylanicum*	32.00	20.00	7.65	4.78	37.50	9.55	8.60	8.13	26.29
5	*Schleichera oleosa*	31.00	19.38	6.59	4.12	42.50	10.83	8.33	7.00	26.17
6	*Myristica fragrans*	30.00	18.75	6.74	4.21	32.50	8.28	8.06	7.16	23.51
7	*Mangifera indica*	26.00	16.25	7.21	4.51	22.50	5.73	6.99	7.66	20.39
8	*Cinnamon malabatrum*	26.00	16.25	5.77	3.61	20.00	5.10	6.99	6.14	18.22
9	*Mallotus philippensis*	21.00	13.13	5.32	3.32	15.00	3.82	5.65	5.65	15.12
10	*Terminalia bellarica*	17.00	10.63	3.93	2.45	12.50	3.18	4.57	4.17	11.93
11	*Garcinia gammigatta*	14.00	8.75	3.61	2.26	10.00	2.55	3.76	3.84	10.15
12	*Garcinia indica*	9.00	5.63	2.06	1.29	10.00	2.55	2.42	2.19	7.16

13	*Syzygium gardneri*	7.00	4.38	1.45	0.91	7.50	1.91	1.88	1.54	5.34
14	*Artocarpus hirsutus*	5.00	3.13	1.19	0.74	7.50	1.91	1.34	1.26	4.52
15	*Careya arborea*	5.00	3.13	1.00	0.63	7.50	1.91	1.34	1.07	4.32
16	*Myristica malabarica*	5.00	3.13	0.96	0.60	7.50	1.91	1.34	1.02	4.28
17	*Artocarpus heterophyllus*	4.00	2.50	0.60	0.38	5.00	1.27	1.08	0.64	2.99
18	*Garcinia morella*	1.00	0.63	0.17	0.11	2.50	0.64	0.27	0.19	1.09
19	*Michelia champaca*	1.00	0.63	0.28	0.18	2.50	0.64	0.27	0.30	1.20
	Total	372	232.50	94.10	58.82	392.5	100.00	100.00	100.00	300.00

Table 2: Vegetation structure of families of Non timber forest product tree species in Sirsi range

Sl No.	Family	No. of spp	No. of ind	Basal area (m^2)	density /ha	BA(m^2 /ha)	Relative density	Relative dominance	Relative diversity	FIV
1	Anacardiaceae	1.00	26.00	7.21	16.25	11.54	6.81	7.46	5	19.26
2	Arecaceae	1.00	56.00	15.76	35.00	25.21	14.66	16.29	5	35.95
3	Clusiaceae	3.00	24.00	5.85	15.00	9.36	6.28	6.05	15	27.33
4	Combretaceae	1.00	17.00	3.93	10.63	6.28	4.45	4.06	5	13.51
5	Euphorbiaceae	2.00	63.00	17.28	39.38	27.65	16.49	17.86	10	44.35
6	Lauraceae	3.00	68.00	16.06	42.50	25.70	17.80	16.60	15	49.40
7	Lecythidaceae	1.00	5.00	1.00	3.13	1.61	1.31	1.04	5	7.35
8	Magnoliaceae	1.00	1.00	0.28	0.63	0.45	0.26	0.29	5	5.55
9	Moraceae	2.00	9.00	1.79	5.63	2.86	2.36	1.85	10	14.21
10	Myristicaceae	2.00	35.00	7.71	21.88	12.34	9.16	7.97	10	27.13
11	Myrtaceae	2.00	47.00	13.28	29.38	21.25	12.30	13.73	10	36.03
12	Sapindaceae	1.00	31.00	6.59	19.38	10.55	8.12	6.81	5	19.93
	Total	20.00	382.00	96.74	238.75	154.78	100.00	100.00	100.00	300.00

Table 3: Key diversity values of NTFP species in different ranges of Sirsi forest range.

Parameters	Diversity Values
Species Richness	20.00
Genus	14.00
No of Individuals per Ha	382.00
Total basal area (sq.m) /ha	60.46
Shannon-Weiner index	2.59
Simpson index	0.92
Evenness index	0.72

Conclusion

The research study offers crucial insights into the current state of woody species diversity and structure of Non-Timber Forest Product (NTFP) species in the Sirsi forest range, Karnataka. The research highlights the significant influence of anthropogenic factors on the regeneration status and population structure of these species. The variation in population density of seedlings, saplings, and adult trees across the forest ranges is attributed to both environmental and anthropogenic factors, reflecting the high demand and dependency on NTFPs in the study area.

The findings provide baseline data essential for future assessments of species migration and the response of vegetation to recent climatic changes. Understanding initial species composition, vegetation structure, and environmental conditions is key to predicting how NTFP species might adapt to these changes. The data can also inform the formulation of policies or reforms in NTFP marketing and management practices.

To ensure the sustainable use of NTFP resources, it is imperative to educate local communities on sustainable harvesting techniques. By reducing pressure on NTFP populations, such educational initiatives can help preserve the biodiversity and ecological balance of the Sirsi forest range, thereby supporting the livelihoods of rural and tribal populations dependent on these resources.

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