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Current Botany 2020, 11: 51-59
doi: 10.25081/cb.2020.v11.6032
https://updatepublishing.com/journal/index.php/cb

Research Article

ISSN: 2220-4822

Floristic diversity and vegetation analysis of the community forests of South-West Haryana, India

Harikesh, Himanshi, Somveer Jakhar*

Ecology Lab, Department of Botany, Kurukshetra University, Kurukshetra-136119, Haryana, India

ABSTRACT

Community forestry is an important form of forests and provides resources to over a half billion people in developing countries. They also play a significant part in mitigating the CO_2 levels by sequestering a significant amount of carbon in the soil as well as biomass. The present paper assessed floristic diversity and vegetation structure in three different community forests of southwest Haryana which is a part of tropical dry deciduous forests. The vegetation sampling and data analysis were done following standard procedures. A total of 76 plant species belonging to 37 families in the form of 11 trees, 13 species of shrubs, 46 species of herbs, and 6 species of climbers are documented from all three sites. Poaceae was the most specious family in three sites. The highest tree diversity was recorded in Bhera forest followed by Daya and Dhanger. Regarding understory, the forest of Daya has a greater diversity than Bhera and Dhanger forests. *Salvadora oleoides* was the dominant tree species in Daya site and Dhanger site while in Bhera the dominant tree species was *Ailanthus excelsa*. The incidence of rampant livestock grazing and other anthropogenic disturbances were visible in all three sites which are primarily responsible for the degradation of these already fragmented village community forests.

KEYWORDS: Community forest, tropical dry deciduous forests, importance value index, biodiversity, phytosociology

Received: November 26, 2019
Revised: April 30, 2020
Accepted: May 08, 2020
Published: May 23, 2020

***Corresponding Author:**
Somveer Jakhar,
Email: somveerjakhar@hotmail.com

INTRODUCTION

Haryana is a landlocked state in northwest India with a geographical area of 1.3% of the country. As the development is concerned, the state has well-developed agricultural as well as industrial sectors. However, the state has poor forest/tree cover compromising only about 3.62% of its total geographical area according to India State Forest Report, 2019. The area under forest and trees is an important indicator of its environmental condition. In the mid-1970s, worldwide research interest arose into the interrelation between people and trees which led to the establishment of the definitions of the term 'community forestry [1,2]. Learning the significance of community forests, virtually all countries around the world are working in the field of community forestry [3].

The importance of forests can be estimated by the fact that they provide half a billion with substantial livelihoods, from which millions of rural people living in poverty depend on community forests for their sustenance in this developing world. It is also found evident that community forests also provide various benefits along with plenty of livelihoods such as biodiversity conservation and carbon storage [4,5]. With contradiction to the forest products required by the ever-increasing population, the availability of forest resources is scarce. Inclusive of this, the non-sustainable means of resource extraction used by the people, due to lack of knowledge and ignorance among them causing the hazardous effects on the community forests. The species of an ecosystem are very important because their activities are essential processes that support and maintain those environments [6].

In Haryana, a small portion of land is occupied by community forests that are mainly present in the south-western region of the state. As, due to the presence of subtle soil moisture and water availability in the rest of the state, the area lately under community forests has now been converted into agricultural land. Hence, community forests are mainly confined to only a few districts in Haryana i.e., Hisar, Bhiwani, Fatehabad, Jhajjar, Sirsa, and Mahendergarh. Thus, the community forests of Haryana are very significant for study. Also, no study has been reported on these ecosystems by other workers from Hisar, Bhiwani, and Fatehabad.

Keeping this and the benefits as well as rapidly degrading conditions of community forests in mind, the present study revolves around the community forests of these three districts of Haryana. During this study, various parameters like Density, Basal area, IVI, and Diversity indices (Shannon-Weiner, Simpson, Pielou, and Margalef) were estimated to analyze the ecological conditions of the flora of selected community forests.

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MATERIALS AND METHODS

Study Site

The present investigation was carried out in community forest ecosystems of Daya village (Hisar), Dhangar village (Fatehabad), and Bhera village (Bhiwani) of south-west Haryana (Figure 1). These sites are located in the arid regions of Haryana and are influenced by the local steppe climate. There is a little rainfall during the year. The average temperature of Bhiwani is 25.2°C with annual precipitation of 465 mm. The average temperature of Hisar is 25.1°C with about 459 mm of precipitation falls annually. While the average temperature in Fatehabad is 24.9°C with an annual rainfall of 390 mm.

The selected community forests are natural ecosystems having significant biodiversity as well as a certain level of disturbance due to activities performed by local people like grazing of animals, tree felling for obtaining fuelwood, etc. The area occupied by the three community forests i.e., Daya village (Hisar), Dhangar village (Fatehabad), and Bhera village (Bhiwani) is 50 ha, 35 ha, and 22 ha respectively. Due to the lack of literature on the community forests of Haryana, the present study was carried out as an initiative in this direction.

Vegetation Sampling

For analyzing vegetation composition and plant diversity, the quadrat method was used in the selected community forests at the three sites, i.e., Daya village (Hisar), Bhera village (Bhiwani), and Dhanger village (Fatehabad), by sampling 10 quadrats of 20×20m, randomly placed. The trees occurring within in each quadrat were quantized. The circumference of trees was measured at 1.37 m height above the ground. The shrubs and herbs were observed within sub-quadrats of size 5×5m and 1×1m respectively placed further within 20×20m quadrats.

Analysis of Vegetation Composition

The density (D), basal area (B.A.), and important value index (IVI) of the flora of selected sites were analyzed following Phillips, 1959 [7], and Mishra 1968 [8]. The importance value index (IVI) was calculated using Curtis and McIntosh, 1951 [9]. Along with this, disturbance status was also analyzed by calculating the Frequency class distribution pattern given by Raunkiaer, 1934 [10].

Population Structure of Tree Species

The population structure of trees was determined by girth class measurement and it was done according to NRSA Manual, 2008[11].

Analysis of Species Diversity Indices

The plant species diversity (H') was measured using the Shannon and Wiener equation [12] and concentration of dominance (Cd) was determined by Simpson's index [13]. Equitability (E) was also calculated for the given vegetation using Pielou [14]. Whereas, Species richness (d) was calculated by Margalef's index [15].

RESULTS

Vegetation Composition

A total of 76 plant species including trees, shrubs, climbers and herbaceous plants were recorded in the community forest of the given three sites. The number of species was greater in the community forests of Daya, Hisar (54) as compared to that of the community forests of Bhera, Bhiwani (50), and Dhanger, Fatehabad (27).

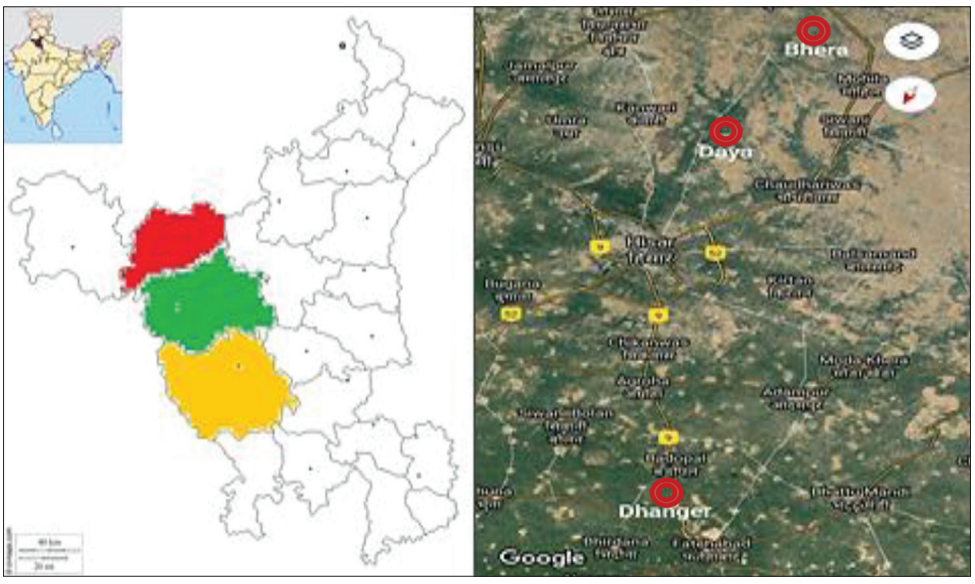

Figure 1: Location of study sites in Haryana, India (left), google imagery showing location of community forests in three districts with respect to each other (right)

A total of 7 tree species were recorded in the community forest at Daya, which was dominated by *Salvadora oleoides* (IVI-71.47) followed by *Prosopis juliflora* (IVI 43.45), *Acacia leucocephala* (IVI 43.40) and *Acacia nilotica* (IVI 40.45). The IVI of other tree species varied from 24.88 to 39.36. The IVI of various tree species in the community forest at Bhera varied from 5.75 to 87.69, dominated by *Ailanthus excelsa* (IVI 87.69), and followed by the co-dominance of *Acacia nilotica* (IVI 69.88) and *Prosopis cineraria* (IVI 49.79). The IVI of other tree species varied from 7.24 to 26.78 in this community forest. The community forest at Dhanger was dominated by *Salvadora oleoides* (IVI 117.57) followed by the co-dominance of *Prosopis juliflora* (IVI 113.93), *Prosopis cineraria* (IVI 34.51) and *Acacia nilotica* (33.97).

In shrub layer of dry deciduous forest at Bhera, the IVI value ranged from 2.14 to 126.64. *Capparis decidua* was the dominant shrub (IVI-126.64) followed by *Parthenium hysterophorus* (IVI-85.55) and *Calotropis procera* (IVI-26.92). In the community forest at Bhera, *Capparis decidua* was the dominant shrub (IVI-109.29) followed by *Parthenium hysterophorus* (IVI-98.59) and *Lantana camara* (IVI-33.92). The shrub layer of the community forest at Dhanger was dominated by *Capparis decidua* (IVI-122.59) followed by *Parthenium hysterophorus* (IVI-105.09) and *Abutilon indicum* (IVI-57.40).

In the case of ground floor vegetation, a total of 33 herb species were found in the community forest at Daya village having IVI values ranging from 0.79 to 51.39, dominated by *Peristrophe bicalyculata* (IVI-51.39). Whereas *Dactyloctenium aegyptium* was found to be dominant with an IVI value of 25.89 at Bhera among the total 29 species of herbs recorded from there. In the community forest of Dhanger village, 17 herbs were recorded of which *Peristrophe bicalyculata* was found to be dominant with IVI value of 143.31.

In the case of climbers *Tribulus terrestris* (IVI-127.48) was dominant at Daya. *Cucumis melo* (IVI-165.13) was dominant at Bhera and at the community forest of Dhanger, *Hedera helix* (IVI-173.53) was found to be dominant.

The distribution pattern of plant species was also analyzed by dividing value of abundance by frequency and calculating the ratio of the two. The maximum number of plant species were found to show a contiguous pattern of plant distribution i.e., A/F ratio>0.050. Regular distribution was found completely absent while only three plant species were found to have random distribution i.e., *Acacia nilotica* and *Prosopis cineraria* in Bhera village community forest and *Salvadora oleoides* and *Prosopis cineraria* in Dhanger village community forest (A/F ratio=0.025 to 0.050).

Species Diversity Indices

The species diversity indices i.e., H', Cd, E, and d were also calculated for the flora of given community forests. The value of H' was found to be maximum for Bhera village community forest, followed by community forests of Daya village and Dhanger village respectively. Other than this, concentration of dominance i.e., Cd was observed maximum for Dhanger village community forest, followed by Bhera village community forest and Daya village community forest respectively. The value of E was found to be greatest for Dhanger village community forest, followed by Daya village community forest and Bhera village community forest respectively. While, the value of d was found to be maximum for Daya village community forest, followed by Bhera village community forest and Dhanger village community forest respectively.

Frequency Class Distribution

When frequency class distribution of different plant species in Daya village community forest was plotted on a graph it showed that maximum percentage of the total number of species is found in the frequency class 1-20% and the minimum number of species and minimum percentage of the total number of species are found in the frequency class 61-80% (Figure 2a). In the case of Bhera village community forest, the maximum percentage of the total number of plant species is found in the frequency class 21-40% while the minimum number of plant species and minimum percentage of the total number of plant species are found in the frequency class 41-60% (Figure 2b). While at Dhanger village community forest, the maximum percentage of the total number of plant species was obtained by frequency class 1-20%, and the minimum percentage of the number of plant species was shown by frequency class 41-60% (Figure 2c).

A certain level of disturbance was recorded in all three community forests, as the frequency distribution curve was not found to be J-shaped as suggested by Raunkiaer (1934). A J-shaped curve of frequency distribution indicates that the ecosystem is intact with no signs of disturbance which was not deliberated for the three community forests indicating ecosystem disturbance in the given community forests.

Population Structure

The population structure of tree species in different community forests was also calculated (Figures 3-5) by assigning them to the girth classes as per to NRSA manual (2008). In the present study it was found that in the community forest of Daya village, the maximum number of tree species was found in the lowest girth class i.e., 0-30cm, such as *Morus alba*, *Prosopis juliflora* and *Azadirachta indica*. While in Bhera forest the maximum number of tree species was found to be in the girth class of 31-60cm and 61-90cm like *Morus alba*, *Prosopis cinereria*, and *Pongamia pinnata*. While in Dhanger forest *Acacia nilotica, Prosopis cineraria, and Salvadora oleoides* were found to belong to the girth class of 61-90 and 121-150.

Pearson Correlation Analysis (PCA)

Pearson correlation was also calculated for the three community forests (Table 1). It was found that density showed a positive correlation with the A/F ratio, Simpson index (Cd) and Margalef index (d) while it was found to be negatively correlated with the basal area (BA), Shannon Weiner index (H') and Pielou index

(E). Other than this, BA was found to be positively correlated with E while negatively correlated with all other parameters i.e., D, A/F ratio, IVI, H', Cd, and d. H' was found to be positively correlated with E and negatively correlated with all the other parameters i.e., D, A/F ratio, IVI, H', Cd, and d.

DISCUSSION

Phytosociological studies are crucial for understanding the studies of any ecosystem. It also helps in understanding species interactions, ecosystem processes as well as services and change exerted by the external forces like various natural and anthropogenic disturbances. Many phytosociological studies have been accomplished in the forest ecosystems of Haryana [16-18]. In an ecosystem, plant species assemble in a particular manner and hence can help in vegetation mapping or quantification and evaluation. Thus, information regarding the floristic composition of natural ecosystems and habitat types becomes a key component for improving the long-term management of natural resources [19-21]. In the present study, it was found that the community forest of Daya site, Hisar is rich in plant diversity as revealed by its vegetation analysis in comparison to the other two sites i.e., Dhanger site in Fatehabad and Bhera site in Bhiwani district. The findings of the current study are equivalent to that of different ecosystems under tropical climates [22,23]. In the study, a total of 76 plant species belonging to 37 families were recorded from all three sites (Table 2-4). Similarly, Sahu *et al.*, 2012 [24] recorded 57 species in dry deciduous forests of Eastern Ghats. Studies from the tropical dry deciduous forest in Sagar district reported a total of 36 trees, 8 shrubs, and 34 herbs [25]. Whilst a total number of 29 tree species belonging to 17 families were recorded across six sites from the tropical dry deciduous forests of Central India [26] and 14 tree species under 10 families were reported from Amarkutir, tropical dry deciduous forest of West Bengal [27].

The basal area of a tree is the circumference occupied at breast height (cbh) and is an important attribute to quantify the

Table 1: Pearson correlation for the different ecological parameters calculated during the study

	D	A/F Ratio	BA	IVI	H	Cd	E	d
D	1	0.989**	-0.325	0.274	-0.413	0.560	-0.521	0.755**
A/F Ratio	0.989**	1	-0.378	0.276	-0.455	0.615*	-0.453	0.817**
BA	-0.325	-0.378	1	-0.265	-0.133	-0.045	0.409	-0.263
IVI	0.274	0.276	-0.265	1	-0.158	0.276	-0.083	0.307
H	-0.413	-0.455	-0.133	-0.158	1	-0.961**	0.065	-0.696*
Cd	0.560	0.615*	-0.045	0.276	-0.961**	1	-0.138	0.832**
E	-0.521	-0.453	0.409	-0.083	0.065	-0.138	1	-0.196
D	0.755**	0.817**	-0.263	0.307	-0.696*	0.832**	-0.196	1

**Correlation is significant at the 0.01 level (2-tailed).*Correlation is significant at the 0.05 level (2-tailed)

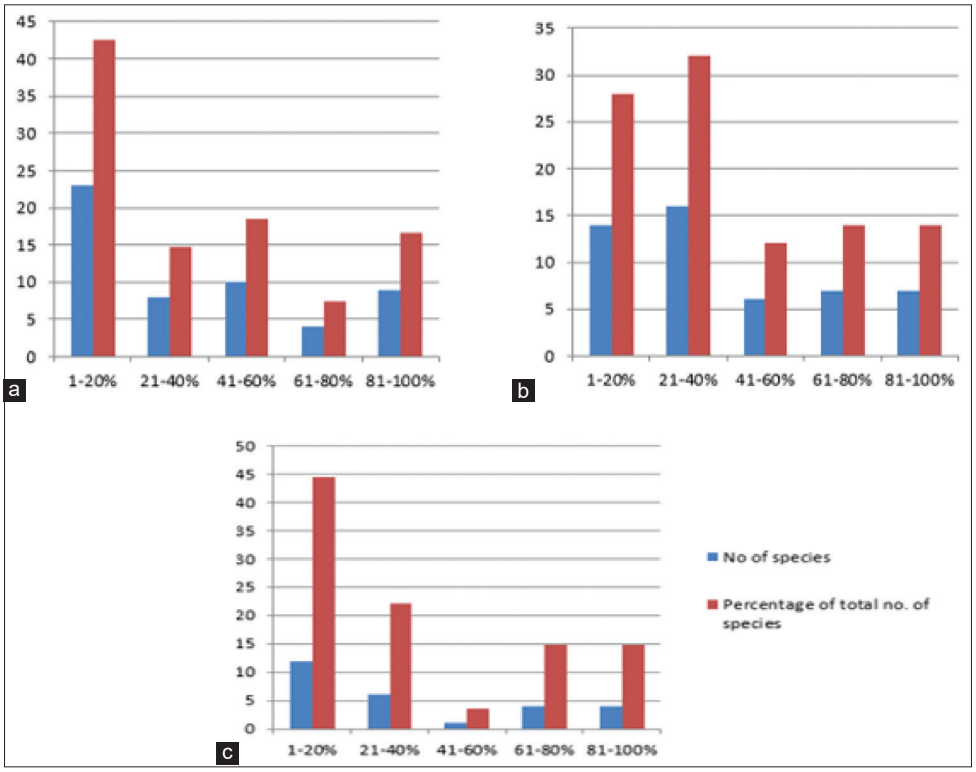

Figure 2: Frequency class distribution curve of the community forests of Daya, Hisar (a); Bhera, Bhiwani (b), and Dhanger, Fatehabad (c)

vegetation structure and site quality [28]. In the present study, the basal area of the plant species varied significantly across the three sites Daya, Bhera and Dhanger village community forest. The basal area of trees in the three sites was found to be 23.739 m^2/ha, 23.1048m^2/ha, and 4.357m^2/ha respectively, suggesting that the stand structure is quite healthy in all three sites. The values obtained are nearly in conformity with studies reported from some other workers [27,29,30]. The basal area of shrubs during the present study was calculated as 4.7449 m^2/ha, 0.3857 m^2/ha, and 0.5094 m^2/ha for Daya, Bhera, and Dhanger

Table 2: Consolidated details of phytosociological analysis in the community forest ecosystem at Daya village, Hisar, Haryana, India

S.N.	Name of the plant species	Family	D (ind./ha)	A/F Ratio	B.A. (m^2/ha)	IVI	H′	Cd	E	d
A	Trees									
1	*Acacia leucocephala*	Mimosaceae	80	0.128	1.24491	43.4019	0.27969	0.02093	0.14373	1.36922
2	*Acacia nilotica*	Mimosaceae	52.5	0.058	1.95961	40.4504	0.27016	0.01818	0.13883	1.51484
3	*Azadirachta indica*	Meliaceae	37.5	0.06	0.00178	24.8841	0.20650	0.00688	0.10612	1.65547
4	*Dalbergia sissoo*	Fabaceae	15	0.15	6.98255	39.3641	0.26648	0.01721	0.13694	2.21561
5	*Prosopis cineraria*	Mimosaceae	32.5	0.026	1.9929	36.9722	0.25801	0.01518	0.13259	1.72352
6	*Prosopis juliflora*	Fabaceae	70	0.043	0.12456	43.4523	0.27985	0.02097	0.14381	1.41226
7	*Salvadora oleoides*	Salvadoraceae	32.5	0.052	11.43297	71.4747	0.34175	0.05676	0.17562	1.72352
	Total		320		23.73928	300	1.90247	0.15613	0.97767	11.6144
B	Shrubs									
1	*Abutilon indicum*	Malvaceae	30	0.3	0.01735	5.7376	0.07567	0.00036	0.03286	2.64612
2	*Calotropis procera*	Asclepiadaceae	145	0.058	0.0132	26.9229	0.21635	0.00805	0.09396	1.80841
3	*Capparis sepiaria*	Capparaceae	65	0.072	0.48141	25.1863	0.20799	0.00704	0.09033	2.15600
4	*Capparis decidua*	Capparaceae	425	0.17	4.17357	126.645	0.36405	0.17821	0.15810	1.48709
5	*Ipomoea carnea*	Convolvulaceae	100	0.25	0.00042	12.4731	0.13222	0.00172	0.05742	1.95432
6	*Maytenus heterophylla*	Celastraceae	7.5	0.3	0.00043	2.37245	0.03827	0.00006	0.01662	4.46671
7	*Parthenium hysterophorus*	Asteraceae	1502.5	0.601	0.02495	85.5576	0.3578	0.08133	0.15539	1.23036
8	*Phyllanthus reticulatus*	Phyllanthaceae	17.5	0.175	0.00058	4.8465	0.06664	0.00026	0.02894	3.14443
9	*Urena lobata*	Malvaceae	2.5	0.1	0.00001	2.1485	0.03537	0.00005	0.01536	9.82221
10	*Ziziphus nummularia*	Rhamnaceae	30	0.133	0.03303	8.1088	0.09759	0.00073	0.04238	2.64612
	Total		2325		4.74495	300	1.592	0.27785	0.69139	31.3618
C	Herbs									
1	*Achyranthes aspera*	Amaranthaceae	5175	2.07	0.09012	47.9062	0.29295	0.0255	0.08378	3.74199
2	*Aerva lanata*	Amaranthaceae	2330	5.825	0.00753	11.7365	0.12679	0.00153	0.03626	4.12710
3	*Aerva tomentosa*	Amaranthaceae	40	0.177	0.00149	2.86268	0.04439	0.00009	0.01269	8.67472
4	*Ageratum conyzoides*	Asteraceae	32.5	0.325	0.0004	1.75513	0.03007	0.00003	0.00860	9.19212
5	*Boerhavia diffusa*	Nyctaginaceae	5	0.2	0.000009	0.79168	0.01566	0.000006	0.00448	19.8827
6	*Cenchrus ciliaris*	Poaceae	1205	3.012	0.00337	7.41708	0.09147	0.00061	0.02616	4.51070
7	*Commelina benghalensis*	Commelinaceae	7.5	0.3	0.00009	0.82178	0.01616	0.000007	0.00462	15.8816
8	*Crotalaria medicaginea*	Fabaceae	80	0.8	0.00011	1.80444	0.03075	0.000036	0.00879	7.30255
9	*Croton bonplandianus*	Euphorbiaceae	5507.5	2.203	0.09268	49.5631	0.29746	0.02729	0.08507	3.71494
10	*Cyamopsis tetragonaloba*	Fabaceae	7.5	0.3	0.00023	0.86179	0.01681	0.000008	0.00480	15.8816
11	*Cynodon dactylon*	Poaceae	3937.5	1.575	0.00714	20.7496	0.18475	0.004784	0.05284	3.86552
12	*Cyperus rotundus*	Cyperaceae	917.5	9.175	0.00779	6.3297	0.08141	0.000445	0.02328	4.69094
13	*Dactyloctenium aegyptium*	Poaceae	3280	1.312	0.0105	19.88	0.17985	0.004391	0.05143	3.95276
14	*Digera muricata*	Amaranthaceae	380	0.422	0.00642	7.5432	0.09260	0.000632	0.02648	5.38705
15	*Digitaria ciliaris*	Poaceae	95	3.8	0.00007	1.0595	0.01994	0.000012	0.00570	7.02698
16	*Eragrostis* Spp	Poaceae	3625	1.45	0.00087	18.088	0.16933	0.003635	0.04843	3.90453
17	*Euphorbia hirta*	Euphorbiaceae	60	0.6	0.0007	1.9173	0.03229	0.00004	0.00923	7.81565
18	*Euphorbia prostrata*	Euphorbiaceae	372.5	0.413	0.00011	5.7191	0.07549	0.000363	0.02159	5.40518
19	*Evolvulus nummularius*	Convolvulaceae	95	0.422	0.00003	2.5985	0.04113	0.000075	0.01176	7.02698
20	*Heliotropium strigosum*	Boraginaceae	5	0.2	0.000004	0.7902	0.01564	0.000006	0.00447	19.8827
21	*Indigofera linnaei*	Fabaceae	25	0.1	0.00003	0.8533	0.01667	0.000008	0.00476	9.94135
22	*Malvastrum coromandelianum*	Malvaceae	497.5	0.406	0.00236	7.4852	0.09208	0.000623	0.02633	5.15331
23	*Oxalis corniculata*	Oxalidaceae	32.5	1.3	0.00002	0.8713	0.01696	0.000008	0.00485	9.19212
24	*Paspalidium geminatum*	Poaceae	32.5	1.3	0.00004	0.8770	0.01705	0.000008	0.00487	9.19212
25	*Peristrophe bicalyculata*	Acanthaceae	6955	4.346	0.09043	51.3978	0.30225	0.02935	0.08644	3.61695
26	*Physalis minima*	Solanaceae	10	0.4	0.00115	1.1316	0.02104	0.000014	0.00602	13.8974
27	*Pupalia lappacea*	Amaranthaceae	525	0.583	0.00549	7.6809	0.09383	0.000656	0.02683	5.10904
28	*Setaria viridis*	Poaceae	12.5	0.5	0.000002	0.81055	0.01597	0.000007	0.00457	12.6696
29	*Sida cordifolia*	Malvaceae	402.5	0.447	0.00611	7.5172	0.09237	0.000628	0.02642	5.33538
30	*Solanum xanthocarpum*	Solanaceae	7.5	0.075	0.00003	1.5798	0.02762	0.000027	0.00790	15.8816
31	*Trianthema portulacastrum*	Aizoaceae	130	5.2	0.00031	1.2255	0.02247	0.000016	0.00642	6.57417
32	*Verbesina encelioides*	Asteraceae	5	0.2	0.00015	0.8319	0.01632	0.000007	0.00467	19.8827
33	*Xanthium strumarium*	Asteraceae	142.5	0.356	0.01415	7.5409	0.09258	0.000632	0.02648	6.45246
	Total		35935		0.349935	300	2.68233	0.10149	0.76714	284.766
D	Climbers									
1	*Coccinia grandis*	Cucurbitaceae	90	0.225	0.00156	35.7788	0.25360	0.01422	0.18293	0.66669
2	*Cucumis melo*	Cucurbitaceae	550	0.271	0.00581	124.532	0.36497	0.17231	0.26327	0.47544
3	*Ipomoea pestigridis*	Convolvulaceae	57.5	2.3	0.00028	12.2020	0.13024	0.00165	0.09395	0.74041
4	*Tribulus terrestris*	Zygophyllaceae	265	0.424	0.02137	127.4871	0.36366	0.18058	0.26232	0.53766
	Total		962.5		0.02902	300	1.11248	0.36878	0.80248	2.42021

Table 3: Consolidated details of phytosociological analysis in the community forest ecosystem at Bhera village, Bhiwani, Haryana, India

S.N.	Name of the plant	Family	D (ind./ha)	A/F Ratio	B.A. (m^2/ha)	IVI	H′	Cd	E	d
A	Trees									
1	*Acacia leucocephala*	Mimosaceae	27.5	0.068	0.22616	22.7435	0.19555	0.00574	0.08900	2.41386
2	*Acacia nilotica*	Mimosaceae	100	0.048	1.63022	69.8899	0.3394	0.05427	0.15446	1.73717
3	*Ailanthus excelsa*	Simaroubaceae	45	0.112	13.76369	87.6988	0.35952	0.08545	0.16362	2.10157
4	*Azadirachta indica*	Meliaceae	17.5	0.077	1.10364	19.9638	0.18033	0.00442	0.08207	2.79505
5	*Dalbergia sissoo*	Fabaceae	20	0.05	1.78917	26.7811	0.21568	0.00796	0.09816	2.67046
6	*Ficus benghalensis*	Moraceae	2.5	0.1	1.451	10.1303	0.11441	0.00114	0.05207	8.73085
7	*Morus alba*	Moraceae	5	0.2	0.22993	5.75451	0.07584	0.00036	0.03451	4.97067
8	*Pongamia pinnata*	Fabaceae	7.5	0.3	0.36329	7.24080	0.08988	0.00058	0.04090	3.97041
9	*Prosopis cineraria*	Mimosaceae	50	0.040	2.54777	49.7970	0.29809	0.02755	0.13566	2.04497
	Total		275		23.10487	300	1.86872	0.18751	0.85049	31.43506
B	Shurbs									
1	*Calotropis procera*	Asclepiadaceae	110	0.122	0.0079	27.3606	0.2184	0.00831	0.10502	1.48920
2	*Capparis decidua*	Capparaceae	47.5	0.029	0.31805	109.295	0.36786	0.13272	0.17690	1.81312
3	*Ipomoea carnea*	Convolvulaceae	22.5	0.9	0.00106	4.78393	0.06599	0.00025	0.03173	2.24826
4	*Lantana camara*	Verbenaceae	160	0.4	0.04247	33.9251	0.24648	0.01278	0.11853	1.37926
5	*Maytenus emarginata*	Celastraceae	5	0.2	0.00006	3.30516	0.04966	0.00012	0.02388	4.34934
6	*Parthenium hysterophorus*	Asteraceae	982.5	0.484	0.01412	98.5981	0.36571	0.10801	0.17587	1.01595
7	*Triumfetta rhomboidea*	Tiliaceae	85	0.85	0.00054	11.9457	0.12835	0.00158	0.06172	1.57563
8	*Ziziphus nummularia*	Rhamnaceae	22.5	0.1	0.00152	10.7855	0.11956	0.00129	0.05749	2.24826
	Total		1435		0.38572	299.999	1.56203	0.26510	0.75117	16.1190
C	Herbs									
1	*Achyranthes bidentata*	Amaranthaceae	1205	0.594	0.00389	21.1140	0.18677	0.00495	0.05546	3.94686
2	*Achyranthes aspera*	Amaranthaceae	167.5	0.744	0.00132	4.95523	0.06777	0.00027	0.02012	5.4677
3	*Aerva javanica*	Amaranthaceae	470	0.752	0.00161	9.40441	0.10854	0.00098	0.03223	4.55082
4	*Boerhavia diffusa*	Nyctaginaceae	227.5	0.364	0.00188	7.48501	0.09208	0.00062	0.02734	5.15924
5	*Brachiaria reptans*	Poaceae	117.5	1.175	0.00077	3.24965	0.04901	0.00011	0.01455	5.87440
6	*Cannabis sativa*	Cannabaceae	105	1.05	0.01039	12.4319	0.13192	0.00171	0.03917	6.01638
7	*Cleome viscosa*	Cleomaceae	10	0.4	0.00011	0.92082	0.01776	0.000009	0.00527	12.1602
8	*Commelinabenghalensis*	Commelinaceae	190	0.844	0.00095	4.80003	0.06616	0.00025	0.01964	5.33635
9	*Croton bonplandianus*	Euphorbiaceae	580	0.472	0.01124	21.1470	0.18696	0.00496	0.05552	4.40042
10	*Cynodon dactylon*	Poaceae	1397.5	0.559	0.00221	21.9462	0.19131	0.00535	0.05681	3.8661
11	*Dactyloctenium aegyptium*	Poaceae	1500	0.6	0.00534	25.8919	0.21143	0.00744	0.06279	3.82868
12	*Datura innoxia*	Solanaceae	150	0.375	0.01466	18.4114	0.17127	0.00376	0.05086	5.58811
13	*Digera muricata*	Amaranthaceae	292.5	0.182	0.00174	10.1080	0.11423	0.00113	0.03392	4.93091
14	*Eragrostis spp.*	Poaceae	1260	0.504	0.00028	18.8453	0.17384	0.00394	0.05162	3.92219
15	*Euphorbia hirta*	Euphorbiaceae	270	0.22	0.00215	9.57727	0.10996	0.00101	0.03265	5.00140
16	*Euphorbia prostrata*	Euphorbiaceae	445	1.112	0.00348	10.2617	0.11545	0.00117	0.03428	4.59161
17	*Malvastrum coromandelianum*	Malvaceae	62.5	0.277	0.00017	2.90008	0.04484	0.00009	0.01331	6.77119
18	*Pedalium murex*	Pedaliaceae	517.5	0.575	0.01409	22.6140	0.19487	0.00568	0.05787	4.48071
19	*Phyllanthus niruri*	Phyllanthaceae	380	0.422	0.00516	12.7498	0.13422	0.00180	0.03986	4.71366
20	*Physalis minima*	Solanaceae	10	0.4	0.00004	0.85319	0.01667	0.000008	0.00495	12.1602
21	*Poa annua*	Poaceae	587.5	0.94	0.00011	9.01155	0.10529	0.000902	0.03126	4.39155
22	*Polygonum aviculare*	Polygonaceae	220	2.2	0.00163	5.00212	0.06826	0.000278	0.02027	5.19131
23	*Polygonum persicaria*	Polygonaceae	145	5.8	0.00082	2.82057	0.04387	0.000088	0.01303	5.62618
24	*Portulaca oleracea*	Portulacaceae	82.5	0.206	0.00051	4.13304	0.05903	0.00019	0.01753	6.34518
25	*Pupalia lapacea*	Amaranthaceae	152.5	0.67	0.00202	5.49669	0.07328	0.000336	0.02176	5.56974
26	*Sida cordifolia*	Malvaceae	57.5	0.143	0.00084	4.22711	0.06005	0.000199	0.01783	6.91053
27	*Solanum xanthocarpum*	Solanaceae	30	0.075	0.00031	3.46779	0.05155	0.000134	0.01531	8.23239
28	*Verbesina encelioides*	Asteraceae	470	0.378	0.01413	22.9503	0.04870	0.005852	0.01446	4.55082
29	*Xanthium strumarium*	Asteraceae	20	0.2	0.00165	3.22329	0.04870	0.000115	0.01446	9.34663
	Total		11122.5		0.1035	300	2.94393	0.053422	0.87427	168.9316
D	Climbers									
1	*Cucumis melo*	Cucurbitaceae	632.5	0.3	0.00397	165.135	0.32862	0.30299	0.23705	0.62018
2	*Ipomoea pestigridis*	Convolvulaceae	32.5	1.3	0.00015	10.0488	0.11376	0.00112	0.08206	1.14901
3	*Tinospora cordifolia*	Menispermacea	67.5	0.168	0.00046	32.7672	0.24186	0.01193	0.17446	0.94963
4	*Tribulus terrestris*	Zygophyllaceae	557.5	0.454	0.00084	92.0485	0.36250	0.09414	0.26149	0.63256
	Total		1290		0.00542	300	1.04676	0.41019	0.75507	3.3514

village community forests respectively. This can be related to the range of basal area calculated for shrubs during a study of tropical dry deciduous forests of Haryana [18], i.e., 0.77 m^2/ha to 2.87 m^2/ha. The total value of Basal area for shrubs, herbs and climbers was recorded as 1.48 m^2/ha during a study reported from tropical dry deciduous forests of Bundelkhand, Uttarpradesh [31]. Whilst, during the present study it was found to be 5.1177m^2/ha, 0.4946 m^2/ha and 0.8052 m^2/ha in Daya,

Table 4: Consolidated details of phytosociological analysis in the community forest ecosystem at Dhanger village, Fatehabad, Haryana, India

S.N.	Name of the plant	Family	D (ind./ha)	A/F Ratio	B.A. (m^2/ha)	IVI	H′	Cd	E	d
A	Trees									
1	*Acacia nilotica*	Mimosaceae	22.5	0.018	3.0181	33.9706	0.24665	0.01282	0.17792	0.96354
2	*Prosopis cineraria*	Mimosaceae	30	0.033	4.013	34.5136	0.24877	0.01323	0.17945	0.88204
3	*Prosopis juliflora*	Fabaceae	462.5	0.185	0.517	113.939	0.36768	0.14424	0.26523	0.48886
4	*Salvadora oleoides*	Salvadoraceae	60.25	0.045	32.809	117.576	0.36711	0.15360	0.26481	0.73197
	Total		575.25		40.3571	299.999	1.23023	0.32390	0.88742	3.06642
B	Shrubs									
1	*Abutilon indicum*	Malvaceae	815	2.037	0.00195	57.4027	0.31642	0.03661	0.22824	0.44754
2	*Calotropis procera*	Asclepiadaceae	12.5	0.125	0.00093	14.9053	0.14915	0.00246	0.10759	1.18777
3	*Capparis decidua*	Capparaceae	57.5	0.143	0.46878	122.595	0.36569	0.16699	0.26379	0.74041
4	*Parthenium hysterophorus*	Asteraceae	1980	4.95	0.03777	105.096	0.36745	0.12272	0.26506	0.39521
	Total		2865		0.50945	299.999	1.19872	0.32880	0.86469	2.77095
C	Herbs									
1	*Achyranthes bidentata*	Amaranthaceae	60	0.15	0.00046	6.7779	0.08563	0.00051	0.03022	3.90782
2	*Alternanthera sessilis*	Amaranthaceae	222.5	2.225	0.0012	4.2588	0.0604	0.000202	0.02131	2.96026
3	*Cenchrus ciliaris*	Poaceae	32.5	1.3	0.000009	1.7071	0.02941	0.000032	0.01038	4.59606
4	*Croton bonplandianus*	Euphorbiaceae	5157.5	2.063	0.04017	44.193	0.28213	0.0217	0.09958	1.87173
5	*Cynodon dactylon*	Poaceae	3165	2.583	0.00067	20.397	0.18278	0.00462	0.06451	1.98513
6	*Cyperus rotundus*	Cyperaceae	237.5	9.5	0.0009	2.5845	0.04095	0.000074	0.01445	2.92495
7	*Dactyloctenium aegyptium*	Poaceae	4642.5	2.292	0.00257	28.412	0.22322	0.00896	0.07878	1.89505
8	*Eragrostis spp.*	Poaceae	5457.5	3.410	0.0009	28.522	0.22372	0.00903	0.07896	1.85943
9	*Launaea nudicaulis*	Asteraceae	5	0.2	0.000112	1.6648	0.02882	0.00003	0.01017	9.94135
10	*Malvastrum coromandelianum*	Malvaceae	47.5	1.9	0.000136	1.7922	0.03058	0.000035	0.01079	4.14429
11	*Marsilea minuta*	Marsileaceae	150	6	0.000038	2.0466	0.03402	0.000046	0.01200	3.19320
12	*Oxalis corniculata*	Oxalidaceae	62.5	2.5	0.000002	1.7889	0.03054	0.000035	0.01078	3.86925
13	*Peristrophe bicalyculata*	Acanthaceae	16300	8.049	0.24547	143.31	0.3529	0.22822	0.12455	1.64966
14	*Physalis minima*	Solanaceae	15	0.6	0.00011	1.6922	0.0292	0.000031	0.01030	5.90831
15	*Sida cordifolia*	Malvaceae	37.5	0.166	0.00049	5.1097	0.06936	0.00029	0.02448	4.41459
16	*Trianthema portulacastrum*	Aizoaceae	20	0.8	0.000099	1.7025	0.02934	0.000032	0.01035	5.34093
17	*Xanthium strumarium*	Asteraceae	27.5	0.275	0.00215	4.0305	0.05790	0.00018	0.02043	4.82773
	Total		35640		0.29551	300	1.7909	0.27405	0.63212	65.2898
D	Climbers									
1	*Cucumis melo*	Cucurbitaceae	22.5	0.056	0.000063	126.464	0.36414	0.1777	0.52534	0.32118
2	*Hedera helix*	Araliaceae	80	3.2	0.000194	173.535	0.31664	0.3346	0.45682	0.22820
	Total		102.5		0.000257	300	0.68078	0.5123	0.98216	0.54938

Abbreviations: D= Density (individuals/hectare); BA= Basal Area (m^2/hectare); IVI= Important value index; H′= Shannon Wiener Index; Cd= Simpson Index, E= Pielou Index, d= Margalef Index

Bhera and Dhanger site respectively. The high-value of B.A. in Daya site is due to the high density of *Capparis decidua* which was absent in the other two sites. The results suggest that the diversity and distribution of understorey species are scarce, thus require more attention and in need of management.

Tree density also varies from 15.0 to 462.5 in the present study (Tables 2-4). So much variation may imply that the land is not being fully utilized by the tree stand. The species diversity depends upon adaptations of species and increases with the stability of the community. The Shannon-Weiner (H') index of trees for all three sites varies from 1.23 to 1.902 which falls in the range of 0.67 to 4.05 reported in tropical forests of the Indian subcontinent [29-34]. On the other hand, the concentration of dominance (Simpson's index) in the present study is out of the reported range of 0.08-0.27 in other forests [26, 30]. In the present study, Cd for tree species varies from 0.156 to 0.323 for all three sites. However, Cd for herbs was found to be much lower while higher for shrubs and climbers, as compared to tree species in all three sites. This indicates the dominance of species in shrubs and climbers while diversity among trees and herbs. The value of Pielou index, E for trees was found to range between 0.85 to 0.977 and seen to follow the trend reported during the study of other workers [18,32]. The Margalef richness index for tree species occurred in the range of 0.32 to 23.72 for other tropical forests [26,29,33] for the two sites only i.e., Daya and Dhanger villages. Bhera site exhibited much higher values of 31.43 as compared to two other sites. With these values of diversity indices, it shows how the sites have lost tree species under the influence of man-made and ecological factors. In the present study, none of the sites showed the J-shaped curve as proposed by Raunkiaer (1934). The Inversed J-shaped curve is typical of well-developed forests with a broad range of tree sizes [35]. Invariably, none of the sites had the typical J-shaped curve which may reflect various degrees of disturbance in these sites.

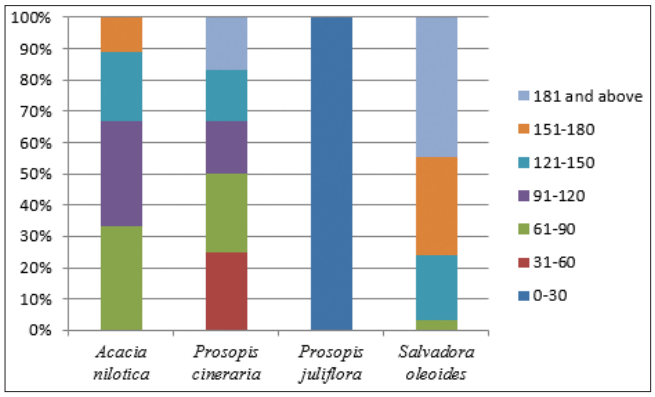

Figure 3: Graph representing the percentage of tree species of Dhanger village community forest belonging to the different girth classes

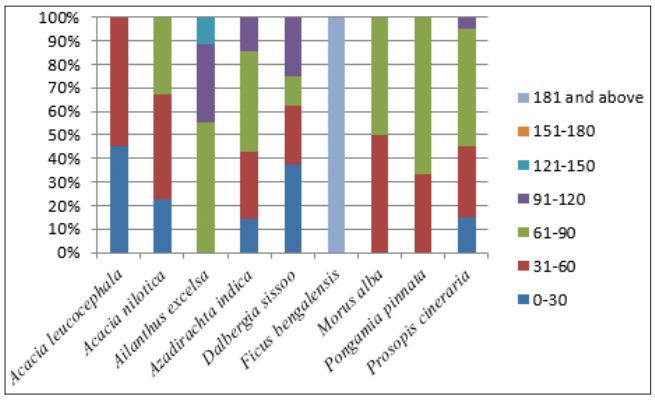

Figure 4: Graph representing the percentage of tree species of Bhera village community forest belonging to the different girth classes

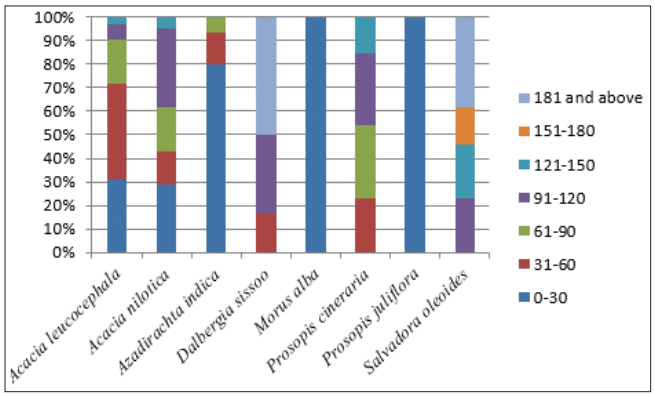

Figure 5: Graph representing the percentage of tree species of Daya village community forest belonging to the different girth classes

CONCLUSIONS

In the last two decades, the popularity of community forests has grown as reflected in the ratification of community forests related programs, policies, and laws. But, the community forests of Haryana are still lacking in gaining the attention of the state government. The present study sites were found to possess a significant amount of floristic composition and diversity in different strata. The Daya village community forest was found to be better flourished and diverse followed by Bhera and Dhanger village community forests respectively. But anthropogenic activities such as tree felling for fuelwood, grazing, encroachment, etc. create high pressure on these ecosystems leading to depletion in their state. Hence, steps should be taken in the field of community forest ecology to improve the fundamental quality of these ecosystems for their sustainability as well as their living flora and fauna. Some further studies are also warranted in this field to attain more knowledge regarding the community forestry in Haryana including level of disturbance and impact of grazing as well as spread of invasive plant species in them for the sustainability and management of these ecosystems.

ACKNOWLEDGMENTS

The authors acknowledge the Sarpanch of the three villages to allow the fieldwork in the selected community forests. Authors are also grateful to the Council of Scientific and Industrial Research, New Delhi for providing JRF to Harikesh and Himanshi. As well as, the authors also acknowledge Chairperson, Botany Department, Kurukshetra University, Kurukshetra for providing necessary laboratory facilities.

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