

Structure and Floristic Composition of Existing Agroforestry Systems in Fatehpur District of Uttar Pradesh, India

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ABSTRACT

The floristic-composition and structure study of existing agroforestry systems was carried out in the farmer's fields of village Dariyapur (Site-I) and Alampur (Site-II) at Fatehpur district (Uttar Pradesh) during 2008-2010. The quantitative characteristics of vegetation were determined by the quadrat method. The floristic diversity study was made by adopting random sampling approach, under which, 20 quadrates of 10 m x 10 m were laid down. The density, frequency, abundance, IVI, Species –diversity, concentration of dominance, species-richness, equitability and beta diversity and other useful parameters for comparison of different types of existing agroforestry systems were analyzed by the simple arithmetic calculation. The study illustrated that *Acacia nilotica* was dominant in these sites with highest IVI values (24.91) in site- II (Alampur) lowest IVI values (22.04) in site- I (Dariyapur). Concentration of Dominance (Simpson Index) of tree species was higher in site -II (0.039) and lowest in site- I (0.032). Species diversity level among the tree species in site was observed and found higher in site-II (0.994) and lowest in site -I (0.934). Tree species equitability was same in site-I and site-II (0.055) while Beta-diversity was recorded highest in site –I (4.176) and lowest in site –II (3.944). Tree species-richness was recorded maximum in site –II (0.154) and minimum in site-I (0.149).

Keywords: Structure and Floristic, Study, agroforestry systems, concentration of dominance.

INTRODUCTION

The land use pattern is one of the important aspects for analyzing the structure, composition and phyto diversity for understanding the vegetation dynamics of the existing sites. The farmers have adopted the trend of growing trees around agricultural land due to significant economics as well as social benefits. But it will be worthwhile to work out an integrated approach with the help of agricultural and forestry scientists, depending on the suitability of crops and locations¹⁵. New land-use strategies that increase livelihood security and reduce vulnerability to climate and environmental change are necessary¹³. Community structure, composition and vegetative function are the most important ecological attributes of forests, which show

variations in response to environmental as well as anthropogenic activities^{7,19}. Species diversity is an important concept and one of the major attributes of a natural community. These differences in vegetation structure, richness, diversity and distribution are directly associated with the intensity of variables like geographical location, agricultural practices and their extent⁶. In Central and Eastern Uttar Pradesh, the agroforestry systems are well established. As multiple cropping is a kind of natural resource management based on environmental, social and economic criteria which is done by combination of trees, pasture and cropland, in order to increase social, economic and environmental benefits. Tree plantation and harvesting of wood, fruits, roots, leaves, fuel, and fodder along with agricultural crops on the same piece of land has been practiced since

the old days. However, under present scenario, the agroforestry techniques used by the farmers seems to be poorly developed and exploitative. In most cases, the trees are neither protected nor properly managed. Hence, there is an immense potential tool for improvement of traditional agroforestry systems in order to realize the real production potential of existing agroforestry systems. Greater agrobiodiversity also may ensure longer term stability of C storage in fluctuating environments⁹, apart from the biomass production potential¹⁰.

Main aimed of this paper are to describe the structural attributes of density, frequency, diversity, equitability and species richness on the existing agroforestry systems in Fatehpur of Uttar Pradesh. This helps in determination of predominating communities of timber trees, horticultural trees and shrubs species and further identify the localities having protection and promotion of these plants.

MATERIAL AND METHODS

The floristic-composition and structure study of existing agroforestry systems was carried out in the farmer's fields of village Dariyapur (Site-I) and Alampur (Site-II) at Fatehpur district (Uttar Pradesh) during 2008-2010. The research area is located between two important river Ganga and Yamuna. The study illustrated that status of density,

frequency, Abundance, IVI, Species –diversity, concentration of dominance, species-richness, Equitability and Beta diversity and other useful parameters for comparison of different types of existing agroforestry systems were analyzed by the simple arithmetic calculation. The quantitative characteristics of vegetation were determined by the quadrat method. The floristic diversity study was made by adopting random sampling approach, under which, 20 quadrates of 10 m x 10 m and 5 m x 5 m size were laid out in each sites for the observation of trees and shrubs respectively. The vegetative structure of trees and shrub in each two sites was estimated for frequency; density and abundance by using expressions given by Curtis and Mc Intosh, 1950⁵. Floristic diversity studies of the herbaceous species were not attempted.

Basal area of trees was calculated as cross sectional area of stem at DBH (1.37 m), while basal area of shrubs was calculated as cross sectional area of main stem at 15 cm above from the ground level.

$$\text{Basal Area} = \pi(d^2/4)$$

Where d is the diameter of tree. The relative density, relative frequency, relative basal areas were calculated using following formula. The importance value index (IVI) is an integrated measure of the relative frequency, relative density and relative

$$\text{Frequency} = \frac{\text{Number of sampling units in which species occurred}}{\text{Total number of sampling unit studies}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individual of species}}{\text{Total number of quadrat studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individual of the species in all sampling units}}{\text{Number of sampling unit in which the species occurred}}$$

$$\text{Basal area per tree} = \frac{\text{Total basal area of trees}}{\text{Number of trees}}$$

basal area/dominance, was calculated for each tree species given by Curtis, 1959⁴.

Importance Value Index (IVI) = RD+RF+RBA

The number of trees falling in the sample unit was counted and classified as per their diameter and height. The Species diversity (Shannon index), concentration of dominance (Simpson index) and

other useful parameters for comparison of different types of existing agroforestry systems were calculated^{17,18}.

Tree diversity analysis

Tree diversity in all two sites of agroforestry systems (trees and shrubs) were calculated by the following diversity indices. Species Diversity Index.

$$\text{Relative density} = \frac{\text{Density of individual of species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of the individual species}}{\text{Total frequency of all the species}} \times 100$$

$$\text{Relative basal area} = \frac{\text{Basal area of the individual of species}}{\text{Total basal area of all the species}} \times 100$$

It was calculated by the formula given by Margalef, 1958¹².

$$\bar{H} = -\sum[(ni/N) \log (ni/N)]$$

Where ni was the total number of individuals of species N was the total number of individuals of all the species on that site. Concentration of dominance was measured by the formula of Simpson Index developed by Simpson, 1949¹⁸.

$$Cd = -\sum \left[\left(\frac{n_i}{N} \right)^2 + \left(\frac{n_j}{N} \right)^2 + \dots + \left(\frac{n_s}{N} \right)^2 \right]$$

Where N was the total number of individuals of species ni was the total number of individuals of all the species on that site. Equitability(e) was calculated as suggested by Pielou (1975)¹⁴ as

$$e = H / \ln s$$

Where H is the Shannon – Wiener Index and s = total number of species Species richness was calculated by the following equation of Margalef

(1958)¹²

$$d = s - 1 / \ln N$$

Where s = number of species, and N =number of individuals of all species. Beta diversity was calculated as outlined by Whittaker, 1977²¹.

$$bd = Sc / s$$

Where Sc = total number of species in all sites and's' is average species per site.

RESULTS AND DISCUSSION

Floristic-diversity analysis and distribution patterns of tree species

The distribution patterns and species composition of existing agroforestry systems viz. agrisilvicultural and agrihorticultural system commonly practiced in Fatehpur was studied. Floristic- diversity at site-I (Dariyapur) of Fatehpur:

The data pertaining to floristic diversity analysis presented in Table: 1 and graphically illustrated in Figure: 1, shows that dominant and

Table 1: Floristic-diversity of site-I (Dariyapur) of Fatehpur district

Name of the species	Density (100m ²)	Freq.	Ab.	BA (cm ²) /100m ²	Re. Den.	Re. Freq.	Re. B. Area	I.V.I	B.A. m ² /ha.
Timber and fuelwood trees									
<i>Acacia leucophloea</i> Willd	0.30	25	1.20	192.00	3.52 941	3.70 370	4.10 583	11.33 894	1.9 20
<i>Acacia nilotica</i> L.Willd.ex del.	0.60	50	1.20	354.45	7.05 882	7.40 741	7.57 980	22.0 4603	3.5 44
<i>Aegle marmelos</i> (L.)Corr.	0.25	20	1.25	156.54	2.94 118	2.96 296	3.34 760	9.25 174	1.5 65
<i>Artocarpus heterophyllus</i> L.	0.25	20	1.25	146.61	2.94 118	2.96 296	3.13 526	9.03 940	1.4 66
<i>Azadirachta indica</i> L.	0.50	45	1.11	363.06	5.88 235	6.66 667	7.76 406	20.3 1308	3.6 30
<i>Eucalyptus tereticornis</i> Sm.	0.25	20	1.25	123.95	2.94 118	2.96 296	2.65 064	8.55 478	1.2 39
<i>Ficus benghalensis</i> L.	0.25	20	1.25	388.98	2.9 4118	2.96 296	8.31 824	14.22 238	3.8 89
<i>Ficus glomerata</i> L.	0.30	25	1.20	196.19	3.52 941	3.70 370	4.19 551	11.42 862	1.9 62
<i>Ficus religiosa</i> L.	0.35	20	1.75	569.32	4.11 765	2.96 296	12.17 482	19.25 543	5.6 93
<i>Limonia acidissima</i> L.	0.25	25	1.00	170.36	2.94 118	3.70 370	3.31 964	10.28 807	1.7 04
<i>Madhuca latifolia</i> Macb.	0.40	30	1.33	510.94	4.70 588	4.44 444	10.92 629	20.07 661	5.1 09
<i>Pithecellobium dulce</i> (Roxb.)Benth.	0.20	15	1.33	164.35	2.35 294	2.22 222	3.51 465	8.08 981	1.6 43
<i>Prosopis juliflora</i> (sw) DC.	0.25	15	1.67	34.8 51	2.94 118	2.22 222	0.74 528	5.90 868	0.3 48
<i>Syzygium cumini</i> (L.)Skeel	0.20	10	2.00	187.26	2.35 294	1.48 148	4.00 445	7.83 888	1.8 73
<i>Tamarindus indica</i> L.	0.15	15	1.00	190.75	1.76 471	2.22 222	4.07 909	8.06 601	1.9 07
<i>Tectona grandis</i> Linn.f.	0.60	40	1.50	194.27	7.05 882	5.92 593	4.15 446	17.13 921	1.9 42
<i>Zizyphus maritiana</i> Lam	0.25	25	1.00	96.89	2.9 4118	3.70 370	2.07 209	8.71 697	0.9 69
Horticultural trees									
<i>Carica papaya</i> L.	0.20	10	2.00	12.0 31	2.35 294	1.48 148	0.25 729	4.09 171	0.1 20
<i>Carissa corandus</i> L.	0.30	25	1.20	9.9 589	3.52 941	3.70 370	0.21 297	7.44 609	0.0 99
<i>Citrus lemon</i> (L)Burm.f	0.30	30	1.00	10.4 24	3.52 941	4.44 444	0.22 291	8.19 677	0.1 04
<i>Cordia myxa</i> Roxb.	0.15	10	1.50	3.5 652	1.76 471	1.48 148	0.07 624	3.32 243	0.0 36
<i>Emblica officinalis</i> Gaertn	0.50	45	1.11	69.1 79	5.88 235	6.66 667	1.47 939	14.02 841	0.6 92
<i>Mangifera indica</i> L.	0.35	30	1.17	499.06	4.11 765	4.44 444	10.67 232	19.23 441	4.9 91
<i>Morus alba</i> L.	0.15	10	1.50	4.8 274	1.76 471	1.48 148	0.10 323	3.34 942	0.0 48
<i>Musa paradisiaca</i> L.	0.15	10	1.50	2.3 339	1.76 471	1.48 148	0.04 991	3.29 610	0.0 23
<i>Psidium guajava</i> L.	0.15	10	1.50	21.321	1.76 471	1.48 148	0.45 594	3.70 213	0.2 13
Shrubs species									
<i>Bougainvillea glabra</i> L.	0.20	15	1.33	0.8 458	2.35 294	2.22 222	0.01 809	4.59 325	0.0 08
<i>Hibiscus rosa-sinensis</i> L.	0.15	10	1.50	0.64 53	1.76 471	1.48 148	0.01 380	3.25 999	0.0 06
<i>Ipomoea lacunosa</i> L.	0.15	15	1.00	0.32 09	1.76 471	2.22 222	0.00 686	3.99 379	0.0 03
<i>Lantana camara</i> L.	0.20	10	2.00	0.2 263	2.35 294	1.48 148	0.00 484	3.83 926	0.0 02
<i>Ricinus communis</i> L.	0.15	15	1.00	0.7 074	1.76 471	2.22 222	0.01 513	4.00 206	0.0 07
<i>Ziziphus zizyphus</i> L.	0.05	10	0.50	0.0 166	0.58 824	1.48 148	0.00 035	2.07 007	0.0 00
Total	8.50	675	42.11	467 6.20	100.00	100.000	100.000	300.000	46.7

co-dominant species were *Acacia nilotica* and *Azadirachta indica* having IVI values of 22.04 and 20.31, respectively. The highest tree density (60 trees ha⁻¹) was also recorded for *Acacia nilotica*.

In horticultural and shrubs species, dominant and co-dominant species were *Mangifera indica* and *Embliba officinalis* with their IVI values of 19.23 and 14.02, respectively. The highest tree density (50

Table: 2 Floristic diversity of site-II (Alampur) of Fatehpur district

Name of the species	Density		BA (cm ²)		Re. Den	Re. Relative (RBA)		IVI	B.A. ^{M2} /ha.
	(100m ²)	Freq.	Abun.	/100m ²		Freq.	Basal Area		
Timber and fuel wood trees									
<i>Acacia leucophloea</i> Willd	0.30	20	1.50	164.66	3.87 097	3.30 579	4.402 24	11.57 899	1.6 466
<i>Acacia nilotica</i> L. Willd. ex del.	0.60	55	1.09	302.23	7.74 194	9.09 091	8.08 047	24.91 332	3.0 223
<i>Aegle marmelos</i> (L.) Corr.	0.25	15	1.67	137.21	3.22 581	2.47 934	3.66 853	9.37 368	1.3 721
<i>Artocarpus heterophylus</i> L.	0.25	15	1.67	146.61	3.22 581	2.47 934	3.91 976	9.62 491	1.4 661
<i>Azadirachta indica</i> L.	0.55	50	1.10	235.01	7.09 677	8.26 446	6.28 316	21.64 440	2.3 501
<i>Dalbergia sissoo</i> Roxb.	0.15	15	1.00	82.453	1.93 548	2.47 934	2.20 445	6.61 928	0.8 245
<i>Eucalyptus teretiocornis</i> Sm.	0.20	15	1.33	84.654	2.58 065	2.47 934	2.26 328	7.32 327	0.8 465
<i>Ficus benghalensis</i> L.	0.25	15	1.67	351.80	3.22 581	2.47 934	9.40 567	15.11 081	3.5 18
<i>Ficus glomerata</i> L.	0.30	20	1.50	152.67	3.87 097	3.30 579	4.08 183	11.25 858	1.5 267
<i>Ficus religiosa</i> L.	0.35	15	2.33	469.97	4.51 613	2.47 934	12.56 514	19.56 060	4.69 97
<i>Limonia acidissima</i> L.	0.25	10	2.50	147.79	3.22 581	1.65 289	3.95 139	8.83 009	1.4 779
<i>Madhuca latifolia</i> Macb.	0.40	35	1.14	486.40	5.16 129	5.78 512	13.00 430	23.95 071	4.8 64
<i>Populus deltoids</i>	0.20	20	1.00	42.523	2.58 065	3.30 579	1.13 689	7.02 332	0.4 252
<i>Prosopis juliflora</i> (sw) DC.	0.25	15	1.67	34.851	3.22 581	2.47 934	0.93 177	6.63 691	0.3 485
<i>Syzygium cumini</i> (L.) Skeel	0.20	15	1.33	164.35	2.58 065	2.47 934	4.39 408	9.45 407	1.6 435
<i>Tamarindus indica</i> L.	0.15	15	1.00	109.28	1.93 548	2.47 934	2.92 162	7.33 644	1.0 928
<i>Tectona grandis</i> Linn.f.	0.60	50	1.20	194.27	7.74 194	8.26 446	5.19 400	21.20 039	1.9 427
<i>Zizyphus maritiana</i> Lam	0.25	15	1.67	79.596	3.22 581	2.47 934	2.12 807	7.83 321	0.7 96
Horticultural trees									
<i>Carica papaya</i> L.	0.10	5	2.00	5.32 19	1.29 032	0.82 645	0.14 228	2.25 905	0.05 32
<i>Carissa corandus</i> L.	0.15	10	1.50	4.57 44	1.93 548	1.65 289	0.12 230	3.71 068	0.0 457
<i>Citrus lemon</i> (L) Burm.f	0.20	15	1.33	6.3 364	2.58 065	2.47 934	0.16 941	5.22 939	0.0 634
<i>Embliba officinalis</i> Gaertn	0.50	45	1.11	60.894	6.45 161	7.43 802	1.62 805	15.5 1768	0.6 089
<i>Mangifera indica</i> L.	0.25	25	1.00	258.12	3.22 581	4.13 223	6.90 104	14.25 907	2.5 812
<i>Morus alba</i> L.	0.15	10	1.50	3.4 75	1.93 548	1.65 289	0.09 291	3.68 128	0.03 48
<i>Musa paradisiaca</i> L.	0.10	10	1.00	1.4 059	1.29 032	1.65 289	0.03 759	2.98 080	0.0 141
<i>Psidium guajava</i> L.	0.10	10	1.00	12.12	1.29 032	1.65 289	0.32 404	3.26 726	0.1 212
Shrubs species									
<i>Bougainvillea glabra</i> L.	0.10	10	1.00	0.42 29	1.29 032	1.65 289	0.01 131	2.95 452	0.0 042
<i>Hibiscus rosa-sinensis</i> L.	0.10	5	2.00	0.35 65	1.29 032	0.82 645	0.00 953	2.12 630	0.0 036
<i>Ipomoea lacunosa</i> L.	0.15	15	1.00	0.2 41	1.93 548	2.47 934	0.00 644	4.42 127	0.0 024
<i>Lantana camara</i> L.	0.10	10	1.00	0.0 986	1.29 032	1.65 289	0.00 264	2.94 585	0.0 01
<i>Ricinus communis</i> L.	0.15	15	1.00	0.57 56	1.93 548	2.47 934	0.01 539	4.43 021	0.0 058
<i>Zizyphus zizyphus</i> L.	0.10	10	1.00	0.0 229	1.29 032	1.65 289	0.00 061	2.94 383	0.0 002
Total	7.75	605	43.81	374 0.30	100.0 000	100.0 0000	100.0 0018	300.000	37.403

Table 3: Diversity Index of study sites-I, and II of Fatehpur districts

AF system	Species – Diversity Index (Shannon Index)		Simpson Index (Concentration of Dominance)		Species Richness		Equitability		Beta Diversity	
	Trees	Shrubs	Trees	Shrubs	Trees	Shrubs	Trees	Shrubs	Trees	Shrubs
AS/S _I	0.934	0.084	0.032	0.0003	0.149	0.277	0.055	0.021	4.176	3.500
AS/S _{II}	0.994	0.096	0.039	0.0002	0.154	0.357	0.055	0.024	3.944	3.500
AH/S _I	0.330	0.047	0.008	0.0003	0.177	0.000	0.036	0.023	3.444	3.000
AH/S _{II}	0.256	0.038	0.003	0.000	0.225	0.000	0.032	0.019	3.875	3.000

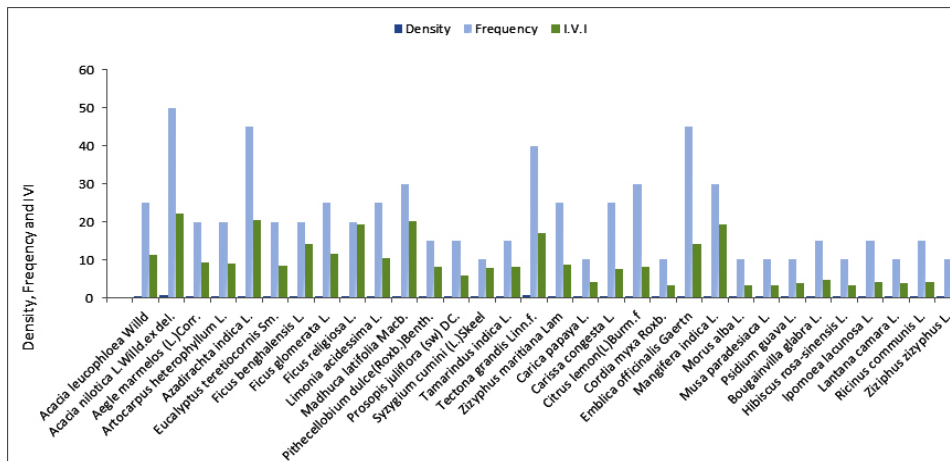


Fig. 1: Floristic diversity of site-I (Dariyapur) of Fatehpur district

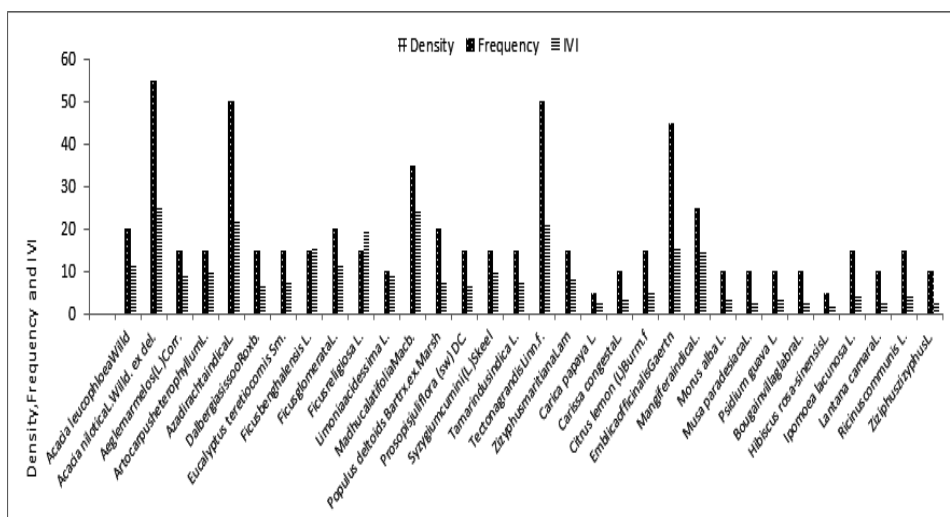


Fig. 2: Floristic diversity of Site-II (Alampur) Fatehpur, district

trees/ha) was recorded for *Emblia officinalis*. Total basal cover was recorded markedly higher (5.69 m²/ha) in *Ficus religiosa* as compared to *Madhuca latifolia* (5.10 m²/ha). In horticultural and shrub species the basal cover was recorded maximum in case of *Mangifera indica* (4.99 m²/ha) and *Emblia officinalis* (0.69 m²/ha). The similar results were also reported by Rawat and Chandhok (2009)¹⁶. Among tree species, total forest density ranged from 470 to 600 trees ha⁻¹.

Floristic- diversity at site –II (Alampur) of Fatehpur

Floristic- diversity analysis data of site-II are presented in Table: 2 and graphically illustrated in Figure: 2, shows that the dominant and co-dominant species were *Acacia nilotica* and *Madhuca latifolia* having their values of IVI 24.91 and 23.95, respectively. *Acacia nilotica* showed highest tree density (60 trees ha⁻¹) among the other species. Total basal cover for tree was recorded comparatively higher in case of *Madhuca latifolia* (4.86 m²/ha) as compared to *Ficus religiosa* (4.69 m²/ha). In horticultural and shrubs species, the dominant and co-dominant species were *Emblia officinalis* and *Mangifera indica* with their IVI values 15.51 and 14.25, respectively. *Emblia officinalis* recorded the highest value of tree density (50 trees ha⁻¹). In horticultural and shrubs species, the basal cover was recorded markedly higher in *Mangifera indica* (2.58 m²/ha) and *Emblia officinalis* (0.61 m²/ha).

Diversity Index Analysis

Diversity index analysis of vegetation of both sites of the district Fatehpur is presented in Table: 3. A close insight of the data shows that the comparatively higher value of index of dominance (Simpson index) and species diversity (sd) was recorded (0.039) and (0.994) respectively at site

–II while lowest (0.934) and (0.032) respectively. In agrihorticultural system highest species of diversity was recorded at site-I (0.330) and lowest at site-II (0.256).

Equitability (e) was found equal value (0.055) in agrisilviculture system at site-I and II whereas in agrihorticulture system the higher value was recorded at site-I (0.36) and minimum in site-II (0.032). Perusal of data shows that higher species richness was found in agrisilviculture system in site –II (0.154) compared to agrihorticulture system in site –II (0.225). Beta diversity was found highest in agrisilviculture system in site –I (4.176) and lowest at site –II (3.944), whereas in agrihorticulture system it was found highest in site –II (3.875) and lowest at site-I (3.444). The Shannon-Wiener Index Value (H') showed that the diversity was almost similar to that in a tropical forest (5.45). H' value in tropical rain forest generally varies between 5.06 in a young stand to 5.4 in an old stand¹¹.

CONCLUSIONS

In view of the above findings, it is concluded that the IVI was recorded maximum in *Acacia nilotica* in both the research sites. As far as concerned to maximum value of Concentration of Dominance (Simpson Index), Equitability, Beta diversity and Species diversity, Site-I (Dariyapur) is superior while species richness was found at site –II (Alampur).

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