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Comparative Study on Homegardens of Assam and Arunachal Pradesh in Terms of Species Diversity and Plant Utilization Pattern

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ABSTRACT

In the present investigation, species diversity and plant uses were studied in the homegardens of Assam and Arunachal Pradesh. High diversity of plant species is recorded in studied homegardens with a total of 268 species (107 trees, 53 shrubs and 108 herbs) belonging to 200 genera under 82 families. Species richness per homegarden varied greatly and it ranged from 25 to 87 with an average of 46 (SE ± 1.98) species. Five vertical strata (emergent, canopy, under storey, shrub and herb) were identified in the studied homegardens with highest percentage of species in herb stratum (37%). In case of plant utilization pattern, almost similar occurrences of medicinal plants, vegetables, spice and condiments, fuel wood and timber trees were recorded both in Assam and Arunachal Pradesh. But, there was a difference in occurrence of ornamental, fruit and plants of miscellaneous uses. Diverse life style, tradition and cultural practices in both the states may also have a greater effect in such variation in species composition and plant utilization pattern. Besides, owners are cultivating some rare/endangered species like *Aquilaria malaccensis*, *Livistona jenkinsiana, Clerodendrum colebrookianum* along with other homegarden species.

Key words: Homegardens, Stratification, Species diversity, Floristic composition, Plant use

Homegarden are production system of diverse crop plants, which is easily accessible and adjacent to household (Sunwar *et al.* 2006). It is the site of highest species diversity where several landraces, cultivars and rare/endangered species have been maintained and conserved (Watson and Eyzaguirre 2002). The wide range of species of different heights and life forms found in traditional homegardens add to their ecological efficiency in terms of use of water, sunlight and nutrients (Blanckaert *et al*. 2004, Wiersum 1982). Homegardens are multistory combinations of various trees and crops around household (Kumar and Nair 2004), which provide the family with food and other goods, including construction materials, ornaments or additional income (Del and Mendoza 2004, Michon and Mary 1994). Research on homegardens has focused mainly on species composition and diversity, structure and ecological functions (Albuquerquea *et al.* 2005, Coomes and Ban 2004), plant uses (Blanckaert *et al.* 2004), socio economic importance and contribution to income generation (Mendez *et al.* 2001) and household food supply (Fernandez and Nair 1986). In northeast India, traditional homegarden have been practice mainly by the rural people for their survival as well as for economic upliftment. It has a complex vegetation pattern with high diversity of local plant species (Tangjang and Arunachalam 2009). To understand the structure and multiple functions of the homegardens, Das and Das (2005) inventoried the homegarden diversity of Barak valley of northeast India and they found that homegardens are complex systems where plant diversity is conserved through their use. The great contribution to indigenous people's livelihoods, biodiversity conservation, ecological and socio-economic functions, homegardens have been receiving enormous attention from scientists and researchers. Again, studies on homegardens of northeast India are still very less compared to other region of the world. Therefore, a comparative study of homegarden of Assam and Arunachal Pradesh has been attempted in terms of species diversity and plant utilization pattern.

MATERIALS AND METHODS

The study was carried out in forty selected homegardens of Lakhimpur and Papumpare districts located in Assam and Arunachal Pradesh, respectively states in northeast India. Of which twenty homegardens from three villages were located in Harmati of Lakhimpur district, whereas, the other twenty homegardens were selected from three villages located in Nirjuli of Papumpare district (Fig 1). Lakhimpur district is situated on the northeast corner of Assam. The district lies between 26°48' to 27°53' N latitude and 93°42' to 94°20' E longitude. It is bounded on the north by Siang and Papumpare district of Arunachal Pradesh, on the east by Dhemaji district and Subansiri River on the south by Jorhat district and Sonitpur district is on the west. The district covers an area of 2,277 km^2. Total number of villages inhabited in this district is 1,185. The inhabiting people of the district are mainly non-tribal including Kuch, Kalita, Chutia, Bengali, Brahmin, etc. The climate of the district is mainly tropical type with distinct hot and humid

summer (temperature range 35-38°C) and cool winter (temperature range 6-8°C) and experiences heavy rainfall and high humidity. The soil of the district is alluvial and fertile which favours the crops flourish without use of any artificial manure or hard labour. Papumpare is an administrative district in the state of Arunachal Pradesh. It is located between 26°55' to 28°40' N latitude and 92°40' to 94°21' E longitude. It is bounded by Kurung Kumey district in the north, Lower Subansiri district in the east, East Kameng district in the west and Assam in the south. The district occupies an area of 2875 km². There are 274 villages and two towns in the district. It is inhabited by members of the Nishi and the Mikir tribe. Although, altitude of Papumpare district is higher than the Lakhimpur district, climate and soil of both the districts is almost similar.

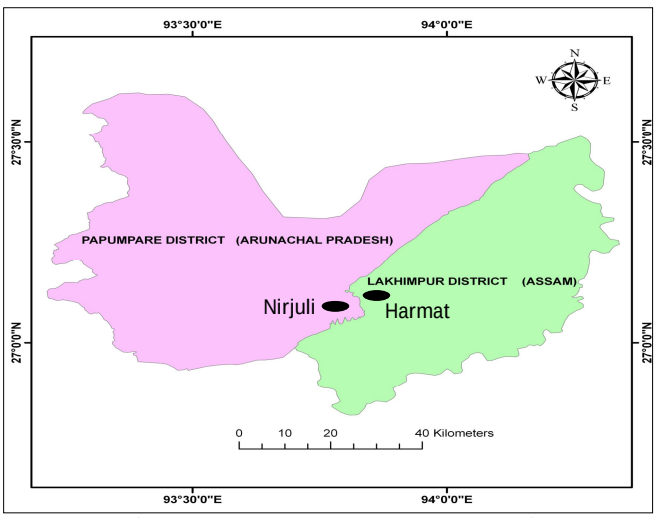

Fig 1 Map of Lakhimpur and Papumpare districts of Assam and Arunachal Pradesh showing the location of the study site

Randomly selected forty homegardens from six villages (three villages from each of the selected district of Assam and Arunachal Pradesh) were studied during 2011 with an average of seven homegardens per village. Vegetation was studied using quadrat method covering a minimum of 30% area in each homegarden. Random quadrats of 10m × 10m size were laid for trees and within the same 10m × 10m quadrat, one 5m × 5m quadrat for shrubs and two 1m × 1m quadrats for herbs were laid in the studied homegardens. Girth at breast height (1.37m above ground) and visual height of all the individual trees were recorded during the study. Based on the average height of the plant species, vegetation of homegardens is divided in to five distinct strata. These are emergent (>15m), canopy (>10-15m), understorey (>5-10m), shrub (1-5m including saplings of the higher strata) and herb (<1m including seedlings of the higher strata) strata. Plant species were identified on the basis of vernacular names, published field inventories, floras and consulting available herbaria of the region. Herbarium specimens were collected and deposited in the Department of Forestry, North Eastern Regional Institute of Science and Technology, Arunachal Pradesh. Information regarding plant uses was collected by interviewing the homegarden owners by interactive questionnaires. Economically important plants were then classified into eight different use categories viz fruit, timber, medicinal, ornamental, vegetable, spice and condiments, fuel wood and miscellaneous category based on the main use of the species. Plants like oil yielding, sugar yielding, non alcoholic beverage yielding, masticators, construction materials and plants of religious and sacred values were included under miscellaneous category.

Quantitative analysis of vegetation was done following Misra (1968). Importance value index (IVI) was computed by summing up relative density, relative frequency and relative dominance for trees and summing up relative frequency and relative density values for bamboos, shrubs and herbs. Species richness was defined as the total number of species present in the homegardens. The Shannon-Wiener (1963) diversity index was calculated from the IVI values using the formula given by Magurran (1988):

$$H = -\sum_{i=1}^{s} pi \ln pi$$

where p_i is the proportion of the IVI of *i*th species and IVI of all the species (n_i /*N*).

Simpson's index was calculated according to Simpson[25] to measure the concentration of dominance (CD) of plant species:

$$CD = \sum_{i=1}^{s} (pi)^2$$

where p_i is the same as for the Shannon-Wiener information function.

Different statistical analysis (Standard error, correlation and t-test) has been done using different statistical software like MS-excel, SYSTAT and ORIGIN.

RESULTS AND DISCUSSION

Species diversity

A total of 268 species were recorded in forty studied homegardens from two study sites (Assam and Arunachal Pradesh) which belong to 200 genera under 82 families (Table 1). Out of the total 268 species, 107 are the tree species, 53 shrub species and 108 herb species. State wise data showed that homegardens of Assam were more species rich (230) compared to the homegardens of Arunachal Pradesh (205). At the family level, Poaceae (14 species), Euphorbiaceae (11), Solanaceae (11), Caesalpinaceae (10) and Rutaceae (10) demonstrated the highest floristic importance in homegardens (Table 2). Similarly, in Assam and Arunachal Pradesh also families Poaceae, Solanaceae, Euphorbiaceae, Caesalpinaceae and Rutaceae contributed the highest species diversity. *Areca catechu, Artocarpus heterophyllus, Mangifera indica* and *Carica papaya* were the most frequent species in the homegardens because these provides edible fruits that can be used for daily household consumption and marketed locally. Occurrence of beetle nut, jackfruit, mango, bamboo, banana and papaya were very common and found in more than 60% studied homegardens. Homegardens of northeast India is very much

species rich which is evident in the present report with a total of 268 plant species (107 trees, 53 shrubs and 108 herbs) recorded from the fouty studied homegardens. Though, it is less than the 323 species recorded from the homegardens of upper Assam (Saikia 2011) and 419 plant species from homegardens of southwestern Bangladesh (Kabir and Webb 2008), it is significantly higher than the earlier reports from Assam (Das and Das 2005) as well as other parts of India (Kumar *et al.* 1994) and the world[7] (Padoch and de Jong 1991). The high plant density and the resultant of higher basal area can be attributed to the presence of a larger number of beetle nut trees and also the inclusion of different bamboo species in the studied homegardens. *Areca catechu* is the principle tree species in both the homegarden in Assam and Arunachal Pradesh, whereas, *Prosopis julifora* is the principal tree species in homegardens in northeastern Brazil which often dominating and monopolizing the homegardens (Albuquerquea *et al.* 2005).

Table 1 List of the ten most dominant trees (>10 cm GBH), shrubs and herbs species and their density ha^{-1} (D) and frequency % (F) in overall, Assam and Arunachal Pradesh homegardens

Species Name	Family	Overall		Assam		Arunachal Pradesh	
		D	F	D	F	D	F
Tree							
Areca catechu L.	Arecaceae	656.54	45.55	1094.06	56.44	165.56	33.33
Bambusa balcooa Roxb.	Poaceae	1988.48	7.33	2958.42	9.90	900.00	4.44
Bambusa nutans G. C. Wall. ex Munro	Poaceae	256.54	2.09	445.54	1.98	44.44	2.22
Bambusa pallida Munro.	Poaceae	6387.43	17.28	6801.98	18.81	5922.22	15.56
Bambusa tulda Roxb.	Poaceae	1385.34	3.66	1926.73	4.95	777.78	2.22
Dendrocalamus hamiltonii Arn. Ex Munro	Poaceae	1544.50	4.19	-	-	3277.78	8.89
Dendrocalamus strictus (Roxb.) Nees	Poaceae	130.89	0.52	-	-	277.78	1.11
Musa acuminata Colla.	Musaceae	112.57	14.14	84.16	13.86	144.44	14.44
Musa balbisiana Colla.	Musaceae	95.81	10.47	117.82	13.86	71.11	6.67
Musa calosperma F. Muell.	Musaceae	104.19	14.14	112.87	17.82	94.44	10.00
Shrub							
Capsicum annum L. var. *longum*	Solanaceae	481.68	17.80	415.84	16.83	555.56	18.89
Capsicum chinense Jacq.	Solanaceae	148.69	7.33	19.80	0.99	293.33	14.44
Chromolaena odorata King & H.E. Robins.	Asteraceae	182.20	7.85	380.20	15.84	235.56	11.11
Clerodendrum colebrookianum Wall.	Verbenaceae	368.59	20.94	174.26	10.89	586.67	32.22
Codiaeum variegatum (L.) Juss.	Euphorbiaceae	211.52	8.90	297.03	11.88	115.56	5.56
Euonymus japonicus Thunb.	Celastraceae	534.03	17.28	724.75	24.75	320.00	8.89
Gardenia jasminoides Ellis.	Rubiaceae	113.09	5.76	106.93	4.95	120.00	6.67
Ocimum sanctum L.	Lamiaceae	230.37	10.47	320.79	13.86	128.89	6.67
Solanum melongena L.	Solanaceae	391.62	14.14	590.10	18.81	168.89	8.89
Solanum torvum Swartz.	Solanaceae	157.07	10.99	142.57	5.94	173.33	16.67
Herb							
Ageratum conyzoides L.	Asteraceae	13376.96	13.35	21435.64	15.84	4333.33	10.56
Axonopus sp.	Poaceae	29267.02	12.83	15247.52	9.41	45000.00	16.67
Brassica juncea Czern. & Cross. var. *cuneifolia* Roxb.	Brassicaceae	12277.49	15.45	16237.62	19.80	7833.33	10.56
Centella asiatica (L.) Urban	Apiaceae	23717.28	12.04	32970.30	16.83	13333.33	6.67
Cynodon dactylon (L.) Pers.	Poaceae	19345.55	10.99	21485.15	12.38	16944.44	9.44
Dryopteris sp.	Dryopteridaceae	10287.96	10.99	13762.38	13.86	6388.89	7.78
Houttuynia cordata Thunb.	Saururaceae	9502.62	6.81	11633.66	8.42	7111.11	5.00
Hydrocotyle rotundifolia Roxb. ex DC.	Apiaceae	11649.21	6.02	16089.11	9.41	6666.67	2.22
Oplismenus sp.	Poaceae	12408.38	7.07	12821.78	8.42	11944.44	5.56
Oxalis corniculata L.	Oxalidaceae	13691.10	7.59	7821.78	6.93	20277.78	8.33

Species with higher density were almost same in both the states and bamboo, beetle nut and banana contributed the most. The inhabiting people of northeast India practicing homegardens of different sizes based on their economic status. The size of the studied homegardens varied greatly and it ranged from 0.05 to 0.27 ha (mean 0.13 ± 0.01 ha) (Table 3). Species richness per homegarden also varied in different homegardens and it ranged from 25 to 87 with an average of 46 (SE ± 1.98). In Assam, it ranged from 28 to 87 (mean 51 ± 3.15), whereas, in Arunachal Pradesh, it ranged from 25 to 59 (mean 41 ± 1.97) (Fig 2). Present study revealed positive correlations between homegarden size and species richness ($r = 0.021$, $p > 0.001$) (Fig 3). In the present study, basal area of tree species was higher in Arunachal Pradesh (2.12 m^2 ha^{-1}) than in Assam (1.27 m^2 ha^{-1}). On the other hand, values of density of tree, shrub and herb were

higher in Assam compared to Arunachal Pradesh (Table 4). Similarly, diversity of tree and herb species (Shannon-Wiener diversity index) was also higher in Assam (3.81 and 4.15, respectively) than Arunachal Pradesh (3.66 and 3.90, respectively) but, it was higher in Arunachal Pradesh (3.68) in case of shrub species. Although, concentration of dominance (Simpson's index) of tree and shrub species was found to be same in both the states, in case of herb species, it was higher in Arunachal Pradesh (0.03) compared to Assam (0.02). Biophysical factors, altitude and slope of the farms, affect the diversity of crop species. In the conformity with the present report, Soemarwoto and Conway (1991) had also reported a decrease in plant species diversity of homegardens with increasing altitude. In Assam, a total of 230 species were found which include 91 trees, 42 shrubs and 97 herbs and used as fruit, vegetable, medicinal, timber, ornamental and miscellaneous etc. Whereas, in Arunachal Pradesh, a total of 205 plant species were recorded which include 82 trees, 44 shrubs and 79 herbs and they were used as ornamental, fruits, vegetables, timber and miscellaneous etc.

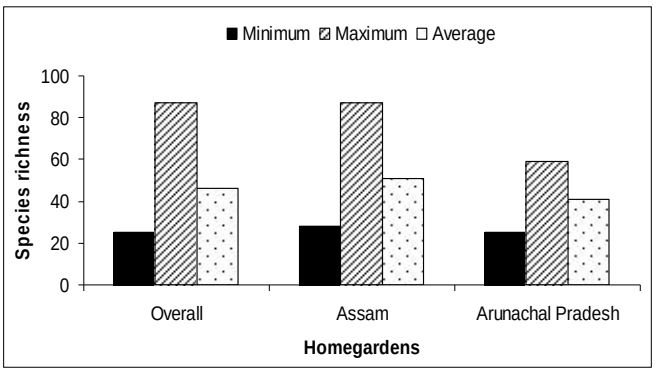

Fig 2 Minimum, maximum and average species richness of overall, Assam and Arunachal Pradesh homegardens

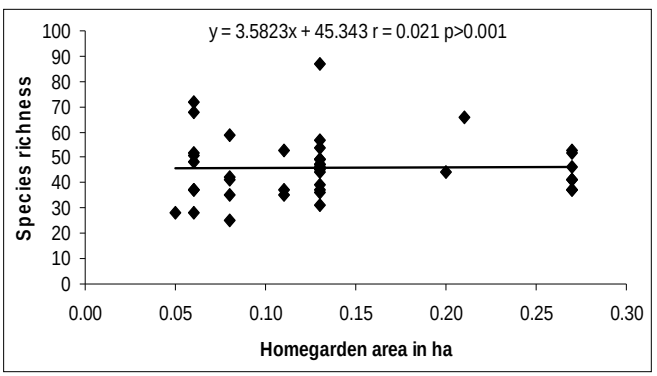

Fig 3 Correlation between homegarden size and species richness in different studied homegardens

The species composition and species richness of Assam and Arunachal Pradesh were varied due to the ecological and ethnicity differences. Diverse life style, tradition and cultural practices in both the states may also have a greater effect in such variation in species diversity in the region. In the present study species richness per homegarden was varied greatly (25 to 87 species with an average of 46±1.98 species per garden) which is in conformity with the earlier report from Yunnan (Dao *et al*. 2000). Differences in soil fertility among different homegardens could be the reasons for the variation in species richness per homegarden. Again, homegardens of the study site was predominated by herbs and trees followed by shrubs. Similar findings were also reported by Kabir and Webb (2008). Mean Shannon-Wiener diversity indices vary widely in tropical homegardens and are reported from 0.93 in rural Zambia (Drescher 1998) to almost 3.0 in West Java, Indonesia (Karyono 1990). Present study reported higher Shannon-Wiener diversity index for tree, shrub and herb (3.98, 3.96 and 4.18, respectively) than the earlier report. It also revealed positive correlations between homegarden size and species richness and it is found to be related with the socio-economic status and the interest of the owners. Similarly, Das and Das (2005) also found a positive relation between homegarden size and diversity which is also related to the socio-economic conditions of the owners.

Plant Sstratification

Homegardens are multistory combinations of various trees and crops around homesteads. It shows complex vertical structure somewhat similar with the nearby forest vegetation. Five vertical strata (emergent, canopy, under storey, shrub and herb) had been identified in the studied homegardens based on the average height of the plant species. Percentage of species in different strata varied greatly and it was highest in herb stratum (37%) and lowest in emergent stratum (1%) (Fig 4). Emergent stratum was composed of mainly bamboos and timber species like *Anthocephalus chinensis*. Similarly, in canopy stratum also bamboos and timber species were the most frequent component along with some other fruit plants like *Mangifera indica*, *Cocus nucifera* and *Artocarpus heterophyllus*. On the other hand, understorey stratum was consisted of mainly by *Areca catechu* and by some other ornamental and medicinal species. Shrub species like *Hibiscus rosa sinensis*, *Clerodendrum viscosum*, *Capsicum annum* and saplings of the trees were the most frequent component of the shrub stratum, whereas, herbs stratum consisted of many herbaceous species like *Centella asiatica*, *Ageratum conyzoides*, *Achyranthus aspera*, etc. and also seedlings of the higher strata. In homegardens of Assam, all the five above mentioned strata were found with predominance of species in herb stratum (40%) but, in homegardens of Arunachal Pradesh only herb, shrub, understorey and canopy strata had been recorded with highest percentage of species in herb stratum (35%). The vertical structure of many homegardens described in the literature is often complex, but quite variable. Light intensity decreases successively from the emergent strata towards ground cover in the homegarden (Gajaseni and Gajaseni 1999). Vertical stratification is a common structure among homegardens throughout the tropics (Gillespie *et al.* 1993, Karyono 1990). Five vertical strata were being observed in the homegardens of Assam, but only four strata were observed in homegardens of Arunachal Pradesh excluding the emergent stratum. These entire five strata were not observed in all the studied homegarden, but the canopy,

shrub and herb strata were observed in all the studied homegardens. The multilayered canopy configuration of the homegardens, with less plant density and species richness in the upper strata were also recorded by Millat-e-Mustafa *et al.* (1996). Fernandez and Nair (1986) recorded three to four canopy layers in tropical homegardens, whereas; present study recorded four to five vertical strata similar with the homegardens of Barak Valley, Assam (Das and Das 2005).

Table 2 Family wise species richness in overall, Assam and Arunachal Pradesh homegardens, NE India

Family	Overall	Assam	Arunachal Pradesh
Acanthaceae	6	4	2
Agavaceae	1	1	-
Alliaceae	1	1	1
Amaranthaceae	7	6	4
Anacardiaceae	2	2	1
Annonaceae	2	2	1
Apiaceae	5	6	5
Apocynaceae	4	3	4
Araceae	4	4	3
Araliaceae	1	1	-
Araucariaceae	1	-	1
Arecaceae	7	6	4
Asparagaceae	1	-	1
Asteraceae	7	7	7
Athyriaceae	1	1	1
Averrhoaceae	2	2	1
Balsamniaceae	1	1	1
Begoniaceae	1	-	1
Boraginaceae	2	2	1
Brassicaceae	4	3	4
Bromeliaceae	1	1	1
Caesalpinaceae	10	5	8
Cannabinaceae	1	1	1
Caricaceae	1	1	1
Caryophyllaceae	1	1	1
Celastraceae	1	1	1
Chenopodiaceae	3	3	3
Clusiaceae	5	5	1
Combretaceae	3	3	2
Commelinaceae	1	1	1
Covolvulaceae	2	2	1
Crassulaceae	1	1	1
Cucurbitaceae	8	7	6
Cyperaceae	2	2	2
Dilleniaceae	1	1	1
Dioscoreaceae	2	1	1
Dipterocarpaceae	2	-	2
Dryopteridaceae	1	1	1
Elaeocarpaceae	1	1	1
Euphorbiaceae	11	10	7
Flacourtiaceae	1	1	1
Lamiaceae	5	4	3
Lauraceae	5	4	3
Lawsoniaceae	1	1	1
Liliaceae	2	-	2
Lythraceae	3	3	3
Magnoliaceae	3	2	3
Malvaceae	8	6	7
Melastomaceae	1	1	1
Meliaceae	2	2	2
Mimosaceae	6	4	4
Moraceae	6	6	5
Moringaceae	1	1	1
Musaceae	5	5	4
Myrtaceae	5	4	4
Nyctaginaceae	2	1	2
Oleaceae	2	2	2
Orchidaceae	1	1	-
Oxalidaceae	3	3	2
Papilionaceae	7	7	4
Piperaceae	4	3	2
Plantaginaceae	1	1	1
Poaceae	14	11	14
Polygonaceae	4	3	3
Proteaceae	1	1	-
Pteridaceae	2	2	1
Punicaceae	1	1	1
Rhamnaceae	1	1	2
Rhizophoraceae	1	1	-
Rosaceae	6	6	5
Rubiaceae	7	6	4
Rutaceae	10	9	8
Sapindaceae	1	1	1
Sapotaceae	2	1	2
Saururaceae	1	1	1
Scrophulariaceae	2	2	1
Solanaceae	11	10	11
Strelitziaceae	1	1	-
Thymelaeaceae	1	1	1
Unknown	2	1	1
Urticaceae	1	1	-
Verbenaceae	6	6	5
Zingiberaceae	2	2	1
Total	269	230	205

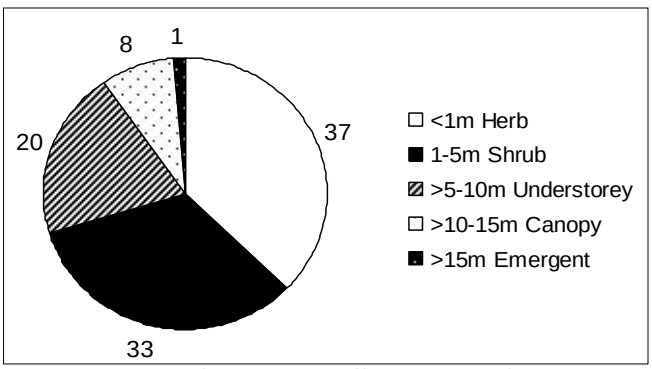

Fig 4 Percentage of species in different strata of the studied homegardens of Northeast India

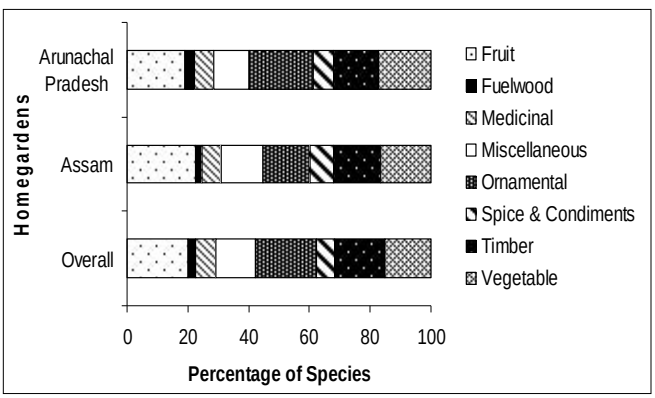

Fig 5 Percentage of species found in different use category of overall, Assam and Arunachal Pradesh homegardens

Table 3 Location, area (ha) and species diversity of studied homegardens (HGs) of Assam and Arunachal Pradesh, NE India

HG No.	State	Village	Area in ha	Species diversity			
				Tree	Shrub	Herb	Total
HG1	Assam	Gutibari	0.13	32	20	35	87
HG2	Assam	Gutibari	0.06	28	13	31	72
HG3	Assam	Gutibari	0.21	23	11	32	66
HG4	Assam	Gutibari	0.27	15	4	33	52
HG5	Assam	Gutibari	0.13	29	8	10	47
HG6	Assam	Gutibari	0.06	13	7	8	28
HG7	Assam	Merbill	0.13	24	7	26	57
HG8	Assam	Merbill	0.27	21	5	15	41
HG9	Assam	Merbill	0.13	15	1	15	31
HG10	Assam	Merbill	0.13	24	7	18	49
HG11	Assam	Merbill	0.06	18	1	18	37
HG12	Assam	Merbill	0.13	21	8	16	45
HG13	Assam	Merbill	0.13	25	7	15	47
HG14	Assam	Merbill	0.06	37	9	22	68
HG15	Assam	Merbill	0.06	29	8	15	52
HG16	Assam	Merbill	0.06	20	12	19	51
HG17	Assam	Bordoloni	0.13	14	8	22	44
HG18	Assam	Bordoloni	0.13	23	7	19	49
HG19	Assam	Bordoloni	0.27	26	3	17	46
HG20	Assam	Bordoloni	0.27	20	6	15	41
HG21	Arunachal Pradesh	Nirjuli 2B	0.27	19	6	28	53
HG22	Arunachal Pradesh	Nirjuli 2B	0.06	17	6	25	48
HG23	Arunachal Pradesh	Nirjuli 2B	0.06	13	9	15	37
HG24	Arunachal Pradesh	Nirjuli 2B	0.08	30	12	17	59
HG25	Arunachal Pradesh	Nirjuli village 1	0.08	24	4	13	41
HG26	Arunachal Pradesh	Nirjuli village 1	0.05	13	5	10	28
HG27	Arunachal Pradesh	Nirjuli village 1	0.11	16	7	14	37
HG28	Arunachal Pradesh	Nirjuli village 1	0.08	18	6	11	35
HG29	Arunachal Pradesh	Nirjuli village 1	0.08	7	5	13	25
HG30	Arunachal Pradesh	Nirjuli village 1	0.13	12	10	14	36
HG31	Arunachal Pradesh	Nirjuli village 1	0.27	13	7	17	37
HG32	Arunachal Pradesh	Nirjuli village 1	0.13	11	9	17	37
HG33	Arunachal Pradesh	Nirjuli village 1	0.27	9	10	18	37
HG34	Arunachal Pradesh	Doimuk	0.13	16	13	17	46
HG35	Arunachal Pradesh	Doimuk	0.11	14	8	13	35
HG36	Arunachal Pradesh	Doimuk	0.13	14	9	16	39
HG37	Arunachal Pradesh	Doimuk	0.20	16	7	21	44
HG38	Arunachal Pradesh	Doimuk	0.08	14	10	18	42
HG39	Arunachal Pradesh	Doimuk	0.11	21	11	21	53
HG40	Arunachal Pradesh	Doimuk	0.13	19	12	23	54

Plant utilization pattern

Most of the species present in the studied homegardens are being used by the owners for different purposes. Out of the total 268 species recorded, 208 species were economically important with different household utilities. Rest 60 species were weeds and grasses which perform different ecosystem services in the form of wildlife habitat, species conservation, preservation and enhancement of water quality, reduction in erosive force of water, maintenance of hydrological cycle, conservation of soil, preservation and enhancement of soil quality including carbon sequestration, etc. Overall study showed that out of the total economically important species, 20% was contributed by each of the fruit and ornamental plants followed by timber, vegetables, miscellaneous, medicinal, spice and condiment and fuel wood species (Fig 5). In Assam, fruit bearing species were the most dominant one (20%) followed by vegetables, timber, ornamental, miscellaneous, spice and condiment, medicinal and fuel wood plants, whereas, in Arunachal Pradesh, ornamental plants contributed the most (21%) followed by fruits, vegetable, timber, miscellaneous, spices and condiments, medicinal and fuel wood plants. This may be because of the differences in the life style of the inhabiting community of both the states. On the other hand, state wise data showed almost similar occurrences of medicinal plants, vegetables, spice and condiments, fuel wood and timber trees. But, there was a difference in occurrence of ornamental, fruit and

plants of miscellaneous uses. Some of the good timber species common in both the states are *Anthocephalus chinensis, Tectona grandis, Shorea robusta, Michelia champaca* and *Gmelina arborea*. Fruits plants of common occurrence are *Artocarpus heterophyllus, Litchi chinensis, Mangifera indica* and *Psidium guajava.* Owners of the studied homegardens used to cultivate different ornamental plants in their homegardens mainly in the front yard to enhance the aesthetic beauty of their homegardens. Commonly cultivated ornamental species are *Delonix regia, Hibiscus rosa chinensis, Messua ferrea* and *Rosa alba.* Besides, they also used to cultivate some medicinal plants for the basic treatment of various ailments and diseases of both human beings and their livestocks. Some of the most commonly cultivated medicinal plants are *Aloe vera, Azadirachta indica, Terminalia arjuna* and *Houttuynia cordata.* Although, fuelwood plant contributed lowest percentage (2%) to the total economically important plants, plants of other utilities were also used for fuelwood purpose.

Table 4 Community characteristics of overall, Assam and Arunachal Pradesh homegardens, NE India

Parameter		Overall	Assam	Arunachal Pradesh
Number of families		82	77	75
Number of genera		200	176	163
Species richness		268	230	205
Density (ha^{-1})	Tree	13,331	14,176	12,383
	Shrub	6,442	7,267	5,516
	Herb	3,62,565	4,10,396	3,08,889
Diversity (Shannon's H')	Tree	3.98	3.81	3.66
	Shrub	3.96	3.67	3.68
	Herb	4.18	4.15	3.90
Concentration of dominance	Tree	0.04	0.05	0.05
	Shrub	0.03	0.04	0.04
	Herb	0.02	0.02	0.03
Basal area (m^2 ha^{-1})	Tree	1.85	1.27	2.12

Species available in homegarden were being utilized in different ways like fruit, vegetable, medicine, timber, fuelwood, ornamental plant, construction materials, spice and condiments and also in religious and sacred purposes. In the present study, homegarden plants were used mainly as fruit, ornamental plants followed by timber and vegetables, whereas, other studies (Rico-Gray *et al*. 1990, Padoch and De-Jong 1991) reported the predominance of food, fruit as well as medicinal plants. 50 out of the 101 plant species recorded in the homegardens of Cuba are cultivated as medicinal plants (Hammer *et al*. 1989). On the other hand, Sunwar *et al*. (2006) reported vegetable species as the most important component in Nepalese homegardens followed by fruit, fodder and spices. Like the homegardens of northeastern Brazil (Albuquerquea *et al.* 2005) homegarden of Assam were also characterized by a high density of the fruit plants, whereas, predominance of ornamental plants was recorded in homegarden of Arunachal Pradesh. This may be due to the difference in the tradition, culture and food habit of the inhabiting community. In the present study, owners used to cultivate different species mainly for household consumption and sometimes they used to sell the surplus to the nearby market. But, the villagers of Barak Valley, Assam used to plant trees for both household consumption and income generation (Das and Das 2005). In both the states, minimum utilization of species was found in fuel wood category, because owners preferred to cultivate the species with multiple uses and they utilize the plants of other use categories also for fuel wood purposes.

The present study reported a great diversity of plant species from small herbs to tall trees. Although, homegardens have similar species composition with the neighbouring forest vegetation, it also shares species which is exotic in origin and not common in the nearby areas. Owners are cultivating some rare/endangered species like *Aquilaria malaccensis, Livistona jenkinsiana, Clerodendrum colebrookianum* etc. along with other traditional homegarden species. Thus, it can be considered as a reservoir of rare plant genetic resources. Aboveground structures of the homegardens have evolved for a high utilization efficiency of space and resources, especially light, water and soil nutrients. Besides, homegardens are suitable from environmental as well as long term sustainability considerations as it provides higher returns compared to lower inputs. Further studies may be conducted to understand the plant utilization pattern in details and genetic diversity of rare/endangered species in the homegardens to assess the potential of homegardens for their conservation.

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