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Dominance Hierarchies, Diversity and Spatial Connect of Crops in Banana Based High Range Home Gardens

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Authors' contributions

This work was carried out in collaboration among all authors. Author MNB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript and managed the literature searches. Authors AT and UCT managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Home gardens are a time tested food production system which can be projected as a promise to the future to mitigate the issues related to the global food security crisis. The home gardens in Kerala are an integral part of the rich tradition which impart a dominant role in livelihood security of the people. The diversity profile of traditional homegardens of high range area and its spatial patterns were investigated in the present study revealed that a mean Shannon and Wiener diversity index (H) of 2.185 was recorded which denoted a dwindling trend in species diversity in banana based high range home gardens of Idukki. An appraisal of the diversity of crops revealed that the highest diversity was recorded in spices (H=1.425) and was on par with fruit crops (H=1.339) whereas lowest was noted on fodder crops (H= 0.054) followed by medicinal plants (H=0.197). Furthermore, the mean total diversity index exhibited a positive significant correlation with the total area of the home garden with a correlation coefficient of 0.621 which signified the importance of spatial dimensions in determining the diversity profile of the home gardens.

Keywords: Biodiversity; banana; high range; home gardens; Kerala; Shannon–wiener index.

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1. INTRODUCTION

Home gardens are considered as a sustainable approach to feed a hungry planet strives for ensuring food and nutritional security to the escalating population. Home gardens are traditional land-use systems located near to the home with a multitude of crop plants and woody plants sometimes along with livestock, which ensure the ecological, social and economic well-being of the people [1]. Being one of the ancient agricultural system, second to the shifting cultivation, the home garden has still its role in sustainable food production systems across the globe. Home gardens mimic the natural ecosystems and ensure ecological resilience with special emphasize on edaphic factors, groundwater table and nurturing of biodiversity. Home gardens are hot spots of biodiversity and also act as a reservoir of endangered species, landraces and wild cultivars [2]. The tropical homegardens provided an array of services to the ecosystem by act as a highly diversified ecological niche that provide refugee to the micro and macro fauna coupled with conservation of threatened plant species [3]. Home gardens are also considered as the socio-economic unit that play a significant role in dissemination of indigenous knowledge for the future generation [4].

Kerala, the Gods own country, bestowed with rich biodiversity is often sanctified as the paradise of home gardens. The home gardens in Kerala are low input agricultural production systems which exhibit structural and temporal resemblance with tropical home gardens [5]. The home gardens of Kerala considered as the predominant food production system of the state with the unique structural arrangement and diversified cropping patterns [6]. Most of the home gardens in Kerala played a vital role in the maintenance of soil nutrient status, rising groundwater table and fostering biodiversity [7].

The traditional home gardens are in the menace of homogenization which creates downstream effects on the ecosystem balance. Unanticipated developments may induce a paradigm shift in the structural configuration and diversity profile of home gardens in Kerala. Furthermore, the role of home gardens in augmenting the livelihood security is less a discussed topic of research in Kerala. In this scenario, the present study focused on the spatial dimensions and diversity profile of high range home gardens of Kerala to develop site-specific policies for the renovation of traditional home gardens.

2. MATERIALS AND METHODS

2.1 Study Area

A study was undertaken in the high range home gardens of Idukki, the second largest district in Kerala renowned for its rich biodiversity as it is bordered by the Western Ghats. This picturesque district in Kerala recorded the lowest population density with about 97% of the area under forest and perilous terrains. Being the spice garden of Kerala, it is also famous for the cultivation of cash crops owing to the climatic, edaphic and ecological factors prevailing on the area.

The present study was performed in the high range home gardens of Adimaly (10.01150 N, 76.95280 E) in the Idduki district of Kerala during the year 2018 to 2020. This panchayath was purposively selected owing to the dominance of banana-based home gardens.

2.2 Sampling Methods

The biodiversity of the region was appraised by selecting fifteen home gardens from the panchayat and by enumerating the plant component in each home garden. The home gardens were divided into three regions *viz.,* courtyard (CY), mid-region (MR) and outer region (OR). The courtyard is defined as the immediate surroundings of the home with frequent access by the farmer family whereas the outer region is the place located away from the house and mid-region situated in between these regions. The details on the area of the home garden and plant components were collected from the regions separately for the comparison of biodiversity in this region. The crops were categorized into groups based on the functional aspect as vegetables, spices, plantation crops, beverages, fruits, tubers, medicinal plants, ornamentals and multipurpose trees and the total count of plants were recorded. The taxonomic identification of the uncommon plant species was done by experts in the relevant fields.

Shannon-Wiener diversity index was used to calculate the biodiversity of different regions of home gardens. The equation is $H = -\Sigma Pi \log (Pi)$, where, $Pi = ni/N$ (ni = number of individuals of a species, N = total number of individuals of all species). ANOVA analysis was performed to identify the variations in biodiversity using WASP 2.0 software. The mean Shannon-Wiener diversity index was calculated for each home garden and was correlated with a total area of the home garden. Furthermore,

correlation analysis was also conducted for the diversity index of different regions of the home garden with area using Pearson's correlation coefficient test in WASP 2.0 software.

3. RESULTS AND DISCUSSION

The Shannon-Wiener diversity index of the different regions of tested fifteen home gardens exhibited a significant difference which denoted the role of spatial dimensions in the maintenance of agro biodiversity. About 154 plant species under 58 families were recorded from the banana-based high range home gardens of Idukki which signified the rich biodiversity of the high range areas as it lies amid the Western Ghats. Majority of plants were belonging to the families Fabaceae followed by Myrtaceae and Aracaeceae (Fig. 1). Likewise, a study conducted in home gardens of North-East regions revealed that Fabaceae was the dominant family flowed by Rutaceae and Zingiberaceae [8].

The biodiversity index of different regions of banana-based home gardens is presented in Table 1. The total mean biodiversity index of the banana dominant high range home gardens was varied from 1.798-2.641 with a mean value of 2.185. The results were similar to the average biodiversity index of tropical home gardens ranged from 1.12 – 3 that mimics the diversity index of a forest ecosystem [9]. Despite the fact, the biodiversity index of high range region was dwindling owing to the deforestation, introduction of more cash crops in the crop cafeteria coupled with unforeseen changes in the climatic regime.

The diversity index of courtyard region ranged from 1.745-2.983 and was recorded with the highest diversity index of 2.596 compared to mid-region and outer region. The courtyard region is the immediate surroundings of the home which enable the easy access to the resources by farmer family, so that a diverse crop cafeteria was maintained in this region in high range home gardens. The mid-region of different home gardens exhibited a diversity index of range 1.742 - 2.755. The mid-region of banana-based home gardens were found to be on par with courtyard region with a mean diversity index of 2.332. However, the lowest diversity index was noted in the outer region and the diversity indices were varied from 0.883-2.609 with a mean diversity index of 1.626. This was contradictory to the findings of a study conducted at Kerala as it suggested that the mid -region was recorded with a higher biodiversity index in home gardens of Kerala [10].

The area of home gardens ranged from 0.500-4.000 acre with an average size of 2.070 acres. The average home garden size varied from 0.10 – 0.50 ha around the world [11] that was lower than the size of home gardens in high range regions. The significantly higher size of the holdings in the high range regions provides sufficient space for growing crops to meet food security along with commercial cultivation of cash crops which assure additional income.

The correlation analysis pointed out that the total mean diversity index exhibited a positive significant correlation with a correlation coefficient of 0.621. Species richness exhibited a positive correlation with size of home gardens based on a study conducted at Western Nepal which corroborated the present findings[12]. Likewise, positive correlation of home garden size with species richness in Nepal were also recorded [13]. Similar results were also pointed out in home gardens of North- East region [8]. In contradictory to the present finding, size of home garden greatly varied and not exhibit any correlation with species richness but related to the number of individual species in Northeastern Brazil [14]. Besides, the crop diversity of mid-region also exhibited a significant positive response with the total area of the home garden with a correlation coefficient of 0.681. Similarly, the courtyard region and outer region exhibited a positive yet non-significant correlation with the total size of holding of the homegardens.

An appraisal on the diversity of various crop groups in the home gardens of the banana-based ecosystem is depicted in Table 2.

The findings revealed that spice crop was the dominant member in banana based high range home gardens with a diversity index of 1.425 and was statistically on par with the fruit crops (H=1.339). The geographic and climatic peculiarities of the region provides strong footing and support for the cultivation of cash crops in the high range regions. The cultivation of spice crops modify the soil micro habitat and improve the soil productivity which enhance the diversity of crops [6]. A higher diversity of spice crops were reported in home gardens of Ethiopia that were mainly concerned for house hold use and also as a source of income to the farmers [15]. The higher vegetative cover provided by these crops mitigate the soil erosion problems, improves soil health and upgrade the species composition in the area [16].

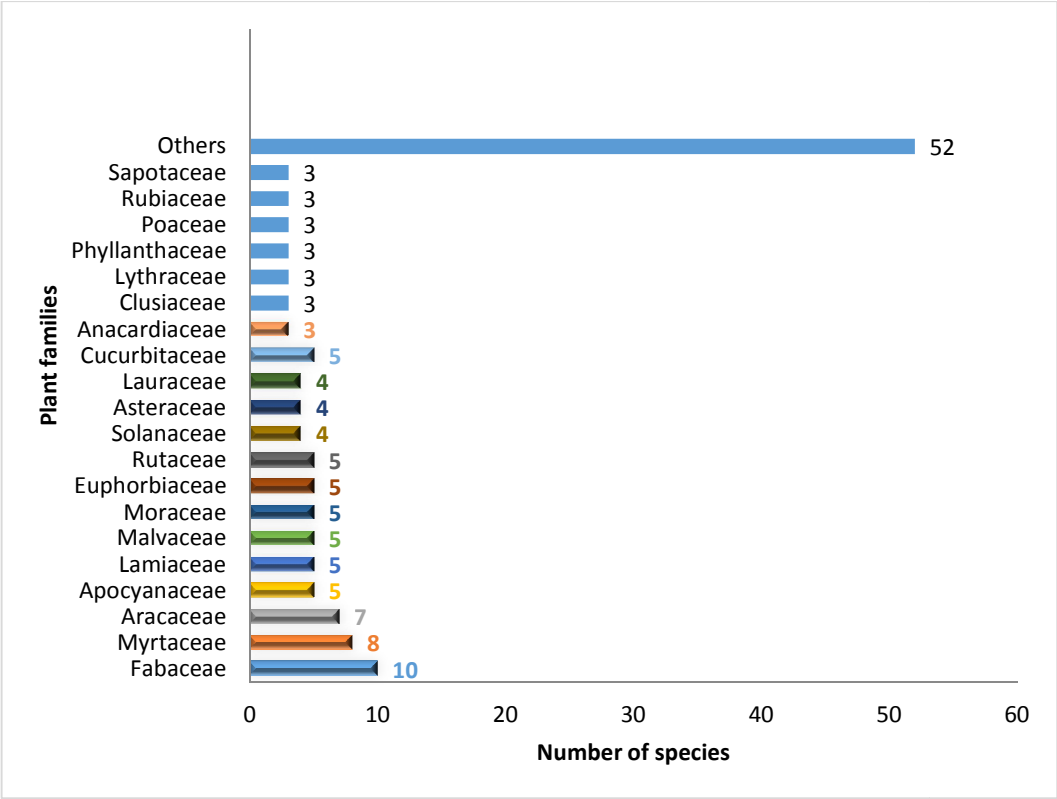

Fig. 1. Species-richness of plant families (≥ 3) in the banana based high range home gardens of Idukki district

Table 1. Region wise and total diversity index of each banana dominant homegardens and relationship between its area and total diversity index

HGS	CY	MR	OR	Mean Total DI	Area(acre)
1	2.718	2.362	2.609	2.563	4.000
2	2.736	2.755	0.883	2.125	1.500
3	2.398	2.325	0.930	1.884	2.250
4	1.745	2.418	1.230	1.798	1.250
5	2.772	2.666	2.050	2.496	3.000
6	2.891	2.492	1.237	2.207	3.000
7	2.838	2.137	1.836	2.271	2.000
8	2.227	2.289	1.998	2.171	1.500
9	2.089	1.953	1.704	1.915	1.250
10	2.582	2.300	0.970	1.951	2.300
11	2.811	2.321	2.563	2.565	1.500
12	2.983	1.742	1.025	1.917	0.500
13	2.504	2.013	1.770	2.096	1.500
14	2.776	2.704	2.443	2.641	3.000
15	2.872	2.500	1.134	2.169	2.500
Mean total	2.596	2.332	1.626	2.185	2.070
SD	0.347	0.284	0.614	0.274	0.914
SE	0.089	0.073	0.159	0.071	0.236
Min-Max	1.745-2.983	1.742- 2.755	0.883-2.609	1.798-2.641	0.500-4.000
F value	19.622			Correlation coefficient=0.621*	
CD (0.01)	0.432**				

Table 2. The diversity index of crops in banana - based high range home gardens

Type of home garden (H) / Crop (C)	Banana
Vegetables	0.529
Tubers	0.405
Fruits	1.339
Plantation	1.175
Spices	1.425
Medicinal plants	0.197
Ornamentals	0.709
MPTS	0.721
Fodder crops	0.054
F value	37.700
CD (0.01)	0.292

A higher diversity of fruit crops in banana based high range home gardens with a Shannon-Wiener diversity index of 1.339 signified the role of homegardens in maintenance of nutritional security. Fruits are one of the major component in the home gardens which supplemented the nutritive needs of the farmer family [17]. A study conducted in the household gardens of Peru also revealed that fruits and medicinal plants were dominated which were in partial agreement with the present finding [18].

The lowest diversity index was exhibited by fodder crops (0.054) which was on par with medicinal plants (0.197). This may be due to the less prevalence of livestock components in the high range homegardens. Furthermore, the ample availability of food sources such as weeds and wild flora reduced the necessity in cultivation of fodder crops. A perusal of the table disclosed that medicinal crops also shown a less biodiversity index in the region. This may be due to the increased reliance of the community on allopathic medicines that impart dwindling interest in traditional medicines. A study conducted in Vietnam suggested that the medicinal plants were the most dominant crop in the surveyed 120 homegardens [19]. Similar results were also reported in homesteads of Ghana [20] and in Peruvian homegardens [18] which were contradictory to the present findings. Likewise, ornamental plants were also recorded with a low biodiversity index in high range home gardens of Idukki. An investigation on the crop dominance in home gardens of Gautemala disclosed that the majority of the plants belongs to the ornamental group [21]. Similarly, exploration of crop components in the households of Austria bring to light that ornamental crops dominate the crop cafeteria which associated with the religious customs of the community [22].

4. CONCLUSION

The homegardens of Kerala were considered as typical agro ecosystems which were renowned for its sustainability, diversity and also as an ecological niche for the endangered species complex. The homegardens of high range area was peculiar with specialized topographic and climatic regime which ensure a high biodiversity index in the region. However, incorporation of more cash crops may create unforeseen impacts in the high range ecosystems. In this scenario, programmes should be implemented to promote the cultivation of vegetables via the association of SHG's and youth clubs of the region.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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