IMPACT OF NUTMEG (*Myristica fragrans*) DOMINANCE ON VEGETATION COMPOSITION AND DIVERSITY IN KANDYAN HOME GARDENS

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Kandyan home gardens are well-established land use systems found in the mid country wet zone especially in and around the Kandy District. Due to their unique vegetation characteristics, these ecosystems play an important role in enhancing food security and biodiversity. Among the cultivated species, nutmeg (*Myristica fragrans*) has become a popular crop due to its high economic value. This study aims to investigate the dominance of nutmeg in Kandyan home gardens and its impact on plant diversity by comparing the species diversity of home gardens with and without nutmeg trees. Vegetation data were collected using the Point-Centered Quarter Method (PCQM) at 10 sampling points along a 50 m transect, recording 40 trees in total. Light intensity at each point was measured and for each plant, the distance from the central point, diameter at breast height (DBH), and tree height were recorded. Species dominance, diversity, and structure were assessed using standard ecological indices. A species abundance matrix within study sites was analyzed using PCORD software. Cluster analysis and Detrended Correspondence Analysis (DCA) were used to determine species composition patterns across Kandyan home gardens. Biodiversity indices were computed using Biodiversity Pro software for comparative analysis between sampling sites. Nutmeg was found in 78% of the sites surveyed, contributing an average of 17% to total tree density and 19.75% to overall basal area, indicating its strong ecological presence. Home gardens with higher nutmeg density showed lower absolute tree density, reduced light intensity, and a strong negative correlation between nutmeg abundance and understory light levels. Species diversity was notably lower in nutmeg-dominated sites. Cluster and DCA analyses grouped home gardens into distinct clusters based on species assemblages, with nutmeg-dominated sites forming separate ecological outliers. DCA ordination confirmed that *Myristica fragrans* strongly influenced site distribution, highlighting its role as a key driver of species composition. These findings suggest that nutmeg dominance can substantially alter species diversity and ecosystem structure in Kandyan home gardens. Adaptive management strategies are recommended to maintain productivity, ecological resilience, and biodiversity conservation in these systems.

Keywords: nutmeg, dominance, home gardens, diversity, composition

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INTRODUCTION

Home gardens are agroforestry systems that originated in the past and are still practiced worldwide, offering multiple functions such as food, medicine, firewood, and income while conserving biodiversity (Kumar, 2015). These systems play a critical role in enhancing food security and environmental sustainability. The Kandyan home garden system in Sri Lanka, which is located in the central highlands, is well known for its cultural significance, species diversity, and unique vegetation structure. These ecosystems support both livelihoods and biodiversity conservation (Pushpakumara et al., 2020). Among the cultivated species in these home gardens, nutmeg (*Myristica fragrans*) has become a popular crop due to its high economic value. Nutmeg, which is native to Indonesia, was introduced to Sri Lanka during the colonial period and is currently cultivated extensively by smallholder farmers (Sasikumar, 2021). Due to its shade tolerance ability, long productive life, and intercropping compatibility it has become an attractive choice for agroforestry practices. Ecological studies report that diverse agroforestry systems are more resilient to environmental and economic stress (Murthy et al., 2016). A reduction in agroecosystem resilience due to single species dominance has been observed in arecanut-based systems in India (Sridhar, 2009). A similar risk exists in Kandyan home gardens, where nutmeg may displace other species, undermining structural complexity and ecosystem functions. However, the ecological impacts of increasing nutmeg dominance in home gardens remain less investigated. This study aims to assess the ecological impact of nutmeg dominance in Kandyan home gardens to promote balanced agroforestry practices.

METHODOLOGY

The study was conducted in home gardens in the Kandy District of Sri Lanka. A total of twenty-three (23) home garden sites were randomly selected from four (04) Grama Niladhari Divisions (GNDs), namely Menikhinna, Yatihalagala, Dehideniya, and Gannoruwa; sites 1–5 in Menikhinna, sites 6–9 in Yatihalagala, sites 10–18 in Dehideniya, and sites 19–23 in Gannoruwa (Figure 1). To examine the vegetation structure and species composition of each home garden, the Point-Centered Quarter Method (PCQM) was used. At each home garden, 10 sampling points were established along a 50 m transect, and data were collected from four 90° quarters at 5 m intervals. A total of 40 trees were recorded per site. The plant species were identified using standard field guides, taxonomic keys, and the Flora of Ceylon (Dassanayake and Fosberg, 1981). For each quarter, the distance from the central point to the nearest tree was measured.

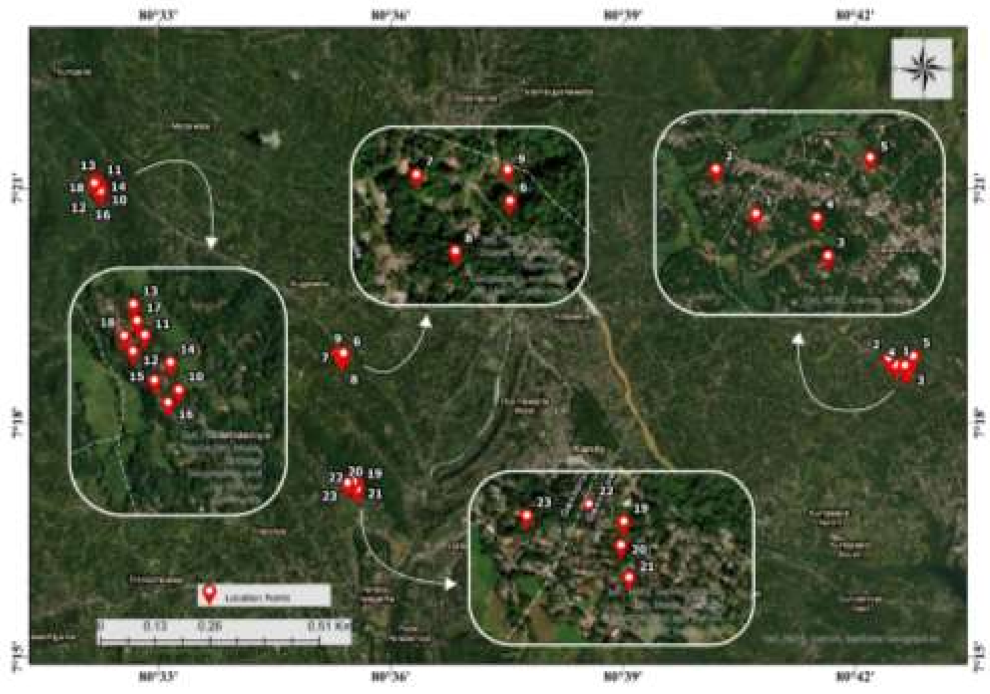

Figure 1: GPS locations of 23 sites of Kandyan home gardens

Other parameters such as diameter at breast height (DBH) were measured using a measuring tape, a clinometer was used to measure tree height, and light intensity beneath the canopy was measured using a light meter. Spatial and compositional patterns in plant communities across the 23 Kandyan home gardens were analyzed using multivariate analysis techniques in PCORD$_4$ software. Cluster analysis grouped the sites based on species composition similarity, showing distinct clusters of home gardens with comparable plant communities. Ecological gradients were further analyzed using Detrended Correspondence Analysis (DCA). Key diversity indices such as Shannon's Index, Simpson's Diversity, Alpha Diversity, and Berger-Parker Dominance were calculated using Biodiversity Pro software.

RESULTS AND DISCUSSION

Structure of vegetation in Kandyan home gardens

Nutmeg density in Kandyan home gardens

Nutmeg (*Myristica fragrans*) density notably varied across the 23 Kandyan home garden sites, reflecting differences in management strategies, site-specific environmental conditions, and farmers' economic or ecological priorities. Nutmeg was present in 18 out of 23 sites, with densities ranging from 317 to 1,023 trees per hectare (Table 1). The highest nutmeg density was recorded at site 22 (1,023 trees/ha). These dense sites likely correspond to commercially oriented home gardens where nutmeg is grown extensively for its high economic value as a spice crop.

Sites 3, 8, 14, 15, and 19 recorded zero nutmeg density, indicating either a lack of interest in this species or unsuitable environmental factors such as soil conditions. Mid-range densities (400-700 trees/ha) suggest a balanced grouping of nutmeg within a diverse crop collection.

Species composition of Kandyan home gardens

A total of 54 plant species belonging to 48 genera and 29 families were recorded across the 23 Kandyan home garden sites. These systems resemble traditional tropical home gardens in Indonesia and Central America, which integrate food, timber, spices, and ecological services. The most dominant species was coconut (*Cocos nucifera*), which was found in all sites, while banana, jackfruit, mango, and avocado were also common. Nutmeg (*Myristica fragrans*) was widely present and occupied the sub canopy layer along with species such as *Alstonia macrophylla* and *Artocarpus heterophyllus*.

Table 1: Vegetation structural characteristics across 23 study sites in relation to nutmeg (*Myristica fragrans*) distribution in Kandyan home gardens.

Site	Distance to Nearest Tree (m)	Absolute Density (trees/ha)	Nutmeg Density (trees/ha)	No of Nutmeg Trees	Total Basal Area (m^2)	Total Nutmeg Basal Area (m^2)
1	2.77	3613	451	5	14.12	2.8
2	3.15	3177	635	8	13.64	3.63
3	2.76	3623	0	0	23.67	0
4	2.84	3524	881	10	11.05	3.36
5	2.94	3407	426	5	19.17	1.47
6	3.01	3320	498	6	12.45	2.76
7	3.39	2954	739	10	11.47	6.16
8	2.94	3404	0	0	17.26	0
9	3.34	2994	973	13	11.07	6.54
10	3.53	2831	779	11	11.35	4.95
11	3.21	3113	467	6	13.52	1.95
12	3.18	3142	707	9	10.08	4.07
13	3.06	3273	409	5	13.92	1.51
14	3	3328	0	0	21.29	0
15	2.8	3568	0	0	17.17	0
16	3.98	2516	692	11	13.12	4.88
17	3.24	3084	925	12	14.86	5.06
18	2.87	3487	698	8	14.12	3.59
19	2.68	3728	0	0	23.75	0
20	3.14	3187	797	10	17.52	6.39
21	2.93	3413	853	10	12.63	3.88
22	3.67	2729	1023	15	15.77	8.28
23	3.15	3172	317	4	18.11	1.47

Nutmeg tree relationships with environmental factors

Nutmeg dominance vs. light intensity

The number of nutmeg (*Myristica fragrans*) trees and light intensity (Lux) across 23 Kandyan home gardens showed a strong negative linear relationship (Figure 2). With a high R^2 value of 0.832, the regression equation $y = -99.11x + 3046$ shows that each additional nutmeg tree reduces light by approximately 99.11 Lux. This highlights the shading effect of nutmeg trees, which alter microclimatic conditions. Due to their dense canopies, nutmeg trees limit light availability in the understory. Similar dynamics are seen globally. Shade improves soil health by reducing temperature extremes and enhancing organic matter decomposition. However, excessive shading can reduce crop yield by attracting pests and diseases. Thus, managing nutmeg shade through spacing, pruning, and careful crop selection is crucial.

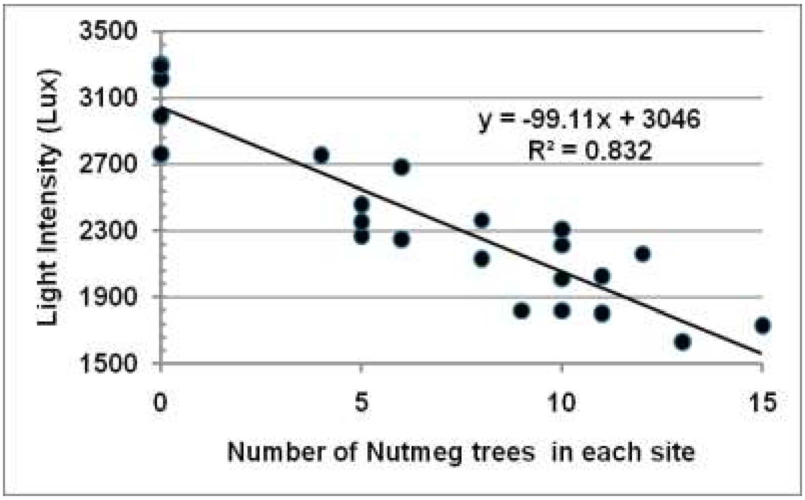

Figure 2: Relationship between nutmeg tree density and light intensity (Lux) under a tree canopy.

Diversity indices and species richness of plant communities across study sites

Results from 23 Kandyan home gardens reveal a clear negative correlation between nutmeg (*Myristica fragrans*) density and biodiversity. Sites with the highest nutmeg densities, such as Site 22 (1,023 trees/ha), recorded the lowest biodiversity indices: Shannon J' (0.84), Alpha diversity (3.61), Berger-Parker Dominance (1/d = 2.67), and Simpson's diversity (1/D = 5.38). In contrast, sites without nutmeg (e.g., Sites 8, 14, and 15) showed significantly higher biodiversity, implying that decreased species richness and evenness are due to nutmeg dominance. However, sites with moderate nutmeg densities (400–500 trees/ha) showed intermediate biodiversity levels, suggesting that strategic planting can balance economic and ecological goals.

Trends and relationships between study sites and species dominance

Multivariate approaches such as cluster analysis and ordination were used to analyze species dominance across sampling sites. Four major clusters were found in the dendrogram (Figure 3). Sites in Cluster A (S1, S5, S6, S11, S13) had a moderate density of nutmeg and showed a high degree of ecological similarity. These sites clustered near the center-left in the DCA ordination diagram, indicating shared species and relatively balanced diversity. Cluster B (S3, S19, S23) was moderately similar and consisted of sites where nutmeg was present but not dominant (Figure 4). Cluster C (S4, S21, S9, S16, S17, S20) showed gradual fusion in the dendrogram, reflecting more variation in both nutmeg presence and overall species composition. Cluster D, which contained S10 and S22, represented sites with very high nutmeg density.

The DCA ordination plot showed gradients in species composition, and most sites (e.g., S2, S5, S6, S9, S11, S13, S16, S21) were plotted close to the origin, reflecting lower nutmeg dominance and greater species diversity. Sites S1 and S12, slightly left of center, aligned with species such as *Myristica fragrans*, suggesting moderate dominance. In contrast, S10 and S22, positioned in the south-west, were strongly associated with reduced species diversity and distinct species like *Flacourtia indica* and *Garcinia mangostana*, reflecting the suppressive effect of nutmeg on overall species composition. These analyses confirm that high degree of nutmeg dominance corresponds with reduced species diversity, as shown by both the dendrogram and DCA.

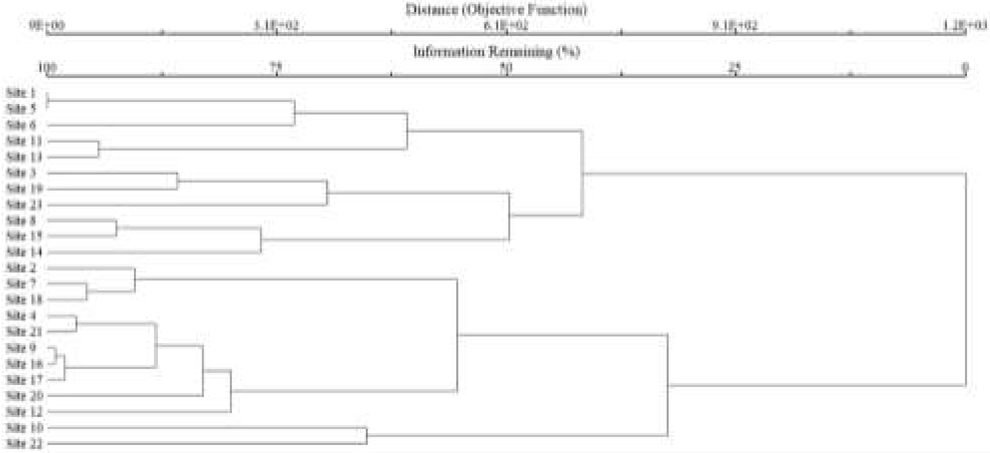

Figure 3: Dendrogram of 23 separate plots based on species composition.

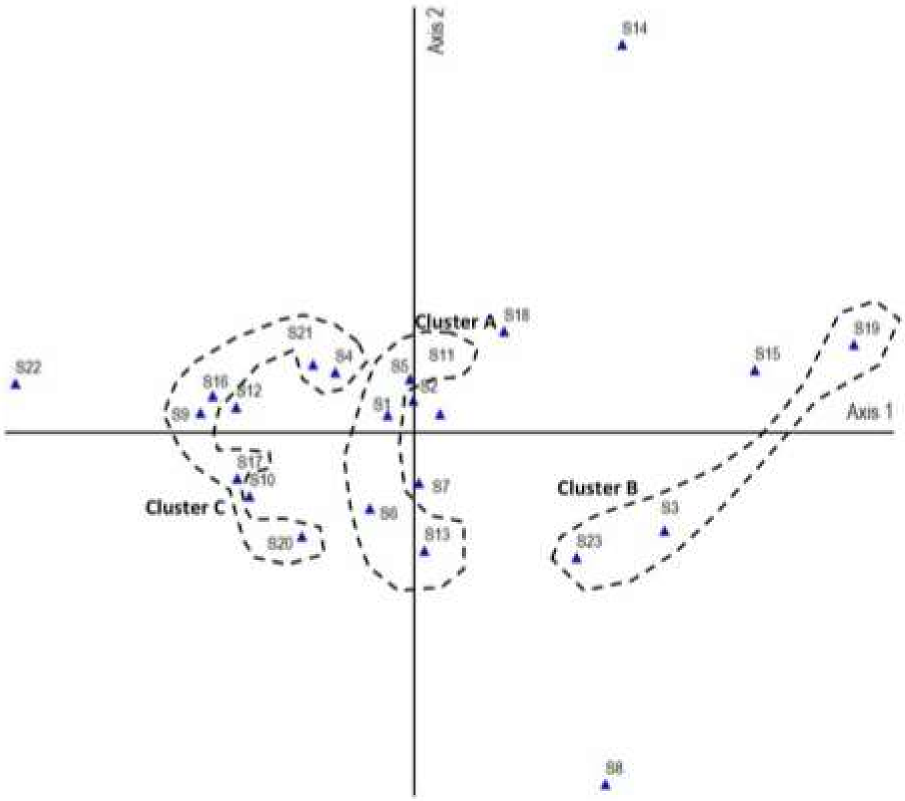

Figure 4: DCA ordination of sites (S1 to S23), with three clusters delineated by dashed-line polygons. The clusters were defined based on the hierarchical grouping results from the dendrogram.

CONCLUSIONS/RECOMMENDATIONS

Nutmeg (*Myristica fragrans*) was found in 78% of the study sites. It provides shade and regulates the microclimate but reduces understory light and diversity at high densities. Moderate levels of nutmeg cultivation support greater biodiversity, while dominance reduces ecological balance. Adaptive management strategies are crucial for maintaining productivity, resilience, and biodiversity within the ecosystem. Establishing mixed-species systems is recommended to balance both economic and ecological benefits in these agroforestry gardens.

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