SPECIES DIVERSITY IN COASTAL HOMEGARDENS OF KERALA

Abstract

This study profiles the biodiversity of coastal homegardens in Kerala, focusing on crop and regional diversity across different Agro-Ecological Units (AEUs). Utilizing the Shannon-Weiner index, biodiversity levels were quantified and analyzed, revealing significant variations among the different AEUs. Mean diversity values ranged from 0.347 for tubers to 0.998 for fruits, emphasizing the influence of local ecological conditions, cultural practices, and socio-economic factors on crop diversity. Additionally, the study investigated the biodiversity index across different regions of coastal homegardens, specifically comparing the Courtyard, Mid region, and Outer region. The mean biodiversity indices were found to be 1.117 for the Courtyard, 1.433 for the Mid region, and 1.255 for the Outer region. Overall mean biodiversity indices for AEU 1, AEU 3, and AEU 4 were 1.058, 1.159, and 1.547, respectively that can be considered to be relatively low as the coastal homegardens had mean biodiversity less than 2. Statistical analysis yielded an F value of 0.961 and a P value of 0.4345, indicating no significant difference in biodiversity indices across the regions within homegardens studied. The correlation analysis revealed significant relationships between personal and social factors of coastal homegarden farmers and biodiversity. Education, information source utilization, and economic motivation were significantly correlated with biodiversity at the 0.05 level, while market orientation showed a stronger correlation at the 0.01 level. Collaborative efforts are essential for designing and implementing interventions to promote the biodiversity sustainability and resilience of coastal homegardens. This includes enhancing crop diversification, integrating agroforestry practices, supporting small-scale farmers, and empowering marginalized groups.

Keywords: Coastal homegardens, Biodiversity, Crop diversity, Diversification, Agro-ecological units (AEUs)

INTRODUCTION

Homegardens have been reported mainly from the tropical and sub-tropical regions in India, primarily concentrated in high rainfall areas in the Western Ghats region of Kerala (Kunhamu *et al.,* 2015, George and Christopher 2020) and Uttara Kannada district of Karnataka (Bhat *et al.,* 2014, Bhat and Rajanna, 2016). Coastal homegardens in Kerala are crucial for sustaining local livelihoods, bridging the rural-urban divide and conserving biodiversity (Ijinu *et al.,* 2011). These gardens host a wide variety of plant species, including both commercial and non-commercial crops with diverse life cycles (Gillespie *et al.*, 1993). Factors such as technological advancements, socio-economic conditions, and the psychological well-being of gardeners shape the biodiversity of these gardens (Kumar and Nair, 2006; Jose, 2009).

Kerala's coastal regions support diverse plant species due to their unique ecological niches. Cultivation practices are influenced by geographic features, climate and socio-cultural traditions. For example, Shehana *et al*. (1992) noted the dominance of spice crops in coastal homegardens due to favourable growing conditions and economic incentives. Gautam *et al*.

(2008) emphasized the role of these gardens in food security through vegetable cultivation. Research by Chandrashekara (2009) and Thomas and Kurien (2013) highlighted the diversity of fruit trees and other crops in these gardens, underscoring their ecological and economic importance. Factors such as landholding size, income, homestead size, and time investment are key predictors of home garden vegetation characteristics (Kabir *et al.,* 2016).

This study aims to explore and analyze crop biodiversity in coastal homegardens of Kerala across different Agro-Ecological Units (AEUs). Understanding these patterns is essential for promoting sustainable agriculture by informing practices tailored to specific AEUs (Altieri, 1999). It enhances ecosystem resilience by fostering diverse crop species that adapt to environmental changes (Folke *et al*., 2011). It also improves food and nutritional security by ensuring a steady supply of various crops (Eyzaguirre and Linares, 2004). Profiling biodiversity also conserves plant genetic resources vital for future agricultural innovation (Thrupp, 2000) and optimizes garden productivity, leading to better socio-economic outcomes for local farmers (Mendez *et al*., 2001).

By analyzing the biodiversity of coastal homegardens in Kerala, this study seeks to contribute to the body of knowledge necessary for developing effective policies and practices that support sustainable development and ecological preservation in coastal regions.

Research Problem

The biodiversity of coastal homegardens in Kerala, which plays a crucial role in sustaining local livelihoods and ecological conservation is influenced by various ecological, socio-economic and cultural factors. However, there is limited comprehensive analysis of how these factors affect crop diversity across different Agro-Ecological Units (AEUs). Understanding these biodiversity patterns is essential for promoting sustainable agricultural practices, enhancing ecosystem resilience, and improving food and nutritional security.

Research Gap

Despite the recognized importance of highly fragile coastal homegardens in biodiversity conservation and local sustenance, there is a lack of detailed profiling of crop diversity within these gardens across different AEUs in Kerala. Previous studies have highlighted specific aspects of home garden biodiversity, but a holistic analysis that incorporates regional variations, cultural practices, and socio-economic influences is missing. Furthermore, there is insufficient data on the specific biodiversity indices of various regions within homegardens, which is critical for devising targeted interventions.

Objectives

- To quantify and analyze the crop biodiversity of coastal homegardens in Kerala across different Agro-Ecological Units (AEUs) using the Shannon-Weiner index.
- To compare the biodiversity indices of different regions within the homegardens (Courtyard, Mid region, and Outer region).
- To identify the ecological, socio-economic, and cultural factors influencing crop diversity in coastal homegardens.

- To evaluate the implications of crop biodiversity patterns for sustainable agriculture, ecosystem resilience and food and nutritional security.

Hypotheses

- H1: There are significant variations in crop biodiversity among Agro-Ecological Units (AEUs) in Kerala's coastal homegardens.
- H2: Biodiversity indices vary significantly across spatial regions within homegardens (Courtyard, Mid region, and Outer region).
- H3: Ecological conditions, socio-economic factors, and cultural practices are significant predictors of crop diversity in coastal homegardens.
- H4: Crop biodiversity in coastal homegardens is positively linked to agricultural resilience, ecosystem sustainability and improved food and nutritional security.

METHODOLOGY

The study was conducted in the coastal homegardens of southern Kerala from 2021 to 2023. A survey-based approach was employed to gather data on crop diversity within these homegardens.

Sampling and Data Collection

Three Agro-Ecological Units (AEU 1, AEU 3, and AEU 4) were selected as study areas. Within each AEU, fifteen functional homegardens from the panchayat having the highest number of functional homegardens were sampled, resulting in a total of 45 homegardens being assessed.

To assess biodiversity, each home garden was divided into three distinct regions: 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, while the Outer Region is located away from the house and the Mid-Region lies in between these areas. Data on the area of each home garden and the plant components were collected separately for each region to facilitate a comprehensive comparison of biodiversity.

The crops were categorized based on their functional aspects into vegetables, spices, plantation crops, beverages, fruits, tubers, medicinal plants, multipurpose trees and ornamentals. The total count of plants in each category was recorded. Taxonomic identification of uncommon plant species was performed by experts in the relevant fields to ensure accurate classification.

Biodiversity Assessment

The biodiversity of each home garden was quantified using the Shannon-Weiner index of diversity, calculated with the formula:

$$H' = -\sum_{i}^{s} Pi \log(Pi)$$

Where, Pi - proportion of total sample belong to the i^{th} species, s – no. of species, $Pi = ni/N$ (ni= number of individual species, N= total number of individuals of all species)

Statistical Analysis

The statistical analysis included calculating mean biodiversity values for each crop category and comparing these values across the different regions (CY, MR, OR) and AEUs. The mean biodiversity indices were calculated to assess the overall diversity in each AEU. The ANOVA analysis was employed to determine if there were significant differences in biodiversity indices across the various regions and AEUs. An F value and a P value were calculated to establish statistical significance, with a P value of less than 0.05 indicating significant differences. This rational methodological approach ensured a comprehensive analysis of crop biodiversity in coastal homegardens of Kerala, providing meaningful insights for promoting sustainable agricultural practices and enhancing ecosystem resilience.

RESULTS AND DISCUSSION

The crop species and their composition found in homegardens may be influenced by various factors such as the techno-socio-economic and psychological conditions of the home garden farmers. Therefore, it is crucial to profile the biodiversity of coastal homegardens. The crop-wise diversity indices of AEU 1, AEU 3 and AEU 4 are presented in Table 1 and Fig 1.

Table 1. Crop wise diversity index of coastal homegardens of selected three AEUs

n=45

AEUs/ Crops	Vegetable crops	Tubers	Fruits	Plantation crops	Spices	Medicinal plants	MPTS	Ornamental plants
AEU 1	0.770	0.310	0.648	0.494	0.801	0.741	0.397	0.350
AEU 3	0.800	0.364	1.181	0.479	0.881	0.225	0.380	0.311
AEU 4	1.065	0.367	1.164	0.660	0.868	0.226	0.511	0.451
Mean	0.878	0.347	0.998	0.544	0.850	0.397	0.429	0.371
SD	0.162	0.009	0.303	0.100	0.043	0.298	0.071	0.081
SE	0.094	0.005	0.175	0.058	0.025	0.172	0.041	0.047

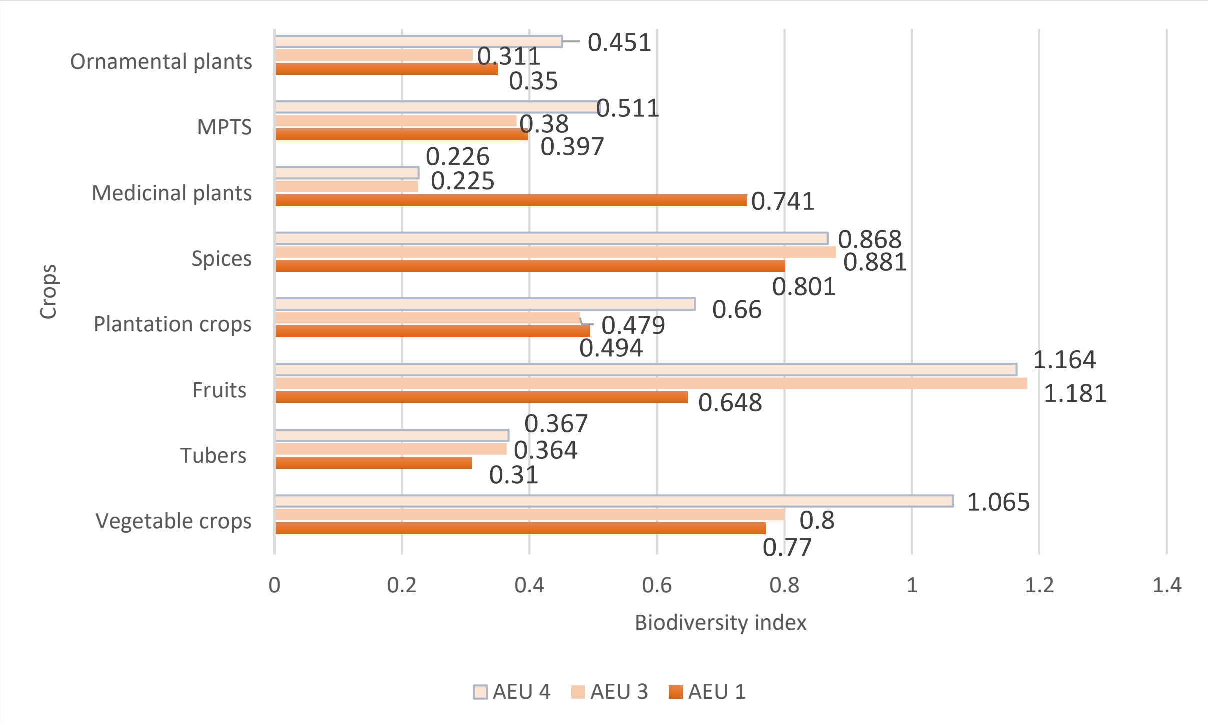
The study examined biodiversity of 45 homegardens in the coastal Agro-Ecological Units (AEUs) of southern Kerala, identifying 82 plant species in AEU 1, 78 in AEU 3, and 85 in AEU 4. These numbers indicate a lower species diversity compared to homegardens of other regions, such as Thrissur (106 species, Niyas *et al.,* 2016), Idukki (154 species, Babu *et al.*, 2020), Central Kerala (463 species, Kumar, 2011) and Attappady (182 species, George and Christopher, 2020). This decline in biodiversity, especially in fragile coastal ecosystems, highlights the need for targeted conservation efforts and sustainable practices to ensure ecosystem integrity and livelihood security.

In AEU 1, diversity index values ranged from 0.310 for tubers to 0.801 for spices, with spices showing the highest mean biodiversity due to favourable ecological conditions and economic benefits (Shehana *et al*., 1992). Vegetable crops (0.770) and medicinal crops (0.741) also thrived, reflecting their adaptability to coastal conditions (Gautam *et al*., 2008). Despite low organic matter, coastal soils can support these crops through traditional practices like the addition of organic amendments which enhances soil fertility and structure (Shehana *et al*., 1992).

In AEU 3, fruit crops had the highest diversity index (1.181), followed by spices (0.881) and vegetables (0.800), while ornamental plants (0.311) and medicinal crops (0.225) showed the lowest. The decline in the diversity of medicinal plants may result from increased allopathic medicine use and urbanization (Gaunt, 2015). Favourable conditions and economic incentives encourage farmers to maintain a variety of fruit crops and thus contribute to the high diversity of fruit crops (Prashanth and Shiddamallayya, 2022).

In AEU 4 also fruit crops had the highest diversity index (1.164), followed by vegetables (1.065) and spices (0.868). Fruits are one of the major components in homegardens which supplement the nutritive needs of the farmer family (Mitchell and Hanstad, 2004). A study conducted in the household gardens of Peru also found that fruits and medicinal plants dominated, similar to the present finding (Coomes and Ban, 2004). The high diversity of fruits and vegetable crops is linked to the region's favourable ecological conditions, such as well-drained soils and a supportive microclimate that promotes year-round cultivation. The economic returns from fruits and vegetables, which are in constant demand for both local consumption and markets, also drive this diversity (Babu *et al*., 2020, Ray *et al.,* 2021).

Fig 1. Crop wise biodiversity index of coastal homegardens of selected AEUs



Overall Trends and Implications

Overall, fruit crops exhibited the highest diversity (0.998) across all AEUs, followed by vegetables (0.878), with ornamentals (0.371) and tubers (0.347) showing the lowest diversity. These results align with previous studies on home garden diversity, which revealed a higher diversity of fruit trees (Chandrashekara, 2009). The inclusion of diverse tree species in homegardens supports ecological sustainability and provides multiple benefits, including shade, firewood, and soil fertility (Gautam *et al*., 2008). The variability in crop diversity among different homegardens relies on family preferences, socio-economic, and ecological factors (Vogl *et al.,* 2002).

Understanding these patterns is crucial for developing targeted interventions to enhance the sustainability and productivity of coastal homegardens (Singh *et al.,* 2021). Strategies should prioritize promoting crop diversity tailored to local ecological conditions and market demands, integrating traditional knowledge with sustainable practices. This approach enhances ecosystem resilience, supports biodiversity conservation, and improves food security and livelihood stability in Kerala's coastal regions.

Factors Contributing to Lower Diversity

The lower species diversity in coastal homegardens compared to highland and midland regions can be attributed to several factors. Coastal areas face unique ecological constraints, such as high salinity, frequent flooding and strong winds, which limit the variety of plant species that can thrive (Nair *et al*., 2021). The sandy and less fertile soils, typical of coastal regions, also support a narrower range of species compared to the richer soils found in other regions (Gillespie *et al*., 1993). Socio-economic factors, including smaller landholdings, lower income levels and distinct agricultural practices, further influence the biodiversity in these gardens (Kumar and Nair, 2006).

Additionally, the livelihood and dietary habits of Kerala's coastal communities, which rely primarily on fishing and consume fewer vegetables, lead to a focus on cultivating economically viable and culturally significant crops like coconut, banana, mango and jackfruit. This emphasis on a limited range of crops, rather than a broader diversity of vegetables that require more care, contributes to the lower species diversity observed in coastal homegardens.

The study highlights the complex interplay of ecological, socio-economic and cultural factors that shape the biodiversity of coastal homegardens in southern Kerala. The lower species diversity observed in these gardens reflects the unique challenges and preferences of coastal communities. Strategies that integrate traditional knowledge with modern sustainable practices and focus on promoting crop diversity aligned with local ecological conditions and market demands can enhance ecosystem resilience, support biodiversity conservation and improve food security and livelihood stability in coastal regions.

Crop Biodiversity Differences in Coastal Homegardens

The one-way ANOVA comparing the diversity index of dominant crops across the selected Agro-Ecological Units (AEUs) yielded an F-statistic greater than the critical F value (2.66 at the 0.05 per cent significance level), indicating a significant difference in biodiversity among different crops across AEUs.

Table 2: One way ANOVA between crops

Source	Degrees of freedom	Sum of squares	Mean square	F-Stat	P-Value
Between groups	7	1.46	0.21	7.26	0.0005
Within groups	16	0.46	0.03		
Total	23	1.92			

Crop	Descending order of means	
Fruits	0.99	On par
Vegetables	0.88	On par
Spices	0.85	On par
Plantation crops	0.54	Significant difference

Multipurpose trees	0.43	Significant difference
Medicinal plants	0.39	Significant difference
Tubers	0.36	Significant difference
Ornamentals	0.36	Significant difference

The critical difference value was determined to be 0.29 at a 0.05 per cent significance level. Crops with mean values greater than 0.71 were statistically on par, while those with lower means were significantly different. This analysis highlights significant differences in diversity among plantation crops, multipurpose trees, medicinal plants, tubers and ornamentals in the selected AEUs.

The significant differences in crop diversity within coastal homegardens stem from a complex interplay of ecological, socio-economic, and cultural factors. Ecologically, crops like fruits, vegetables and spices adapt well to coastal conditions due to their tolerance to specific soils, moisture levels and microclimatic conditions. For instance, mangoes and bananas thrive in warm, humid climates, while spices like black pepper and turmeric benefit from the shaded, moist environments under coconut canopies.

In contrast, plantation crops and ornamentals, requiring specific soil or climate conditions, exhibit lower diversity in coastal areas. Tuber crops, although suited to sandy soils, suffer from rodent attacks, leading to low diversity. Despite these challenges, tubers like yams and sweet potatoes are resilient in coastal environments. By highlighting the benefits of tubers in improving soil structure and providing a resilient food source, farmers can be encouraged to include tubers in their crop diversity strategies. Additionally, promoting pest management techniques tailored to tuber cultivation can help mitigate the risk of rodent attacks, further incentivizing farmers to explore tuber crops as part of their agricultural practices in coastal homegardens.

Socio-economically, crop selection is driven by market demand and profitability, leading to a focus on high-value crops like fruits and vegetables, while less profitable crops like medicinal plants and ornamentals are less prevalent. Culturally, crops like coconut and jackfruit, which have a significant role in culinary traditions, religious practices, or cultural significance are commonly cultivated, influencing diversity patterns.

Additionally, agricultural practices such as crop rotation, intercropping and pest management strategies vary across crop types and environmental conditions, further impacting diversity (Gills *et al.,* 2013). Monoculture plantation crops may result in lower overall diversity compared to mixed cropping systems commonly used for fruits and vegetables. Understanding these dynamics is crucial for promoting sustainable agricultural practices and biodiversity conservation in coastal agroecosystems.

The following analysis pondered into the region-wise diversity index of selected homegardens in coastal AEUs, providing a detailed comparison of biodiversity across different regions within the AEUs.

Table 3. Region-wise diversity index of selected homegardens in coastal AEUs

Homegardens	Region-wise bio diversity index								
	Courtyard (n=45)			Mid region (n=45)			Outer region (n=45)		
	AEU 1	AEU 3	AEU 4	AEU 1	AEU 3	AEU 4	AEU 1	AEU 3	AEU 4
1	1.234	1.226	1.142	1.142	1.710	1.342	0.587	0.849	1.538

2	1.475	1.813	1.775	1.431	0.944	1.931	0.648	0.865	1.799
3	1.231	0.622	0.631	1.106	0.906	1.906	0.363	1.058	2.088
4	1.172	1.172	1.472	1.508	1.108	2.508	1.236	0.345	0.849
5	1.087	0.587	1.187	1.248	1.148	1.848	1.677	1.477	1.677
6	1.235	0.648	1.648	0.528	1.828	1.528	0.366	0.528	1.528
7	1.877	1.277	1.377	1.365	1.165	1.965	1.602	1.339	1.492
8	0.523	1.223	1.123	1.043	1.023	2.043	0.886	1.318	1.748
9	0.786	0.486	0.886	0.868	1.368	1.868	1.259	0.910	0.910
10	1.211	1.126	1.259	1.347	1.847	2.847	1.670	1.113	1.729
11	1.270	1.170	1.670	1.903	1.303	1.903	1.447	0.366	0.766
12	1.147	0.234	1.447	1.489	2.489	2.489	0.763	1.602	1.902
13	0.663	0.363	0.763	0.795	0.495	0.995	0.631	0.736	2.136
14	1.362	1.236	1.562	0.624	0.545	0.545	1.472	1.418	1.718
15	0.328	0.328	0.528	1.264	1.564	1.664	1.187	1.139	1.885
Mean total	**1.107**	**0.803**	**1.231**	**1.178**	**1.296**	**1.826**	**1.053**	**1.004**	**1.584**
SD	0.390	0.704	0.388	0.365	0.527	0.581	0.472	0.395	0.427
SE	0.101	0.182	0.100	0.094	0.136	0.150	0.122	0.102	0.110
Highest	1.475	1.813	1.775	1.903	2.489	2.489	1.677	1.602	2.136
Lowest	0.328	0.328	0.528	0.528	0.495	0.545	0.363	0.345	0.766

Table 3 presents the diversity index values for selected coastal Agro-Ecological Units (AEUs) by region. The analysis reveals notable differences across regions. In the Courtyard region, AEU 4 had the highest diversity index (1.231), followed by AEU 1 (1.107) and AEU 3 (0.803). In the Mid region, AEU 4 again showed the highest diversity index (1.826), compared to AEU 3 (1.296) and AEU 1 (1.178). Similarly, in the Outer region, AEU 4 exhibited higher diversity (1.584) than AEU 1 (1.053) and AEU 3 (1.004). AEU 4 consistently displayed the highest diversity across all regions.

The mean total diversity index underscores biodiversity variations among the AEUs, with AEU 1 ranging from 0.697 to 1.615, AEU 3 from 0.531 to 1.362, and AEU 4 from 1.221 to 1.946, reflecting notable differences in biodiversity.

Regional summaries show a mean diversity index of 1.117 in the Courtyard, 1.433 in the Mid region (the highest), and 1.255 in the Outer region (Figure 2). Statistical analysis yielded an F value of 0.961 and a P value of 0.4345, indicating no significant difference in biodiversity across the regions.

These findings contrast with Thomas and Kurien (2013), who reported the highest diversity in the outer regions of homegardens, followed by mid-regions and courtyards. However, the results align with a study in Kerala that found higher biodiversity in mid-regions due to profitable crop cultivation (Thomas, 2004). The higher biodiversity index in mid-regions may be due to the accessibility for farmers and the central arrangement of key species. Since the mid-region was more convenient, the homegarden farmer might have fully stocked his garden with more important species arranged centrally and then structurally dominant towards the outer periphery, whether accidentally or intentionally (Thomas *et al.,* 2017). Courtyards had the lowest biodiversity due to aesthetic modifications, while outer regions showed low biodiversity due to neglect.

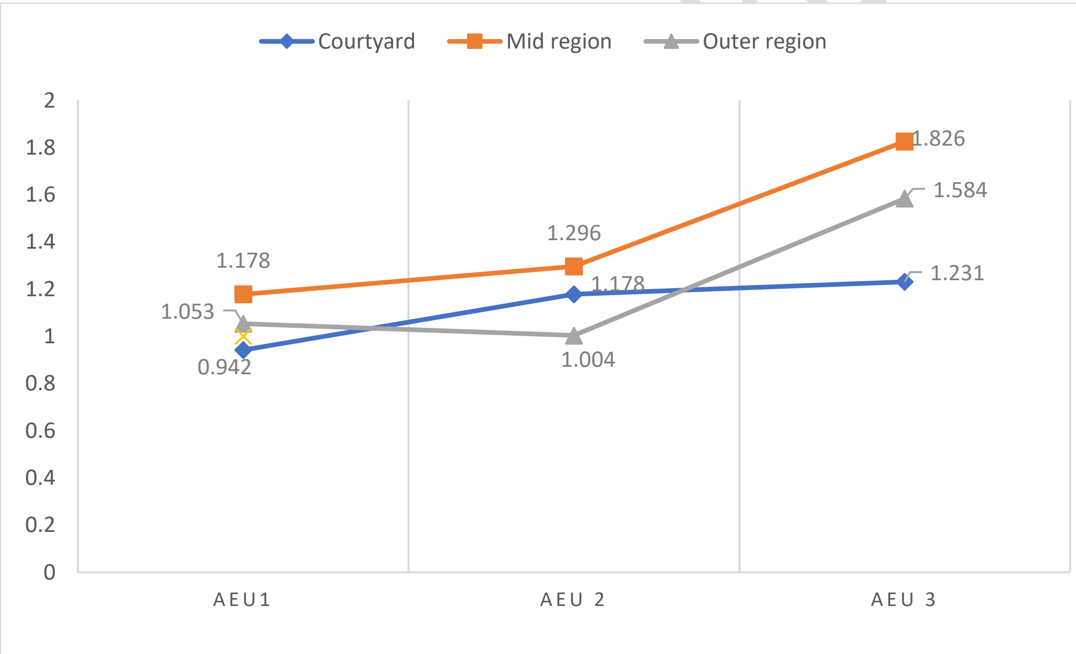
AEU 4 exhibited the highest total mean biodiversity (1.547), surpassing other coastal AEUs. AEU 3 had a mean diversity index of 1.159, and AEU 1 recorded the lowest at 1.058. Coastal biodiversity was lower compared to high-range homegardens in Kerala, which had a Shannon-Weiner diversity index of 1.034 to 2.185 (Babu, 2022). However, Mohan (2004) noted that Kerala homegardens have diversity indices ranging from 1.15 to 1.42.

The higher crop diversity in AEU 4 suggests favourable conditions or cultural practices supporting a broader range of crops, highlighting the potential for knowledge sharing to improve diversity in other AEUs. The lower diversity in AEU 1 underscores the need for interventions like access to diverse crop varieties, training and supportive policies.

Variations in diversity across AEUs impact ecosystem resilience and food security. Higher crop diversity enhances stability by reducing vulnerability to pests, diseases and climate variability, and it provides a more diverse and nutritious food supply. Promoting crop diversity in coastal homegardens supports ecosystem services, livelihoods and food security in the face of environmental and socio-economic changes.

Farmers tend to prioritize high-value crops with strong market demand, concentrating certain crops like fruits and vegetables. Crops with lower demand, such as medicinal plants or ornamentals, may be less cultivated, leading to lower diversity indices. Cultural preferences also influence crop diversity; for instance, fruits like coconut and jackfruit, which are culturally significant in Kerala, are commonly grown. Agricultural practices such as crop rotation, intercropping and pest management further impact diversity, with monoculture plantations resulting in lower diversity compared to mixed cropping systems.

Figure 2. Region-wise diversity index of coastal AEUs



The correlation analysis between various personal and social factors of coastal homegarden farmers and biodiversity yielded insightful results, as mentioned in Table 4.

Table 4. Correlation analysis between various personal and social factors and biodiversity

Sl. No.	Independent variable	Pearson Correlation
1	Age	-0.023
2	Gender	-0.229

3	Education	0.361*
4	Occupation	0.180
5	Family size	0.005
6	Annual income	0.266
7	Economic motivation	-0.351*
8	Extension orientation	-0.023
9	Information source utilization	0.333*
10	Credit orientation	0.293
11	Training need	0.078
12	Market orientation	-0.391**
	*Correlation is significant at the 0.05 level (2-tailed).	

Education showed a positive correlation with biodiversity, indicating that higher education levels among farmers are linked to better biodiversity outcomes. Educated farmers are more likely to adopt sustainable practices and innovative farming techniques, thereby enhancing biodiversity. Additionally, these farmers often maintain diverse homegardens, supporting biodiversity through the cultivation of perennial crops and the use of organic methods.

Although not statistically significant, the positive correlation between annual income and biodiversity suggests that higher income levels may facilitate investments in sustainable technologies, leading to improved biodiversity. The positive correlation between information source utilization and biodiversity indicates that farmers who access diverse information sources are more likely to adopt practices that benefit biodiversity, such as integrated pest management and agroforestry.

The positive correlation between credit orientation and biodiversity, though not statistically significant, suggests that access to credit may support investments in biodiversity-friendly practices.

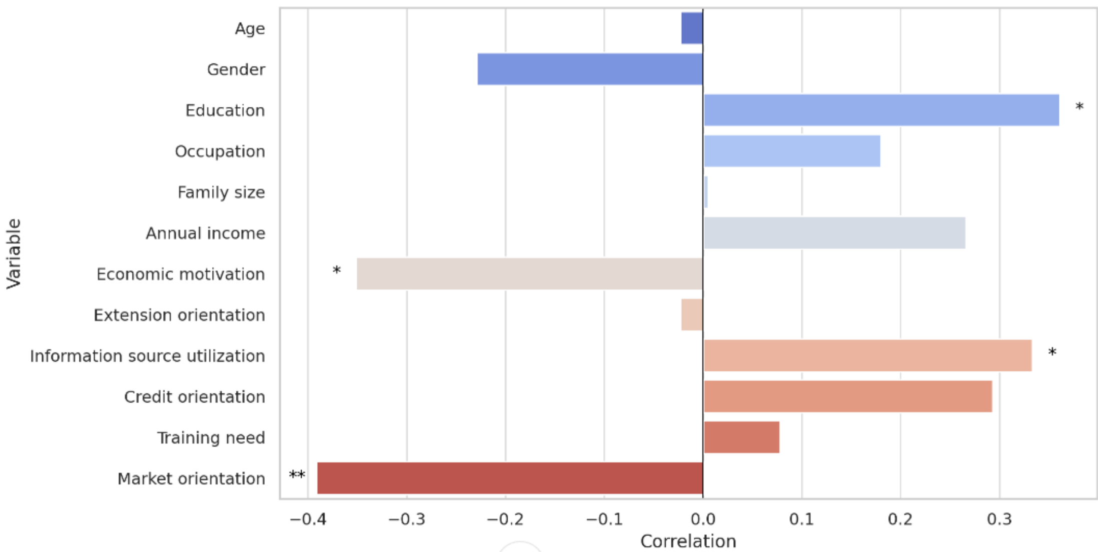
Conversely, a significant negative correlation was observed between economic motivation and biodiversity, indicating that a focus on short-term economic gains often leads to practices harmful to biodiversity, such as monocropping and excessive chemical use. Similarly, the significant negative correlation between market orientation and biodiversity suggests that market-driven practices, which prioritize monoculture and high yields, can reduce habitat diversity and harm biodiversity.

The negative correlation between gender and biodiversity, while not statistically significant, suggests potential gender-related differences in biodiversity practices, with women typically enhancing biodiversity through homegardens, despite facing challenges such as limited access to resources. Age and extension orientation showed negligible correlations with biodiversity, indicating minimal direct influence.

The analysis highlights that education and information source utilization positively impact biodiversity by promoting sustainable practices, while economic motivation and market orientation negatively affect biodiversity by emphasizing short-term gains over long-term sustainability. These findings underscore the need for targeted interventions to enhance education, improve information access, and balance economic activities with biodiversity conservation in agricultural communities.

Figure 3. shows the correlation values for each independent variable, with significant correlations (at the 0.05 and 0.01 levels) marked with asterisks. The vertical line at 0 indicates no correlation, helping to distinguish between positive and negative relationships.

Figure 3. Correlation between various personal and social factors and biodiversity



CONCLUSION

The observed biodiversity across Agro-Ecological Units (AEUs) in coastal homegardens emphasizes the need for diversification to enhance agricultural resilience, ecosystem sustainability, and food security. Biodiversity levels in coastal areas are generally lower, necessitating targeted interventions and knowledge sharing among farmers. This study reveals significant differences in crop diversity among AEUs, influenced by local ecological conditions, cultural practices and socio-economic factors. AEU 4 consistently exhibited the highest diversity across the courtyard, mid-region and outer region, suggesting favourable conditions and effective practices. In contrast, AEU 1 showed the lowest diversity indices, highlighting the need for focused efforts to improve crop diversity. The mid-region had the highest overall biodiversity index, attributed to its accessibility and central arrangement of key species, while the courtyard and outer regions had lower indices due to aesthetic modifications and neglect, respectively. Traditional knowledge is crucial for managing coastal homegardens and conserving agro-biodiversity. The correlation analysis revealed significant relationships between personal and social factors of coastal homegarden farmers and biodiversity. Notably, education, information source utilization, and economic motivation were significantly correlated with biodiversity at the 0.05 level, while market orientation showed a stronger correlation at the 0.01 level. Collaborative efforts are needed to design and implement context-specific interventions, such as enhancing crop diversification, promoting underrepresented crops, integrating agroforestry practices, supporting small-scale farmers, and empowering marginalized groups.

Further research and community engagement are essential for understanding the socio-economic dynamics, market opportunities, and ecosystem services of coastal homegardens. This will support evidence-based interventions and adaptive management strategies, fostering sustainable agricultural practices and preserving traditional knowledge in coastal regions.

References

1. Altieri, M.A. 1999. The Ecological Role of Biodiversity in Agroecosystems. *Agriculture, Ecosystems Environment*, 74 (3): 19-31
2. Babu, N., Thomas, A., and Thomas, U. 2020. Dominance Hierarchies, Diversity and Spatial Connect of Crops in Banana Based High Range Homegardens. *Curr. J. Applied Sci. Technol.* 39(24): 102-107.
3. Babu. N. 2022. Participatory technology intervention and its assessment through environmental scanning of high range homegardens in Idukki district: An action research. Ph.D. (Ag.) thesis, Kerala Agricultural University, Thrissur, 202p.
4. Bhat, S. and Rajanna, L. 2016. Plant diversity studies and role of Halakki community agroforestry homegardens of Uttara Kannada District, Karnataka, India. *Inter. J. Life Sci.* 5(2): 54-62.
5. Bhat, S., Bhandary, M.J., and Rajanna, L. 2014. Plant diversity in the homegardens of Karwar, Karnataka, India. *Biodiversitas*. 15(2): 229-235.
6. Chandrashekara, U. M. 2009. Tree species yielding edible fruit in the coffee based homegardens of Kerala, India: Their diversity, uses and management. *Food Security*. 1(1): 361-370.
7. Coomes, O. T. and Ban, N. 2004. Cultivated plant species diversity in homegardens of an Amazonian peasant village in northeastern Peru. *Econ Bot.* 58(3): 420–434.
8. Eyzaguirre, P. B. and Linares, O. F. 2004. Homegardens and Agro Biodiversity. Washinton, DC: Smithsonian Press. 296p.
9. Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S. R., Chapin, F. S., and Westley, F. 2011. Reconnecting to the biosphere. *Ambio*. 40(7): 719-738.
10. Gaunt, R. 2015. Herbs, Home Medicine, and Self-Reliance: A Study on the Current Status of Traditional Home Medicine in Idukki District, Kerala, Independent Study Project (ISP) Collection, 2078p.
11. Gautam, R., Sthapit, B., Subedi, A., Poudel, D., Shrestha, P., and Eyzaguirre, P. 2008. Homegardens management of key species in Nepal: A way to maximize the use of

useful diversity for the wellbeing of poor farmers. *Plant Genet. Resour. Characterization Utilis*. 7(2): 142-153.

12. George, M. V. and Christopher, G. 2020. Structure, diversity and utilization of plant species in tribal homegardens of Kerala, India, *Agroforestry Syst*. 94 (1): 297-307.
13. Gillespie, A.R., Knudson, D.M., and Geilfus, F. 1993. The structure of four homegardens in the Peten, Guatemala. *Agroforestry Syst.* 24(2): 157-170.
14. Gills, R., Singh, R. and Nain, M. S. 2013. Extent of Adoption and Perceived Reasons for Organic Cardamom Production in Idukki District of Kerala. *J. Community Mobilization Sustain. Dev.* 8(1): 41-47.
15. Ijinu, T. P., Anish, N., Shiju, H., George, V., and Pushpangadan, P. 2011. Homegardens for nutritional and primary health security of rural poor of South Kerala, *Indian J. Tradit. Know.* 10 (3): 413-428.
16. Jose, D. 2009. Biodiversity and conservation strategies of traditional homegardens of Kerala, India. *Biodivers. Conserv.* 18(3): 1083-1092.
17. Kabir, R., Khan, H. T. A., Ball, E., and Kaldwell, C. 2016. Climate Change and public health situations in coastal areas of Bangladesh. *Int. J. Social Sci. Stud*. 2(3): 109-116.
18. Kumar, B. M. 2011. Species richness and above ground carbon stocks in the homegardens of central Kerala, India. *Agric. Ecosys. Environ*. 140 (3): 430-440.
19. Kumar, B.M., and Nair, P.K.R. (Eds.). 2006. Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Springer. 378p.
20. Kunhamu, T. K., Ajeesh, R., and Kumar, V. 2015. Floristic analysis of periurban homegardens of Southern Kerala, India. *Indian J. Ecol.* 42 (2): 300-305.
21. Mendez, V. E., Lok, R., and Somarriba, E. 2001. Interdisciplinary analysis of homegardens in Nicaragua: Micro-zonation, plant use and socioeconomic importance. *Agrofor. Syst.* 51(2): 85-96.
22. Mitchell, R. and Hanstad, T. 2004. Small homegarden plots and sustainable livelihoods for the poor. LSP Working paper no.11. Food and agriculture organization of the United Nations. *LSP Working*, (11).
23. Mohan. S. 2004. An assessment of the ecological and socioeconomic benefits provided by homegardens: a case study of Kerala, India. University of Florida, 216p.
24. Nair P.K.R., Kumar B.M., and Nair V. D. 2021. Tropical Homegardens. In: An Introduction to Agroforestry: Four Decades of Scientific Developments. Springer, Cham.113-135p.

25. Niyas, P., Kunhamu, T. K., Ali, S. K., Jothsna, C., Anees, C. R. 2016. Functional diversity in the selected urban and peri-urban homegardens of Kerala, India. *Indian J Agrofor.* 18 (1): 39-46.
26. Prashanth, K. G. M. and Shiddamallayya, N. 2022. Documentation of plant species in homegardens of three physiographic regions of Hassan District, Karnataka, *Indian J Ecol.* 49 (2): 569-580.
27. Ray, A., Ray, R., and Sreevidya, E.A. 2021. How many wild edible plants do we eat-there a diversity, use, and implications for sustainable food system: An exploratory analysis in India. Front. *Sustain. Food Syst*. 5 (1): 1-2
28. Shehana, R. S., Sathees, B. K., and Salam, M. A. 1992. Spices: A Multipurpose Homestead Component in South Kerala. *Spice India*. 5(9): 15-18.
29. Singh, M., Nara, U., Kumar, A., Choudhary, A., Singh, H., and Thapa, S. 2021.Salinity tolerance mechanisms and their breeding implications. *J. Genet. Eng. Biotechnol.* 19(1): 173 - 191
30. Thomas A. 2004. Technology assessment in the homegarden systems. Ph. D. thesis, Kerala Agricultural University; Thrissur, 258p.
31. Thomas, A., and Kurien, S. 2013. Homegardens of Kerala: Structural Configuration and Biodiversity. *Indian J. Res*. 2(1): 133-135.
32. Thomas, A., Usha, C. T. and Kishore, R. M. 2017. Biodiversity regime in Kerala homegardens: the case of Thiruvananthapuram district. *Ecol. Environ. Conserv*. 23 (3): 1656-1661.
33. Thrupp, L.A. 2000. Linking Agricultural Biodiversity and Food Security: The Valuable Role of Agrobiodiversity for Sustainable Agriculture. *Int. Aff*. 76(2): 283-297.
34. Vogl, C. R., Vogl-Lukraser, B., and Caballero, J. 2002. Homegardens of Maya Migrants in the district of Palenque, Chiapas, Mexcio: Implications for Sustainable Rural Development, In: (Stepp J R, Wyndham F S, and Zarger R K), Ethnobiology and Bicultural Diversity, University of Georgia Press, Athens, GA, 112p.