Species Diversity in Coastal Homegardens of Kerala: A Study Across Agro-Ecological Units (AEUs)

Abstract

This study examines the biodiversity of coastal homegardens in Kerala, focusing on crop and regional diversity across Agro-Ecological Units (AEUs). Using the Shannon-Weiner index, the study found crop diversity values ranging from 0.347 for tubers to 0.998 for fruits, influenced by local ecology, cultural practices, and socio-economic factors. Biodiversity indices for Courtyard, Mid-region, and Outer region were 1.117, 1.433, and 1.255, respectively, with overall biodiversity indices of 1.058, 1.159, and 1.547 for AEU 1, AEU 3, and AEU 4. 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. The study underscores the need for collaborative efforts to enhance biodiversity through crop diversification, agroforestry, and support for small-scale and marginalized farmers.

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). These systems hold significant potential for climate change mitigation (Siyum and Tassew, 2019). In Kerala, coastal homegardens play a crucial role in sustaining local livelihoods, bridging the rural-urban divide and conserving biodiversity (Ijinu *et al*., 2011). They 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).

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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).

Understanding the biodiversity patterns of coastal homegardens is critical for promoting sustainable agricultural practices and conserving plant genetic resources. By analyzing these patterns, this study contributes to the development of effective policies and practices for enhancing the sustainability and ecological resilience of coastal regions. Insights from this research can inform strategies to optimize garden productivity, support local farmers, and improve socio-economic outcomes while preserving biodiversity for future agricultural innovation.

METHODOLOGY

The study was conducted in the coastal home gardens of southern Kerala from 2021 to 2023. An interview-based approach was employed, along with a direct recording of plant species in individual homegardens, to collect detailed data on biodiversity.

Sampling and Data Collection

Three coastal Agro-Ecological Units (AEU 1, AEU 3, and AEU 4) were selected as study areas. Within each AEU, fifteen functional homegardens were sampled from the panchayat exhibiting the highest number of functional homegardens, resulting in a total sample size of 45 homegardens. This purposive sampling approach ensured that the study focused on homegardens with active agricultural practices, providing a robust basis for biodiversity assessment.

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, tubers, fruits, plantation crops, spices, medicinal plants, multipurpose trees and shrubs, and ornamental plants. 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. This rigorous approach to data collection and categorization provided a reliable foundation for assessing the biodiversity of coastal homegardens across the selected AEUs.

Biodiversity Assessment

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

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

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 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)

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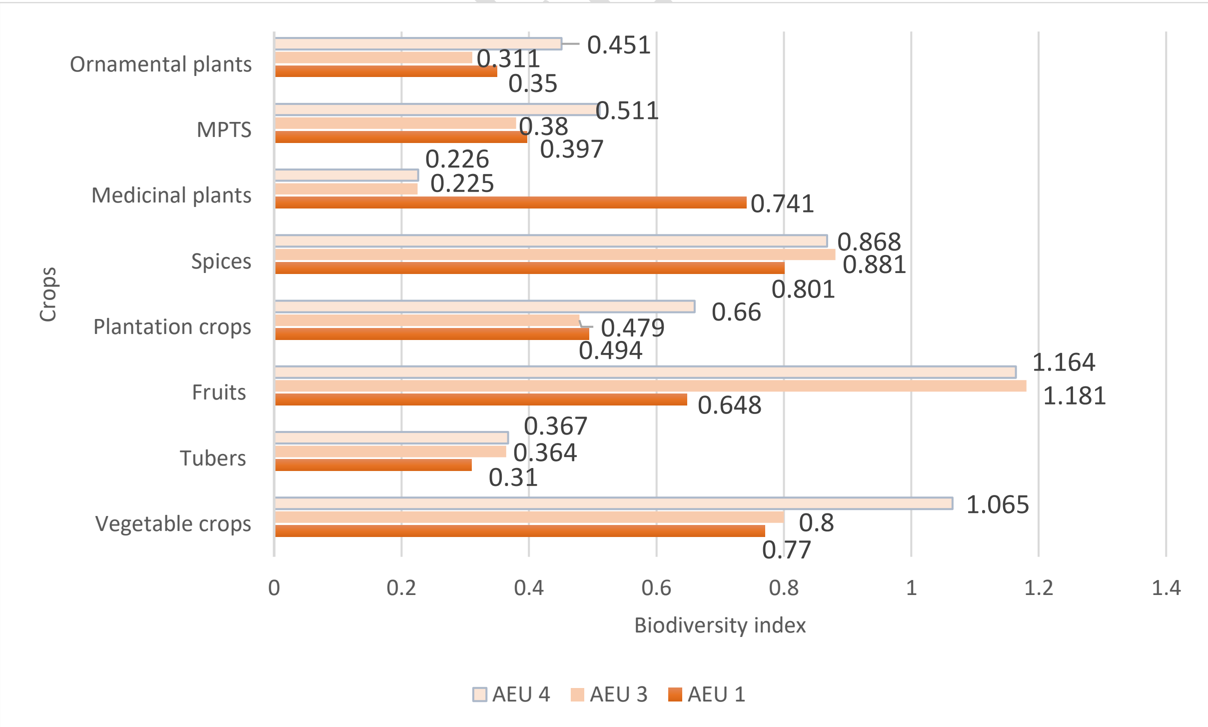
also thrived, reflecting their adaptability to coastal conditions (Gautam *et al*., 2008). Despite low organic matter, coastal soils can support these crops through traditional practices like the addition of organic amendments which enhances soil fertility and structure (Shehana *et al*., 1992).

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 reduced diversity of medicinal plants could be linked to the growing reliance on allopathic medicine and urbanization, which diminish the cultural and economic incentives to cultivate traditional species (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).

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 lower species diversity observed in these gardens reflects the unique challenges and preferences of coastal communities. To address these limitations and promote sustainable practices, it is essential to design strategies that integrate traditional knowledge with modern agricultural practices (Aich *et al*., 2022). These strategies should focus on promoting crop diversity that is aligned with local ecological conditions and market demands. Such approaches would not only enhance ecosystem resilience but also contribute to the conservation of biodiversity, improving food security and livelihood stability in Kerala's coastal regions (Singh *et al.,* 2021).

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			

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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.

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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.

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). Although statistical analysis (F = 0.961, P = 0.4345) indicated no significant differences in biodiversity across these regions, understanding the observed patterns remains essential.

The higher biodiversity in the Mid-region may be attributed to its accessibility and its role as a central space for cultivating economically important species, aligning with findings from Thomas (2004) and Thomas *et al*. (2017), who highlighted the strategic arrangement of key species in this zone. In contrast, the Courtyard exhibited the lowest biodiversity, likely due to aesthetic modifications and frequent human activity favouring ornamental plants, while the Outer region, despite being more spacious, often suffered from neglect, resulting in reduced diversity. These findings differ from Thomas and Kurien (2013), who reported the highest diversity in the Outer regions of homegardens.

Despite the lack of significant differences, analyzing these trends provides valuable ecological and practical insights into how accessibility, cultural practices, and management preferences shape biodiversity distribution. This contextual understanding is essential for developing targeted interventions to conserve biodiversity and enhance the sustainable management of homegardens, offering a deeper comprehension of the interplay between ecological, social, and economic factors.

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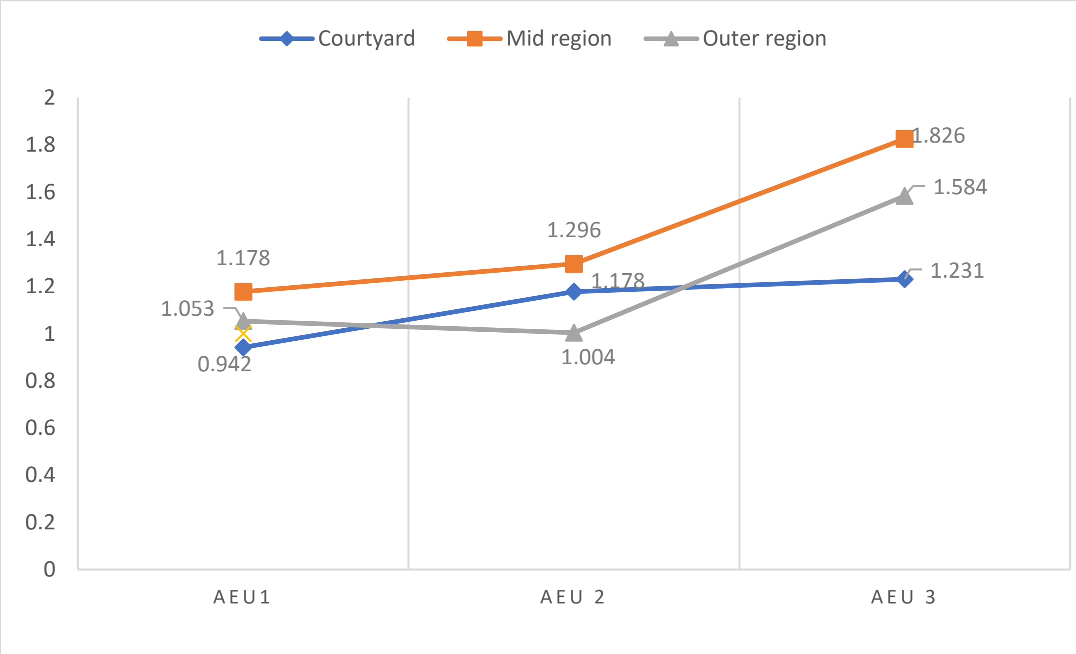
Figure 2. Region-wise diversity index of coastal AEUs



Biodiversity Across Agro-Ecological Units

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. The biodiversity ranges also highlighted notable differences, 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.

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 biodiversity in AEU 4 suggests the presence of favourable environmental conditions or cultural practices that support a broader range of crops. These practices could be documented and shared to enhance biodiversity in other AEUs. In contrast, the lower diversity in AEU 1 underscores the need for targeted policy interventions.

Biodiversity variations across AEUs have significant implications for ecosystem resilience and food security. Higher biodiversity strengthens stability by reducing vulnerability to pests, diseases, and climate variability while offering a diverse and nutritious food supply. Enhancing crop diversity in coastal homegardens is crucial to maintaining ecosystem services, supporting livelihoods, and ensuring food security amidst 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.

To effectively address the challenges faced by AEUs with low biodiversity, such as AEU 1, targeted interventions must integrate agroecological principles, community collaboration, and farmer education to address socio-economic and environmental constraints. Promoting mixed cropping systems, introducing culturally relevant underutilized species, and providing financial incentives for biodiversity-friendly practices are key strategies. Governmental and private sector collaboration can support farmers through access to diverse crop varieties, sustainable agricultural training, and policy-driven incentives. These measures can bridge biodiversity gaps, enhance agricultural resilience, and ensure equitable ecological and socio-economic benefits across AEUs (Abay, 2024).

Personal and Socio-economic factors

The correlation analysis between various personal and socio-economic 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.	Variables	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

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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.

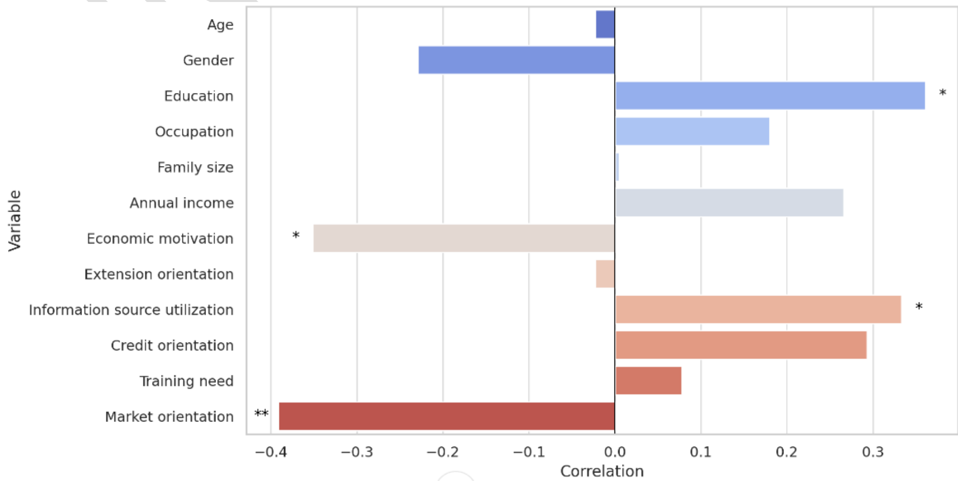
The observed negative correlation between economic motivation and biodiversity highlights a critical challenge in coastal homegardens, where a focus on short-term profits often drives practices such as monocropping and excessive use of chemical inputs. Similarly, market-oriented farming systems prioritize high-yield, market-demanded crops, marginalizing traditional and underutilized species, thereby reducing biodiversity. These socio-economic dynamics underscore the need for interventions that align economic goals with biodiversity conservation. Policies promoting diversified cropping, financial incentives for cultivating underrepresented species, and education on the long-term benefits of biodiversity can help balance market pressures with ecological sustainability.

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 underscores the dual role of personal and socio-economic factors in influencing biodiversity. While education and the use of information sources positively impact biodiversity by promoting sustainable practices, economic motivation and market orientation often negatively affect it by prioritizing short-term profitability over ecological health. These findings emphasize the necessity for targeted interventions, such as enhancing knowledge dissemination, improving information accessibility, and promoting biodiversity-friendly economic activities.. Balancing economic pursuits with conservation efforts is crucial to fostering sustainable agricultural practices in coastal homegardens, ensuring both ecological resilience and livelihood stability.

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. 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.

Practical implementation of sustainable practices must address accessibility, promote underrepresented crops, and consider socio-economic dynamics. Policies play a pivotal role by fostering market incentives, supporting capacity-building programs, and funding research on ecosystem services in coastal homegardens. Emphasizing traditional knowledge within policy frameworks will further enhance adaptive management strategies.

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.

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Disclaimer (Artificial intelligence)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Authors hereby declare that no competing interests exist.

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APPENDIX

Taxonomic list of the species constituting biodiversity in coastal homegardens of Kerala

Vegetables

1. *Solanum lycopersicum (Tomato)*
2. *Capsicum annuum (Chili)*
3. *Cucumis sativus (Cucumber)*
4. *Momordica charantia (Bitter Gourd)*
5. *Trichosanthes cucumerina (Snake Gourd)*
6. *Amaranthus viridis (Green Amaranth)*
7. *Amaranthus tricolor (Red Amaranth)*
8. *Basella alba (Malabar Spinach)*
9. *Alternanthera sessilis (Sessile Joyweed)*
10. *Ipomoea aquatica (Water Spinach)*
11. *Lagenaria siceraria (Bottle Gourd)*
12. *Momordica charantia (Bitter Gourd)*
13. *Benincasa hispida (Ash Gourd)*
14. *Coccinia grandis (Ivy Gourd)*
15. *Solanum melongena (Brinjal/Eggplant)*
16. *Vigna unguiculata (Cowpea)*
17. *Vigna radiata (Green Gram)*
18. *Pisum sativum (Green Pea)*
19. *Cajanus cajan (Pigeon Pea)*
20. *Allium cepa (Onion)*
21. *Allium sativum (Garlic)*
22. *Moringa oleifera (Drumstick)*

Tuber crops

1. *Colocasia esculenta (Taro)*
2. *Ipomoea batatas (Sweet Potato)*
3. *Dioscorea alata (Greater Yam)*
4. *Dioscorea rotundata (White Yam)*
5. *Manihot esculenta (Cassava/Tapioca)*
6. *Amorphophallus paeoniifolius (Elephant Foot Yam)*
7. *Dioscorea esculenta (Lesser Yam)*
8. *Curcuma angustifolia (Arrowroot)*
9. *Asparagus racemosus (Shatavari)*

Fruits

1. *Mangifera indica (Mango)*
2. *Artocarpus heterophyllus (Jackfruit)*
3. *Musa spp. (Banana)*
4. *Carica papaya (Papaya)*
5. *Psidium guajava (Guava)*
6. *Citrus limon (Lemon)*
7. *Ananas comosus (Pineapple)*
8. *Syzygium cumini (Jamun/Black Plum)*
9. *Syzygium aqueum (Water Apple)*

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10. *Ziziphus mauritiana (Indian Jujube)*
11. *Flacourtia jangomas (Indian Coffee Plum)*
12. *Elaeocarpus serratus (Ceylon Olive)*
13. *Averrhoa carambola (Starfruit)*
14. *Litchi chinensis (Lychee)*
15. *Citrullus lanatus (Watermelon)*
16. *Annona squamosa (Custard Apple)*
17. *Citrus aurantiifolia (Indian Lime)*
18. *Citrus reticulata (Mandarin Orange)*
19. *Citrus maxima (Pomelo)*
20. *Tamarindus indica (Tamarind)*
21. *Punica granatum (Pomegranate)*
22. *Hylocereus undatus (Dragon fruit)*

Plantation crops

1. *Cocos nucifera (Coconut)*
2. *Anacardium occidentale (Cashew)*
3. *Hevea brasiliensis (Rubber)*
4. *Areca catechu (Arecanut)*

Medicinal Plants

1. *Aloe vera (Aloe)*
2. *Tinospora cordifolia (Guduchi/Heart-leaved Moonseed)*
3. *Centella asiatica (Indian Pennywort/Gotu Kola)*
4. *Ocimum tenuiflorum (Holy Basil/Tulsi)*
5. *Adhatoda vasica (Malabar Nut/Vasaka)*
6. *Phyllanthus amarus (Stonebreaker)*
7. *Azadirachta indica (Neem)*
8. *Melia dubia (Malabar Neem)*
9. *Withania somnifera (Ashwagandha)*
10. *Emblica officinalis (Indian Gooseberry/Amla)*
11. *Saraca asoca (Ashoka Tree)*
12. *Bacopa monnieri (Brahmi)*
13. *Gymnema sylvestre (Gudmar/Sugar Destroyer)*
14. *Curcuma aromatica (Wild Turmeric)*

Spices

1. *Zingiber officinale (Ginger)*
2. *Curcuma longa (Turmeric)*
3. *Piper nigrum (Black Pepper)*
4. *Cinnamomum verum (Cinnamon)*
5. *Syzygium aromaticum (Clove)*
6. *Myristica fragrans (Nutmeg)*
7. *Murraya koenigii (Curry Leaves)*
8. *Garcinia gummi-gutta (Kudampuli/Malabar Tamarind)*
9. *Trigonella foenum-graecum (Fenugreek)*
10. *Coriandrum sativum (Coriander)*
11. *Cuminum cyminum (Cumin)*
12. *Foeniculum vulgare (Fennel)*
13. *Nigella sativa (Black Cumin)*

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14. *Allium sativum (Garlic)*
15. *Allium cepa (Onion)*

Multipurpose trees and shrubs

1. *Tectona grandis (Teak)*
2. *Bambusa spp. (Bamboo)*
3. *Eucalyptus spp. (Eucalyptus)*
4. *Dalbergia latifolia (Indian Rosewood)*
5. *Albizia saman (Rain Tree)*
6. *Leucaena leucocephala (Subabul)*
7. *Gliricidia sepium (Quickstick)*
8. *Acacia auriculiformis (Acacia)*
9. *Sesbania grandiflora (Agathi)*
10. *Delonix regia (Gulmohar/Flame Tree)*
11. *Cassia fistula (Golden Shower Tree)*
12. *Adhatoda vasica (Malabar Nut)*
13. *Avicennia marina (Mangroves)*

Ornamentals

1. *Hibiscus rosa-sinensis (Hibiscus)*
2. *Ixora coccinea (Ixora)*
3. *Bougainvillea glabra (Bougainvillea)*
4. *Clitoria ternatea (Butterfly Pea)*
5. *Rosa spp. (Rose)*
6. *Tagetes erecta (Marigold)*
7. *Mussaenda erythrophylla (Red Mussaenda)*
8. *Calathea spp. (Prayer Plant)*
9. *Aglaonema spp. (Chinese Evergreen)*
10. *Philodendron spp. (Philodendron)*
11. *Nymphaea spp. (Water Lily)*
12. *Nelumbo nucifera (Lotus)*
13. *Dendrobium spp., Vanda spp., Phalaenopsis spp. (Orchids)*

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