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Contribution of home gardens from the Sustainable Reserve Food Garden Program in Pacitan Regency: Supporting nature conservation

Titik Wijayanti[1*], Diyah Ayu Widyaningrum[2], Trio Ageng Prayitno[1], Nikmatul Iza[1]

[1]Biology Education Study Program, Faculty of Exact Sciences and Sport, Universitas Insan Budi Utomo, Jl. Citandui No. 46, Malang, East Java, Indonesia.

[2]Physical Education, Health and Recreation Study Program, Faculty of Exact Sciences and Sport, Universitas Insan Budi Utomo, Jl. Simpang Arjuno No. 14-b, Malang, East Java, Indonesia.

*corresponding author: titikwijayanti083@gmail.com

ABSTRACT

The Sustainable Reserve Food Garden Program is one of the government's strategies to support household food security and environmental conservation. This study aims to assess the contribution of home gardens resulting from the home garden sustainability program to nature conservation efforts in Pacitan Regency, East Java. The analyzed indicators include cultivation practices, utilization of local plant species, resource efficiency, environmentally friendly farming, plant density, and the Shannon-Wiener diversity index. This descriptive-observational study employed a mixed-methods approach, integrating quantitative ecological measurements with qualitative data collected through direct field observations, structured interviews, and questionnaires involving 300 household participants. Quantitative analysis included the Shannon-Wiener diversity index, plant density measurements, descriptive statistics, and Principal Component Analysis, while qualitative information supported the interpretation of household conservation practices. The results show that home gardens significantly contribute to the conservation of local genetic resources and increase household-level biodiversity. Principal Component Analysis revealed clusters of respondents based on their level of conservation contribution. The majority were classified as "successful" in integrating food production and conservation functions. These findings emphasize the importance of promoting home gardens as sustainable micro-conservation spaces at the household level.

Keywords: Biodiversity, community-based conservation, home garden, Shannon-Wiener diversity, sustainable agriculture.

INTRODUCTION

Home gardens hold significant potential in supporting household food security as well as biodiversity conservation at the local level. As green spaces surrounding residential areas, home gardens can be utilized for cultivating various types of food crops (Irham et al., 2021; Nurholis, 2021; Wijayanti et al., 2025), medicinal plants (Agustina et al., 2022; Mncwango et al., 2020; Sudarmono, 2018), and horticultural commodities (Purnaningsih & Lestari, 2021). This practice not only meets daily household needs but also supports environmental conservation (Saptana et al., 2021; Wijayanti et al., 2023, 2024). In the context of climate change and increasing natural resource degradation, optimizing the ecological functions of home gardens has become an important and sustainable strategy.

The Indonesian government, through the Sustainable Reserve Food Garden (SRFG) Program, its call Home Garden Sustainability Program, encourages the use of home gardens as sources of independent and environmentally friendly food production (Badan Ketahanan Pangan, 2018; Kementerian Pertanian RI, 2019). The program aims to increase the availability of food based on local resources, reduce market dependence, and promote sustainable agricultural practices (Badan Ketahanan Pangan Kementerian Pertanian, 2019; Kementan RI et al., 2019). A key component of home garden

sustainability program is the conservation of local plant species and the application of efficient and adaptive cultivation technologies suited to local agroecological conditions (Saptana et al., 2021; Wijayanti et al., 2021, 2024). However, the extent to which home garden sustainability program contributes to biodiversity conservation and resource efficiency requires further study. This research focuses on evaluating the contribution of home garden sustainability program-based household gardens in Pacitan Regency to local nature conservation efforts (Badan Ketahanan Pangan Kementerian Pertanian, 2018; Wijayanti et al., 2021, 2024).

In Indonesia, home gardens have long been recognized as multifunctional agroecosystems that contribute to household food security, nutritional diversity, and the conservation of local plant genetic resources. To strengthen these functions, the government has implemented the SRFG, encouraging households to cultivate diverse food crops in their home gardens. Previous studies in Indonesia have primarily reported the program's contribution to food security, dietary diversity, and community empowerment. However, empirical evidence regarding its ecological contribution to biodiversity conservation and sustainable management of home gardens remains limited.

Previous studies have largely emphasized the economic and food security aspects of sustainable food garden programs, such as increased vegetable consumption (Hakim., 2014; Husain & Wahidah, 2018; Thomas et al., 2020) food diversification (Oelviani, 2015; Santos et al., 2022; Trinh et al., 2008) and the empowerment of women in household management (Al-Mayahi et al., 2019; Ardren & Miller, 2020; Erlana et al., 2023; Mellisse et al., 2018). However, fewer studies have thoroughly examid the ecological dimensions of sustainable food garden programs, particularly their contribution to biodiversity and environmental conservation. Existing studies linking home gardens to conservation have often been descriptive, lacking systematic ecological measurements.

This study introduces a novel approach by integrating ecological indicators such as plant density and the Shannon-Wiener diversity index, alongside conservation variables such as resource efficiency, preservation of local plant species, and environmentally friendly farming practices. Furthermore, it provides a comprehensive categorization of the success of home garden sustainability program, which has not been extensively explored in Pacitan Regency, one of the priority implementation areas of the SRFG Program in East Java. The regency represents a predominantly rural landscape where home gardens are widely utilized for household food production, making it an appropriate setting to evaluate the ecological contribution of the SRFG Program to biodiversity conservation.

Several home garden research studies generally examine soil quality from a microbiological perspective (Wijayanti et al., 2021), the use of yard land to support food security and resilience (Ashari et al., 2016; Wijayanti et al., 2024), and the impact of home garden on food expenditure and consumption patterns (Purwantini et al., 2016). Therefore, this study aims to measure the potential contribution of home gardens from the home garden sustainability program to nature conservation efforts in Pacitan Regency.

This study contributes empirical evidence on the ecological and socio-cultural roles of the Sustainable Reserve Food Garden (SRFG) Program in supporting nature conservation. By integrating ecological indicators (plant diversity and vegetation structure) with household conservation practices, this study provides a comprehensive understanding of how home garden-based interventions contribute to biodiversity conservation. The findings also offer scientific evidence to support community-based conservation strategies and inform future policies for sustainable home garden management.

METHOD

This study adopted a descriptive-observational mixed-methods design by integrating quantitative ecological assessments with qualitative information obtained from household observations and interviews.

Study area

The study was conducted from July to September 2023 in 12 sub-districts of Pacitan Regency: Donorojo, Punung, Pringkuku, Pacitan, Arjosari, Kebonagung, Tegalombo, Tulakan, Nawangan, Bandar, Ngadirojo, and Sudimoro. The subjects were households actively participating in food garden sustainability program and utilizing their home gardens for at least two years. Respondents were selected purposively, with 25 participants from each sub-district, totaling 300 respondents. Selection considered active participation in that program, the existence of productive home gardens, and willingness to be interviewed and observed.

Data collection

The data were collected using purposive sampling through field observations, structured interviews, and closed-ended questionnaires. Observation instruments recorded vegetation structure, plant species, and plant density in each home garden. Interviews explored respondents' conservation practices, including motivations, challenges, and ecological values. Questionnaires assessed conservation contributions based on indicators such as sustainable cultivation, utilization of local plants, resource efficiency, and environmentally friendly farming practices. The questionnaire used in this study was developed by the authors based on the objectives of the SRFG Program and supported by a comprehensive review of previous studies on home gardens, biodiversity conservation, and sustainability agriculture (Korpelainen, 2023; Saptana et al., 2021; Wijayanti et al., 2025). The instrument comprised four principal indicators: cultivation practices, utilization of local plant species, resource efficiency, and environmentally friendly farming practices. Prior to field implementation, the questionnaire underwent expert judgment by specialists in biodiversity conservation and environmental education to evaluate the relevance, clarity, and appropriateness of each item. Suggestions from the experts were incorporated into the final version of the instrument before data collection.

They also evaluated ecological aspects such as plant density and biodiversity using the Shannon-Wiener diversity index. The Shannon-Wiener diversity index (H′) was calculated to assess plant diversity in the home gardens. The index was determined using the following formula:

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

where H′ is the Shannon-Wiener diversity index, S is number of species in the community, pi is proportion of individual of the i-th species relative to the number of individuals, ni is number of individuals of the i-th species, ln is natural logarithm. In this study, the H′ values were interpreted as follows: values less than 1 indicate low diversity, values between 1 and 3 represent moderate diversity, and values greater than 3 indicate high diversity (Urrea, 2008).

Statistical analysis

All statistical analysis were performed using PAST version 4.13 (Hammer et al., 2001). Descriptive statistics were used to summarize respondent's perceptions of conservation indicators. The Shannon-Wiener diversity index (H') was calculated to assess plant diversity, while plant density was determined to evaluate vegetation structure. Principal Component Analysis (PCA) was conducted to identify relationships among ecological and socio-cultural variables associated with the success of the Sustainable Reserve Food Garden (SRFG) Program. Furthermore, regression analyses were performed to examine relationships among conservation variables. Polynomial regression models were applied to analyze the relationships

between woody plant density and resource efficiency (Figure 2), and between herbaceous plant density and cultivation practices (Figure 3), whereas simple linear regression was used to evaluate the relationship between the Shannon–Wiener diversity index and local plant conservation scores (Figure 4). The coefficient of determination (R^2) was used to evaluate the goodness-of-fit of each regression model.

RESULTS AND DISCUSSION

Survey results indicated that Home Gardens Sustainability Program in Pacitan significantly contributed to conservation. A total of 96.5% of respondents rated cultivation practices as very good, 94.0% rated local plant use as very good, and 89.8% rated environmentally friendly farming as very good. Resource efficiency was rated good by 51.4% and very good by 48.6%. These findings confirm that home gardens sustainability program play a key role in biodiversity preservation at the household level.

Table 1. Result of the respondent survey regarding the contribution of home garden sustainability program to nature conservation.

No	Variables	Respondent Perception (%)				Total (%)
		Poor	Fair	Good	Very Good	
1	Cultivation	0	0	3.5	96.5	100
2	Local crops	0	0	6.0	94.0	
3	Eco-friendly agriculture	0	0	10.2	89.8	
4	Resource efficiency	0	0	51.4	48.6	

These results indicate that the Home Garden Sustainability Program in Pacitan Regency has contributed significantly to environmental conservation through the utilization of home garden. The high proportion of respondents cultivating local plants is an important indicator of successful biodiversity conservation at the domestic level. This aligns with the principle of in-situ conservation, where biological resources are preserved in their natural habitat (Anindya et al., 2021; Anisha et al., 2019; Maryanti et al., 2022). The implementation of environmentally friendly agriculture, although not yet widespread, reflects increasing public awareness of farming practices that minimize the use of chemicals. This condition aligns with the results of studies (Kusumaningsih & Tyas, 2019; Miterianifa & Mawarni, 2024), which state that the home garden sustainability program system can be an effective ecological education medium for households in supporting sustainable agriculture. Resource efficiency presents significant opportunities for optimizing domestic waste management, particularly water and organic waste. Using rice washing water every morning to water the plants in the home garden and utilizing kitchen waste for compost are concrete examples of resource efficiency on a micro-scale. A moderate to high diversity index indicates that home gardens not only have aesthetic or economic value, but also significant ecological value. Household home garden serves as microhabitats that support species diversity, including food crops such as vegetables, woody plants that produce fruit, and plants that can be used as medicines.

The relationship between home garden diversity and conservation value

The Home Garden Sustainability Program in Pacitan Regency demonstrates a positive contribution to nature conservation, particularly through the enhancement of home garden plant diversity. The analysis presented in Figure 1 shows that the Shannon-Wiener diversity index is positively correlated with community perceptions of conservation. This finding indicates that the greater the diversity of plant species in home gardens, the higher the level of community awareness and appreciation of the conservation functions of these spaces.

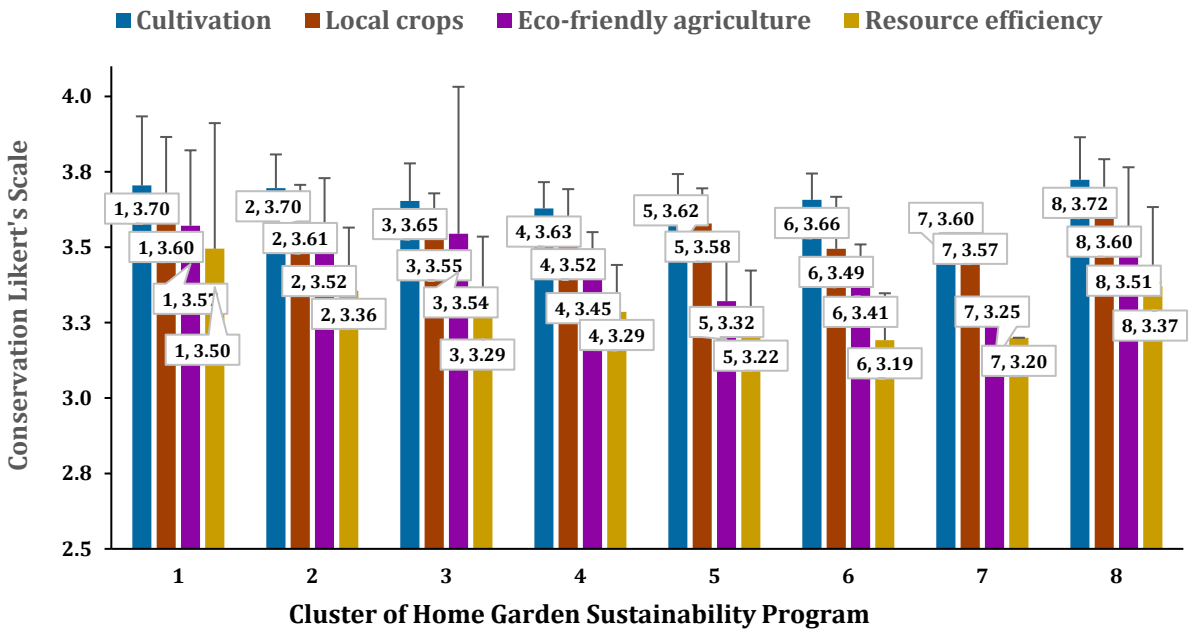

Figure 1. Variation among respondent clusters in assessing household garden contributions within the Home Garden Sustainability Program.

Figure 1 illustrates the variation in home garden contributions within the Home Garden Sustainability Program across four conservation variables: cultivation, local plant species, environmentally friendly farming, and resource efficiency, analyzed based on eight respondent clusters. Contribution values were measured using a Likert scale and presented as the average score per indicator for each cluster. Overall, clusters 1 through 8 exhibited relatively similar trends, although cluster 8 showed a distinct difference with the highest scores for cultivation and local plant indicators. In contrast, the resource efficiency indicator consistently displayed the lowest average values across all clusters.

The variation among clusters in Figure 1 indicates that, although most respondents demonstrated relatively similar levels of conservation contribution, certain clusters excelled in specific aspects. For instance, Cluster 8 recorded the highest contributions in cultivation and local plant preservation, reflecting intensive household-based conservation practices within this group. On the other hand, the consistently low scores for resource efficiency across nearly all clusters suggest that this aspect remains a primary challenge in the implementation of the Home Garden Sustainability Program. This aligns with previous studies (Abdurrohim, 2024; Fakhriyah et al., 2021; Kusumaningsih & Tyas, 2019; Miterianifa & Mawarni, 2024; Yunita et al., 2019), which reported that household waste management and irrigation efficiency are often overlooked in home garden farming systems. These findings highlight the considerable potential of the Home Garden Sustainability Program in supporting community-based nature conservation. The program's success is evident not only in terms of utilizing home gardens for food security but also in its ecological contributions, particularly in preserving local plant species and enhancing biodiversity within domestic environments.

Contribution of plant types to conservation perceptions

Further correlation analysis of the density of plant types (herbaceous and woody) in home gardens revealed a significant relationship between the diversity of each plant group and community perceptions of conservation. This is

reflected in shrubs (R^2 = 0.93) as shown in Figure 2, and woody plants (R^2 = 0.83) as shown in Figure 3. These two plant groups provide different ecological contributions but simultaneously shape community understanding of the importance of maintaining local ecosystem balance. Herbaceous plants, for example, serve as sources of food (vegetables) and household medicine. Meanwhile, woody plants not only function as food crops producing various fruits but also act as soil protectors and microclimate regulators, while contributing to climate change mitigation through carbon sequestration. Such conditions may reflect garden intensification as an adaptive strategy to optimize limited household land while simultaneously meeting increasing food demands and supporting biodiversity conservation (Ashari et al., 2016; Korpelainen, 2023; Santos et al., 2022).

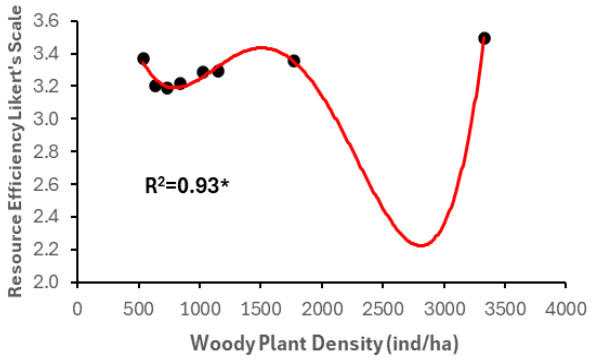

Figure 2. Relationship between woody plant density and resource efficiency in household gardens under the Home Garden Sustainability Program.

Figure 2 presents the nonlinear relationship between woody plant density and resource efficiency based on polynomial regression analysis. It illustrates the relationship between woody plant density (ind/ha) and resource efficiency scores, measured using a Likert scale, in home gardens under the Home Garden Sustainability Program. The polynomial curve model indicates a nonlinear relationship between the two variables, with a very high coefficient of determination (R^2 = 0.93), reflecting a strong correlation. Resource efficiency followed a fluctuating pattern as woody plant density increased. At moderate density levels (around 1.500 ind/ha), resource efficiency reached its peak, likely due to optimized shading, biomass utilization, and litter management. However, at higher densities (>2,500 ind/ha), efficiency declined, possibly because of plant competition or limited growing space, before rising again to extreme densities (>3,300 ind/ha), which may be attributed to more intensive management practices.

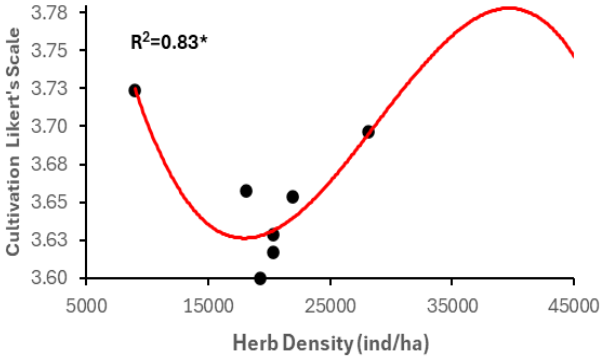

Figure 3. Relationship between herbaceous plant density and cultivation activities in household gardens under the Home Garden Sustainability Program.

Figure 3 illustrates the nonlinear relationship between herbaceous plant density and cultivation practices analyzed using polynomial regression. It shows the relationship pattern between herbaceous plant density (ind/ha) and cultivation scores based on the Likert scale. A nonlinear relationship was observed, with a coefficient of determination of R^2 = 0.83, indicating a strong correlation between the two variables. Cultivation activities declined at low to medium herbaceous plant densities but increased significantly as plant density rose above 25.000 ind/ha. This suggests that the higher the herbaceous plant density in home gardens, the more active the cultivation activities undertaken by household members. Such conditions may reflect garden intensification as an adaptive response to land limitations and the growing demand for household food consumption.

The findings indicate that garden structure, represented by plant density and biodiversity index, has a significant relationship with the achievement of conservation indicators in the Home Garden Sustainability Program. The relationship between woody plant density and resource efficiency (Figure 2) showed a nonlinear pattern with a high coefficient of determination (R^2 = 0.93). This suggests that at certain density levels (around 1.500 ind/ha), resource efficiency reached optimal conditions. However, efficiency declined sharply at higher densities, reflecting ecological and technical saturation points in home garden utilization. A similar pattern was observed in the relationship between herbaceous plant density and cultivation activities (Figure 3), where increasing density progressively stimulated cultivation intensity, peaking at around 35.000 ind/ha (R^2 = 0.83). This reflects household adaptation to food consumption needs and space availability.

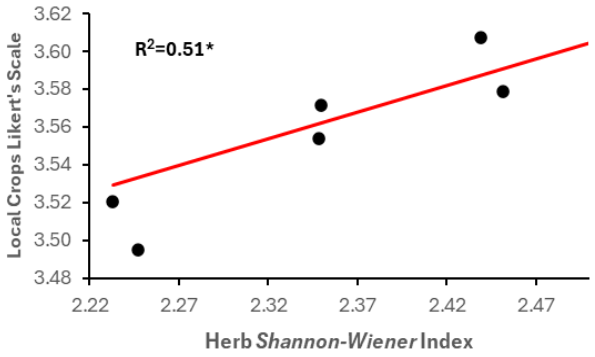

Figure 4. Relationship between Herb *Shannon-Wiener* Index and Local Crops in household garden under the Home Garden Sustainability Program.

Figure 4 shows the positive relationship between the Shannon–Wiener diversity index and local plant conservation scores based on simple linear regression analysis. It illustrates the relationship between the Shannon-Wiener diversity index for herbaceous plants and community perception scores regarding local plants in the context of garden conservation. The analysis shows a positive linear correlation with a coefficient of determination (R^2 = 0.51), indicating that approximately 51% of the variation in local plant scores can be explained by variations in herbaceous plant diversity. This positive relationship suggests that the greater the diversity of herbaceous species in home gardens, the higher the level of community attention and appreciation toward the importance of local plants. Gardens with high species diversity also tend to accommodate more local plants, whether driven by conservation awareness or functional needs such as food, medicinal resources, and culinary spices. Although the R^2 value is moderate, this trend reinforces the role of biodiversity in shaping ecological values at the household level. These findings also support a community-based conservation approach, in which species diversity maintenance directly contributes to the preservation of local genetic resources. The relatively high plant diversity observed indicates that home gardens can serve as important microhabitats within sustainable agricultural landscapes. The Shannon-Wiener index values obtained are consistent with previous findings (Silvia et al., 2025; Surayasa et al., 2024; Susanto et al., 2015; Trisnanto, Soekmadi, et al., 2023a), which highlight that high biodiversity in household agroecological systems enhances the stability of local ecosystems.

Furthermore, the relationship between herbaceous plant diversity (*Shannon-Wiener* index) and perceptions of local plants (Figure 4) revealed a positive linear correlation (R^2 = 0.51). This indicates that the higher the species diversity within a home garden, the greater the community's concern for and commitment to preserving local plant species. These findings strengthen the socio-ecological perspective of conservation, wherein biodiversity in home gardens functions not only as an ecological asset but also as a cultural indicator of local conservation values (Surayasa et al., 2024; Trisnanto et al., 2023b). As a result, home gardens serve dual roles not only as spaces for food production but also as educational and ecological instruments that support the

sustainability of the Home Garden Sustainability Program at the household level.

Principal Component Analysis (PCA): Ecological and social dimensions of the program's success

The Principal Component Analysis (PCA) plot in Figure 5 illustrates the relationships among various conservation variables (respondents' perceptions of cultivation, local plants, environmentally friendly farming, and resource efficiency) as well as ecological-environmental variables such as woody and herbaceous plant diversity, and other indicators of the success of the Home Garden Sustainability Program (including cultivation, local plants, resource efficiency, woody plant density, and woody plant diversity). It also incorporates inhibiting factors such as crop failure, pest and disease outbreaks, and drought. Two principal components explained a total of 89.43% of the data variance: Component 1 accounted for 60.40%, while Component 2 accounted for 29.03%.

Cultivation and local plant variables showed high positive loadings on Component 2, indicating their critical role in conservation success as perceived by respondents. Environmentally friendly farming and resource efficiency tended to contribute to Component 1, positively associated with the number of woody plants and biodiversity. Respondents from clusters 2 and 4 were in the upper-right quadrant, suggesting that these groups demonstrated high conservation performance and good biodiversity levels. In contrast, external environmental factors such as crop failure and drought were distributed in the opposite direction, signifying negative influences on the conservation index. This PCA analysis highlights that the Home Garden Sustainability Program contributes substantially to conservation indicators, particularly through the integration of local plants and environmentally friendly cultivation practices. The relationship between community perceptions and ecological variables reinforces that conservation success is determined not only by ecological factors but also by social awareness and community engagement in managing home gardens.

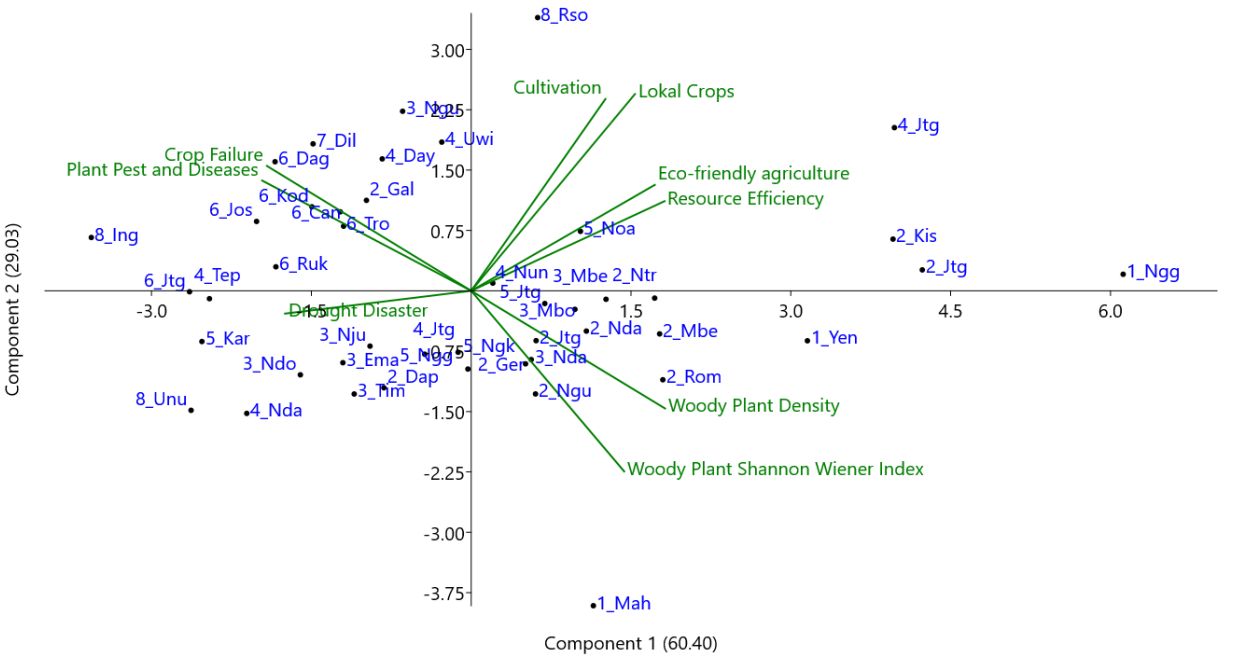

Figure 5. Principal Component Analysis (PCA) plot of the success of the Home Garden Sustainability Program in supporting nature conservation.

Figure 5 presents the results of the Principal Component Analysis (PCA) on the success of the Home Garden Sustainability Program in supporting conservation. The two principal components explained a total variance of 89.43%, with Component 1 (60.40%) representing ecological variables such as resource efficiency, woody plant density (ind/ha), and environmentally friendly farming practices. Component 2 (29.03%) highlighted social and cultural variables, including the utilization of local plants, cultivation, and resilience to crop failure. The distribution of observation points (respondents) across the quadrants indicates clusters that reflect the integration of community preferences, plant species availability, and conservation orientation. Groups located in the positive quadrants of both components generally demonstrated optimal garden utilization, both in terms of productivity and ecosystem functions.

Table 2. Explanatory notes on abbreviations and full village names.

Abbrev.	Village Name	Abbrev.	Village Name
Mah	Gemaharjo	Nun	Tahunan
Yen	Kayen	Tep	Baru
Ngg	Nanggungan	Nda	Ketepung
Jtg	Jatigunung	Day	Bandar
Kis	Pakis Baru	Kar	Sedayu
Rom	Ngromo	Uwi	Sekar
Mbe	Sumberejo	Tro	Kluwih
Mtr	Mantren	Dag	Ketro
Ndo	Sukodono	Can	Bodag
Dap	Dadapan	Ruk	Cangkring
Gal	Tegalombo	Jos	Jeruk
Ngu	Ngunut	Ema	Arjosari
Tro	Ketro	Noa	Tremas
Tim	Jatimalang	Kod	Wonoanti
Ndo	Gondosari	Mbo	Sukodono
Ger	Pagerejo	Nju	Tegalombo
Rso	Dersono	Dil	Punjung
Unu	Punung	Mbe	Hadiluwih
Ing	Pringkuku		Sumber harjo

The implementation of environmentally friendly farming practices, such as the use of compost, botanical pesticides, and irrigation with domestic wastewater, reflects the growing ecological awareness at the household level. This aligns with the principles of community-based conservation, where active community involvement is the key to program sustainability. Nevertheless, the presence of less successful cases among a small portion of participants in the Home Garden Sustainability Program indicates the continued need for mentoring, ongoing education, and access to resources and technical training. As highlighted by previous studies (Gush et al., 2024; Korpelainen, 2023; Prasetyo et al., 2021; Suwardi et al., 2024), the success of community-based programs is strongly influenced by internal factors such as motivation and knowledge, as well as external factors including institutional support and the availability of supporting facilities.

The findings also show that the Home Garden Sustainability Program in Pacitan Regency has made a tangible contribution to environmental conservation through the utilization of household gardens. Based on surveys and field observations, gardens included in the program generally applied sustainable cultivation principles, such as planting local food crops, using organic fertilizers, and adopting environmentally friendly farming techniques. From a conservation perspective, most gardens contained a relatively high diversity of local plant species. The *Shannon-Wiener* index (H′) ranged from 2.22 to 2.47, indicating a moderate level of diversity. Plant density was also relatively high, even though the gardens were limited to household plots of participating families. Resource efficiency was evident in practices such as using household wastewater for irrigation and composting organic kitchen waste (Indriani et al., 2024; Kharisma & Kaswanto, 2021). These practices support the principles of environmentally friendly agriculture while promoting resource efficiency through the recycling of household waste (Hendrayana et al., 2022; Keswari Krisnandika et al., 2023; Maisyaroh et al., 2023; Mariah et al., 2023).

Overall, the results affirm that the household-based approach of the Home Garden Sustainability Program can serve as a highly effective strategy for community-based conservation. The diversity of plants cultivated in home gardens contributes not only to household food security but also to strengthening ecological and conservation values at the local level. The program's success is strongly influenced by the integration of local knowledge, active community participation, and the efficient and sustainable use of garden resources. Consequently, the Home Garden Sustainability Program holds strong potential as a replicable model for community-based conservation in other regions with similar characteristics, particularly rural areas highly dependent on local natural resources.

Although this study provides comprehensive evidence regarding the contribution of the SRFG Program to nature conservation in Pacitan Regency, several limitations should be acknowledged. The study was conducted in a single regency, which may limit the generalizability of the findings to regions with different ecological and socio-economic characteristics. In addition, the assessment focused primarily on plant diversity and household conservation practices, while other ecological indicators, such as soil quality, ecosystem services, and long-term biodiversity dynamics, were beyond the scope of this study. Future research involving multiple regions and broader ecological assessments is therefore recommended.

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CONCLUSION

The Home Garden Sustainability Program in Pacitan Regency has positively contributed to biodiversity conservation through the enhancement of plant diversity in home gardens. Herbaceous and woody plant diversity correlated with increased community awareness of conservation. The success of the home gardens sustainability program was influenced by ecological and socio-cultural integration, including resource efficiency, use of local plants, and environmentally friendly farming practices. It has strong potential to serve as an effective and sustainable household-based conservation model, adaptable to rural areas with similar characteristics.

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