

## Sustainability Assessment of Homegarden Agroforestry Based on RAPFISH in Reducing Community Dependence on Forest Products

Radian Anwar<sup>1\*</sup>, Christine Wulandari<sup>2</sup>, Pitojo Budiono<sup>3</sup>, Samsul Bakri Indra Gumay  
Febryano<sup>4</sup>, Teguh Endaryanto<sup>5</sup>

<sup>1,2,3,4,5</sup>Universitas Lampung  
[radiananwar480@gmail.com](mailto:radiananwar480@gmail.com)

### Abstract

*This study aimed to analyze the sustainability status of home garden agroforestry systems and formulate development strategies to reduce community dependence on forest resources in buffer zone areas. The study was conducted from January to March 2026 in Cilimus Village, Pesawaran Regency, using the RAP-AFS method based on Multidimensional Scaling (MDS). Data were collected through questionnaires, structured interviews, and field observations involving 90 respondents and analyzed across five sustainability dimensions: ecological, economic, social, institutional, and technological. The findings showed that the home garden agroforestry system achieved a sustainability index of 65.50, which was categorized as moderately sustainable. Among the five dimensions, the economic dimension was identified as the weakest, owing to limited income diversification, restricted market access, low technology adoption, and weak institutional support. Strengthening agroforestry systems through integrated development strategies is essential for improving socio-ecological resilience and reducing long-term pressure on forest resources. This study was limited to one buffer zone village and focused only on household-level agroforestry practices. This study provides policy recommendations for agroforestry-based income diversification, local supply chain development, and the integration of agroforestry into regional conservation and spatial planning programs in Lampung Province.*

**Keywords:** Agroforestry System, Income Diversification, Reduction of Forest Pressure Socio-Ecological Resilience

### 1. INTRODUCTION

Forest degradation in Wan Abdul Rachman Grand Forest Park (TAHURA WAR) has been reported in remote sensing-based studies, revealing land degradation and land cover changes across several management blocks owing to human activities and policy shifts ([Auliya Fikri et al., 2022](#); [Boinot et al., 2022](#); [Zhang et al., 2023](#)). Forest cover within the protection block declined by 791.46 ha during the 2018–2021 period, whereas mixed garden cover decreased by 340.18 ha. This decline was accompanied by an increase in coffee plantation cover of 390.4 ha, as well as expansions of open land and shrubland by 52.25 and 55.6 ha, respectively. This phenomenon indicates significant land-use pressure, as also reported in studies related to land-use change and the sustainability of agroforestry systems ([Fikry & Sarjan, 2024](#); [Salim, Reniati, & Sumiyati, 2025](#)).

[Pertiwi, Safe'i, and Kaskoyo \(2019\)](#) showed that forest stands in community-managed areas have experienced damage across various plant organs, indicating intensive utilization pressure. Previous studies have also demonstrated that communities surrounding forest areas exhibit a high level of dependence on forest products, both timber and non-timber ([Aaron et al., 2024](#); [Kristin, Qurniati, & Kaskoyo, 2018](#)). Community activities within forest areas tend to be intensive, characterized by frequent entry and exit to obtain economic benefits from non-timber forest products ([Budiono et al., 2024](#); [Fauziah & Sanudin, 2021](#); [Susanti, Wulandari, Kaskoyo, Safe'i, & Yuwono, 2021](#)). This condition has the potential to increase pressure on forest areas if not balanced with sustainable management systems ([Ariandi & Mukti, 2023](#); [Rettob, Kaswanto, & Yovi, 2025](#)).

Locally, Cilimus Village in Pesawaran Regency is one of the villages directly bordering the TAHURA WAR area, representing the real dynamics of community pressure on forests. The village has served as a site for multi-strata agroforestry research around TAHURA WAR, where the agroforestry system has been developed as a restoration effort for forest areas under pressure from community cultivation activities ([Kristin et al., 2018](#)). Most residents work as farmers and are highly dependent on the surrounding land and forest resources. Community interaction with TAHURA WAR land is influenced by low income levels and the absence of alternative livelihoods, where most

respondents belong to low-income groups, driving dependence on the forest area ([Bhimasta, Surya, & Pramudita, 2025](#)). Ecological conditions in Cilimus Village have already shown indications of significant exploitation pressure, as demonstrated by forest health mapping results in the TAHURA WAR conservation forest area using the Forest Health Monitoring method. This pressure is further complicated by limited livelihood alternatives and poor access to markets and agricultural technology.

Non-timber forest products utilized by communities in TAHURA WAR have not been fully marketed optimally, due to low entrepreneurial spirit, lack of promotion, and an underdeveloped marketing system ([Angelus, Aloysius, & Felix, 2025](#)). Therefore, Cilimus Village represents a strategic locus for examining the potential of developing home garden agroforestry as a community-based solution that can simultaneously improve welfare and reduce pressure on forest areas. One alternative that can be developed is homegarden agroforestry, a land-use system that integrates forestry and agricultural crops within a single spatial unit. This system is characterized by high plant diversity and a multilayered structure resembling a forest ecosystem, and it functions to meet food needs, increase household income, and maintain environmental sustainability ([Aaron et al., 2024](#); [Satish et al., 2024](#); [VijayKumar et al., 2024](#)). Homegarden agroforestry has also been proven to enhance food security, improve land-use efficiency, and support biodiversity conservation ([R. R. Sari, Ishaq, Purnamasari, & Saputra, 2025](#); [Zhang et al., 2023](#)).

## 2. LITERATURE REVIEW

This study aimed to analyze the sustainability status of homegarden agroforestry systems and formulate development strategies to reduce community dependence on forest resources. The utilization of homegardens with high economic value crops can serve as a strategy for income diversification and the fulfillment of subsistence needs ([Duryat et al., 2025](#); [Salim et al., 2025](#)). The sustainability of agroforestry systems is influenced by multiple dimensions, including ecological, economic, social, institutional, and technological factors. Therefore, it is necessary to identify the leverage attributes and develop appropriate strategies to enhance system sustainability ([Silondae, Rosmalah, Hartati, & Putri, 2026](#); [Suhartini et al., 2024](#)).

Sustainability assessments of natural resource management systems can be conducted using various methodological approaches. Multi-Dimensional Scaling (MDS) is one approach that can be used to assess the sustainability status of natural resource ecosystems, and RAPFISH (Rapid Appraisal for Fisheries) is the most widely applied tool for conducting MDS analysis ([Abdillah, Thamrin, Nofrizal, & Wijayanto, 2023](#)). The primary advantage of using MDS in RAPFISH lies in its ability to produce simple yet comprehensive sustainability evaluation analyses, making this method compatible with and adaptable to various fields beyond fisheries, including agriculture and forestry ([Karyani, Djuwendah, Yudha, Supriyadi, & Arifin, 2024](#)). Furthermore, MDS-based RAPFISH excels at visualizing and exploring complex ecological data by reducing data dimensionality, making analytical results easier to interpret and communicate to policy stakeholders.

Previous studies have generally focused on assessing the multidimensional sustainability status of agroforestry systems without directly linking it to the community's dependence on forest resources. For instance, [Syahputra, Mardiyah, and Undadraja \(2025\)](#) applied the RAP-AFS method based on Multidimensional Scaling (MDS) to evaluate ecological, economic, and social dimensions and identify sensitive attributes, but did not explicitly measure its relationship with forest pressure. Similarly, [Abdillah et al. \(2023\)](#) emphasized the determination of sustainability indices without associating them with community dependence on forest resources.

Nevertheless, the RAPFISH method and its adaptations have a number of limitations that need to be critically acknowledged. RAPFISH was fundamentally developed as a rapid evaluation tool for assessing fishery sustainability; therefore, when adapted to an agroforestry context, the scoring and value ranges for each attribute require careful adjustment to remain relevant and non-arbitrary. Additionally, data quality gaps across locations or contexts pose distinct challenges in the RAP-based multidimensional analysis process, particularly in terms of the consistency and comparability of results across regions ([Silondae et al., 2026](#)). These limitations must be considered when interpreting the results and formulating evidence-based policy recommendations.

Previous studies have generally focused on assessing the multidimensional sustainability status of agroforestry systems without directly linking them to the community's dependence on forest resources. For instance, applied the RAP-AFS method based on MDS to evaluate ecological, economic, and social dimensions and identify sensitive attributes but did not explicitly measure the relationship with forest pressure. Similarly, [Abdillah et al. \(2023\)](#) focused on determining sustainability indices without linking them to community dependence on forest resources. Therefore, this study explicitly examines the relationship between the sustainability status of homegarden agroforestry and the level of community dependence on forest resources. This approach represents a novel contribution, as it quantifies the role of homegarden agroforestry as an alternative strategy for reducing pressure on forest areas in a measurable manner based on sustainability indices ([Retto et al., 2025](#)).

### 3. METHODOLOGY

#### 3.1 Time and Location

The research was conducted from January to March 2026 in Cilimus Village, Teluk Pandan Subdistrict, Pesawaran Regency. SHK Lestari is an organizational forum of the Forest Farmer Group Association (Gapoktanhut) that partners with the Wan Abdul Rachman Grand Forest Park (TAHURA WAR) to manage a portion of the forest area. The forest area managed by SHK Lestari within TAHURA WAR has been designated as a flora and fauna collection site.

The number of farmer household samples was determined using the Slovin formula with a margin of error of 10%, which is commonly applied in socioeconomic research in rural forestry and agroforestry ([Kristin et al., 2018](#); [Wicaksono, Setiawati, & Mawardi, 2024](#)). Sample selection was carried out through purposive sampling based on specific considerations, with the primary criterion being household heads who actively manage home garden land based on the agroforestry system in the forest buffer zone. Data were collected through structured interviews using questionnaires covering the socioeconomic aspects of households, plant composition, land management patterns, and the level of dependence on forest resources. Field observations were conducted to verify the actual conditions of the agroforestry systems managed by the respondents. As a forest farmer group organization, SHK Lestari has the obligation and responsibility to manage forest resources and conserve the forest within the flora and fauna collection block of the TAHURA WAR forest area.

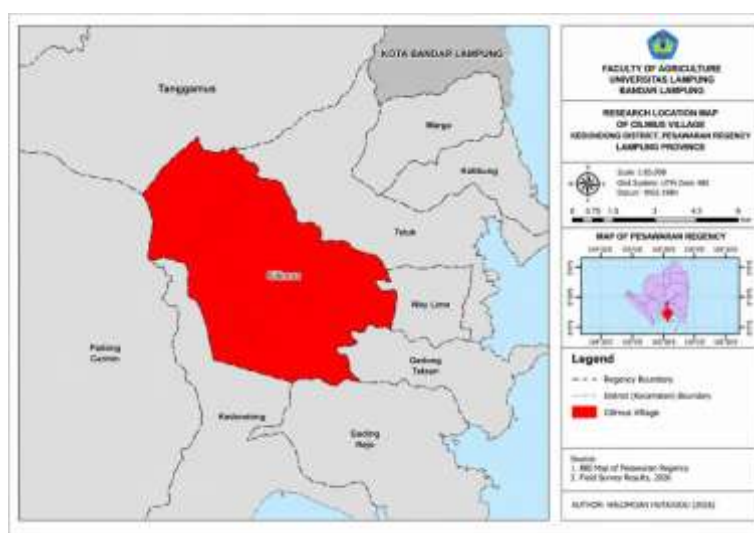


Figure 1. Map of the study area

#### 3.2 Implementation Stages

The research activities consisted of several stages: (a) determining the RAPFISH analytical tool based on Multidimensional Scaling (MDS), (b) selecting the research respondents, (c) developing dimensions and attributes in the questionnaire, and (d) collecting data through interviews

and field observations. According to [Sutisna, Affandi, Kamal, and Yulianto \(2020\)](#), these stages represent the general procedure in sustainability analysis using RAPFISH, which begins with the identification of dimensions and attributes based on a literature review and field conditions, followed by data collection through surveys, interviews, and observations to obtain attribute scores for each dimension.

The number of respondents was 70 individuals, representing members of each Forest Farmer group (*Kelompok Tani Hutan*, KTH). The total population of this study was 672 individuals. Based on this population, [Amalia, Khusaini, Atikawati, Hidayati, and Prismadianto \(2026\)](#) suggested that the number of respondents could be determined as 10% of the total population; therefore, 70 respondents were selected using the Slovin formula. [Suprijanto, Khusaini, and Antariksa \(2025\)](#) state that data analysis was conducted using the RAPFISH method based on MDS with five dimensions: ecological, economic, social, institutional, and technological dimensions. The analysis included sustainability index assessment, leverage analysis and Monte Carlo analysis. Questionnaires were distributed to respondents, and the data collection process involved informal, interactive discussions with farmers.

### 3.3 Perception Measurement

Respondents' perceptions of homegarden agroforestry were measured using a Likert scale, a commonly applied method to assess attitudes, perceptions, and levels of agreement toward specific statements in social and environmental research. The Likert scale enables researchers to transform qualitative responses into quantitative data that can be statistically analyzed ([Taherdoost, 2019](#)). In this study, the respondents' perceptions were measured using a three-point Likert scale. The scoring criteria for each response option were as follows score 1: disagree/poor, score 2: moderately agree/neutral, and score 3: agree/good.

Thus, the assessment criteria in this study consisted of three levels: score 1 for "disagree/poor," score 2 for "moderately agree/neutral," and score 3 for "agree/good." The use of Likert scales with varying numbers of categories (e.g., three, four, or five points) has been widely applied in perception studies, depending on analytical needs and respondent characteristics ([Taherdoost, 2019](#)). Data processing for each attribute in the questionnaire was conducted as follows:

1) Likert Scale Scoring Formula

$$NL = \sum (n_1 \times 1) + (n_2 \times 2) + (n_3 \times 3) \tag{1}$$

NL refers to the Likert scale score used in the measurement, while n represents the number of responses for each score category. The response categories are based on a three-point Likert scale, ranging from 1 to 3, which reflects the distribution of respondents' answers across the provided scale alternatives.

2) Average Score for Each Question Aspect

$$Q = NL / r \tag{2}$$

Q refers to the average score for each question aspect (i-th item) in the measurement. NL represents the Likert scale score used in the assessment, while r denotes the number of respondents participating in the study.

3) Final Score for Each Aspect

$$NA = (Q_1 + Q_2 + Q_3 + \dots + Q_n) / p \tag{3}$$

NA refers to the final score for each aspect in the analysis. Q represents the average score for each question aspect, while p denotes the total number of questions included in the measurement

Data processing was performed by calculating the Likert scale scores for each attribute based on the number of respondents in each response category, which were then averaged to obtain the value of each indicator. This approach is commonly used in perception analysis to generate aggregate values that represent respondents' tendencies toward the variables under study (Wulandari, Kurniasari, Bakri, Dewi, & Safe'i, 2024).

#### 4. RESULTS AND DISCUSSIONS

##### 4.1 General Conditions of the Study Area and Respondent Characteristics

The study was conducted from January to March 2026 in Cilimus Village, Pesawaran Regency, which has a population of 2,378 people and 609 households managing a conservation area of 844.02 ha. The Forest Farmer Group Association (Gapoktanhut) SHK Lestari consists of 672 members distributed across 22 Forest Farmer Groups. According to [Jamika, Amran, Umar, and Gusman \(2023\)](#), the potential of forest resources in the area serves as a source of income and provides ecological benefits for forest farmers in Cilimus Village, thereby creating a dependence on forest products within the Tahura WAR area. This dependence has led to land-use changes and functional shifts in forested areas ([Wicaksono et al., 2024](#)). Therefore, it is necessary to evaluate the sustainability of homegarden agroforestry as a basis for developing strategies to reduce dependence on forest resources by integrating ecological, economic, social, institutional, and technological capacities to conserve and sustain forest ecosystems.

##### 4.2 Sustainability Status of Homegarden Agroforestry

The results of the sustainability analysis of homegarden agroforestry in the SHK Lestari Forest Farmer Group Association (\*Gapoktanhut\*), Cilimus Village, located in the buffer zone of Wan Abdul Rachman Forest Park, indicate a multidimensional index with an average value of 65.50. This value falls within the "moderately sustainable" category of the RAPFISH index classification. This finding suggests that the agroforestry system has an adequate foundation for sustainability; however, it still requires improvements in several attributes to achieve optimal conditions for sustainability.

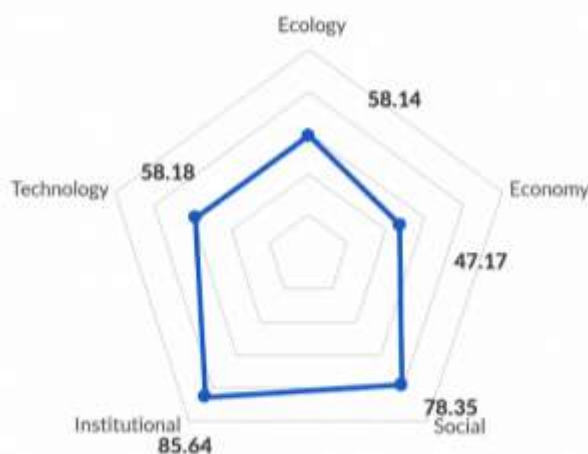


Figure 2. Five-dimensional sustainability diagram

Figure 1 shows the stability of the obtained index value, as demonstrated through the Monte Carlo analysis, indicates that the measurement results have a high level of confidence. This further confirms that the multidimensional approach using RAPFISH can provide a comprehensive assessment of the sustainability status of agroforestry systems. The following presents the sustainability index values and parameters of the homegarden agroforestry in Figure 3.

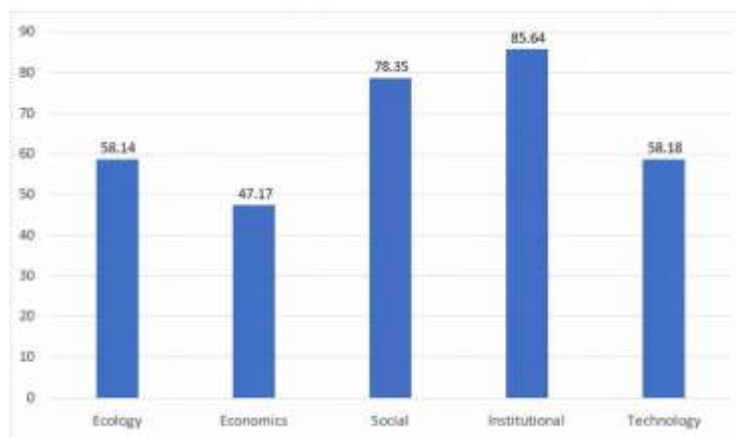


Figure 3. Sustainability index values and parameters of homegarden agroforestry

#### 4.2.1 Ecological Dimension

The results of the MDS analysis using RAPFISH indicate that the sustainability index value for the ecological dimension of homegarden agroforestry in the SHK Lestari Forest Farmer Group Association (Gapoktanhut) was 58.14, based on five evaluated attributes. This value falls within the “moderately sustainable” category of the index. Based on the leverage analysis for the ecological dimension, the water availability attribute had the highest Root Mean Square (RMS) value of 31.14, indicating that it is the most sensitive attribute influencing the sustainability status of home garden agroforestry. A high RMS value suggests that even small changes in water availability can lead to significant shifts in sustainability ordination position. [Lensari, Rosianty, Syachroni, and Paridawati \(2022\)](#) indicated that water is a critical ecological factor determining the sustainability of agroforestry systems, as it is directly related to plant growth, homegarden productivity, and the system’s capacity to adapt to seasonal variability and climate change.

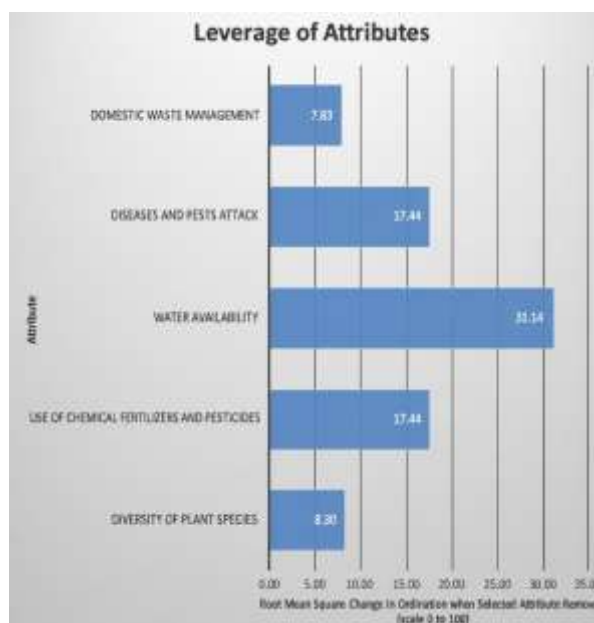


Figure 4. Leverage analysis of the ecological dimension

Figure 4 presents a Leverage of Attributes analysis, showing the Root Mean Square (RMS) change in ordination when each attribute is removed from the system. The results indicate that Water Availability (31.14) is the most influential attribute, meaning it has the strongest impact on system stability. This is followed by Diseases and Pests Attack (17.44) and Use of Chemical Fertilizers and Pesticides (17.44), which also show relatively high leverage values. Meanwhile, Domestic Waste



Management (7.83) and Diversity of Plant Species (8.30) have the lowest influence on the system. Overall, the analysis suggests that water availability is the key driving factor in the system and should be prioritized in management strategies. In practice, several constraints persist, including pest and disease infestations and the uncontrolled use of chemical inputs. According to [Zahro, Fajarwati, Sandy, and Ratih \(2023\)](#), this indicates that although the ecological conditions are relatively favorable, improvements in sustainable cultivation practices are still required.

#### 4.2.2 Economic Dimension

The results of the MDS analysis using RAPFISH indicate that the sustainability index value for the economic dimension of homegardens in the SHK Lestari Forest Farmer Group Association (Gapoktanhut) is 47.17, based on five evaluated attributes. This value falls within the “less sustainable” category of the sustainability index. Based on the leverage analysis for the economic dimension, the attribute of resilience to economic crises was identified as the most sensitive, with the highest Root Mean Square (RMS) value of 5.96. According to [Supriatna, Djumarno, Saluy, and Kurniawan \(2024\)](#), this dominant RMS value indicates that changes in the economic resilience of households or groups in facing shocks such as rising prices of basic necessities, declining purchasing power, or income fluctuations will have the greatest influence on shifts in the sustainability ordination position. In the context of homegarden agroforestry within the SHK Lestari Gapoktanhut, resilience to economic crises is a crucial indicator, as it reflects the capacity of the homegarden system to support household economic stability, whether through food production, additional income sources, or by reducing the risk of sudden livelihood loss ([Hamzah & Hasannudin, 2025](#)).

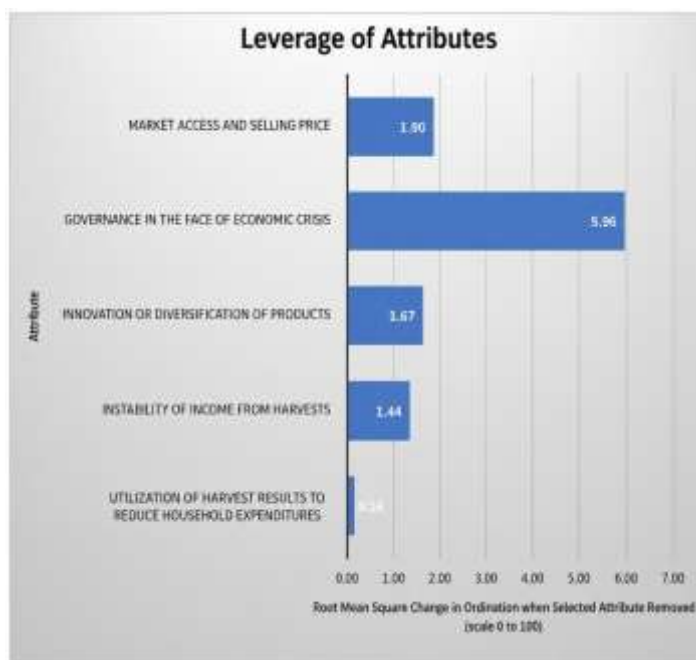


Figure 5. Leverage Analysis of the Economic Dimension

Figure 5 shows leverage of Attributes analysis shows that governance in the face of economic crisis is the most influential factor in the system, with the highest RMS change value (5.96). This is followed by market access and selling price (1.90), innovation or product diversification (1.67), and income instability from harvests (1.44), while the utilization of harvest results to reduce household expenditures has the lowest influence (0.16). Overall, the findings indicate that governance plays a dominant role in shaping system stability compared to other economic and production-related factors. This finding indicates that the agroforestry system at the study site remains largely subsistence-oriented and has not yet developed into a competitive agribusiness system, as it has not generated value-added or processed products from homegarden outputs. Other sensitive attributes

with relatively high RMS values include market access, selling prices, product innovation, and diversification (Harafah, 2023). Therefore, strategies are needed to strengthen the economic dimension, including the development of value chains, product diversification, and improved market access for these products.

#### 4.2.3 Social Dimension

The results of the MDS analysis using RAPFISH indicate that the sustainability index value for the social dimension of homegarden agroforestry in the SHK Lestari Forest Farmer Group Association (\*Gapoktanhut\*) was 78.35, based on five evaluated attributes. This value falls within the “highly sustainable” category of the sustainability index. Based on the leverage analysis for the social dimension, the most sensitive attribute is family conflict or disharmony, with the highest Root Mean Square (RMS) value of 6.89 (Ampim, Ogbe, Obeng, Akley, & MacCarthy, 2021). The highest RMS value indicates that social relations at the household level have the strongest influence on shifts in the sustainability ordination position. Family conflicts can hinder the division of roles, reduce consistency in homegarden management, and weaken collective decision-making regarding the utilization of homegarden produce. Referring to Suek and Mella (2021), in the context of homegarden agroforestry within the SHK Lestari \*Gapoktanhut\*, family harmony is crucial. This is because homegarden agroforestry systems are generally managed based on family labor; therefore, the stability of internal household relationships becomes a key determinant in maintaining the sustainability of management, particularly in the long term.

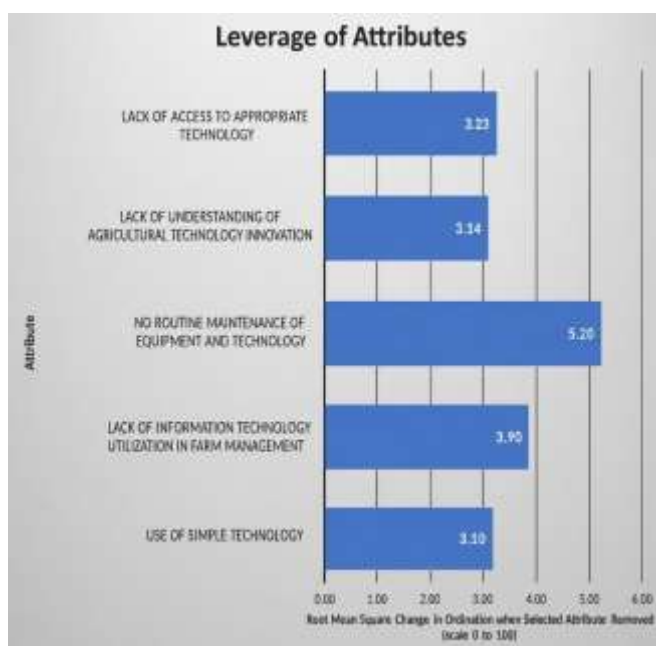


Figure 6. Leverage analysis of the social dimension

Figure 6 shows the Leverage of Attributes analysis indicates that no routine maintenance of equipment and technology (5.20) is the most influential factor affecting the system. This is followed by lack of information technology utilization in farm management (3.90), lack of access to appropriate technology (3.23), and lack of understanding of agricultural technology innovation (3.14). Meanwhile, use of simple technology (3.10) shows the lowest influence among the variables. Overall, the findings suggest that maintenance issues and digital technology utilization are the most critical factors influencing the system, highlighting the importance of improving equipment maintenance and strengthening technology adoption in agricultural management.

Other sensitive attributes include local knowledge of homegarden management and the involvement of family members in agroforestry practices. Both aspects play a crucial role in maintaining system sustainability, particularly in preserving experience-based practices and local

wisdom (P. H. B. Sari, Rumengan, & Indrawan, 2025). However, challenges remain in farmer regeneration, as younger generations tend to show declining interest in the agricultural sector because of various social and economic factors. This condition may threaten the long-term sustainability of agroforestry systems if not properly addressed.

#### 4.2.4 Institutional Dimension

The results of the MDS analysis using RAPFISH indicate that the sustainability index value for the institutional dimension of homegarden agroforestry in the SHK Lestari Forest Farmer Group Association (\*Gapoktanhut\*) is 85.64 based on five evaluated attributes. This value falls within the “highly sustainable” category of the sustainability index. Based on the leverage analysis for the institutional dimension, the most sensitive attribute is the presence of external support, with the highest Root Mean Square (RMS) value of 14.36 (Endaryanto, Seta, & Saleh, 2025). This significantly higher RMS value compared to the other attributes indicates that external support is a key factor influencing shifts in the sustainability ordination position within the institutional dimension. According to Suwartapradja et al. (2023), external support may include program assistance, provision of production inputs, access to financing, and facilitation of market access and partnership networks. In the context of homegarden agroforestry within the SHK Lestari \*Gapoktanhut\*, such support acts as an important leverage factor in strengthening organizational capacity, improving the effectiveness of group management, and assisting members in adapting to various challenges in terms of production and institutional aspects.

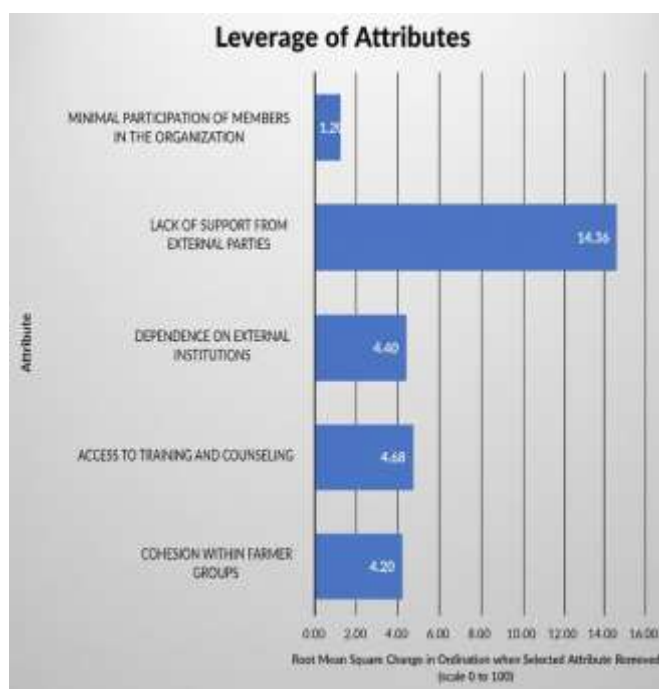


Figure 7. Leverage analysis of the institutional dimension

Figure 7 shows the Leverage of Attributes analysis reveals that lack of support from external parties (14.36) is the most influential factor in the system. This is followed by access to training and counseling (4.68), dependence on external institutions (4.40), and cohesion within farmer groups (4.20). Meanwhile, minimal participation of members in the organization (1.20) shows the lowest influence among all variables. Overall, the results indicate that external support systems play a dominant role in shaping the dynamics of farmer group performance, highlighting the importance of strengthening external institutional support and capacity-building programs.

#### 4.2.5 Technology Dimension

The application of RAPFISH analysis using the MDS approach indicates that the sustainability index value for the technological dimension of homegarden agroforestry in the SHK Lestari Forest Farmer Group Association (Gapoktanhut) was 58.18, based on five analyzed attributes. This value falls within the “moderately sustainable” category of the index. Based on the leverage analysis for the technological dimension, the most sensitive attribute was the lack of routine maintenance of tools and technologies, with the highest Root Mean Square (RMS) value of 5.20. The highest RMS value indicates that the sustainability of homegarden agroforestry is strongly influenced by the maintenance of facilities and technological equipment used in cultivation and homegarden management activities.

[Karyani et al. \(2024\)](#) stated that when equipment maintenance is not performed regularly, the risk of damage increases, work efficiency declines, and repair costs increase, ultimately hindering homegarden productivity. In the context of SHK Lestari Gapoktanhut, this condition reflects that technological sustainability is determined not only by the availability of tools but also by the users’ capacity to maintain their functionality over time.

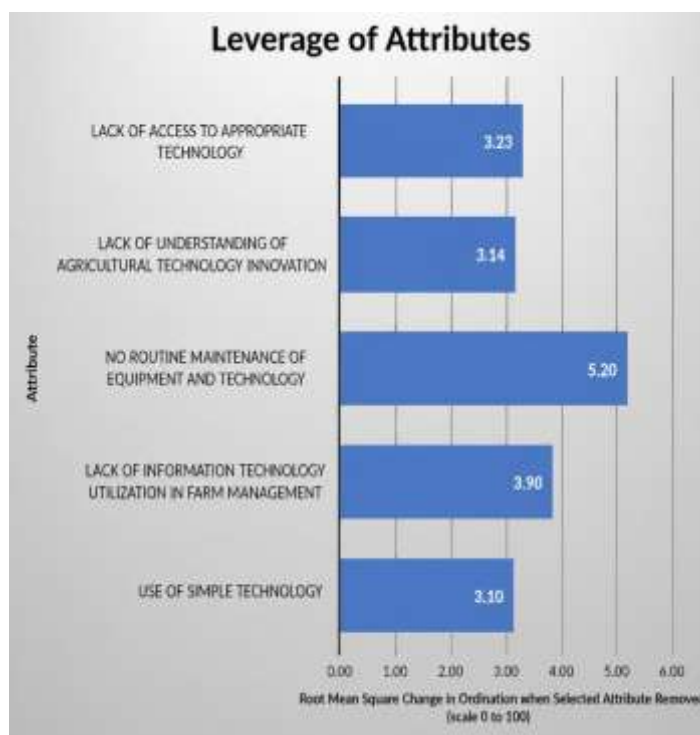


Figure 8. Leverage analysis of the technological dimension

Figure 8 shows the Leverage of Attributes analysis indicates that no routine maintenance of equipment and technology (5.20) is the most influential factor in the system. This is followed by lack of information technology utilization in farm management (3.90), lack of access to appropriate technology (3.23), and lack of understanding of agricultural technology innovation (3.14). Meanwhile, use of simple technology (3.10) shows the lowest influence among the attributes. Overall, the findings highlight that equipment maintenance and digital technology utilization are the most critical factors affecting the system, emphasizing the importance of improving technological management and adoption in agriculture.

Limited access to information, lack of training, and low human resource capacity are the main factors hindering technology adoption in agroforestry systems. [Pippi et al. \(2025\)](#) stated that this condition results in low productivity and management efficiency, given that technology plays a crucial role in improving agricultural system performance. [Wibowo, Harianto, Dewi, and Febryano \(2024\)](#) demonstrate that enhancing technological capacity, particularly in cultivation and post-

harvest practices, is a strategic step in supporting agroforestry sustainability. In addition, the utilization of information technology and the availability of appropriate technologies were identified as sensitive attributes that determine the success of agroforestry system management.

#### 4.2.6 Leverage Attribute Analysis

Leverage attribute analysis is a component of the Multidimensional Scaling (MDS) approach within the RAPFISH method, used to identify the attributes or indicators that are most sensitive to influencing the sustainability index of a system. According to [Bajo-Rubio and Gómez-Plana \(2020\)](#), the sensitivity level of each attribute was measured using the Root Mean Square (RMS) value. Attributes with the highest RMS values were categorized as key leverage factors, as small changes in these attributes could significantly impact the overall sustainability score.

Prioritizing dimensions and attributes in sustainability analysis provides insight into the relative importance of each component in an agroforestry system. Dimensions with the highest priority represent the most influential factors on system sustainability, while attributes with the highest sensitivity values serve as the main leverage factors that determine changes in the sustainability index. Identifying this priority order is crucial for determining intervention focus, formulating appropriate management strategies, and supporting evidence-based policy making in the development of home garden agroforestry. Current conditions require policy recommendations from relevant stakeholders to ensure sustainable and resilient homegarden agroforestry management ([Wattie & Sukendah, 2023](#)).

#### 4.2.7 Implications for Reducing Forest Dependence

Homegarden agroforestry plays a strategic role in reducing community dependence on forest resources. According to [Sudomo et al. \(2023\)](#), this system can provide alternative livelihoods, enhance food security, and reduce the pressure on forest areas. The effectiveness of home garden agroforestry in diminishing forest dependence largely depends on the sustainability of the system itself. Weak economic and technological dimensions indicate that communities may revert to relying on forest resources if home garden agroforestry cannot adequately meet their economic needs. Therefore, the development of homegarden agroforestry must be comprehensive, considering the interconnections between sustainability dimensions. An integrated approach, as suggested by [Bakri, Apriliani, Kaskoyo, and Wulandari \(2024\)](#), ensures that agroforestry functions not only as a production system but also as an effective long-term conservation strategy.

## 5. CONCLUSIONS

### 5.1 Conclusion

Based on the sustainability analysis of homegarden agroforestry using the RAPFISH multidimensional approach based on Multidimensional Scaling (MDS), an index value of 65.50 was obtained at Gapoktanhut SHK Lestari. This value indicates that the homegarden agroforestry system falls into the moderately sustainable category. This suggests that the system is functioning well but still requires reinforcement in several dimensions to achieve optimal sustainability. Efforts to enhance sustainability can focus on strengthening the economic dimension through expanded market access, including the utilization of digital marketplaces, and increasing the added value of agroforestry products through post-harvest processing. Furthermore, improving technology adoption is essential through training and guidance, particularly in processing, post-harvest handling, and access to digital information to enhance efficiency and productivity.

Strengthening local institutions is also necessary by improving the management capacity of farmer/forest groups, ensuring the sustainability of assistance programs, and developing networks of cooperation among various stakeholders. Meanwhile, the already high community participation should be maintained and enhanced by integrating local knowledge into the development of innovative and adaptive agroforestry practices. Overall, the development of homegarden agroforestry needs to be carried out in an integrated and multidimensional manner, considering the interconnections between the ecological, economic, social, technological, and institutional aspects. The model implemented at SHK Lestari also has the potential to be replicated and adapted in other

areas with similar characteristics, particularly in forest buffer zones

## **5.2 Research Limitations**

This study had several limitations that should be considered when interpreting the findings. First, the analytical approach employing RAPFISH based on Multidimensional Scaling (MDS) is highly dependent on the selection of attributes and respondents' subjective judgments, which may introduce bias in determining the sustainability index. Although efforts were made to ensure consistency in the assessment, elements of subjectivity could not be entirely eliminated. Second, this study was conducted at a single location, namely Gapoktanhut SHK Lestari, which limits the generalizability of the findings to other regions with different social, economic, and ecological conditions. Local-specific characteristics may significantly influence the sustainability of homegarden agroforestry systems.

Third, the data used in this study are cross-sectional in nature and therefore do not capture the temporal dynamics of agroforestry sustainability. Agroforestry systems are dynamic and influenced by various external factors, including policy changes, market fluctuations, and environmental conditions. Fourth, the technological dimension and access to digital markets, which were identified as important factors for improving sustainability, were not examined. In particular, aspects such as the level of technology adoption, implementation barriers, and the readiness of human resources to utilize digital tools remain underexplored in the literature.

## **5.3 Suggestions and Directions for Future Research**

Based on the findings and identified limitations, several recommendations and directions for future research are proposed. First, future studies should adopt a longitudinal approach to monitor changes in the sustainability of homegarden agroforestry systems over time, thereby providing a more comprehensive understanding of system dynamics. Second, further research should expand the study area to include multiple regions with diverse characteristics to test the robustness of the agroforestry sustainability model and enhance the external validity of the findings. This approach would also help identify context-specific factors that influence agroforestry performance.

Third, future research should provide a more in-depth analysis of the economic and technological dimensions, particularly in relation to strategies for improving market access, the utilization of digital platforms, and innovations in the processing and post-harvest management of agroforestry products. Such efforts are expected to generate more practical recommendations for increasing value-added products and product competitiveness. Fourth, strengthening institutional aspects and community participation should be a key focus of future studies. This includes examining the effectiveness of extension and facilitation models, group management practices, and integrating local knowledge with modern innovations. Finally, future research should develop more integrative and adaptive models for homegarden agroforestry management by applying multidisciplinary approaches. Such models are expected to support optimal sustainability across ecological, economic, social, technological, and institutional dimensions while facilitating replication in other regions, particularly in forest buffer zones.

## **AUTHOR CONTRIBUTION**

RA conceptualized the study, designed the research, formulated the research objectives, and developed the RAP-AFS framework based on Multidimensional Scaling (MDS). CW was responsible for data collection through questionnaires, structured interviews, and field observations, as well as organizing the respondent data from Cilimus Village. PB contributed to the data analysis across the ecological, economic, social, institutional, and technological dimensions and assisted in interpreting the sustainability index results. SBIGF and TE supported the development of agroforestry-based policy recommendations, including income diversification, local product supply chain development, and integration into conservation and spatial planning programs. All authors contributed to manuscript writing, reviewed the final draft, and approved the final version.

## REFERENCES

- Aaron, W., Amritbir, R., Stephane, S., Laura, A., Harun, C., Milka, K., Marc, C. (2024). The ecological and socioeconomic sustainability of organic agroforestry: a systematic review. *Agroforestry Systems*, 98(8), 2933-2949. doi:<https://doi.org/10.1007/s10457-024-01064-w>
- Abdillah, N., Thamrin, T., Nofrizal, N., & Wijayanto, G. (2023). Quantifying ecological, economic, social, and governance attributes for urban forest eco-tourism using MDS-RAPFISH approach. *International Journal of Sustainable Development & Planning*, 18(8). doi:<https://doi.org/10.18280/ijstdp.180807>
- Amalia, Y. S., Khusaini, M., Atikawati, D., Hidayati, B., & Prismadianto, G. (2026). Sustainability status analysis of urban mangrove management using Multidimensional Scaling (MDS) Rapfish. *Jurnal Presipitasi*, 23(1), 351-365. doi:<https://doi.org/10.14710/presipitasi.v23i1.351-365>
- Ampim, P. A., Ogbe, M., Obeng, E., Akley, E. K., & MacCarthy, D. S. (2021). Land cover changes in Ghana over the past 24 years. *Sustainability*, 13(9), 4951. doi:<https://doi.org/10.3390/su13094951>
- Angelus, E. F., Aloysius, N. M., & Felix, N. (2025). Understanding opportunity focus and its effects on douala micro-small enterprises sales performance. *Annals of Management and Organization Research*, 7(1), 31-44. doi:<https://doi.org/10.35912/amor.v7i1.2355>
- Ariandi, R., & Mukti, J. (2023). Strategi Keberlanjutan agroforestry Di Desa Ulusaddang Kabupaten Pinrang. *Journal Of Forestry Research*, 6(2), 73-88.
- Auliya Fikri, A., Darmawan, A., Hilmanto, R., Banuwa, I. S., Agustiono, A., & Agustiana, L. (2022). Pemanfaatan platform google earth engine dalam pemantauan perubahan tutupan lahan di Taman Hutan Raya Wan Abdul Rachman. *Journal of Forest Science Avicennia*, 5(1), 46-57. doi:<https://doi.org/10.22219/avicennia.v5i1.19938>
- Bajo-Rubio, O., & Gómez-Plana, A. G. (2020). Provision of public health services and sustainable development: Evidence for 12 emerging countries. *Sustainability*, 12(16), 6546. doi:<https://doi.org/10.3390/su12166546>
- Bakri, S., Apriliani, A. P., Kaskoyo, H., & Wulandari, C. (2024). Are the physical and social capitals still productive resources for coffee agroforestry development?: The evidence of endogenous growth role in leveraging the sluggish production factors at Batutegi Forest Management Unit. *Jurnal Manajemen Hutan Tropika*, 30(2), 284. doi:<https://doi.org/10.7226/jfm.30.2.284>
- Bhimasta, R. A., Surya, R. A., & Pramudita, D. P. D. (2025). Integrating marketing, HRM, and accounting systems for customer value sustainability. *Jurnal Relevansi: Ekonomi, Manajemen dan Bisnis*, 9(2), 149-162. doi:<https://doi.org/10.61401/relevansi.v9i2.307>
- Boinot, S., Barkaoui, K., Mézière, D., Lauri, P.-E., Sarthou, J.-P., & Alignier, A. (2022). Research on agroforestry systems and biodiversity conservation: what can we conclude so far and what should we improve? *BMC ecology and evolution*, 22(1), 24. doi:<https://doi.org/10.1186/s12862-022-01977-z>
- Budiono, P., Erdian, Z., Wulandari, C., Puspasari, E., Syahiib, A. N., Sari, F. Y., & Apriliani, A. P. (2024). Forest resource management decision making based on gender equality in the Way Betung Watershed, Lampung Province. *Sosiohumaniora*, 26(2), 358-368. doi:<https://doi.org/10.24198/sosiohumaniora.v26i2.56566>
- Duryat, D., Dewi, B. S., Qurniati, R., Bakri, S., Manaf, L. A., & Rodiani, R. (2025). Edukasi khasiat obat tanaman pekarangan untuk kesehatan masyarakat mitra Taman Hutan Raya Wan Abdurachman Provinsi Lampung. *Jurnal Pengabdian Fakultas Pertanian Universitas Lampung*, 4(1), 126-141. doi:<https://doi.org/10.23960/jpfp.v4i1.10857>
- Endaryanto, T., Seta, A. P., & Saleh, Y. (2025). Enhancing sustainability of cassava agribusiness in Lampung province to ensure food security. *AGRARIS: Journal of Agribusiness and Rural Development Research*, 11(1), 70-88. doi:<https://doi.org/10.18196/agraris.v11i1.419>
- Fauziyah, E., & Sanudin, S. (2021). Review on adoption of agroforestry innovation by farmers' social forestry program. *Jurnal Penelitian Sosial dan Ekonomi Kehutanan*, 4(1), 51-60. doi:<https://doi.org/10.20886/jai.2021.4.1.51-60>

- Fikry, M. Y., & Sarjan, M. (2024). Peran agroforestri dalam mendukung pengelolaan sumberdaya alam berkelanjutan. *LAMBDA: Jurnal Ilmiah Pendidikan MIPA dan Aplikasinya*, 4(1), 16-22. doi:<https://doi.org/10.58218/lambda.v4i1.846>
- Hamzah, B., & Hasannudin, D. A. L. (2025). Circular economy integration in community-based forest management: A sustainability analysis in Indonesia. *Jurnal Hutan dan Masyarakat*, 17(1), 73-87. doi:<https://doi.org/10.24259/jhm.v17i1.44325>
- Harafah, P. J. M. (2023). The importance of training activities based on environmental potential in realising community welfare. *Kolokium: Journal of Out-of-School Education*, 11(3), 1146-1150. doi:<https://doi.org/10.24036/kolokium.v11i3.761>
- Jamika, F. I., Amran, A., Umar, I., & Gusman, M. (2023). Perhutanan sosial dalam pengelolaan sumber daya hutan di Indonesia. *Pro-Life*, 10(2), 853-863. doi:<https://doi.org/10.33541/pro-life.v10i2.4814>
- Karyani, T., Djuwendah, E., Yudha, E. P., Supriyadi, E., & Arifin, Z. (2024). Keberlanjutan finansial teknologi (FINTEK) sebagai sumber pembiayaan komoditas sayuran di Kabupaten Garut. *Agricore: Jurnal Agribisnis dan Sosial Ekonomi Pertanian Unpad*, 9(2), 79-101. doi:<https://doi.org/10.24198/agricore.v9i2.58895>
- Kristin, Y., Qurniati, R., & Kaskoyo, H. (2018). The interaction of community around the forest towards land use Tahura Wan Abdul Rachman. *Jurnal Sylva Lestari*, 6(3), 1-8. doi:<https://doi.org/10.23960/jsl361-8>
- Lensari, D., Rosianty, Y., Syachroni, S. H., & Paridawati, I. (2022). Optimalisasi penggunaan lahan pekarangan dengan sistem agroforestri di Kota Prabumulih. *Jurnal Pengabdian Kepada Masyarakat*, 12(2), 167-171.
- Pertiwi, D., Safe'i, R., & Kaskoyo, H. (2019). Identifikasi kondisi kerusakan pohon menggunakan metode forest health monitoring di tahura war provinsi lampung. *Jurnal Perennial*, 15(1), 1-7.
- Pippi, L., Alibani, M., Antichi, D., Caruso, G., Finocchi, M., Fontanelli, M., Peruzzi, A. (2025). Use of digital technologies into agroforestry systems: A review. *Agronomy*, 15(12), 2671. doi:<https://doi.org/10.3390/agronomy15122671>
- Rettob, A. M., Kaswanto, R. L., & Yovi, E. Y. (2025). Strategi pengelolaan agroforestri dusung berkelanjutan di DAS Wai Batu Gajah: Pendekatan berbasis SWOT (Sustainable dusung agroforestry management strategy in the Wai Batu Gajah Watershed: A SWOT-Based Approach). *Jurnal Penelitian Pengelolaan Daerah Aliran Sungai (Journal of Watershed Management Research)*, 9(1), 55-78. doi:<https://doi.org/10.59465/jppdas.2025.9.1.55-78>
- Salim, W. Y., Reniati, & Sumiyati, S. (2025). Financial stability, financial target, and external pressure on financial statement fraud: An empirical study of mining companies listed on the Indonesia Stock Exchange (2019–2023). *Jurnal Relevansi : Ekonomi, Manajemen Dan Bisnis*, 9(2), 137–148. doi:<https://doi.org/10.61401/relevansi.v9i2.163>
- Sari, P. H. B., Rumengan, A. E., & Indrawan, M. G. (2025). The influence of regulation, planning and controlling on financial management performance through competence as an intervening variable in Regional Apparatus Organizations in the district of Karimun. *Global Academy of Business Studies*, 2(1), 63-80. doi:<https://doi.org/10.35912/gabs.v2i1.3587>
- Sari, R. R., Ishaq, R. M., Purnamasari, E., & Saputra, D. D. (2025). Fungsi ganda agroforestri kopi: Konservasi cadangan karbon dan keanekaragaman vegetasi. *Jurnal Tanah dan Sumberdaya Lahan*, 12(1), 159-169. doi:<https://doi.org/10.21776/ub.jtstl.2025.012.1.16>
- Satish, P., Madiwalar, A. F., Lallawmkimi, M. C., Reddy, K. J., Parveen, S., Ashoka, P., Anand, G. (2024). Agroforestry: multifunctional benefits and implementation strategies. *Journal of Geography, Environment and Earth Science International*, 28(10), 1-12. doi:<https://doi.org/10.9734/jgeesi/2024/v28i10821>
- Silondae, A. A., Rosmalah, S., Hartati, H., & Putri, A. H. (2026). Analysis of clove agroforestry productivity and sustainability using a systemic approach (MDS RAP-AFS) in Wolo District, Kolaka Regency. *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering)*, 15(1), 396-407. doi:<https://doi.org/10.23960/jtepl.v15i1.396-407>
- Sudomo, A., Leksono, B., Tata, H. L., Rahayu, A. A. D., Umroni, A., Rianawati, H., Utomo, M. M.

- B. (2023). Can agroforestry contribute to food and livelihood security for Indonesia's smallholders in the climate change era? *Agriculture*, 13(10), 1896. doi:<https://doi.org/10.3390/agriculture13101896>
- Suek, J., & Mella, W. I. (2021). Agroforestri tradisional sebagai sistem pertanian lahan kering berkelanjutan. *Jurnal Excellentia*, 10(01), 118-131.
- Suhartini, S., Ishaq, R. M., Lasitya, D. S., Mujaddid, M. A., Jihad, B. N., Harun, A. A., Arcelia, D. Y. (2024). Evaluasi keberlanjutan usahatani sayuran dalam sistem agroforestry di daerah aliran sungai (DAS) brantas hulu, jawa timur, Indonesia dengan metode multi dimensional scaling (MDS). *Jurnal Ekonomi Pertanian Dan Agribisnis*, 8(1), 427-437. doi:<https://doi.org/10.21776/ub.jepa.2024.008.01.35>
- Supriatna, J., Djumarno, D., Saluy, A. B., & Kurniawan, D. (2024). Sustainability analysis of smallholder oil palm plantations in several provinces in Indonesia. *Sustainability*, 16(11), 4383. doi:<https://doi.org/10.3390/su16114383>
- Suprijanto, I., Khusaini, M., & Antariksa, A. E. (2025). Sustainability index mapping for green building of vertical housing in Ibu Kota Nusantara (IKN) Using the Multidimensional Scaling (MDS) Approach. *Planning*, 20(7), 2913-2924. doi:<https://doi.org/10.18280/ijstdp.200715>
- Susanti, Y., Wulandari, C., Kaskoyo, H., Safe'i, R., & Yuwono, S. B. (2021). Persepsi masyarakat terhadap pengelolaan agroforestri di tahura wan abdul rachman, bandarlampung. *Jurnal Hutan Tropis*, 9(2), 472-487. doi:<https://doi.org/10.20527/jht.v9i2.11299>
- Sutisna, E., Affandi, R., Kamal, M., & Yulianto, G. (2020). On status assessment and management strategy formulation for sustainable aquaculture of the Hoven's Carp (*Leptobarbus hoevenii*, Bleeker, 1851) in Jambi Municipality. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, 10(3), 524-532. doi:<https://doi.org/10.29244/jpsl.10.3.524-532>
- Suwartapradja, O. S., Iskandar, J., Iskandar, B. S., Mulyanto, D., Nurjaman, D., & Nisyapuri, F. F. (2023). Plants diversity and socioecological functions of homegarden in Sundanese rural area: A case in Sumedang District, West Java, Indonesia. *Biodiversitas: Journal of Biological Diversity*, 24(1), 156-175. doi:<https://doi.org/10.13057/biodiv/d240120>
- Syahputra, F., Mardiyah, A., & Undadraja, B. (2025). Assessing the sustainability of agroforestry systems in South Lampung Regency, Indonesia: A case study from Register 6 Way Buatan. *Agriecobis: Journal of Agricultural Socioeconomics and Business*, 8(02), 167-179. doi:<https://doi.org/10.22219/agriecobis.v8i02.41971>
- Taherdoost, H. (2019). What is the best response scale for survey and questionnaire design; review of different lengths of rating scale/attitude scale/Likert scale. *International Journal of Academic Research in Management (IJARM)*, 8(1), 1-10.
- VijayKumar, R., Lallawmkimi, M. C., Gautam, S. K., Tiwari, P., Aneesh, K., Sekhar, M., & Upadhyay, L. (2024). Agroforestry practices as a keystone for biodiversity conservation: a review. *Journal of Experimental Agriculture International*, 46(9), 61-76. doi:<https://doi.org/10.9734/jeai/2024/v46i92805>
- Wattie, G. G. R. W., & Sukendah, S. (2023). Peran penting agroforestri sebagai sistem pertanian berkelanjutan. *Jurnal Ilmu Pertanian dan Perkebunan*, 5(1), 30-38. doi:<https://doi.org/10.55542/jipp.v5i1.506>
- Wibowo, N., Harianto, S. P., Dewi, B. S., & Febryano, I. G. (2024). Integrasi teknologi lokal dalam pemanenan resin damar: studi kasus budaya pemanenan di Desa Pahlungan, Lampung. *Jurnal Makila*, 18(2), 325-337. doi:<https://doi.org/10.30598/makila.v18i2.15410>
- Wicaksono, M. D., Setiawati, R., & Mawardi, M. (2024). Family role in Sugar Palm Agroforestry Management at Community Forest Park (Tahura) Wan Abdul Rachman Lampung. *RADEN INTAN: Proceedings on Family and Humanity*, 1(1), 366-373. doi:<https://doi.org/10.47352/3032-503x.55>
- Wulandari, C., Kurniasari, N., Bakri, S., Dewi, B. S., & Safe'i, R. (2024). Perception of forest farmer groups as a mediating variable in achieving goals as members of the forestry partnership. *Jurnal Sylva Lestari*, 12(2), 401-417. doi:<https://doi.org/10.23960/jsl.v12i2.867>



- Zahro, F. A., Fajarwati, S. K., Sandy, Y. Y., & Ratih, D. (2023). Pengendalian hama dan penyakit tanaman pekarangan di kawasan pedesaan di Desa Pagung, Kediri, Jawa Timur. *Jurnal Pertanian Agros*, 25(3), 2126-2133. doi:<http://dx.doi.org/10.37159/jpa.v25i3.3097>
- Zhang, S., Huang, G., Zhang, Y., Lv, X., Wan, K., Liang, J., Zhang, L. (2023). Sustained productivity and agronomic potential of perennial rice. *Nature Sustainability*, 6(1), 28-38. doi:<https://doi.org/10.1038/s41893-022-00997-3>