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Plant diversity under traditional agroforestry system of *repong damar* in Pesisir Barat District, Lampung Province, Indonesia

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Abstract. *Santoso T, Paridduar R, Bintoro A. 2023. Plant diversity under traditional agroforestry system of* repong damar *in Pesisir Barat District, Lampung Province, Indonesia. Biodiversitas 24: 4675-4683. repong damar*, a traditional agroforestry system, benefits farmers and the environment; hence, it must be maintained. As a conservation endeavor and for long-term ecosystem management, *repong damar*'s plant must be researched further. The study evaluated plant variety and composition in Pekon (Village) Pahmungan (PHG) and Pekon Negara Ratu Tenumbang (NRT) areas of Pesisir Barat Districts, Lampung Province, Indonesia, where both communities utilized *repong damar* for decades. The data was obtained systematically by marking 69 sample plots with sub-plots for different growth stages of 20 × 20 m for trees (S1), 10 x 10 m for poles (S2), 5 x 5 m for saplings (S3), and 2 x 2 m for seedlings (S4). A total of 56 species from 30 families were recorded in this study, which consisted of different life forms of trees (69.64%), shrubs (26.78%), and herbs (3.57%). *Shorea javanica* Koord. & Valet had the maximum IVI value in both study areas except for the S4 growth level. IVI values in PHM for S1, S2, and S3 were 136.41, 113.93 and 20.94, respectively. In NRT for S1, S2, and S3 were 89.25, 68.25 and 48.64, respectively. The farmers' preferences for *Shorea javanica* Koord and Valet are mainly caused by the fact that farmers have tapped its resin to provide their primary source of revenue, making them inherently dominant. Conversely, farmers neglecting *Shorea javanica* seedlings raises worries about its future viability, in addition to contemplating possible pests and diseases. Calculations of species diversity and evenness revealed moderate values and a generally even species distribution in both study areas. At the same time, Species richness calculation showed medium value and low in NRT. The three indices' values generate higher PMH ratings than NRT.

Keywords: Agroforestry, Pesisir Barat Districts, *repong damar*, *Shorea javanica*, species diversity

INTRODUCTION

Local communities in Indonesia know ecosystem management and employ various traditional agroforestry systems. Local communities have adapted the system to their environment and culture over generations (Siarudin et al. 2021; Wakhidah et al. 2020). One of the most prominent is the *repong damar* system, traditionally practiced by people in the Pesisir Barat Districts, Lampung Province, Indonesia. The effectiveness of traditional agroforestry systems managed by a local community is demonstrated by the case of *repong damar* (Siarudin et al. 2021). Within a family, possessions typically pass from generation to generation. They are a part of the heritage passed down from generation to generation (Wakhidah et al. 2020).

The *repong damar* area in Pesisir Barat District is a mixed forest ecosystem managed by local communities or individuals sustainably (Bhaskara et al. 2018). *Repong damar* is a complex agroforestry system that grows *Shorea javanica* Koord. & Valet is the main tree besides other fruit trees, spices, medicinal plants, and natural forest management (Achmad et al. 2022). In the *repong damar* agroforestry system, *S. javanica* became the main plant maintained because it produces a very valuable resin. Since 1783, the production of damar resin has been acknowledged as a significant contributor to the economy of Sumatra, and it has since evolved into one of Sumatra's most valuable exports (Foresta et al. 2004).

Repong damar in Pesisir Barat Districts is a forest area covering 2,900 ha with a special purpose based on the Minister of Forestry Decree No. 47//Kpts-II/1998, which was community-based forest management and was able to fulfill the socio-economic life of the community so that its existence must be maintained (Saputri et al. 2015). However, *repong damar*'s traditional agroforestry system was established as the natural resource shrunk (Foresta et al. 2004). During the 1990s, the accelerated regional development posed a threat to the region's agroforests. On the other hand, the younger generation did not find the *repong damar* business to be appealing at the moment. They leave their damar agroforests because many agroforestry workers and their children are moving to urban areas for employment (Sunardi et al. 2021).

Repong damar, a successful forest management strategy developed by local communities, may be crucial in formally recognizing local people's right over forest resources (Foresta et al. 2004). Efforts must be made to preserve this agroforestry system to remain viable and grow because *repong damar* has many important environmental and farmer benefits (Gamfeldt et al. 2013). One of the primary efforts could be to analyze the wide variety of tree species found in the *repong damar* (Sunardi et al. 2021).

The evaluation of plant diversity within the *repong damar* agroforestry system is essential for the preservation of biodiversity, ecological sustainability, socio-economic benefits, and traditional knowledge (Gamfeldt et al. 2013; Marini et al. 2010; Santoro 2023; Toujgani et al. 2021; Viñals et al. 2023).

In addition, it is important to evaluate vegetation diversity within this system because there are insufficient references concerning the vegetation diversity of *repong damar* from the past decades that have been published. So, in this study, we analyzed plant diversity to determine plant structure and composition. Additionally, the Species Diversity, Richness, and Evenness are used to ascertain the present vegetation condition in *repong damar*.

MATERIALS AND METHODS

Study area

The study area was located in two Pekon (Village), namely Pahmungan (PHG), which is located at latitude 5°10'3.80" S and longitude 103°58'32.05"E and Pekon Negara Ratu Tenumbang (NRT) which is located at latitude 5°13'47.83"S and longitude 104°0'5.05"E. Both villages are included in administrative areas of the Pesisir Barat Districts, Lampung Province, Indonesia. People of both villages have utilized *repong damar* for decades. In general, *S. javanica* predominates the sloping terrain. The research location can be seen in Figure 1.

Pesisir Barat Districts is situated between latitude 5°21' and 5°28' S and between longitude 105°48,' and 105°48' E. Pesisir Barat Districts covers approximately 2,889.98 km^2 or 8.39% of Lampung Province's total land area. Pesisir Barat Districts has a 210-kilometer coastline that faces the Indian Ocean and is surrounded by the extensive tropical forest of Bukit Barisan Selatan National Park, Lampung, Indonesia.

PHG is located in the Pesisir Tengah District with an administrative area of 120.64 km^2, a population of 20,040 people, a population density of 166.16 inhabitants per km2, and a population development rate of 0.72% annually (BPS Pesisir Barat 2023). NRT is located in the Pesisir Selatan District, which has an administrative area of 409.17 km^2, a population of 26,850, a population density of 65.62 inhabitants per km^2, and a population development rate of 0.72% per year (BPS Pesisir Barat 2022).

Both districts are adjacent to the Bukit Barisan Selatan National Park (TNBBS) on the east side. The PHG has a varied topography, consisting of both level and sloping land. The flat portion of the land is utilized for rice crops and other purposes. Pesisir Barat Districts receives an average of 2,500-3,500 mm of precipitation annually, or about 140-221 mm per month (Paski and Pertiwi 2018).

The people's economic activities are supported by the roads and transit infrastructure that connect both villages to Krui, the district capital. Pesisir Tengah district is 1 km from Krui, and the south coast area is 25 km away. The distance between Krui and Lampung Province's capital city is 231 kilometers on roads (BPS Pesisir Barat 2023).

Data collection

Data collection occurred between May and June 2019, followed by data processing and analysis from January to March 2020. The main plots, each measuring 20 by 20 meters and separated by a distance of 100 meters, were arranged in a south-to-north orientation using a systematic method. Within the larger plot, smaller plots were laid out to monitor the development of different plant types, including poles (10 x 10 m), saplings (5 x 5 m), seedlings (2 x 2 m), and trees (20 x 20 m) (Figure 2).

Under the *repong damar* agroforestry system, plant data was gathered with traditional elders via field observation in 69 plots (45 in PMG and 24 in NRT) based on the village size and the Slovin formula for 0.2% sample intensity.

The local names of the plants discovered were recorded, and their scientific names were later confirmed using *http://www.plantsoftheworldonline.org*. Plants of unknown species were collected and identified in the Laboratory of Sylviculture, Department of Forestry, Lampung University, Indonesia.

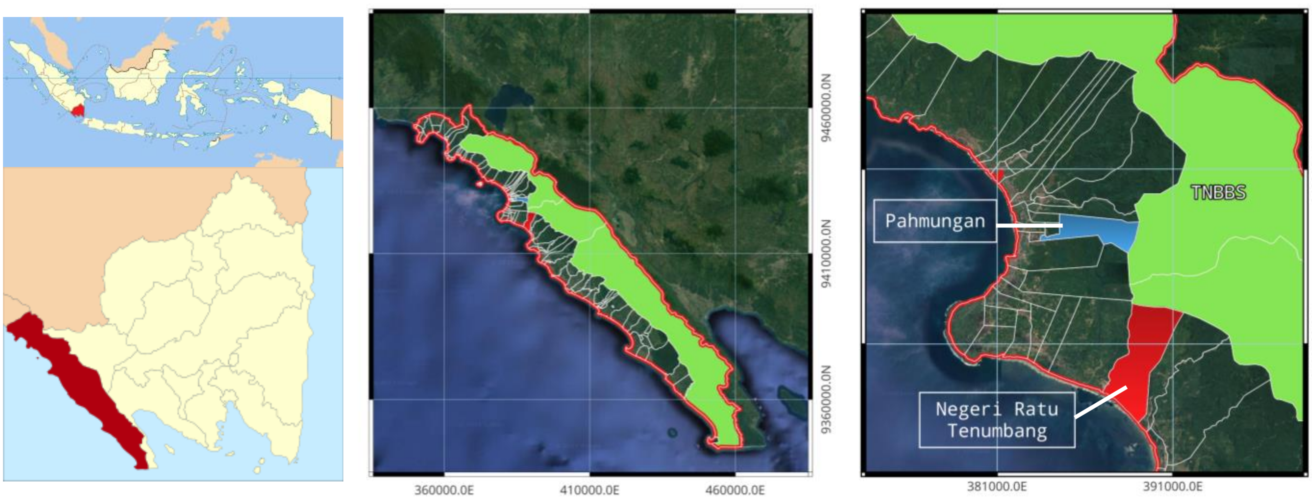

Figure 1. Map of research site location in Pekon Pahmungan and Pekon Negara Ratu Tenumbang, Pesisir Barat, Lampung, Indonesia

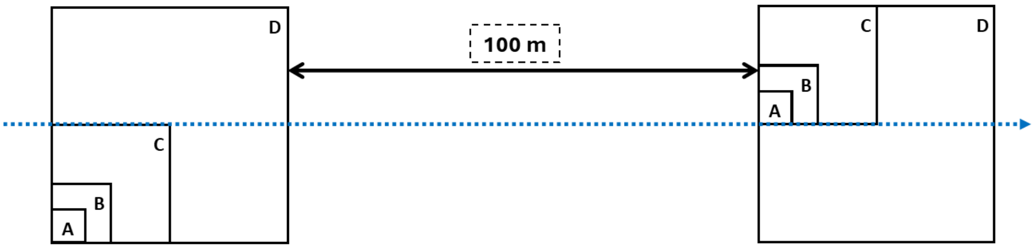

Figure 2. Plot design for vegetation observation

Data analysis

Statistical methods were used to calculate data for Important Value Indices (IVI), Species Diversity Index (SDI), Species Richness Index (SRI), and Species Evenness Index (SEI) using MS Office Excel.

Important Value Indices (IVI)

The importance value index (IVI) of each species at the three successional stages was calculated to examine which species is ecologically significant in the forest ecosystem, and this index was used to relate how important they are in providing ecosystem goods (Reshad et al. 2020). The index was calculated by integrating the Relative Frequency (RF), Relative Density (RD), and Relative Dominance (RB) of each woody species (Mueller-Dombois and Ellenberg 1974) as follows:

$$\text{Density (D)} = \frac{\text{Total number of individuals}}{\text{Size of plots}}$$

$$\text{Relative Density (RD)} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} x100$$

$$\text{Frequency (F)} = \frac{\text{Number of quadrats in which species occured}}{\text{Total size of plots}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Number of occurrence of the species}}{\text{Number of occurence of all species}} x100$$

$$\text{Dominance (Dm)} = \frac{\text{Total basal area of the species}}{\text{Total size of plots}}$$

$$\text{Relative Dominance (RDm)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} x100$$

IVI of tree and pole growth level = RD + RF + RDm
IVI of sapling and seedling growth level = RD + RF

Frequency refers to the proportion of quadrats where a certain species is observed, expressed as a percentage of the total number of quadrats. It indicates how evenly a species is distributed within a specific area (Whitford 1949). Hence, to determine the distribution of each species within the research area, the frequency was computed as a proportion of the total number of quadrats in which a species was observed relative to the overall number of quadrats surveyed (Worku et al. 2022). Density is a quantitative measure that represents the population size of a species. It is calculated by dividing the total number of individuals of each species seen in all quadrats by the total number of quadrats surveyed (Mohammed 2018). While dominance in each stand is considered the largest proportion of importance is regarded as the dominant species within each stand (Risser and Rice 1971).

Species diversity index

The species diversity index was calculated using the Shannon-Wiener index (H) (Magurran 1988, 2004):

$$H' = -\Sigma \frac{n_i}{N} \ln\left(\frac{n_i}{N}\right)$$

Where: H was the Shannon-Weiner index, n_i was the number of species' individuals, and N was all species' total individuals. The range of values from the calculation of the Shannon-Wiener index can be interpreted as follows: H' ≤ 1 = Low diversity, 1 < H' ≤ 3 = Moderate diversity, and H'≥ 3 = high diversity.

Species richness index

The species richness index was estimated using the Margalef index (DMg) (Magurran 1988, 2004):

$$D_{Mg} = \frac{(S-1)}{\ln(n)}$$

Where: S was the Total of species that could be found, and n was the Total of individuals. The criteria used for D_{Mg} were <3.5 (low), 3.5-5.0 (medium), and >5.0 (high).

Species evenness index

Species evenness was calculated using the Pielou index with the following formula (Pielou and Evelyn 1977):

$$E = \frac{H'}{\ln S}$$

Where: H' was the Shannon-Wiener index and S was the number of species found. The criteria of the Pielou index can be interpreted as follows: 0.00-0.25 = uneven; 0.26-0.50 = less evenly; 0.51-0.75 = fairly even; 0.76-0.95 = almost evenly; 0.96-1.00 = evenly.

RESULTS AND DISCUSSION

The structure and composition of vegetation on *repong damar*

Cumulatively, there were 30 families and 65 species in the life form of trees, shrubs, and herbs. Tree life forms were known consisted of 69.64%, Shrub 26.78%, and Herb 3.57%. Each plant family contains one to five species (more in Figure 2). In PHM, 54 species of plants were identified, and their growth levels were categorized as Trees (26 species), Poles (33 species), Saplings (34 species), and Seedlings (7 species). In the NRT, 49 plant species were discovered within growth levels of Trees (20 species), Poles (24 species), Saplings (23 species), and seedlings (5 species). The extended details of plant family species and vernacular names, site locations, growth levels, and IVI scores are explained in Table 1.

The highest IVI value was obtained by *S. javanica* Koord. & Valet. (136.41) and the lowest by *Eurycoma longifolia* Jack (0.77) in PMH (Table 1). In NRT, the highest IVI value was obtained by *S. javanica* Koord. & Valet. (89.25), and the lowest was obtained by *Azadirachta indica A. Juss.* (1.11) And *Ficus montana Burm. Fil.* (1.11) (Table 1).

Shorea javanica Koord. & Valet. have a high dominance because they were kept as the main plant whose sap was harvested by farmers with periodic tapping. This finding was also reported by Ariyanti et al. (2018) in their study in Pesisir Barat Districts, which stated that *S. javanica* as the most common species found in *repong damar* agroforestry system. These findings contradict other sources asserting the potential disruption of species dominance due to human intervention (D'Antonio and Meyerson 2002; Dangles and Malmqvist 2004; Ricciardi et al. 2013).

Another reason for this is that *S. javanica* is one of the non-timber forest products (NTFP) that has been widely managed and utilized over generations by local people around the Pesisir Barat Lampung Province (Nur'aini et al. 2020). *Shorea javanica* can also survive and develop under many environmental conditions (Bhaskara et al. 2018). *Shorea javanica* is recognized as one of the most significant shade plants in the agroforestry system used for coffee farming in the West Lampung Districts, which is adjacent to the West Districts (Evizal et al. 2016).

Euphorbiaceae, Fabaceae, Malvaceae, and Phyllanthaceae have as many as 5 species, followed by the families Anacardiaceae, Meliaceae, and Moraceae with 4 species, and Myrtaceae with 3 species. Acanthaceae, Apocynaceae, Asparagaceae, Clusiaceae, Lauraceae, Lythraceae, Oxalidaceae, and Rubiaceae have two species. At the same time, families with only one species are Amaranthaceae, Anisophyllaceae, Annonaceae, Araliaceae, Baccaurea, Dipterocarpaceae, Lamiaceae, Leguminoceae, Myristicaceae, Rutaceae, Sapindaceae, Simaroubaceae, Solanaceae and Vitaceae.

Shorea javanica was present as the highest IVI score at all growth stages in PMH except for seedlings. The *L. domesticum* grew well in PMH but did not grow perfectly in the Saplings and Seedling stages. The *D. zibethinus* was absent on the pole growth level, while *P. javanicum* was absent in the seedling stage but growing well in all other stages.

Shorea javanica was absent in the seedling's growth level, likely because of an insect attack that damaged the seedlings' leaves; it was characterized by bite marks with chewing type on the affected leaves (Damayanti et al. 2021). This condition should be a main concern because *S. javanica* has been the farmers' primary economic product (Bhaskara et al. 2018), so its growth's sustainability must be continuously evaluated. It is expected that the species diversity and the types of NTFP species will not be decreased so that the community needs will always be fulfilled (Wulandari et al. 2018).

Durio zibethinus is one of Indonesia's most popular edible durians in almost all archipelago regions (Apuy et al. 2017; Prakoso et al. 2021). It has been the main type of fruit that farmers planted in several places with expectation to bring in a lot of extra income each year (Agesti et al. 2023; Mohd Ali et al. 2021; Muhtadi and Ningrum 2019; Saminathan and Doraiswamy 2020; Selvarajoo 2021); hence, it is the most popular choice, along with *L. domesticum* (Abdallah et al. 2022; Mayanti et al. 2022; Rahmawaty et al. 2020). Other species such as *P. Javanicum*, *B. glauca*, and *P. canescens* have an important role as tree species that provides shade and produces wood for farmers' personal needs or for sale to generate income (Adman et al. 2020; Ahongshangbam et al. 2019; Kardiman et al. 2019; Karyati et al. 2019; Qurniati et al. 2017; Sahithya and Krishnaveni 2022; Wanderi et al. 2019).

In NRT, the highest IVI was *S. javanica* Koord. & Valet., while *P. falcataria (L.) I.C. Nielsen* is the second-highest IVI. *P. falcataria* was cultivated because of the ability of nitrogen pumping into the soil (Harun et al. 2022) and has a high selling value from the wood sold (Stewart et al. 2021). *P. falcataria* was commonly farmed by forest farmers and was known as a fast-growing species with significant economic value (Iskandar et al. 2017; Mulyadi et al. 2022).

Shorea javanica was present at all growth stages except for seedlings with the same condition as PMH. *S. aromaticum* had the highest IVI score in the growth level of trees and seedlings, while *M. fragrans* was the third highest at the tree and lowest at seedling.

Table 1. Plant's family species and vernacular name, site location, growth stages, and individual number

Family	Species	Vernacular	Life form	Site location, growth level, and IVI score									
				PMH	**S1**	**S2**	**S3**	**S4**	**NRT**	**S1**	**S2**	**S3**	**S4**
Acanthaceae	*Justicia gendarussa* Burm.f.	Gandarusa	Shrub	√		1.95	12.98		√		9.4	16.54	
	Graptophyllum pictum (L.) Griffith	Daun Ungu	Shrub	√			11.85						
Amaranthaceae	*Alternanthera sessilis* (L.) DC.	Daun Kremah	Herb						√			4.86	
Anacardiaceae	*Mangifera foetida* Lour.	Limus	Tree	√	4.17								
	Mangifera caesia Jack	Binjai	Tree	√	3.93	6.68	1.62		√		9.39	3.41	
	Spondias pinnata (L.fil.) Kurz	Kedondong Hutan	Tree	√	2.47				√	3.42			
	Mangifera indica L.	Mangga	Tree	√			1.62		√		6.76	4.86	
Anisophyllaceae	*Carallia brachiata* (Lour.) Merr.	Kayu Sepat	Tree	√		6.49			√	1.18			
Annonaceae	*Cananga odorata* (Lam.) Hook.f. & Thomson	Kenanga	Tree	√	3.04		1.62						
Apocynaceae	*Marsdenia tinctoria* R. Br.	Bait Talum	Shrub	√			10.44						
	Alstonia scholaris (L.) R. Br.	Pulai	Tree						√	5.76			
Araliaceae	*Hydrocotyle sibthorpioides* Lam.	Semanggi Gunung	Herb						√			6.82	
Asparagaceae	*Cordyline fruticosa* (L.) A. Chev.	Andong	Shrub						√			2.43	
	Dracaena angustifolia (Medik.) Roxb.	Suji	Shrub	√			3.25		√			13.64	
Baccaurea	*Baccaurea javanica* (Blume) Müll.Arg.	Jajahli	Shrub	√		3.88							
Clusiaceae	*Garcinia mangostana* L.	Manggis	Tree	√	6.62	11.26	1.62		√	5.22			
	Garcinia parvifolia (Miq.) Miq.	Asam Kandis	Tree	√	1.64	1.80							
Dipterocarpaceae	*Shorea javanica* Koord. & Valet.	Damar	Tree	√	136.41	113.93	20.94		√	89.25	68.25	48.64	
Euphorbiaceae	*Acalypha caturus* Blume	Trembesi	Tree	√		3.27			√	1.86	16.9		
	Mallotus paniculatus (Lam.) Müll. Arg.	Balik Angin	Tree	√			5.57	9.22	√				
	Bridelia monoica (Lour.) Merr	Kanihai	Tree	√			8.82		√				
	Ricinus communis L.	Jarak	Shrub	√			7.19		√			9.25	
	Codiaeum variegatum (L.) Rumph. ex A. Juss.	Puding	Shrub						√			6.82	
Fabaceae	*Parkia speciosa* Hassk.	Petai	Tree	√	4.74	2.80	1.62	5.37	√		5.01		
	Archidendron pauciflorum (Benth.) I.C. Nielsen	Jengkol	Tree	√	3.00	2.73	1.62	4.61	√	3.82			
	Erythrina lithosperma Blume ex Miq.	Dadap Minyak	Tree	√	0.78				√			4.86	
	Senna alata (L.) Roxb.	Madat	Shrub	√			3.25		√				
	Sesbania grandiflora (L.) Pers.	Turi	Tree	√			1.62		√			11.68	
Lamiaceae	*Peronema heterophyllum* Miq.	Sungkai	Tree	√	0.82	12.16	5.57						
Lauraceae	*Cinnamomum porrectum* (Roxb.) Kosterm.	Kayu Lada	Tree	√	9.76	5.50	2.33		√	5.51	2.98		
	Persea americana Mill.	Alpukat	Tree	√					√	17.13		3.41	19.55
Leguminoceae	*Paraserianthes falcataria* (L.) I.C. Nielsen	Sengon	Tree						√	63.16	26.9	19.48	81.12
Lythraceae	*Punica granatum* L.	Angsot, Delima	Shrub						√		19.18		
	Lagerstroemia speciosa (L.) Pers.	Bungur	Tree	√	3.38	3.23			√		9.68		
Malvaceae	*Durio zibethinus* Murray	Durian	Tree	√	16.34		12.77	47.50	√	9.84	10.21	3.41	
	Pterospermum javanicum Jungh.	Bayur	Tree	√	12.20	17.46	3.25		√	6.6	14.4		
	Sterculia oblongata R.Br.	Hantak	Tree	√		2.24	3.25		√		8.5		
	Bombax ceiba L.	Randu Hutan	Tree	√		1.97			√		3.13		
	Hibiscus tiliaceus L.	Waru	Tree	√		1.80			√	5.33			

Meliaceae	*Lansium domesticum* Corrêa	Duku	Tree	√	52.77	37.91	4.65	43.69	√	15.96	11.83	4.86	
	Epicharis parasitica (Osbeck) Mabb.	Langsat	Tree	√	3.84				√		7.17		
	Toona sureni (Blume) Merr.	Suren	Tree	√	1.08	3.94	4.87		√		2.22		
	Azadirachta indica A. Juss.	Hamelor	Tree	√		3.44	1.62		√	1.11			
Moraceae	*Artocarpus integer* (Thunb.) Merr.	Cempedak	Tree	√	5.90	1.93			√			2.43	
	Ficus septica Burm. fil.	Tembakak	Shrub	√		4.88	7.90		√				
	Artocarpus heterophyllus Lam.	Nangka	Tree			3.55			√		5.06		
	Ficus montana Burm. fil.	Hampelas	Shrub	√				45.92	√	1.11		2.43	
Myristicaceae	*Myristica fragrans* Houtt.	Pala	Tree						√	24.74			29.5
Myrtaceae	*Syzygium spissifolium* (Ridl.) I. M. Turner	Serungkuk	Tree	√	6.09		7.19		√			9.72	
	Syzygium polyanthum (Wight) Walp.	Salam	Tree	√		1.93			√		2.98		
	Syzygium aromaticum (L.) Merr. & Perry	Cengkeh	Tree	√					√	27.87	12.13	3.41	32.81
Oxalidaceae	*Averrhoa bilimbi* L.	Belimbing	Tree	√					√	6.87			37.05
	Averrhoa carambola L.	Belimbing Wuluh	Tree	√		4.14	6.49	43.69	√		14.4		
Phyllanthaceae	*Baccaurea dulcis* (Jack) Wall.	Tupak	Tree	√	5.44	2.15			√	3.15			
	Phyllanthus obscurus Roxb. ex Willd.	Kayu Salai	Tree	√	3.68	4.01			√		6.96		
	Bridelia glauca Blume	Kanihai Badak	Tree	√		12.77			√		7.99		
	Sauropus androgynus (L.) Merr.	Memata	Shrub	√		4.94	12.77		√				
	Baccaurea racemosa (Reinw.) Müll.Arg.	Cupak, Menteng	Tree	√		2.87			√			4.86	
Rubiaceae	*Neolamarckia cadamba* (Roxb.) Bosser	Kelampai	Tree	√	6.18	4.39	1.62		√			7.8	
	Morinda citrifolia L.	Mengkudu	Tree	√	1.22		1.62		√			4.39	
Rutaceae	*Murraya paniculata* (L.) W. Jack	Kemuning	Tree	√			11.14						
Sapindaceae	*Nephelium ramboutan* (Labill.) Leenh.	Rambutan Hutan	Tree	√	3.75	1.80			√				
Simaroubaceae	*Eurycoma longifolia* Jack	Pasak Bumi	Tree	√	0.77	6.06	1.62		√				
Solanaceae	*Solanum torvum* Swartz	Sirang	Shrub	√			7.19		√				
Vitaceae	*Leea indica* (Burm. fil.) Merr.	Andamali	Shrub	√			8.60		√		18.65		

Note: PMH: Pahmungan Village (Site 1); NRT: Negara Ratu Tenumbang; S1: Tree; S2: Pole; S3: Sapling; S4: Seedling

The diversity of vegetation in *repong damar*

Species diversity calculation using the Shannon-Wiener index showed that the index value reached 1.52 to 3.20 in PMH and 1.18 to 2.75 in NRT. The highest species diversity was found in sapling growth level and the lowest in PHM seedlings. In NRT, the highest species diversity was found in the sapling stage and the lowest in the poles growth level. Every growth level in PMH and NRT has a level of diversity that could be classified as having a medium level of diversity, except for the Sapling growth level in PMH (Table 4).

Similar results were found in previous studies conducted in neighboring areas, which concluded that the species diversity under the *repong damar* agroforestry system was classified as moderate. However, the adjacent forest (Bukit Barisan Selatan National Park) has a high level of biodiversity (Ariyanti et al. 2018).

Species richness index calculation using the Margalef index provides better insight into the cultivated plant diversity of the research communities. The richness index increases as the number of species discovered increases (Ariyanti et al. 2018). SRI ranges from 1.23 to 6.66 in PMH and 0.87 to 4.76 in NRT. The highest species richness index was found in sapling growth level, and the lowest was found in seedlings for both villages (Table 5).

Table 2. IVI value of top 5 species from various growth stages in PMH

Structure	Species	IVI
Trees	*Shorea javanica* Koord. & Valet.	136.41
	Lansium domesticum Corrêa	52.77
	Durio zibethinus Murray	16.34
	Pterospermum javanicum Jungh.	12.20
	Cinnamomum porrectum (Roxb.) Kosterm.	9.76
Poles	*Shorea javanica* Koord. & Valet.	113.93
	Lansium domesticum Corrêa	37.91
	Pterospermum javanicum Jungh.	17.46
	Bridelia glauca Blume	12.77
	Peronema canescens Jack	12.16
Saplings	*Shorea javanica* Koord. & Valet.	20.94
	Justicia gendarussa Burm. f.	12.98
	Durio zibethinus Murray	12.77
	Sauropus androgynus (L.) Merr.	12.77
	Graptophyllum pictum (L.) Griffith	11.85
Seedlings	*Durio zibethinus* Murray	47.50
	Ficus montana Burm. fil.	45.92
	Averrhoa carambola L.	43.69
	Lansium domesticum Corrêa	43.69
	Mallotus paniculatus (Lam.) Müll. Arg.	9.22

Table 3. IVI value of top 5 species from various growth stages in NRT

Structure	Species	IVI
Trees	*Shorea javanica* Koord. & Valet.	89.25
	Paraserianthes falcataria (L.) I.C. Nielsen	63.16
	Syzygium aromaticum (L.) Merr. & Perry	27.87
	Myristica fragrans Houtt.	24.74
	Persea americana Mill.	17.13
Poles	*Shorea javanica* Koord. & Valet.	68.25
	Paraserianthes falcataria (L.) I.C. Nielsen	26.90
	Punica granatum L.	19.18
	Leea indica (Burm. fil.) Merr.	18.65
	Mallotus paniculatus (Lam.) Müll. Arg.	16.90
Saplings	*Shorea javanica* Koord. & Valet.	48.64
	Paraserianthes falcataria (L.) I.C. Nielsen	19.48
	Justicia gendarussa Burm.f.	16.54
	Dracaena angustifolia (Medik.) Roxb.	13.64
	Sesbania grandiflora (L.) Pers.	11.68
Seedlings	*Paraserianthes falcataria* (L.) I.C. Nielsen	81.12
	Syzygium aromaticum (L.) Merr. & Perry	32.81
	Persea americana Mill.	19.55
	Averrhoa bilimbi L.	37.03
	Myristica fragrans Houtt.	29.50

Table 4. Species diversity using Shannon-Wiener index

Growth level	Shannon-Wiener index			
	PMH	Category	NRT	Category
Trees	1.81	Moderate	2.12	Moderate
Poles	2.47	Moderate	1.18	Moderate
Saplings	3.20	High	2.75	Moderate
Seedlings	1.52	Moderate	1.42	Moderate
Average	2.25	Moderate	1.87	Moderate

Table 5. Species richness using the Margalef index

Growth level	Margalef index			
	PMH	Category	NRT	Category
Trees	4.00	Medium	3.08	Medium
Poles	6.13	High	4.71	High
Saplings	6.66	High	4.76	High
Seedlings	1.23	Low	0.87	Low
Average	4.50	Medium	3.35	Low

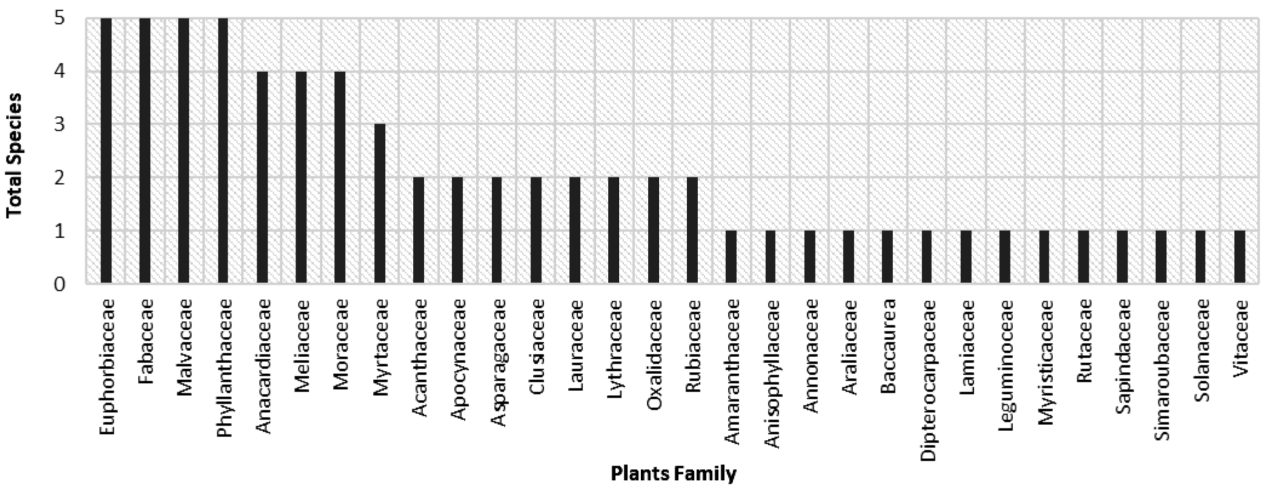

Figure 3. Number of plants in each family

Similar results were discovered for agroforestry practices along the Ciliwung riparian in Bogor municipality. The species richness Dm of talun or forest garden was 4.32 (high category), while homegarden and mixed garden have Dm values in the medium category, with values of 3.90 and 3.63, respectively (Prastiyo et al. 2020). Another study of crop diversity in various cocoa-based agroforestry systems in the Pasaman district, West Sumatra, revealed that complex agroforestry systems had the highest plant species richness index (4.24), followed by simple agroforestry systems (4.06) and non-agroforestry systems (3.23) (Sumilia et al. 2019). The option for enrichment planting is considerable to improve biodiversity in the compartment with a low diversity level. This scheme will also facilitate the conservation of native species from the secondary tropical rainforests (Suyanto et al. 2022).

Evenness refers to the variation in species' relative abundance. The evenness index describes the consistency of species abundance within a community (Briers 2006). Species evenness calculation using the Pielou index resulted in value ranges from 0.56 to 0.91 in PMH and 0.37 to 0.88 in NRT. The highest species evenness index was found in saplings' growth level, and the lowest was in trees. In NRT, the highest species evenness index was found in saplings' growth level, and the lowest was found in poles (Table 6). Species evenness in PMH is more than in NRT, notably at the pole and sapling growth levels, even though the index category was considerably the same. The even distribution of species indicates that the number of species in a habitat is stable, so the resilience tends to be high (Wakhidah et al. 2020).

In this study, the species evenness values were significantly greater than in the homestead agroforests of the drought-prone northwestern region of Bangladesh, where the Pielou score was just 0.45 (Alam and Sarker 2011), but comparable to the Parkland Agroforestry of Northern Ethiopia study results, which achieved 0.81 (Gebrewahid and Meressa 2020).

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