UDC 633; DOI 10.18551/rjoas.2022-02.11

PLANT DIVERSITY AND UTILIZATION OF TRADITIONAL HOME GARDEN IN BANGKALAN DISTRICT, MADURA ISLAND, INDONESIA

Setiani Setiani*
Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung, Taiwan

Setiawan Eko
Faculty of Agriculture, University of Trunojoyo Madura, Indonesia

Huang Wen-Chi
Department of Agribusiness Management, National Pingtung University of Science and Technology, Pingtung, Taiwan

*E-mail: tianiyani@gmail.com

ABSTRACT
Home gardens are traditional agricultural systems, particularly common in the tropics, characterized by high plant diversity and play an important role for local residents' livelihoods. Home gardens are reservoirs of biological diversity. This study aims to analyze the diversity and utilization of plants in the traditional home garden. The study was conducted in Bangkalan District, Madura Island, East Java Province, Indonesia. Data was collected in three sub-districts based on the different sea-level surfaces from June 2019 to February 2020. The techniques used were plant inventory, participatory observations, and individual interviews. A total of 30 home gardens were observed in this study. Plant diversity was calculated using the Shannon diversity index (H). The results of the Shannon index indicate that there is medium species diversity in the home gardens in the Bangkalan district (the diversity ranged from 0.48 to 1.81). Plants grown for fruit, vegetables, ornamentals, medicine, food crops, and other purposes. Traditional communities utilize their home gardens mostly for subsistence purposes.

KEY WORDS
Home garden, biodiversity, plant use, conservation, rural livelihoods, Madura Island.

The term "home garden" refers to a land use system that involves the intentional management of multipurpose trees and shrubs in close association with annual and perennial agricultural crops and, invariably, livestock within the compounds of individual houses. The entire tree-crop and animal units are intensively managed by family labor (Ewuketu et al., 2014). Home gardens are traditional agricultural systems, particularly prevalent in the tropics, that are characterized by high plant productivity (Toledo-Hernández et al., 2016); considered a sustainable production system in the tropics, which contributes to biodiversity conservation. Home gardens serve as agrobiodiversity reservoirs, preserving native natural biodiversity (Naigaga et al., 2021); generally multifunctional and play an important role in providing goods and ecosystem services, as well as numerous benefits for sustaining local residents' livelihoods (Calvet-Mir et al., 2012).

The evolution, composition, and functions of home gardens are all changing. Home gardens are acknowledged as essential in situ sites of biodiversity conservation, notably of agro-biodiversity, in addition to providing a diverse and consistent supply of socio-economic products and services to the people that maintain them, such as food, medicine, firewood, fodder, and timber (Tefera et al., 2019). Home gardens are a time-tested local strategy that is widely adopted and practiced in various circumstances by local communities with limited resources and institutional support. Home gardens have been recognized as an essential additional source for food and nutritional security, as well as livelihoods, around the world.

Globally, home gardens have been documented as an important supplemental source contributing to food and nutritional security and livelihoods (Galhena et al., 2013).

Home gardens have been studied on some Indonesian islands (Darma et al., 2020; Elih Nurlaelih et al., 2019; Kehlenbeck & Maass, 2004; Nila Pamungkas & Hakim, 2013; Pamungkas et al., 2013; Park et al., 2019; Rahu et al., 2013; Swandayani et al., 2016; Wakhidah & Sari, 2019). Very few studies have been carried out on home gardens in Madura Island, which creates a need for research to assess the role of Madura home gardens in plant diversity. This study aims to analyze the diversity and utilization of plants cultivated in the home garden. Specifically, it is aimed at identifying plant species conserved in home gardens through a plant inventory survey.

METHODS OF RESEARCH

The study was conducted in Bangkalan District, Madura Island, East Java Province, Indonesia. It is shaped inland by 1,260.14 km2, located between 6° 51' and 7° 11' South latitude and between 1120 40' and 113° 08' East longitude (BPS (Indonesia Statistic Government Office)., 2021). The elevation of land ranges from 2 to 100 meters above sea level (m.a.s.l), with an average elevation of 23 m.a.s.l. average precipitation of 126.35 mm per month, with the highest occurring in December (267.89 mm^3) and the lowest in August (4.5 mm). The soil in Madura Island is barren, arid, and high in lime content (Supriyadi, 2007).

Surabaya city is the capital of East Java Province, and Bangkalan is the nearest district to Surabaya compared to other districts in Madura Island. Since 2009, the Suramadu bridge has connected Java Island and Madura Island. This bridge changed some aspects of Madura Island, including agriculture (Faoziyah, 2016). This regency is divided into eighteen sub-districts. Data was collected in three sub-districts based on different sea level surfaces: (1) Sepulu sub-district (2 m.s.a.l.) as a coastal area; Tanah Merah sub-district (47 m.a.s.l) as a medium area; and Geger sub-district (100 m.a.s.l) as a high land area; Fig 1.

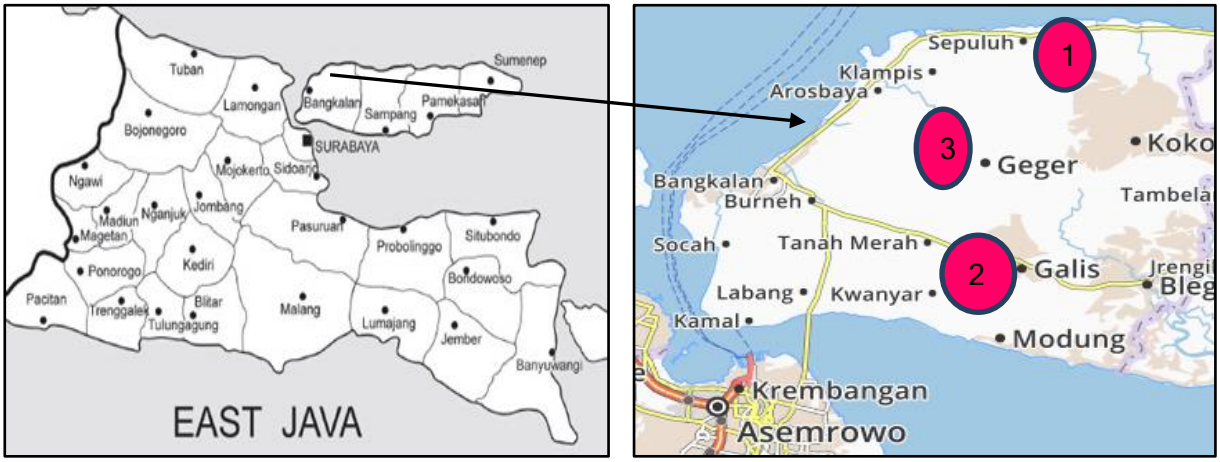

Figure 1 – The map of Study Site, East Java Province, Bangkalan District and three sub-districts in the study

This study was conducted from June 2019 to February 2020. In each home garden, the direct observation of species composing the home gardens was performed. The data collection was based on a plant inventory survey technique to classify and record the taxonomic details of plant species in the region. We divided the utilization into economic, subsistence, and ecological purposes. Madurese student from the faculty of Agricultural Trunojoyo Madura University was trained before the survey and collected the data. Participatory discoveries, field observations, garden inventories, and individual interviews were used in the data collection process. Interviews were conducted only in the Madurese language because most of the traditional families could not speak Indonesian. The surveyor

made the respondents aware of the aims of the study and interview, and also considered ethical aspects.

Analytical tools for botanical data manipulation were used to process data collected (Naigaga et al., 2021). Species classification and nomenclature were based the World Plant List. Plant species were classified into six categories: fruit, vegetable, food crops (tubers), medicine, ornamental and others. Species diversity was calculated using the Shannon-Wiener index (H). The index is calculated using the equations:

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

Where: H'= Shannon-Wiener Diversity Index, s = number of species P_i= the proportion of individuals or abundance of the i^{th} species expressed as proportion of the total abundance.

RESULTS AND DISCUSSION

Home garden diversity. There were 2,962 plants cultivated in traditional home gardens in three sub-districts in Bangkalan (table 1). The largest group of plants cultivated is industrial plants, followed by fruit, ornamental, medicine, food crops (tubers), and vegetables. Most fruit, medicine, and industrial plants were cultivated in the middle land areas, while vegetable, ornamental, and food crop plants were mostly found in coastal land areas.

Table 1 – Plant cultivated in traditional home garden three sub-districts in Bangkalan

No	Group of plant	Sepuluh		Tanah Merah		Geger		Total plants	
		∑ Plant	%	∑ Plant	%	∑ Plant	%	∑ Plant	%
1	Fruit	138	18.83	268	16.43	174	29.10	580	19.58
2	Vegetable	86	11.73	31	1.90	47	7.86	164	5.54
3	Ornamental	257	35.06	104	6.38	143	23.91	504	17.02
4	Medicine	60	8.19	135	8.28	75	12.54	270	9.12
5	Food crop (Tubesr)	129	17.60	64	3.92	42	7.02	235	7.93
6	Others	63	8.59	1029	63.09	117	19.57	1209	40.82
Total		733	100.00	1631	100.00	598	100.00	2962	100.00

In the traditional home garden in the tree sub-district, 70 species of plants were found, including 23 species of food crops and 4 species of industrial plants. The species of plants cultivated in the home garden were numerous (Table 2-7). The plant species diversity is similar to that of a tropical home garden or that of other traditional home gardens in many regions in developing countries (Ferdous et al., 2016) and Java Island (Hakim & Nakagoshi, 2007; Putri et al., 2016; Wiersum, 2006). The difference in species selection for traditional home gardens is primarily due to the altitudinal/climatic regime and also to traditional beliefs and day-to-day requirements of the farming people.

Species and the diversity of fruit are shown in table 2. The highest fruit plant cultivated in three sub-districts was *Musa spp.* (48.43%), followed by *Mangifera indica* L. (12.93%) and *Carica papaya* (9.92%). Based on location, the highland has the highest diversity of fruit compared to the coastal area and the middle land area. The average Shannon index in three locations (1.84) was lower than the species-fruit diversity in Ethiopia (Alemu et al., 2019). The diversity of fruit in the highlands was higher than in the middle land and coastal land areas.

Most *Musa spp.* are planted for economic purposes. Usually, the wife in the traditional family directly sells the fruit to the nearest market. Sometimes they also sell the leaves. Although there were numerous, they were not managed well. The family was careless about the growth of these plants. Basically, *Mangifera indica* L was planted as a shade plant. They argue that it has a lot of leaves and makes their house and home garden cooler and shadier. The family usually sells the mango fruit to the middle man through the "tebasan" system, as it also occurs in another place on Java Island (Anugrah, 2009). *Carica papaya* was grown for food, not only as a fruit but also as a vegetable (immature fruit and leaves).

Table 2 – Fruit species and diversity of traditional home garden in three sub-districts of Bangkalan, Madura, Indonesia

No	Scientific Name	Local name	Species (%)			Diversity Index		
			SP	TM	GG	SP	TM	GG
1	*Anacardium occidentale*	Jambu Mente	-	0.75	-	-	0.04	-
2	*Annona muricata L.*	Sirsak	-	-	1.724	-	-	0.07
3	*Annona squamosal*	Srikaya	5.07	1.87	1.149	0.15	0.07	0.05
4	*Artocarpus integra*	Nangka	-	2.99	-	-	0.10	-
5	*Averrhoa carambola*	Belimbing	-	1.87	-	-	0.07	-
6	*Carica papaya*	Pepaya	10.1	11.57	8.046	0.23	0.25	0.2
7	*Chrysophylum cainito*	Kanitu	-	2.61	1.149	-	0.10	0.05
8	*Citrus aurantifolia sw*	Jeruk Nipis	0.72	-	1.724	0.04	-	0.07
9	*Citrus x paradise*	Jeruk Bali	-	-	2.874	-	-	0.1
10	*Cocos nucifera* L.	Kelapa	7.25	0.75	1.724	0.19	0.04	0.07
11	*Hylocereus undatus*	Buah Naga	2.17	-	2.874	0.08	-	0.1
12	*Mangifera indica*	Mangga	10.1	17.16	11.49	0.23	0.30	0.25
13	*Manilkara zapota*	Sawo	2.9	-	2.299	0.1	-	0.09
14	*Muntingia calabura* L.	Kersen	1.45	1.12	2.299	0.06	0.05	0.09
15	*Musa spp.*	Pisang	51.4	43.28	50.57	0.34	0.36	0.34
16	*Passiflora edulis*	Markisa	-	-	0.57	-	-	0.03
17	*Phoenix dactylifera* L.	Kurma	0.72	-	-	0.04	-	-
18	*Psidium guajava*	Jambu Biji	5.07	7.84	4.02	0.15	0.20	0.13
19	*Salacca zalacca*	Salak	-	2.24	2.87	-	0.09	0.1
20	*Spondias cytherea Sonn*	Kedongdong	2.9	0.75	4.02	0.1	0.04	0.13
21	*Syzygium aqueum* Alst.	Jambu Air	-	4.48	-	-	0.14	-
22	*Syzygium cumini*	Duwet	-	0.75	-	-	0.04	-
23	*Tamarindus indica*	Asem	-		0.57	-	0.00	0.03
	Total		100.00	100.00	100.00	1.72	1.88	1.91

Note: Sub-district: SP Sepuluh, N=138 plants; TM Tanah Merah, N=268 plants, GG Geger, N=174 plants.

Species and the diversity of vegetables are shown in table 3. Only *Capsicum annum* L. and *Capsicum frutescent* were planted in all three sub-districts, but *Capsicum annum* L was planted in a small number (8.3%). On the other hand, *Capsicum frutescent* was planted in a higher percentage in all sub-districts (62.83%). These plants were for subsistence purposes only; they were not only consumed by the owner but also shared with a neighbor because they were consumed daily. The respondents also indicated that it was ingrained to anticipate a higher and fluctuating price (Anwarudin, M et al., 2013). *Sasbania grandiflora* and *Moringa pterygosperma* are the second and third most common vegetables planted, but they are only found in the Sepulu sub-district. *Sasbania grandiflora* was one of the home garden indigenous vegetables suitable for Madura Island (Setiawan, 2017, 2018). Most of the *Moringa pterygosperma* was planted as an organic fence. Part of the *Moringa pterygosperma* organ is used, such as leaves (55%), fruit (21%), roots (9%), and stems (14%) (Bahriyah et al., 2015).

Table 3 – Vegetable species and diversity of traditional home garden in three sub-districts of Bangkalan, Madura, Indonesia

No	Scientific Name	Local name	Species (%)			Diversity Index		
			SP	TM	GG	SP	TM	GG
1	*Amaranthus*	Bayam	8.14	-	-	0.2	-	-
2	*Capsicum annum L.*	Cabai besar	5.81	12.9	6.383	0.17	0.26	0.18
3	*Capsicum frutescent*	Cabai rawit	30.23	77.42	80.85	0.36	0.2	0.17
4	*Ipomoea aquatic*	Kangkung	9.30	-	-	0.22	-	-
5	*Leucaena leucocephala*	Lamtoro	-	9.677	-	-	0.23	-
6	*Moringa pterygosperma*	Kelor	11.63	-	-	0.25	-	-
7	*Nasturtium officinale*	Selada air	-	-	2.128	0	-	0.08
8	*Sachium edule*	Labu siam	4.65	-	8.511	0.17	-	0.21
9	*Sasbania grandiflora*	Turi	27.91	-	-	0.36	-	-
10	*Solanum melongena*	Terong	2.33	-	2.128	0.09	0	0.08
	Total		100.00	100.00	100.00	1.81	0.69	0.72

Note: Sub-district: SP Sepuluh, N=86 plants; TM Tanah Merah, N=31 plants, GG Geger, N=47 plants.

Table 4 – Ornamental species and diversity of traditional home garden in three sub-districts of Bangkalan, Madura, Indonesia

No	Scientific Name	Local name	Species (%)			Shannon Index		
			SP	TM	GG	SP	TM	GG
1	*Adenium obesum*	Kamboja	0.39	5.77	-	0.02	0.16	0.00
2	*Aglaonema*	Sri rejeki	-	1.92	-	-	0.08	0.00
3	*Bougainvillae* sp.	Bugenvil	0.39	-	-	0.02	-	0.00
4	*Caladium* sp.	Keladi	-	-	2.10	-	-	0.08
5	*Cananga odorata*	Kenanga	0.78	-	-	0.04	-	0.00
6	*Catharantus roseus*	Tapak dara	2.33	1.92	-	0.09	0.08	0.00
7	*Codiaeum variegatum*	Puring	3.89	4.81	3.50	0.13	0.15	0.12
8	*Dypsis leutescens*	Palem	-	-	6.99	-	-	0.19
9	*Euphorbia milii*	Euphorbia	2.72	9.62	-	0.10	0.23	0.00
10	*Hibiscus rosa sinensis*	Bunga Sepatu	77.82	52.88	68.53	0.20	0.34	0.26
11	*Impatiens balsamina* L	Bunga pacar air	0.78	-	-	0.04	-	-
12	*Ixora coccinea* L.	Asoka	2.72	-	-	0.10	-	-
13	*Jasminum sambac*	Melati	0.78	13.46	9.09	0.04	0.27	0.22
14	*Oleina syzygium*	Pucuk merah	0.39	-	-	0.02	-	0.00
15	*Opuntia* spp	Kaktus	2.33	-	2.10	0.09	-	0.08
16	*Rosa* sp.	Mawar	1.56	3.85	4.90	0.06	0.13	0.15
17	*Sansevieria* sp.	Lidah mertua	1.95	1.92	1.40	0.08	0.08	0.06
18	*Zamioculcas zamifolia*	Daun dolar	1.17	3.85	1.40	0.05	0.13	0.06
	Total		100	100	100	1.06	1.62	1.21

Note: Sub-district: SP Sepuluh, N=257 plants; TM Tanah Merah, N=104 plants, GG Geger, N=143 plants.

Species and the diversity of ornamental plants are shown in table 4. The most ornamental plant cultivated in all sub-districts was *Hibiscus rosa sinensis* (66.41%), followed by *Jasminum sambac* (7.78%) and *Rosa* sp. (3.43%). Most of the ornamental plants were planted as organic fences and were not used for commercial purposes. The highest diversity of ornamental plants is in the middle land, followed by high land and the coastal area. In the Java and Bali islands, the use of flowers and leaves for traditional rituals is common (Darma et al., 2020; Hakim et al., 2018). The diversity of ornamental plants in the middleland area was higher than in the coastal and highland areas.

Species and the diversity of medicine plants are shown in table 5. *Curcuma domestica Vahl*, *Cymbopogon citratus,* and *Deacaena angustifolia* were found in all of the sub-districts. *Sonchus arvensus* and *Piper Betle are* also numerous in coastal land areas. *Deacaena angustifolia* was found in numerous middle land areas, while *Ocimum basillum* was found in numerous high land areas. The most common medicinal plant cultivated in all sub-districts is *Curcuma domestica Vahl.* Other species of curcuma, such as *Curcuma aeruginosa* and *Curcuma zanthorrhiza,* were distributed randomly in home gardens, and there were indications of spontaneous growth in all gardens (Hakim et al., 2018). The highland area has the highest diversity index of medicinal plants, while the middle land has the lowest diversity.

Table 5 – Medicine species and diversity of traditional home garden in three sub-districts of Bangkalan, Madura, Indonesia

No	Scientific Name	Local name	Species (%)			Shannon Index		
			SP	TM	GG	SP	TM	GG
1	*Aloe vera*	Lidah buaya	6.67	-	1.33	0.18	-	0.06
2	*Bassela rubra linn*	Binahong	-	1.48	-	-	0.06	-
3	*Curcuma domestica Vahl.*	Kunyit	35.00	27.41	26.67	0.37	0.35	0.35
4	*Cymbopogon citratus*	Sereh	13.33	10.37	2.67	0.27	0.24	0.97
5	*Deacaena angustifolia*	Pandan suji	3.33	45.19	12.00	0.11	0.36	0.25
6	*Hibiscus sabdariffa*	Rosella	-	2.22	-	-	0.08	-
7	*Jatropha multifida*	Bunga betadine	3.33	-	-	0.11	-	-
8	*Morinda citrifolia*	Mengkudu	-	-	1.33	-	-	0.06
9	*Ocimum basillum*	Kemangi	-	4.44	33.33	-	0.14	0.37
10	*Piper Betle*	Sirih	10.00	-	-	0.23	-	-
11	*Sonchus arvensus*	Tempuyung	28.33	-	14.67	0.36	-	0.28
12	*Zingiber officinale roxb.*	Jahe	-	8.89	8.00	-	0.22	0.2
	Total		100.00	100.00	100.00	1.63	1.45	2.54

Note: Sub-district: SP Sepuluh, N=60 plants; TM Tanah Merah, N=135 plants, GG Geger, N=75 plants.

Table 6 – Tubber diversity of traditional home garden in three sub-districts of Bangkalan, Madura, Indonesia

No	Scientific Name	Local name	Species (%)			Diversity Index		
			SP	TM	GG	SP	TM	GG
1	*Colocasia esculenta*	Talas	-	6.25	4.76	0	0.17	0.15
2	*Ipomoea batatas L.*	Ubi jalar	67.44	-	35.71	0.27	-	0.37
3	*Manihot esculenta crantz*	Singkong	32.56	93.75	59.52	0.37	0.06	0.31
	Total		100	100	100	0.63	0.22	0.82

Note: Sub-district: SP Sepuluh, N=129 plants; TM Tanah Merah, N=64 plants, GG Geger, N=42 plants.

Species and the diversity of food crops (tubers) plants are shown in table 6. The most cultivated plant in all sub-districts is *Manihot esculenta* Crantz (61.94%), while *Ipomoea batatas* L. is not found in Sepuluh, *Colocasia esculenta* is not found in Tanah Merah. Javanese and Madurese people not only used *Manihot esculenta* Crantz as a carbohydrate sourced from its tubers but also as a vegetable from its leaves (Putri et al., 2016). The same condition of diversity of medicinal plants, high land areas have the highest food crop diversity compared to other areas.

Table 7 – Others plant diversity of traditional home garden in three sub-districts of Bangkalan, Madura, Indonesia

No	Scientific Name	Local name	Species (%)			Diversity Index		
			SP	TM	GG	SP	TM	GG
1	*Bambusa glaucescens*	Bambu	-	91.84	74.36	-	0.08	0.22
2	*Ceiba petandra*	Kapuk Randu	-	0.19	-	-	0.01	-
3	*Saccharum officinarum* L.	Tebu	84.13	1.65	4.27	0.15	0.07	0.13
4	*Tectona grandis*	Jati	15.87	6.32	21.37	0.29	0.17	0.33
	Total		100	100	100	0.44	0.33	0.68

Note: Sub-district: SP Sepuluh, N=63 plants; TM Tanah Merah, N=1,029 plants, GG Geger, N=117 plants.

Species and the diversity of the other plants are shown in table 7. *Bambusa glaucescens* is the most cultivated plant in Tanah Merah and Geger, which are planted over 70% in traditional home gardens, while *Tectona grandis* and *Saccharum officinarum* L. are spread evenly in all sub-districts but mostly in Sepuluh. *Bambusa glaucescens* is used as a building and art material. Bio-fence occurs as an integral part of settlements and consists of bamboo or tree plants (Putri et al., 2016). Bamboo is one of the most important non-wood tree species in rural areas (Hakim et al., 2018).

Traditional household families utilize their home gardens for economic, subsistence, and ecological purposes. For economic purposes, they use the products from their home gardens to generate income or as a business, but most of the traditional home garden families in Bangkalan utilize their home gardens for subsistence purposes. They consume the plant directly in their home garden or share it with neighbors and relatives for subsistence purposes. For ecological purposes, they utilize their home garden to make their home environment more comfortable. The utilization of the home garden of the traditional home garden based on a group of plants is shown in table 8. The home garden's diversity and utilization can be affected by the social-economic status of the household (Wiersum, 2006).

Most plants in the home garden are utilized for subsistence purposes (50.33%), followed by ecological (44.89%) and economic (7.67%). This condition occurs because the production from the home garden is very small and just enough to fulfill their family needs. They are not concerned for economic purposes because the low productivity and quality of home garden products are caused by some environmental factors such as low soil fertility and problems with water availability. They also spent most of their time and resources on farming in the field.

Fruit plants in home gardens are mostly (50%) utilized for subsistence purposes. They use fruit plants not only to consume as a fruit but also other parts of the fruit. For example, the leaves and flowers of *Carica papaya* are utilized as vegetables. *Cocos nucifera* L. utilizes the stem as material for construction and the other parts as fire wood. Fruit plants are utilized

for ecological purposes, mostly as shade plants, for example, *Muntingia calabura* L., *Chrysophylum cainito* and Tamarindus indica. A small portion of the fruit was used for economic purposes (13.67%), for example, *Musa sp.* and *Mangifera indica* L were sold to generate income.

Table 8 – The utilization of home garden of traditional home garden base on group of plant in three sub-districts in Bangkalan, Madura Island, Indonesia

No	Group of plant	Economy (%)				Subsistence (%)				Ecology (%)			
		SP	TM	GG	AVG	SP	TM	GG	AVG	SP	TM	GG	AVG
1	Fruit	14	13	14	13.67	52	46	52	50.00	34	41	34	36.33
2	Vegetable	-	-	-	-	90	67	90	82.33	10	33	10	17.67
3	Ornamental	-	-	-	-	8	5	8	7.00	92	95	92	93.00
4	Medicine	-	-	-	-	26	35	26	29.00	74	65	74	71.00
5	Food crop	24	28	24	25.33	76	72	76	74.67	-	-	-	-
6	Industrial plant	8	5	8	7.00	50	25	50	41.67	42	70	42	51.33
Average		7.67	7.67	7.67	67	50.33	41.67	50.33	47.44	42.00	50.67	42.00	44.89

Note: Sub-district: SP Sepuluh, TM Tanah Merah, plants, GG Geger, AVG Average.

Vegetable plants in home gardens are mostly (82.33%) utilized for subsistence purposes, with a small portion for ecology (17.67%) and none for economic purposes. The same reasoning applies to fruit; a small crop of vegetables is just enough to feed the family or share with others. *pterygosperma, Leucaena leucocephala, Sachium edule,* and *Sasbania grandiflora* were utilized not only for consumption but also as shades and organic fences. There was a high plant that had a lot of branches and leaves and was adaptable to the environmental conditions in the Madura Islands.

More than 90% of ornamental plants are utilized for ecological purposes, a small part for subsistence and none for the economy. Usually, the ornamental plants used as organic fences are *Hibiscus rosa sinensis* and *Jasminum sambac.* In the same way that ornamental plants are used for ecological reasons, most medicine plants are used for ecological reasons (71%), with a small portion used for subsistence (29%).*Deacaena angustifolia* is the most ornamental plant used as an organic fence, and *Curcuma domestica Vahl* was used as traditional medicine and consumed by the household.

No food crop plant is utilized as ecologically as possible, mostly for consumption by the family and a small part (25.33%) for sale to the market to generate income. All of the food crops are small plants that cannot be used as shade plants and utilize their tubers as a carbohydrate food source. A small part of an industrial plant is utilized for economic purposes. Usually, it is used for subsistence and ecological purposes. *Bambusa glaucescens* and *Tectona grandis are* mostly used as shades and construction materials.

CONCLUSION

This study documented plant diversity in the traditional home garden in Bangkalan District, Madura Island, Indonesia. This study indicates that home gardens have high plant species diversity which contributes to plant diversity conservation. Traditional home gardens are constructed by numerous plant species that are planted for fruit, vegetable, ornamental, medicine, food crops, and other purposes. The traditional home garden community in Bangkalan utilizes their home gardens mostly for subsistence purposes for consumption by their family. Future research should focus on home garden management, the impact of social-cultural diversity in the home garden, and household food security.

REFERENCES

1. Alemu, A. A., Kiros, H., & Sorecha, E. M. (2019). Assessing Fruit Tree Species Diversity in Home Garden Agro-Forestry and Their Role Supporting Local People's Livelihoods in Burie District, Ethiopia. Turkish Journal of Agriculture - Food Science and Technology, 7(7), 946. https://doi.org/10.24925/turjaf.v7i7.946-954.1977.
2. Anugrah, I. S. (2009). Considering mangoes as local high priority commodity in an

agribusiness system policy: an ecdeavor to unite institutional support for the benefit of farmers. Analisis Kebijakan Pertanian (Agriculture Policy Analysis), 7(2), 189–211.
3. Anwarudin, M, J., Sayekti, A. L., K, A. M., & Hilman, Y. (2013). Production Dynamics and Price Volatility of Chili : Anticipation Strategy and Development Policy.
4. Bahriyah, I., Hayati, A., & Zayadi, H. (2015). Ethnobotany Study of Moringa (Moringa oleifera) in Somber Village, Tambelangan District, Sampang Regency, Madura. Biosaintropis, 1(1), 61–67. http://biosaintropis.unisma.ac.id/index.php/biosaintropis/article/view/50/25.
5. BPS (Indonesia Statistic Government Office). (2021). Bangkalan regency in figures 2021. BPS-Statictics of Bangkalan Regency.
6. Calvet-Mir, L., Gómez-Baggethun, E., & Reyes-García, V. (2012). Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, Northeastern Spain. Ecological Economics, 74, 153–160. https://doi.org/10.1016/j.ecolecon.2011.12.011.
7. Darma, I. D. P., Sutomo, Hanum, S. F., & Iryadi, R. (2020). Plant conservation based on tri mandala concept on homegarden at Pakraman Penge village, Baru village, Marga district, Tabanan regency, Bali. Journal of Tropical Biodiversity and Biotechnology, 5(3), 189–200. https://doi.org/10.22146/jtbb.56260.
8. Elih Nurlaelih, E., Hakim, L., Rachmansyah, A., & Antariksa, A. (2019). Landscape services of home garden for rural household: A case study of Jenggolo village Malang regency. Agricultural Social Economic Journal, 19(3), 135–143. https://doi.org/10.21776/ub.agrise.2019.019.3.2.
9. Ewuketu, L. M., Zebene, A., & Solomon, Z. (2014). Plant species diversity of homegarden agroforestry in Jabithenan District, North-Western Ethiopia. International Journal of Biodiversity and Conservation, 6(4), 301–307. https://doi.org/10.5897/ijbc2013.0677.
10. Faoziyah, U. (2016). Who Benefits? The Case of the Suramadu Bridge Construction". Procedia - Social and Behavioral Sciences, 227(November 2015), 60–69. https://doi.org/10.1016/j.sbspro.2016.06.043.
11. Ferdous, Z., Datta, A., Anal, A. K., Anwar, M., & Khan, A. S. M. M. R. (2016). Development of home garden model for year round production and consumption for improving resource-poor household food security in Bangladesh. NJAS - Wageningen Journal of Life Sciences, 78, 103–110. https://doi.org/10.1016/j.njas.2016.05.006.
12. Galhena, D. H., Freed, R., & Maredia, K. M. (2013). Home gardens: A promising approach to enhance household food security and wellbeing. Agriculture and Food Security, 2(1), 1–13. https://doi.org/10.1186/2048-7010-2-8.
13. Hakim, L., & Nakagoshi, N. (2007). Plant species composition in home gardens in the Tengger highland (East Java, Indonesia) and its importance for regional ecotourism planning. Hikobia, 15(1), 23–36.
14. Hakim, L., Pamungkas, N. R., Wicaksono, K. P., & Soemarno, S. (2018). The conservation of Osingnese traditional home garden agroforestry in Banyuwangi, East Java, Indonesia. Agrivita, 40(3), 506–514. https://doi.org/10.17503/agrivita.v40i3.1605
15. Kehlenbeck, K., & Maass, B. L. (2004). Crop diversity and classification of homegardens in Central Sulawesi, Indonesia. Agroforestry Systems, 63(1), 53–62. https://doi.org/10.1023/B:AGFO.0000049433.95038.25.
16. Naigaga, H., Ssekandi, J., Ngom, A., Diouf, N., Diouf, J., Dieng, B., Mbaye, M. S., & Noba, K. (2021). Assessment of the contribution of home gardens to plant diversity conservation in Thies region, Senegal. Environment, Development and Sustainability, 0123456789. https://doi.org/10.1007/s10668-021-01737-x.
17. Nila Pamungkas, R., & Hakim, L. (2013). Ethnobotanical Investigation for Conserving Home Gardens Plants Species in Tambakrejo Sumbermanjing Wetan, Southern of Malang. Journal of Tropical Life Science, 3(2), 96–103. https://doi.org/10.11594/jtls.03.02.05.
18. Pamungkas, R. N., Indriyani, S., & Hakim, L. (2013). The ethnobotany of homegardens along rural corridors as a basis for ecotourism planning: a case study of Rajegwesi village, Banyuwangi, Indonesia. Journal of Biodiversity and Environment Sciences

(JBES), 3(8), 60–69. http://www.innspub.net.
19. Park, J. H., Woo, S. Y., Kwak, M. J., Lee, J. K., Leti, S., & Soni, T. (2019). Assessment of the diverse roles of home gardens and their sustainable management for livelihood improvement in West Java, Indonesia. Forests, 10(11). https://doi.org/10.3390/f10110970
20. Putri, W. K., Hakim, L., & Batoro, J. (2016). Ethnobotanical Survey of Home Gardens in Pandansari and Sumberejo to Support Ecotourism Program in Bromo Tengger Semeru National Park, Indonesia. International Journal of Research Studies in Agricultural Sciences, 2(1), 6–12. https://doi.org/10.20431/2454-6224.0201002.
21. Rahu, A. A., Hidayat, K., Ariyadi, M., & Hakim, L. (2013). Ethnoecology of Kaleka: Dayak's agroforestry in Kapuas, Central Kalimantan Indonesia. Research Journal of Agriculture and Forestry Sciences Res. J. Agriculture and Forestry Sci, 1(8), 2320–6063. http://luchmanhakim.lecture.ub.ac.id/files/2013/03/RAhu-Kliwon-Aryadi-HAkim-ISCA.pdf.
22. Setiawan, E. (2017). Studi Etnobotani Pemanfaatan Tanaman Sayuran di Kabupaten Pamekasan. Rekayasa, 10(1), 1. https://doi.org/10.21107/rekayasa.v10i1.3614.
23. Setiawan, E. (2018). Kandungan Flavonoid dan Serat Sesbania grandiflora pada Berbagai Umur Bunga dan Polong. Jurnal Hortikultura Indonesia, 9(2), 122–130. https://doi.org/10.29244/jhi.9.2.122-130.
24. Supriyadi, S. (2007). Fertility of Madura dry land soil. Embryo, 4(2), 124–131.
25. Swandayani, R. E., Hakim, L., & Indriyani, S. (2016). Home garden of Sasak people in Sajang village, Sembalun, East Lombok, Indonesia. International Journal of Research Studies in Agricultural Sciences, 2(1), 32–40. https://doi.org/10.20431/2454-6224.0201005.
26. Tefera, Y., Babu, A., & Bizuayehu, B. (2019). Homegarden plant use and their traditional management practice in Bule Hora district, West Guji Zone, Southern Ethiopia. Agricultural Research & Technology, 21(4). https://doi.org/10.19080/ARTOAJ.2019.21.556168.
27. Toledo-Hernández, M., Denmead, L. H., Clough, Y., Raffiudin, R., & Tscharntke, T. (2016). Cultural homegarden management practices mediate arthropod communities in Indonesia. Journal of Insect Conservation, 20(3), 373–382. https://doi.org/10.1007/s10841-016-9871-0.
28. Wakhidah, A. Z., & Sari, I. A. (2019). Ethnobotany of home garden in West Kaliurang, Pakem, Sleman, Yogyakarta. Jurnal EduMatSains, 4(1), 1–28.
29. Wiersum, K. F. (2006). Diversity and change in homegarden cultivation in Indonesia. In Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry; Kumar, B.M., Nair, P.K.R., Eds.; Springer Science: Dordrecht, The Netherlands. 13–24. https://doi.org/10.1007/978-1-4020-4948-4_2.