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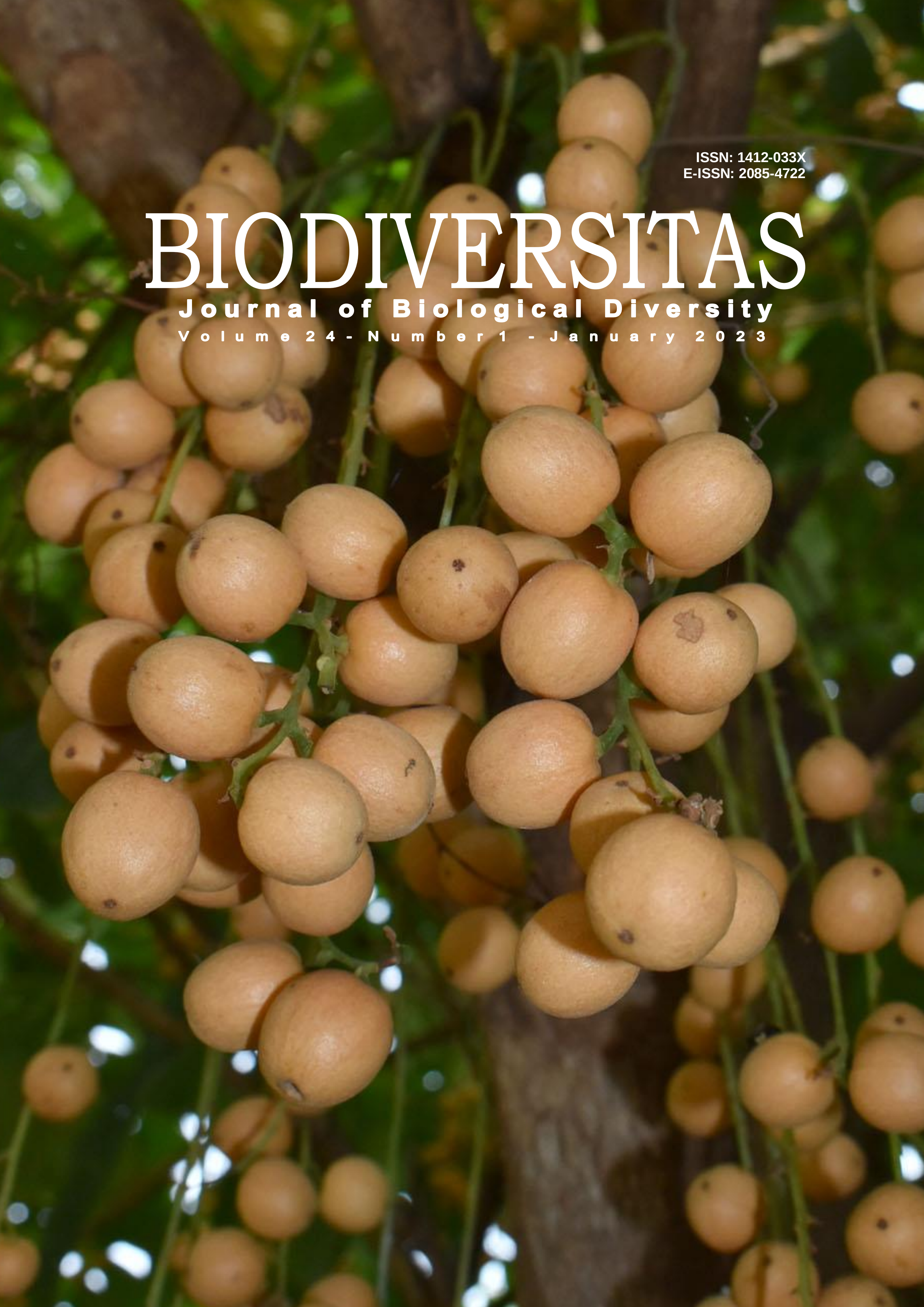

Front cover: Baccaurea racemosa **Müll.Arg.**
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Webb CO, Cannon CH, Davies SJ. 2008. Ecological organization, biogeography, and the phylogenetic structure of rainforest tree communities. In: Carson W, Schnitzer S (eds.). Tropical Forest Community Ecology. Wiley-Blackwell, New York.

Abstract:

Assaeed AM. 2007. Seed production and dispersal of *Rhazya stricta*. 50th annual symposium of the International Association for Vegetation Science, Swansea, UK, 23-27 July 2007.

Proceeding:

Alikodra HS. 2000. Biodiversity for development of local autonomous government. In: Setyawan AD, Sutarno (eds.). Toward Mount Lawu National Park; Proceeding of National Seminary and Workshop on Biodiversity Conservation to Protect and Save Germplasm in Java Island. Universitas Sebelas Maret, Surakarta, 17-20 July 2000. [Indonesian]

Thesis, Dissertation:

Sugiyarto. 2004. Soil Macro-invertebrates Diversity and Inter-Cropping Plants Productivity in Agroforestry System based on Sengon. [Dissertation]. Universitas Brawijaya, Malang. [Indonesian]

Information from the internet: Balagadde FK, Song H, Ozaki J, Collins CH, Barnet M, Arnold FH, Quake SR, You L. 2008. A synthetic *Escherichia coli* predator-prey ecosystem. Mol Syst Biol 4:187. www.molecularsystembiology.com

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Cultivation of underutilized fruit trees by indigenous people in Urug Village, West Java, Indonesia

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Abstract. *Anggraeni A, Yuniati R, Silalahi M, Lestari R, Jumari. 2023. Cultivation of underutilized fruit trees by indigenous people in Urug Village, West Java, Indonesia. Biodiversitas 24: 454-466.* Underutilized Fruit Trees (UFTs) are a group of fruit trees with high potential but underutilized. Some fruit has been identified in Urug Village, but this village was hit by a natural disaster, i.e., a flood and landslide in early 2020 that damaged the location where UFTs grew, threatening the existence of UFTs genetic resources. Therefore, a systematic and integrated effort is needed to maintain UFTs biodiversity. This study aims to discover how to cultivate UFTs by the indigenous peoples in Urug Village, document the location where UFTs grow, and analyze index vegetation using the Normalized Difference Vegetation Index (NDVI). Using the combined method of Focus Group Discussion (FGD) with 16 indigenous people, in-depth interviews with 19 indigenous people, and field observations, this study shows that there are 53 individuals of UFTs from 13 species found in several areas in Urug Village. Indigenous people have a unique way of cultivating UFT, starting from tree selection, preparation of planting sites, tree planting, and fruit tree care. However, more than 60% of UFT was found in the moderate vegetation index. The challenges of UFTs cultivation in Urug Village are changes in fruit consumption patterns, degradation of local knowledge, lack of information about the nutritional and vitamin content of UFTs, land use change, climate change, and the low involvement of both central and regional governments in cultivating UFTs. Thus, changes in consumer and government perceptions, and increased research on UFT are needed to address the challenges of cultivating UFT.

Keywords: Cultivation, indigenous people, local knowledge, underutilized fruit trees, Urug Village

INTRODUCTION

Conducting field research and identifying the cultivation technique of Underutilized Fruit Trees (UFTs) is necessary to preserve the biodiversity of UFTs (Dahanayake 2015). UFTs are a group of fruit trees with high potential but are underutilized, potentially promoting economic growth and national food security. UFTs are rich in nutrients, have commercial value, and have therapeutic, antidiabetic, and antioxidant properties (Mondo et al. 2021). As much as 79% of the total UFTs found in East Kalimantan, such as *Mangifera pajang*, *Artocarpus odoratissimus,* and *Durio kutejensis,* can be used to meet annual nutritional. UFTs identified in East Kalimantan contain at least one micronutrient in high concentrations (Ravindran et al. 2021). Even though they refer to the same definition, each researcher uses different terms to classify fruits as UFTs. Other terms, include underutilized or neglected tropical fruits, native, forgotten, small, orphaned, and underutilized trees (Mondo et al. 2021). In this study, the researchers use the term underutilized fruit trees used by researchers from the Forestry Research and Development Agency (FORDA) (Narendra et al. 2012).

Fruit tree species have been identified in various regions in Indonesia (Santosa et al. 2021), including UFTs that were successfully identified in Bogor District, West Java (Pratama et al. 2019; Ruwaida et al. 2022). UFTs in Bogor District are cultivated by indigenous people in Urug Village, Sukajaya Sub-district. The indigenous people in Urug Village cultivate UFTs in mixed gardens and backyards. However, in early 2020, Urug Village was hit by natural disasters, i.e., floods and landslides due to climate change. As a result, dozens of plants with strong and large-sized root systems were washed away by floods and buried in landslides (Naryanto et al. 2020), including UFTs.

Urug Village is part of the Sukajaya Sub-district, which has an undulating hills morphology with steep slopes to very (above 30%). Besides, Sukajaya Sub-district is also composed of easily weathered rock types such as inseparable volcanic rock units and Endut Volcano units. All areas within the administrative area of Sukajaya District, including Urug Village, have a very high potential for landslides (Naryanto et al. 2020). Therefore, a systematic and integrated effort is needed to maintain UFTs biodiversity through conservation programs and cross-sectoral approaches at the local level.

Ratnayake et al. (2019) state that biodiversity conservation can be conducted by identifying and collecting sample of fruit trees, making UFT arboretums, conducting research on UFTs, and holding workshops to increase public awareness and knowledge about UFTs, and conducting research to identify UFT cultivation methods. Yessoufou et al. (2022) also assert to support the realization of ex-situ plant conservation, researchers must conduct research in the field of ethnobotany by documenting local knowledge of the indigenous people. Indigenous people can conserve various species of plants and animals and their ecosystems (Saguye 2017).

The cross-sectoral approaches at the local level are carried out through by documenting locations where UFTs grow and analyzing the density of vegetation where UFTs grow. This analysis was carried out using Landsat 8 satellite imagery specifically for the Operational Land Imager (OLI) sensor. Through analysis of vegetation density, researchers can determine whether the UFTs found in Urug Village grow in locations with high or low vegetation. If UFTs grow in a location with low vegetation, then the conservation of UFTs must be carried out immediately, so the diversity of UFTs can be maintained.

Based on the background above, the researchers documented the local knowledge of the indigenous peoples in Urug Village on cultivating UFTs, documenting locations where UFTs grow, and analyzing the density of vegetation where UFTs grow using the Normalized Difference Vegetation Index (NDVI). The results of this study present data on UFTs cultivation techniques based on local knowledge of indigenous people in Urug Village and provide the basic data of conservation programs for UFTs. Furthermore, these results can complement the previous research, which has documented the species of UFTs that grow in Urug Village (Pratama et al. 2019).

MATERIALS AND METHODS

The study area

The research was conducted between May and September 2022 in Urug Village, Sukajaya Sub-district, Bogor District, West Java (Figure 1). The Urug village lies at 6^{0}34’42” S and 106^{0}29’28” E, at an altitude of 593 m above sea level, about 57 km from Cibinong, the capital of Bogor District. The total area of the Urug village is 400 ha and is inhabited by 5,326 people consisting of 2,797 males and 2,529 females. They were the descendants of the Sundanese and had been living there since about 450 years ago. Urug village has a tropical climate with bimodal seasonality of dry season from April to July and rainy season from August to April. The average rainfall in this village reaches 3,000 mm/year with a humidity of 77%. According to these data, this village has a high relative humidity (Fan et al. 2021).

Procedures

This research was conducted using a combination of research methods, namely qualitative and quantitative data collection techniques but using them alternately (Wanqing et al. 2022). The types of data used are primary data and secondary data. The data were collected through Focus Group Discussion (FGD), in-depth interviews, and field observation. The FGD aims to discuss the definition of UFTs according to indigenous people, find the existence of UFTs in Urug Village, and the locations where UFTs grow.

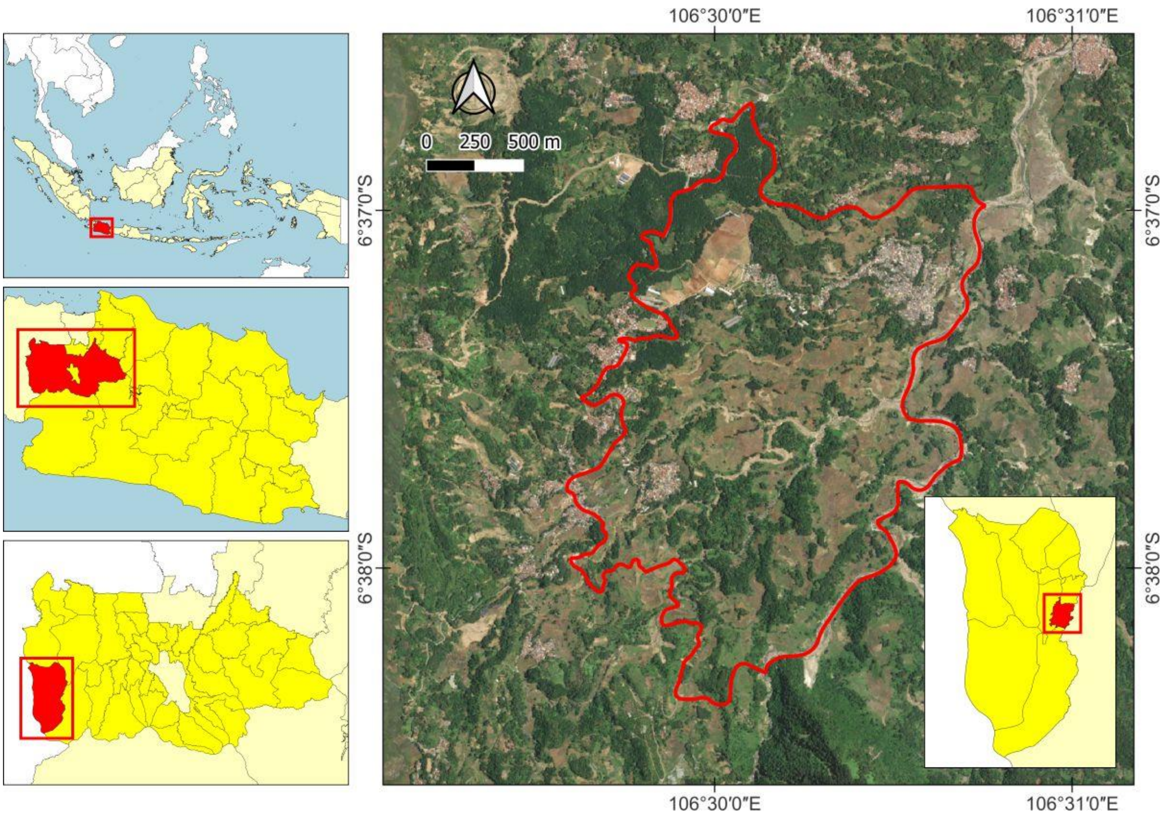

Figure 1. Urug Village, Sukajaya Subdistrict, Bogor District, West Java, Indonesia

There were 16 indigenous people (key informants) involved in the FGD consisting of elders (*Abah*) and indigenous people members appointed= by the elders (*Abah*) who were considered to know UFTs. The in-depth interview aims to discover the indigenous people's knowledge of UFTs, cultivation technique of UFTs in Urug Village, customary regulations, local and national government's role, and indigenous people's participation in maintaining the diversity of UFTs. Moreover, 19 indigenous people (general informants) were interviewed in depth. Selection of general informants through the snowballing technique, while the previous general informants recommended interviewing other people. That was conducted until no additional information was found during the in-depth interview (Pratama et al. 2019). The field observation aims to determine the coordinate point of locations where UFTs grow. After knowing the location of the UFTs, the researchers marked the locations on the Avenza tools, so we could obtain the coordinate points of the locations and analyze the vegetation density.

Data analysis

The data from FGDs and in-depth interviews on UFTs cultivation in Urug Village were analyzed using the Miles and Huberman Model by collecting, reducing, presenting, verifying, and concluding data. The data are presented in tables and diagrams using Microsoft Excel. The coordinate point data where UFTs grow were exported from Avenza tools and analyzed using Quantum Geographic Information System (QGIS). First, the researchers analyzed whether UFT grows in locations with a high or low vegetation index. The analysis was carried out using Landsat 8 satellite imagery specifically for the Operational Land Imager (OLI) sensor provided by the United State Geological Survey (USGS) on the website www.usgs.gov. After obtaining satellite image data, the researchers calculated the vegetation index using NDVI methods in QGIS. Then, the data were processed and presented in table form using Microsoft Excel and a map of vegetation density.

RESULTS AND DISCUSSION

The informants' profile

The key informants who were involved in the FGD were all males. A total of 69% and 31% of key informants were middle-aged and elderly, respectively. Most key informants are farmers, and in terms of education, 94% of key informants have been educated up to primary school. A breakdown of the key informant characteristics is provided in Table 1.

In their opinion, UFTs are a group of fruit trees that produce fruit with a sour taste, have unknown facts about vitamins and minerals, and need large areas to plant. Based on previous research (Pratama et al. 2019), there are 17 UFTs in Urug Village, but the key informants mentioned that 2 of the 17 species of UFTs found previously could not be found anymore. Therefore, to obtain comprehensive data, key informants recommended general informants who were considered to know the existence of these UFTs and were willing to get in-depth interviews. The characteristics of general informants are presented in Table 2. This table shows that 58% of general informants were elderly, and 32% and 11% were young and middle-aged, respectively. Most general informants were males (68%), and the rest were females (32%). They work as farmers, laborers, and housewives with percentages of 68%, 5%, and 26%, respectively. A total of 74% of the general informants had education up to elementary school, 21% did not go to school, and 5% were educated up to junior secondary school.

The local knowledge of UFTs

Furthermore, to obtain data about the local knowledge of UFTs in Urug Village, the general informants were asked about the known species of fruit trees. They also questioned the species of fruit trees classified as UFTs, the utilization of UFTs, why UFTs are rarely consumed, where UFTs are usually found, the utilization of UFTs, and the sources of information on the UFTs utilization (Figure 2).

Table 1. The characteristics of the key informant

Characteristic	Group	Key informants	
		No. of informants	Percentage (%)
Age group (years old)	Young (18-36)	0	0
	Middle-aged (37-55)	11	69
	Elderly (≥56)	5	31
Gender	Male	16	100
	Female	0	0
Occupation	Farmer	16	100
	Labourer	0	0
	Housewife	0	0
Education	No schooling	0	0
	Primary School	15	94
	Junior Secondary School	0	0
	Senior Secondary School	1	6

Table 2. The characteristics of general informants

Characteristic	Group	General informants	
		No. of informants	Percentage (%)
Age group (years old)	Young (18-36)	6	32
	Middle-aged (37-55)	2	11
	Elderly (≥56)	11	58
Gender	Male	13	68
	Female	6	32
Occupation	Farmer	13	68
	Labourer	1	5
	Housewife	5	26
Education	No schooling	4	21
	Primary School	14	74
	Junior Secondary School	1	5
	Senior Secondary School	1	6

Based on Figure 2, all general informants know the fruit trees species found in Urug Village, such as *Bouea macrophylla* (Jatake), *Mangifera foetida* (Limus), *Metroxylon sagu* (Langoko), and *Passiflora foetida* (Ki Leuleu'eur). They also know the fruit tree species that belong to UFT, although not all UFTs can be found in Urug Village anymore. Like, *Antidesma bunius* (Huni), *Baccaurea racemose* (Menteng), *Bouea macrophylla* (Jatake), *Castanopsis argentea* (Saninten), *Garcinia parviflora* (Ceuri), *Lansium domesticum* (Kokosan), *Passiflora foetida* (Ki Leuleu'eur), *Sandoricum koetjape* (Kecapi), *Syzygium polycephaloides* (Kupa Beunyeur), *Syzygium polycephalum* (Kupa Gowok) (Table 3). The general informants said that UFTs are rarely consumed because of their sour taste and are usually found in forbidden forests. A total of 59% of UFTs are mostly used as food, 21% are used as medicine, 17% are used as a building material, and 3% are used as a natural dye for *kaneron* bags (traditional bags for Sundanese). Information about the use of UFT is obtained by the indigenous peoples from parents (90%), television (5%), and doctors (5%). The documentation during the in-depth interview is presented on Figure 3.

After getting the information on UFT species, the researchers conducted field observations to find the existence of UFTs, and determine the location and coordinates point of where UFTs grow. The field observation conducted in several locations based on the information of indigenous people where UFTs grow is shown in Figure 4.

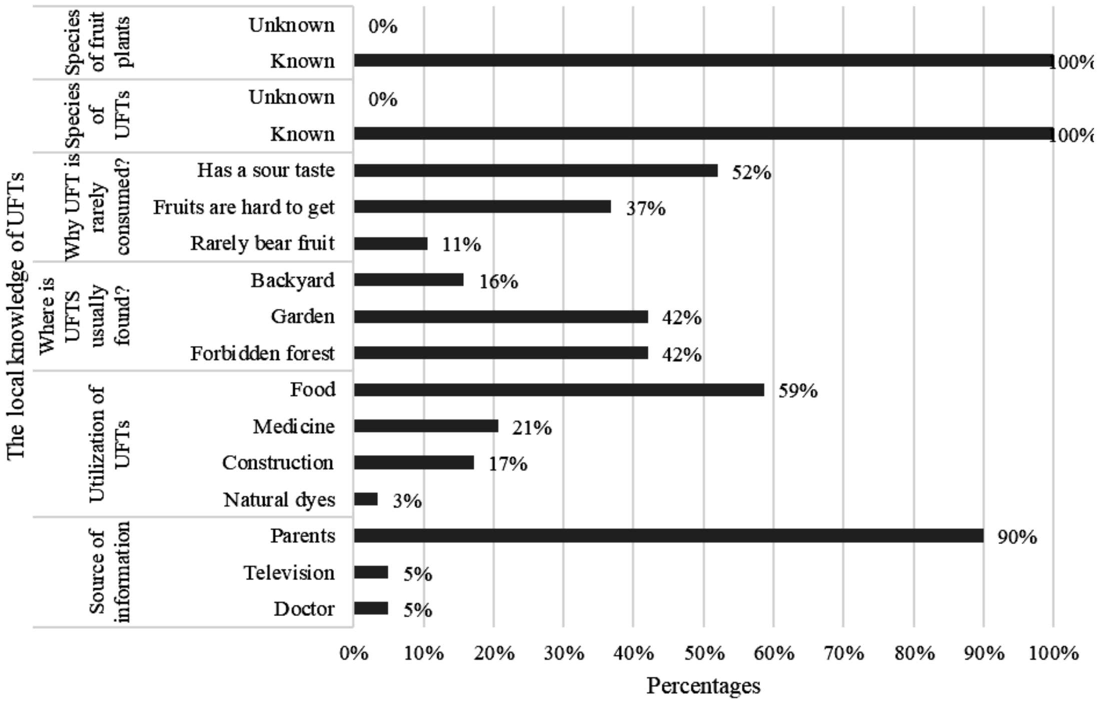

Figure 2. The aspect of human resources

Figure 3. In-depth interview with general informants in Urug Village, Bogor District, West Java, Indonesia

Figure 4 shows that there are 24 placemarks where UFTs are found. Placemarks are place markers to make it easier for researchers to remember the coordinates point of a location. Placemarks 1, 2, 3, 4, 5, and 14 are cemetery areas; placemarks 7, 8, 9, 10, 11, 12, 13, 15, and 18 are backyards; placemarks 6, 17, and 24 are mixed gardens; placemarks 16, 19, 20, 21, 22, and 23 are forbidden forests. Most UFTs were found in the backyard, and each 23% were found in cemetery areas and forbidden forests. Based on Figure 4, the researchers can analyze where the coordinates (latitude and longitude) of UFTs are growing. The detailed location and the coordinates are presented in Table 3.

Table 3 shows that 53 individuals of UFTs from 13 species were found during field observations. After obtaining the coordinates point of where UFTs grow, the researchers analyzed whether UFTs grow in locations with high or low vegetation density. Locations with low vegetation density can cause the soil surface to become infertile. The litter, such as leaves, twigs, small branches, bark, flowers, and fruit which play an important role on increasing the soil's nutrient content is gone. High litter can increase plant productivity because it provides many nutrients for plants. The amount of litter is strongly influenced by the density of vegetation (Bahru and Ding 2020). In addition, low vegetation or non-vegetation index can result in habitat fragmentation, thereby changing the ecological cycle of a system.

This analysis was carried out Landsat 8 satellite imagery specifically for the Operational Land Imager (OLI) sensor provided by the United States Geological Survey (USGS) on the website www.usgs.gov. The analysis was performed using the Normalized Difference Vegetation Index (NDVI) method. The result of the NDVI analysis is shown in Figure 5. It shows that 38% of UFTs were found in areas with low vegetation index and 62% in areas with moderate vegetation index. UFTs that grow in locations with low vegetation index are *Antidesma bunius, Lansium domesticum, Mangifera indica, Mangifera laurina, Phyllanthus acidus, Sandoricum koetjape*, and *Syzygium polycephalum*. Meanwhile, other UFTs species grow in locations with moderate vegetation.

The cultivation technique of UFTs by indigenous people in Urug Village

Indigenous people in Urug Village cultivate UFTs starting from fruit tree selection (*pilihan bibit tatangkalan*), preparing the planting site (*nyiapkeun taneuh*), planting the tree (*melak tatangkalan*), caring of the fruit trees (*ngurus tatangkalan*), harvesting (*panen*), and post-harvest handling (*perawatan sanggeus panén*), as presented below.

Fruit tree selection

The indigenous people in Urug Village obtain fruit tree seeds from various sources, such as forests, rice fields, self-grafting, exchanging fruit tree seeds with neighbors, or seeds collected after eating the fruit. If they get tree seeds from the forest or rice fields, there is a special way to take them so they can grow fast when transferred to the garden. The seeds must be taken along with the soil ball they grow, and the soil should be planted in the garden. According to their belief, the fruit trees and the soil where they first grow have a strong bond, so if they are separated, they will die.

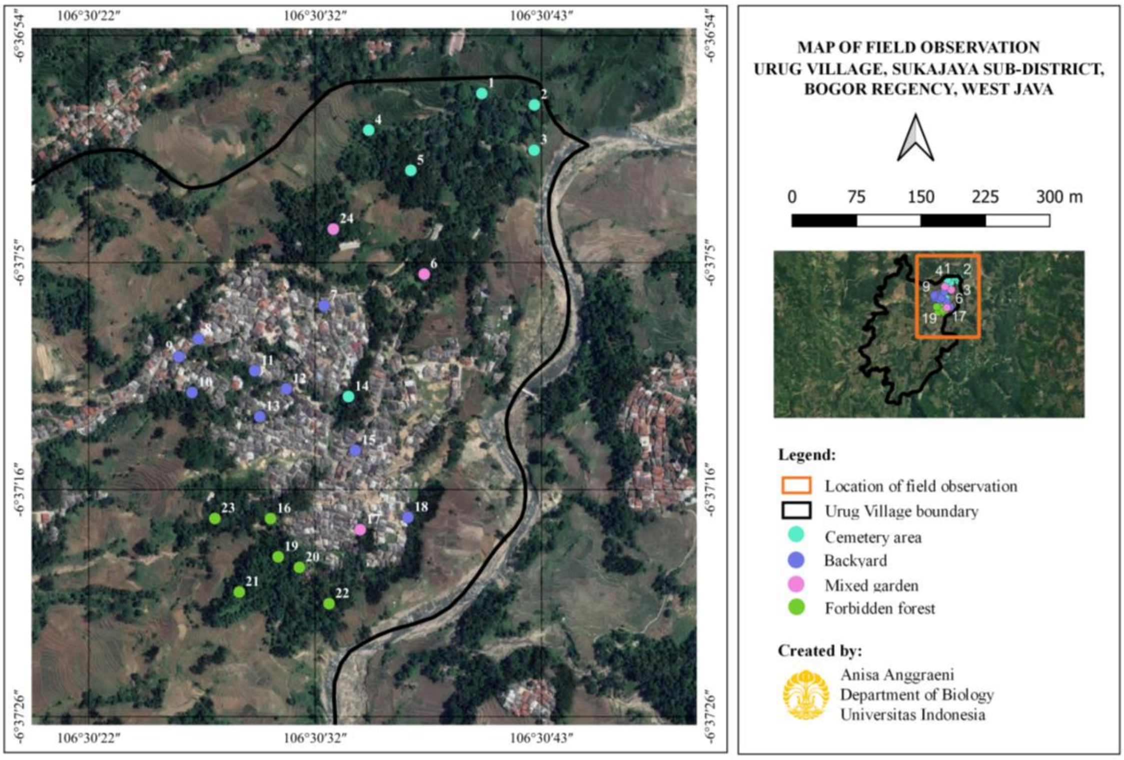

Figure 4. Map of field observation in Urug Village, Bogor District, West Java, Indonesia

Table 3. The data of UFT species found in Urug Village, Bogor District, West Java, Indonesia

Family name	Scientific name	Common name	UFTs		Location	Latitude and Longitude	Freq.
			I*	O			
Phyllanthaceae	*Antidesma bunius*	Huni	√	√	Placemark 7 (Backyard)	6°37'6.85"S; 106°30'32.82"E	1
Moraceae	*Artocarpus elasticus*	Teureup		√	Placemark 3 (Cemetery area)	6°36'59.45"S; 106°30'42.85"E	1
					Placemark 4 (Rice field)	6°36'58.5"S; 106°30'34.96"E	1
					Placemark 10 (Backyard)	6°37'10.97"S; 106°30'26.53"E	1
					Placemark 23 (Forbidden forest)	6°37'16.97"S; 106°30'27.62"E	1
Phyllanthaceae	*Baccaurea racemose*	Menteng	√				
Anacardiaceae	*Bouea macrophylla*	Jatake	√				
Fagaceae	*Castanopsis argentea*	Saninten	√	√	Placemark 1(Cemetery area)	6°36'56.75"S; 106°30'40.35"E	1
					Placemark 19 (Forbidden forest)	6°37'18.79"S; 106°30'30.64"E	1
					Placemark 20 (Forbidden forest)	6°37'19.29"S; 106°30'31.65"E	1
Moraceae	*Ficus variegate*	Loa/ Kondang		√	Placemark 8 (Backyard)	6°37'8.44"S; 106°30'26.83"E	1
Clusiaceae	*Garcinia parviflora*	Ceuri	√				
Meliaceae	*Lansium domesticum* Corrêa 'pisitan-kokosan group'	Kokosan	√	√	Placemark 8 (Backyard)	6°37'8.44"S; 106°30'26.83"E	1
					Placemark 11 (Backyard)	6°37'9.94"S; 106°30'29.52"E	1
					Placemark 14 (Cemetery area)	6°37'11.17"S; 106°30'33.99"E	1
					Placemark 17 (Mixed garden)	6°37'17.5"S; 106°30'34.55"E	1
Meliaceae	*Lansium domesticum* Corrêa 'pisitan-kokosan group'	Pisitan		√	Placemark 7 (Backyard)	6°37'6.85"S; 106°30'32.82"E	2
Anacardiaceae	*Mangifera indica*	Mangga Cupu		√	Placemark 15 (Backyard)	6°37'13.73"S; 106°30'34.32"E	1
Anacardiaceae	*Mangifera kemanga*	Kemang		√	Placemark 1 (Cemetery area)	6°36'56.75"S; 106°30'40.35"E	2
					Placemark 4 (Rice field)	6°36'58.5"S; 106°30'34.96"E	1
					Placemark 16 (Forbidden forest)	6°37'16.98"S; 106°30'30.27"E	2
Anacardiaceae	*Mangifera laurina*	Mangga Pari		√	Placemark 7 (Backyard)	6°37'6.85"S; 106°30'32.82"E	1
					Placemark 12 (Backyard)	6°37'10.8"S; 106°30'31.03"E	1
Passifloraceae	*Passiflora foetida*	Ki Leuleu'eur	√				
Phyllanthaceae	*Phyllanthus acidus*	Ceremai		√	Placemark 9 (Backyard)	6°37'9.28"S; 106°30'25.9"E	2
					Placemark 13 (Backyard)	6°37'12.13"S; 106°30'29.76"E	1
Meliaceae	*Sandoricum koetjape*	Kecapi	√	√	Placemark 3 (Cemetery area)	6°36'59.45"S; 106°30'42.85"E	1
					Placemark 4 (Rice filed)	6°36'58.5"S; 106°30'34.96"E	3
					Placemark 7 (Backyard)	6°37'6.85"S; 106°30'32.82"E	1
					Placemark 11 (Backyard)	6°37'9.94"S; 106°30'29.52"E	1
					Placemark 16 (Forbidden forest)	6°37'16.98"S; 106°30'30.27"E	3
					Placemark 18 (Backyard)	6°37'16.92"S; 106°30'36.83"E	1
					Placemark 19 (Forbidden forest)	6°37'18.79"S; 106°30'30.64"E	1
					Placemark 21 (Forbidden forest)	6°37'20.47"S; 106°30'28.78"E	1
					Placemark 22 (Forbidden forest)	6°37'21.02"S; 106°30'33.06"E	1
					Placemark 24 (Mix garden)	6°37'3.21"S; 106°30'33.27"E	2

Myrtaceae	*Syzygium polycephaloides*	Kupa Beunyeur	√				
Myrtaceae	*Syzygium polycephalum*	Kupa Gowok	√	√	Placemark 6 (Mixed garden)	6°37'5.35"S; 106°30'37.6"E	1
					Placemark 7 (Backyard)	6°37'6.85"S; 106°30'32.82"E	1
					Placemark 17 (Mixed garden)	6°37'17.5"S; 106°30'34.55"E	1
Myrtaceae	*Syzygium pycnanthum*	Kopo		√	Placemark 1 (Cemetery area)	6°36'56.75"S; 106°30'40.35"E	1
					Placemark 2 (Cemetery area)	6°36'57.3"S; 106°30'42.86"E	1
					Placemark 3 (Cemetery area)	6°36'59.45"S; 106°30'42.85"E	1
					Placemark 5 (Cemetery area)	6°37'0.41"S; 106°30'36.97"E	3
					Placemark 10 (Backyard)	6°37'10.97"S; 106°30'26.53"E	2
					Placemark 19 (Forbidden forest)	6°37'18.79"S; 106°30'30.64"E	1

Note: *) I = Recorded during the in-depth interviews; O = Recorded during the field observation

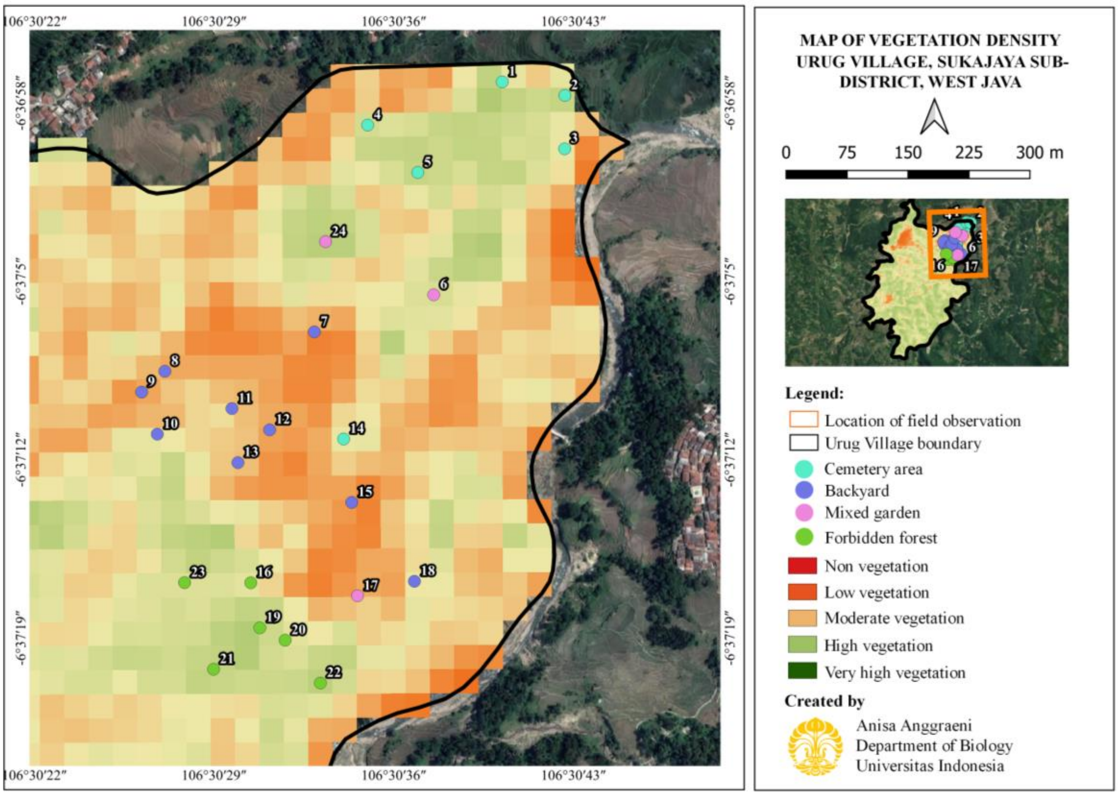

Figure 5. The vegetation density of Urug Village, Bogor District, West Java, Indonesia

Fruit tree collection from forest or rice fields without damaging the soil ball is considered to help reduce the root system's transfer tree shock and increase the tree's stability, so it does not collapse. However, Burcer et al. (2020) stated that disturbing the root ball is needed to maximize the survival of a newly planted tree. Disturbing the root ball can help to remove the clay soil that makes the tree too heavy in the first place and stimulate the growth and development of new roots that will enhance tree establishment in the landscape.

After getting seeds, the indigenous people choose a good day to plant them and pray to God. According to Syukur et al. (2019), determining a good day for planting is a form of effort to be given safety by God. In addition, the determination of an auspicious day for planting is a legacy from the ancestors. Therefore, these must be followed because it has proven successful. There are different opinions about determining a good day, as you should ask the elders (*Abah*) first. Planting fruit trees should follow your birthday or counting a good day is based on the Javanese calendar. On the Javanese calendar, planting fruit trees should be done on the 3rd day of the Javanese calendar (Month of Sura), so the trees produce a lot of fruit.

Several indigenous people said the good days are Monday, Wednesday, Thursday, and Friday, but others said planting fruit trees on Wednesday will only make the trees have dense leaves without bearing fruit. Abah Maman, as one of the general informants, has a unique experience determining a good day for fruit tree cultivation. He said,"If you plant a tree to harvest its flowers, you should plant it on Monday. If you want to plant a tree to harvest the water, you must plant it on Friday. If you want to plant a tree to harvest its fruit, you must plant it on Saturday." Based on the results of this interview, it is known that there are no standard rules in determining a good day to plant trees. The determination of a good day to plant is based on the beliefs of each indigenous person.

Preparing the planting site

After determining a good day to plant, the indigenous peoples determine where the fruit trees will be planted. Fruit trees should not be planted in the rice fields because fruit trees have large sizes, so they can make the rice fields shady. As a result, the rice fields do not get enough sunlight, and rice growth is stunted. In addition, the indigenous people in Urug Village said that planting fruit trees in the rice fields can invite birds to come, harming the rice. Fruit trees should not be planted in the backyard because their fruits can fall and become harmful when they grow. Instead, fruit trees should be planted in gardens far from the settlements. The results of interviews with farmers in northern Thailand also show the same opinion. Farmers believe rice covered by a canopy of fruit trees, such as a mango tree, has more stunted growth than rice in the open area. Planting trees on levees influence rice growth, but the effect depends on the tree species planted, rice species, and field conditions. The decrease in the yield of rice grown under tree canopies is usually caused by the smaller number of spikelets produced per unit area, rice lodging, and post-delay rice (Miyagawa et al. 2017).

Then, the indigenous people will identify the root types of fruit trees to be planted. If the tree has roots that grow to the side (fiber roots), the hole size for planting is wide to the side, but if the tree has roots that grow into the earth (tap roots), the hole size for planting is made long into the ground. The size of the planting hole depends on the size of the seed. But the main rule is that the planting hole should accommodate the size of the ball root (Figure 6a). Haque and Sakimin (2022) asserted that the planting hole is at least twice as wide as the spread of the tree's roots to accommodate the root system after the roots are spread out. Making a planting hole with the right size can help the tree to break up the soil, so there is plenty of space between the lumps of soil for the roots to grow. In addition, the gaps in the soil can also help water and oxygen enter the soil and be absorbed by the roots (Burcer et al. 2020). Therefore, identifying the root types of fruit trees before planting, like what the indigenous people do in Urug Villages, is very important, so the growth of these fruit trees is not hampered.

Planting the tree

After the planting hole is completed, the indigenous people will plant the fruit trees and fill the hole with manure fertilizer mixed with soil. The ratio between fertilizer and soil is 1:1. Also, the indigenous people in Urug Village said some roots should be left slightly visible at the soil surface. Those believed making fruit trees easier to breathe and not being planted against the sun (facing east) (Figure 6b). Plant roots that must be positioned close to the soil surface are lateral because they expand the roots reach to absorb the minerals and water needed by plants (Muller et al. 2019). Meanwhile, the part of the tree that should not be exposed to direct sunlight is the node. If exposed to the sun, it will burn, and the tree will die. Besides, the soil to fill the planting hole is the same soil that comes out of the hole because the best soil to fill the planting holes is the same dig out the soil and add fertilizer without additional materials (Martin et al. 2021).

Caring for fruit trees

After planting the fruit trees, the next step is to take care of the fruit trees by fertilizing and controlling pests. Fertilization usually uses ash from burning dry bamboo leaves and animal manure derived from sheep or chickens. The dried bamboo leaves are burned first, and the ashes are sprinkled around the fruit trees. The bamboo ashes are left to decompose to stop them from inhibiting tree growth if directly used as fertilizer because they contain a high C/N ratio. Therefore, bamboo leaves must be treated first before being used as fertilizer (Luo et al. 2017). Following the findings of Aderounmu et al. (2021), who researched the effect of charred bamboo, its ash showed that it has a significant effect on *Entandrophragma angolense* growth. Bamboo leaves ash is a soil conditioner that can increase soil porosity, water holding capacity, acidity, conductivity, chloride, and other important soil minerals needed by fruit trees.

The indigenous people also use sheep and chicken manure as fertilizer. In the indigenous people's opinion, manure derived from sheep can provide better results than chicken manure. Before being used, manure must be mixed with soil. The ratio between soil and manure is 2:1. Following the findings of Osama et al. (2017), who studied the effect of sheep manure on the growth of *Psidium guajava* from the family Myrtaceae, increasing sheep manure as fertilizer can improve tree growth, leaf mineral content, fruit properties, and fruit quality. However, the results of Gomaa's (2020) research on increasing the productivity of *Psidium guajava* trees show that combining chicken manure, compost, and farmyard could give better results than just one fertilizer. Therefore, the use of manure for fruit trees still requires further research because tree growth is not only influenced by fertilizers but also by other external factors such as soil type, climate, and geographical conditions of an area. Meanwhile, for pest control, the indigenous people use table salt. Research about the effect of tree materials and table salt against *Zabrotes subfasciatus* on *Pisum sativum* L. grain shows that tree materials and table salt can be used as pest control (Zekarias and Haile 2017).

Some fruit trees planted in the backyard are usually not given special fertilizers, as described in the previous paragraph. An example is the *Phyllanthus acidus* (Ceremai) planted in Mr. Nurah's backyard. This tree is planted next to a chicken coop so the chicken manure directly falls to the ground and can be used as fertilizer for the *Phyllanthus acidus*. Besides Mr. Nurah's yard, the same type of yard is also found in Mr. Lapi's backyard. He grows *Lansium domesticum* in his backyard, which is close to a chicken coop. An illustration of the types of backyards found in Urug Village is presented in Figure 7.

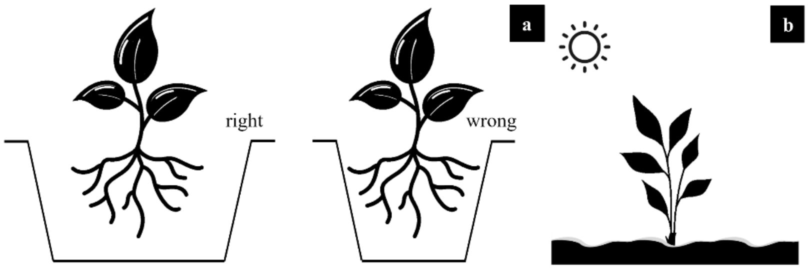

Figure 6. (A) Planting hole should accommodate the size of the ball root; (B) The fruit tree doesn't face the sun

Figure 7. An illustration of the types of backyards in Urug Village, Bogor District, West Java, Indonesia

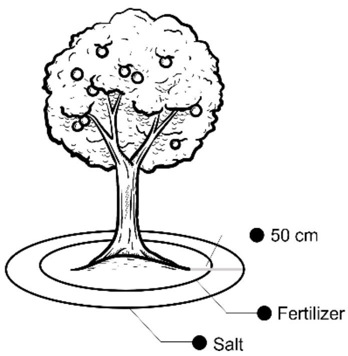

Figure 8. An illustration of controlling pests using table salt

Besides fertilization, the indigenous people control pests that interfere with fruit trees. If there are pests that interfere, usually, the indigenous people use table salt to control them. According to Rathore et al. (2021), Indian Hill Farmers in Uttarakhand, India, also uses salt as much as 1 kg/200 m^2 to control white grub, slugs, and beetles. Table salt is sprinkled around the fruit tree at a distance of about 50 cm from the fruit tree, as shown in Figure 8. The tree will die if the distance between the table salt and the tree is too close. Table salt can cause the tree to burn the shoots, leaves, and small twigs, dry out bud scales, and expose the soft tissues of developing leaves and flowers. Therefore, using table salt as pest control should not be too close to trees and mixed with other materials, such as ash or sand. However, some indigenous people do not control these pests because pests are God's creatures with the right to live. They believe pests are created for a specific purpose, so they have special benefits for the environment, especially fruit trees. Their belief is a form of conservation by maintaining species and genetic diversity (Suwardi et al. 2020).

If a tree does not bear fruit, the indigenous people will take several ways to be fruitful. *First*, every Friday when the call to prayer is sounded, the stems of the trees are slashed using a machete seven times (scoring) and given the threat, "if you don't want to bear fruit, then I will cut you down". Scoring obstructs phloem transport and increases the availability of metabolites for developing organs around the scoring site. Simple scoring is effective in increasing fruit size. This method is easy, fast, and effective for older wood (Fallahi et al. 2020). *Second*, every 17^{th} day, the leaves of the fruit trees are cut (pruning). Pruning can be conducted before or after the tree bears fruit, depending on the final result desired by the researcher. Pruning makes the plant obtain enough sunlight and good air circulation. Plants need a minimum of 6 hours of direct sunlight per day. Flowering and fruit formation will be hampered if sunlight is less than 6 hours per day. In addition, pruning can also help distribute secondary metabolites evenly throughout the plant stem and reduce the potential for disease in plants (Zhang et al. 2018). *Third*, on Eid al-Adha days, the blood of the sacrificial animal, especially goats is rubbed on the fruit tree's trunk. The utilization of sacrifice blood as fertilizer is often used as a dry powder known as a blood meal. Blood contains high levels of N, P, and K minerals, it can be used as a bio-activator to make compost or a mixture of chemical fertilizers (Jastrzebska et al. 2022). The results of Momtaz et al. (2021) research on the use of blood meal to increase onion production in Bangladesh showed that using blood meal mixed with urea fertilizer can increase onion production and provide economic and environmental benefits. *Fourth*, the fruit tree is mortgaged to someone else. Mortgage agreements are made under the tree. Usually, the tree is mortgaged for IDR 2,000. When the tree bears fruit, the owner of the tree can redeem the fruit tree. The tree redemption agreement is also carried out under the tree. *Fifth*, the fruit tree's trunk is tied with a rope often used to tie goats or sheep. If not available, the fruit tree can also be tied using reeds. *Sixth*, the tree trunk is rubbed using golden apple snail eggs. Golden apple snail eggs contain calcium, sodium, and phosphorus, which are needed for plant growth (Ghada et al. 2019). They got this information from their parents.

The indigenous people can directly harvest fruitful trees. Before harvesting, several indigenous people ask the elder (*Abah*) when it is a good day to harvest the fruit. However, some indigenous people directly harvest without specifying a good day. The fruits will generally be eaten by themselves or distributed to neighbors. The fruits can be eaten directly without being processed, but some fruit, such as *Phyllanthus acidus* (Ceremai), will be processed into rujak (Figure 9). *Phyllanthus acidus* (Ceremai) is much preferred by pregnant women because it has a sour taste.

The institutional aspect examines the central and local government's role in introducing these fruit trees. Based on the in-depth interview results, there has never been an activity from the government to introduce the species of fruit trees, especially UFTs. The aspect of regulations examines the customary regulations about environmental management and fruit tree conservation, especially UFTs. According to the indigenous people, they are prohibited from cutting fruit trees in the forbidden forest because fruits are food for animals living there. If fruit trees are cut down, fruit-eating animals can disturb their settlements.

Figure 9. *Phyllanthus acidus*: tree (left) and fruit (right)

The last aspect is community participation which examines indigenous people's participation in conserving fruit trees, especially UFTs in Urug Village. They have participated in preserving UFTs by not cutting down UFTs that grow in forbidden forests, such as *Castanopsis argentea* (Saninten), and planting UFTs such as *Sandoricum koetjape* (Kecapi) and *Phyllanthus acidus* (Ceremai) in their mixed gardens or backyards.

The challenges of UFTs cultivation in Urug Village

The results of this study indicate that the indigenous people in Urug Village have local knowledge about the types of fruit trees classified as UFTs and the methods for cultivating them. However, the local knowledge still needs to be studied more deeply through scientific research to be used as a fruit tree conservation method, especially for UFTs. UFTs have great potential to be developed because they contain high nutritional value. In addition, UFTs are one of the sources for increasing food security through fruit diversification programs, increasing the economy and people's welfare, food sources for birds, encouraging the creation of ecological balance, and playing an important role in cultural diversity such as traditional ceremonies (Nandal et al. 2014; Santosa et al. 2021).

There are several challenges to UFTs cultivation in Urug Village: (i) changes in fruit consumption patterns, (ii) degradation of local knowledge, (iii) lack of information about nutritional and vitamin content of UFTs, (iv) land use change, (v) climate change, and (vi) the low involvement of both central and regional governments in conserving UFTs. Therefore, two actions can be used to face this issue:

Changing the perception

The consumption behavior was changed because consumers didn't have enough information that UFTs have high nutrition and vitamin. According to Nandal et al. (2014), UFTs are rich in sources of carbohydrates, fats, proteins, energy, and vitamins to prevent and cure various diseases such as anemia, diabetes, and cancer. The first thing to do is change their perception of UFTs by increasing public awareness through mass media, campaigns, and exhibitions; disseminating programs; and increasing the promotion frequency and commercialization of UFTs (Dahanayake 2015). Promotion and commercialization not only help consumers meet their daily needs of nutrition and minerals but also empower indigenous people to cultivate UFTs, improve their household livelihoods, and increase the diversification of food production (Mondo et al. 2021). Those also could preserve the diversity of UFTs (Kour et al. 2018). A total of 31% UFTs found in Urug Village have a least concern status, 8% have an endangered status, and the others have unknown conservation status.

Policymakers do not have enough documentation that UFTs could be a source of nutrition to encourage food and economic security. UFTs are sources of sustainable income for indigenous people because UFTs produce roots, leaves, and fruits with high economic value in the market. The policymaker's role is to integrate research results from researchers with various government strategies, as stated in the Indonesia Biodiversity Strategy and Action Plan (IBSAP). That includes developing policies about incentives, felicitation, and monetary support for people involved in cultivating UFTs (Meena 2022); and providing high-quality seeds of UFTs. The seeds of UFTs in Urug Village were acquired through seed exchange/ swap among indigenous people, rice filed, or forests. So, it is necessary to provide evidence for policymakers that UFTs can provide many benefits for humans and the environment by establishing databases and repositories of UFTs (Padulosi et al. 2013).

Enhancing the amount of research on UFTs

The authors have documented the cultivation technique of UFTs by indigenous people in Urug Village and analyzed the vegetation density where UFTs grow. Unfortunately, 38% of UFTs in Urug Village were found in locations with low vegetation density. The vegetation in Urug Village decreases yearly because many trees have been cut down to be sold or used as building materials, and changed in land use. Moreover, the next generation doesn't plant those trees (degradation of local knowledge), and the trees fall during a natural disaster, i.e., flood and landslide caused by climate change. So, further research on adaptation and disaster mitigation strategies due to climate change in Urug Village can be important to preserve the diversity of UFT, considering that Urug Village is located in a disaster-prone area. According to Toppo and Raj (2018), agroforestry plays a viable option in adaptation and disaster mitigation strategies. Agroforestry as an integrated land use system is proven to reduce the problem of biodiversity loss due to climate change (Mulatu and Hunde 2019). Agroforestry systems such as *taungya, pekarangan, talun,* and *simpukng* are closely related to the role of indigenous people in preserving nature and have been widely practiced in Indonesia. Therefore, planting UFTs in agroforestry systems is expected to help reduce the loss of UFTs genetic resources when natural disasters occur due to climate change. In addition, agroforestry is considered to be able to increase tree productivity and open up economic opportunities, promote food security (Ravindran et al. 2021), improve chemical soil conditions, provide social benefits, increase the value of biodiversity, and contribute to carbon sequestration (Noldeke et al. 2021). Most of the indigenous people in Urug Village have extensive mixed gardens, and there is enough labor in Urug Village that can be optimized to realize agroforestry systems. In this study, the authors only made field observations in 3 mixed gardens, as shown in Figure 4. It is due to the steep road to the mixed garden owned by indigenous people. So, the authors were not allowed to conduct a field observation. The author only obtained information on the area of mixed gardens owned by indigenous peoples from in-depth interviews. Besides climate change, this research still needs reinforcement of cultivation techniques through standardization of cultivation practices (Kour et al. 2018) and improvement to obtain data on the utilization of bamboo leaf ash as fertilizer and the utilization of salt as indigenous pest management practices in Urug Village. The ecological effect of salt as a pesticide is influenced by the range of sensitivities among community members and community structure (Rathore et al. 2021). Other research about the uses, socio-economic roles, nutritional and vitamin content, and underutilized factors of UFTs would be necessary to face the challenge of cultivating UFTs (Kamboj et al. 2021; Mondo et al. 2021), especially in Urug Village.

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