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Species Composition, Utilization and Conservation Status of Plant Species in Gmelina arborea Agroforestry System in Boalemo Regency

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ABSTRACT

Agroforestry is a land-use system that integrates trees, crops, and livestock to improve sustainability and resilience in agricultural practices. This research aimed to determine the composition of plant species in the White Teak Agroforestry, the utilization of plants and the conservation status of plant species in the White Teak agroforestry system. Quantitative approach was applied with plant data collection carried out by tracing the research location and observing all existing plant species accompanied by taking pictures using a digital camera. The results of the study indicate that the agroforestry system has significant potential in supporting environmental sustainability and community welfare. The results revealed there were 33 plant species found in the agroforestry, 23 of them were plants that distributed across various regions in Indonesia and 14 are classified as Least Concern by the IUCN Red List.

Keyword: Plant Species Composition, Agroforestry

1. INTRODUCTION

World climate change has become an important issue for every country. Irregular climate, increasingly hot temperatures, energy and food crises are a threat to every country (Georgopoulou et al., 2024; Parimita & Ulfatun, 2023). Global warming causes climate change which is influenced by the concentration of greenhouse gases (GHG) in the atmosphere (Bhatti et al., 2024; Fella Suffa, 2020; Filonchyk et al., 2024). Indonesia is highly vulnerable to the impacts of global warming, climate change and catastrophic events. As a tropical country, Indonesia is famous for its highly biodiverse forests (Nugroho et al., 2023). However, Indonesia is also one of the world's largest emitters of greenhouse gases (GHG) that impact global warming, climate change and catastrophic events that are immediately visible such as high sea levels, extreme weather, floods, landslides, and air pollution (Dianita & Saputra, 2016; Filonchyk et al., 2024).

The existence of forests is increasingly alarming due to forest degradation and deforestation. Forest destruction and land conversion are the main sources of increased carbon emissions (Liu et al., 2024; Mariana, n.d.; Maxwell et al., 2019). Trees that are supposed to absorb carbon dioxide in the air are limited due to decreasing land cover (Indra et al., 2022).

Human activities are the reason for land conversion. Almost all land in Indonesia, which was originally in the form of natural forests, has been gradually converted by humans into various other forms

of land use such as settlements, yards, agriculture, plantations, production forests or industrial plants and others. Many programs have been carried out by the government to overcome or minimize the impact of land conversion, one of which is through the social forestry program, namely regarding wise management of forest areas through agroforestry systems of land management that combine agricultural crops and plantation crops. Agroforestry is a land use system that integrates trees, crops, and livestock to enhance sustainability and resilience in agricultural practices. This approach not only promotes biodiversity and nutrient cycling but also provides economic, ecological, and social benefits, making it an important strategy for climate adaptation and mitigation (Gassner & Dobie, 2022; Gómez et al., 2022; Raskin & Osborn, 2019). The purpose of agroforestry is to integrate annual crops, seasonal crops, and livestock to increase income, protect the environment, and support sustainable resource management by maintaining soil fertility, biodiversity, and food security. The principle of agroforestry system is that components such as trees, agricultural crops, and livestock are integrating with each other to utilize resources optimally and sustainably (Astuti et al., 2023; Fikry & Sarjan, 2024).

2. RESEARCH METHOD

This research was conducted for approximately three calendar months from June to September 2024 in the White Teak agroforestry area, Boalemo Regency, Gorontalo Province.

This research used a quantitative approach, which is research that uses certain populations or samples, uses research instruments for data collection and applies quantitative or statistical data analysis with the aim of testing predetermined hypotheses. The method used in this study was survey method (Sugiyono, 2011).

Plant data collection was carried out by tracing the research location and observing all existing plant species accompanied by taking pictures using a digital camera. Furthermore, additional information was recorded in the form of the collector's name, collection number, collection date, location, and habitus recorded in the observation sheet that had been prepared by referring to the *Royal Botanical Garden Field work*. The identification of higher plants was carried out by observing the morphological characteristics of plants that include special characteristics in each class and family or genus to the species level and then compared with the Sulawesi Flora book by Pitopang, Khaeruddin, Tjoa, and Burhanuddin (2008), Harris and Harris (2001) and Flora for Indonesia (Steenis, 2008). Meanwhile, the identification of ferns was done by comparing the morphological characteristics of ferns using the book *Additions to The Fern Flora of Sulawesi. Blumea: Biodiversity, Evolution and Biogeography of Plants* (Hovenkamp, & Joncheere, 1988). Validation of accepted name and distribution of habitats and populations of each plant species were conducted by using the Plants of the World Online (2024) website (https://powo.science.kew.org/). The identification results were then analyzed descriptively, qualitatively, and their conservation status was determined based on the IUCN website (http://www.iucnredlist.org) (IUCN, 2024).

Sampling of agroforestry plant composition was done by measurement plots. The measurement plots were determined by using purposive sampling method, which is carrying out field observations in advance with the aim to find out and determine the mixed gardens that were later established as measuring plots.

3. RESULTS AND ANALYSIS

White Teak Agroforestry is an agroforestry area dominated by *Gmelina arborea* Roxb. ex Sm. plants, which are referred to by local community as Jati Putih (White Teak). The results of the exploration in the White Teak Agroforestry area show that there were 33 plant species and 23 of them, according to Powo (2024) are plants that have a distribution across various regions in Indonesia including Sumatra, Java, Kalimantan, Sulawesi, Sunda Islands, Maluku, and Papua. Table 1 shows that the Dioscorea genus was the most commonly found genus. There were 3 species found, namely *Dioscorea esculenta, Dioscorea hispida*, and *Dioscorea villosa*.

Table 1 also provides information that Asteraceae, Dioscoreaceae, and Lamiaceae are families that are commonly found in White Teak Agroforestry. Therefore, plant species found in this area were dominated by herbaceous and shrub strata, most of which belong to the Asteraceae and Lamiaceae families. However, plant species with tree strata, tree saplings, vines and pioneer plants were also found in small numbers in the White Teak Agroforestry area.

Table 1. Description of Plant Species found in *Gmelina arborea* Agroforestry

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
1.	*Gmelina arborea* Roxb. ex Sm.	Jati Putih	Lamiaceae	Cylindrical stem with yellowish-white scaly bark. The leaves are pinnately compound and oval, dark green on the upper surface and paler on the lower side.	White teak wood is used as a building material, furniture making, handicrafts, reforestation. The bark, leaves, and roots are used as traditional medicine to treat fever, diarrhea, and skin problems.	
2.	*Piper aduncum* L.	Kayu sirih	Piperaceae	Cylindrical stem with young stems that have fine hairs. The leaves are oblong-shaped with a smooth surface and fine hairs on the lower side	Betel wood is used to treat skin diseases such as eczema and scabies. It has anti-inflammatory properties that help relieve inflammation. Some parts of the plant can be used as natural dyes.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
3.	*Thelypteris pennigera* (G.Forst.) Allan	Pakis tanah	Aspleniaceae	The stem is cylindrical with fine hairs, the color of the stem is greenish brown. The leaves are doubly pinnate, bright green and on the lower surface there are spores.	People use it as an ornamental plant and for its ecological function.	
4.	*Lycopodium digitatum* Dill. ex A.Braun	Lumut Kipas	Lycopodiaceae	The stem grows spreading and branching like a pine or fan. The roots grow from the stem and spread over the terrestrial. The leaves are small like green scales.	This moss plays an important role in the process of ecological succession in nature. In addition, the spores have been used as ingredients to make flammable powder since ancient times.	
5.	*Blumea* sp.	-	Asteraceae	The stem is green and hairy. The leaves are oblong with pinnate veins, green in color and have a rough surface because there are hairs with serrated leaf edges.	Generally, plants within this genus have benefits as herbal medicines to treat wounds and cuts, rheumatism, anti- diarrhea, anti-spam, colds and coughs.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
6.	*Lygodium circinnatum* (Burm.f.) Sw.	Paku Hata	Schizaeaceae	The stem is hairless, slender and flexible in the form of tendrils so that it can spread. Leaves are lanceolate, pinnate with serrated leaf edges.	Used as ornamental plants and traditional medicine to treat wounds, inflammation, and skin problems. In addition, it is also used as a material for making woven and traditional house roofs.	
7.	*Dioscorea esculenta* (Lour.) Burkill	Gembili	Dioscoreaceae	The stem has fine hairs and it is in the form of tendrils so that it can spread. The leaves are heart-shaped with pointed tips and a smooth leaf surface.	A source of carbohydrates and fiber. This plant has the potential as a traditional medicine for diabetes and digestive disorders.	
8.	*Lantana camara* L.	Tahi Ayam	Verbenaceae	The woody stem is brown. The leaves are oval in shape, the leaf surface is rough and finely hairy. The flowers are in the form of orange and pink panicles.	People use it as an ornamental plant and medicinal plant. The leaves can be used as animal feed.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
9.	*Scleria sumatrensis* Retz.	Rija-Rija	Cyperaceae	The stem is triangular-shaped. The leaves are like ribbons with a rough and textured surface. Inflorescences are supported by leaf-like bracts.	The roots are used for herbal medicine to treat gonorrhea. The leaves can be used as animal feed. The stem is used as a material for making woven or simple house roofs.	
10.	*Leersia virginica* Willd.	Rumput Putih	Poaceae	The stem is segmented and typically upright; however, when in a prostrate position, it has the ability to develop roots at each segment. The stem is mostly smooth but the segments are hairy. The leaves are lanceolate with pointed tips. Smooth surface on the top and hairy on the bottom.	Used as animal feed and ornamental plants by the local community.	
11	*Sida rhombifolia* L.	Sidaguri	Malvaceae	Stems are slender, but slightly woody, with tough fibrous bark. The leaves are oblong-shaped and have a hairy surface with serrated edges. Has small yellow flowers.	Used as herbal medicine in traditional medicine such as helping to relieve inflammation, treat infections, relieve toothache and headache pain.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
12.	*Dioscorea hispida* Dennst.	Gadung	Dioscoreaceae	The stem is hairy. The leaves are heart-shaped with a smooth leaf surface and dark green in color. The flowers are dioecious where male and female flowers are borne on different plants.	Used as a food source. Has the potential as a herbal medicine to treat stomach aches, digestive disorders, and joint pain.	
13.	*Blumea balsamifera* (L.) DC.	Sembung	Asteraceae	The stem is covered in fine hairs. Single leaves, alternate, lanceolate-shaped with a rough and hairy surface. The flowers are tubular, small, and short-stemmed.	Used as a traditional medicine for toothache, headaches, inflammation, respiratory problems, and itchy skin.	
14.	Poaceae	-	Poaceae	Hollow stems and open, single-leafed, webbed leaves with ligules at the inner junction with the blade. The leaves are ribbon-shaped, the inflorescences are grass-like spikelets.	-	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
15.	*Scutellaria ovata* Hill.	-	Lamiaceae	Round stem with fine hairs. The leaves are oval and have fine hairs on the surface with serrated edges. The flowers are tubular and blue in color.	Can be used as a sedative to overcome anxiety and insomnia and help relieve inflammation.	
16.	*Stachytarpheta jamaicensis* (L.) Vahl	Pecut kuda	Verbenaceae	The woody stem is brown with a smooth surface, but sometimes there are fine hairs on the young branches. The leaves are oval with serrated edges, opposite each other, and are slightly dull light green in color.	Widely used as a herbal medicine to treat wounds or itching, relieve inflammation, and reduce fever.	
17.	*Dioscorea villosa* L.	Ubi liar	Dioscoreaceae	The stem is creeping and covered with fine hairs. The leaves are heart-shaped with a finely hairy surface. Flowers emerge from the leaf axils, where branches or leaves attach to the main stem.	The tuber can be used to relieve menstrual pain, muscle pain, and joint pain. Also, can be used to reduce inflammation and serve as a food source if processed properly.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
18.	Thallophyta		Thallophyta	Moss leaves are in the shape of lanceolate to oblong.	-	
19.	*Arenga pinnata* (Wurmb) Merr.	Aren/ Enau	Arecaceae	The stem is cylindrical and sturdy. The trunk is covered by a black fibrous leaf sheath and base. The leaves are compound and elongated, with each leaflet being ribbon-like and having a tough texture. The flowers are densely clustered and hang downward.	The liquid from the fruit can be processed into palm sugar, the seeds can be processed into snacks. The stem contains starch and can be processed into flour and can be used as a building material. Leaves are used to make various kinds of handicraft products. Some parts of the tree also have medicinal properties to treat wounds, diarrhea, and digestive problems.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
20.	*Ophiorrhiza* sp.	-	Rubicaeae	The stem is cylindrical, smooth, and green. The leaves are lanceolate, with pointed tips and a smooth surface.	This plant is commonly used in traditional medicine to treat fever, infections, skin disorders, and digestive issues.	
21.	*Trema orientale (L.) Blume*	Mengkirai	Cannabaceae	The stem is woody, smooth. The lenticels are clearly visible and the bark is grayish brown. The leaves are oblong-shaped and alternate with a rough surface. Greenish beige inflorescence.	The wood can be used as raw material for making paper, the leaves can be used as animal feed, especially for ruminants. In addition, the leaves and bark can be used as traditional medicine to treat diarrhea, fever, and wounds.	
22.	*Lygodium* sp.	-	Schizaeaceae	The Lygodium stem is a rhizome that grows horizontally and branches dichotomously. The leaves grow close together, so they look tight. Adventitious roots grow from the ventral side of the rhizome.	Generally used as traditional medicine. Leaves and stems are used for handicrafts and animal feed for ruminants..	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
23.	*Lecanopteris pustulata* (G.Forst.) Perrie & Brownsey	-	Polypodiaceae	Thick rhizome with blackish-brown scales. The leaves are compound, dark green and shiny.	Used as an ornamental plant.	
24.	*Gleichenia* sp.	-	Gleicheniaceae	The cylindrical stems are yellowish-green. Leaves are like leather, branching once or more. Each primary lateral axis is divided pinnately or more compound in the form of a ribbon with a pointed tip and wavy leaf edges.	Stems and leaves are used for handicrafts. Has the potential to be used as traditional medicine	
25.	*Macaranga tanarius* (L.) Müll.Arg.	Pohon Mara	Euphorbiaceae	The stem is striped brown and fragile. The branches are rather thick, gray and hairy when young. The leaves are oval with pointed tips, alternate and generally hairy when young. The lower surface of the leaves is often paler than the top surface	Wood is used as a building material. Some parts of it can be used as traditional medicine to treat various diseases, such as diarrhea, fever, and wounds. The leaves can be used as animal feed, especially for ruminants.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
26.	*Manihot esculenta* Crantz	Ketela pohon	Euphorbiaceae	The stem is woody, with a brownish-gray bark that is rough due to leaf scars. The leaves are finger-shaped with pointed tips. The edges of the leaves are serrated and the surface is smooth or slightly hairy. The root system expands to form a tuber.	Can be a source of carbohydrates and food ingredients. The leaves can be used as animal feed, especially for ruminants. Flour from the tubers can be used as raw materials in various industries	
27.	*Desmodium* sp.	-	Fabaceae	The stem is green in the form of tendrils so that it can spread. The leaves are oval and have many green trifoliate leaves.	Has the potential as a traditional medicine for skin diseases, digestion, fever, and diabetes.	
28.	*Mimosa pudica* L.	Putri Malu	Fabaceae	The stem grows prostrate and has fine thorns. The leaves are compound and arranged in pairs, with a distinctive characteristic of closing rapidly upon touch or vibration. The flowers are small, round clusters and are light purple or pin.	Various parts of the plant, such as leaves, stems, and roots, are used in traditional medicine to treat insomnia, fever, diarrhea, and wounds. The leaves can be used as animal feed for ruminants, as green manure, and as ornamental plants.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
29.	*Ficus septica* Burm.f.	Awar-awar	Moraceae	The stem is cylindrical and segmented, with leaves growing at each node. Oval-shaped single leaves with pointed tips and have a smooth, dark green surface.	The wood is used as a building material, while the leaves serve as animal feed for ruminants. The roots, stems, leaves, and fruits have medicinal properties. The sap is used to treat wounds, abscesses, and snake bites, and the leaves can be used to treat skin conditions, appendicitis, and respiratory issues.	
30.	*Colocasia esculenta* (L.) Schott	Talas/Taro	Araceae	The stem is succulent and grows upright. The leaves are shield-shaped and large, with a smooth, dark green surface. The leaf stalks are long and attach at the center of the leaf blade.	The plant is used as a source of carbohydrates and food. The leaves can be used as animal feed. Also can serve as an ornamental species and traditional remedy for various ailments such as fever, diarrhea, and burns.	
31.	*Ageratum conyzoides* L.	Bandotan	Asteraceae	The stem is cylindrical, finely hairy, and brownish-green in color. The leaves are oval with serrated edges and fine hairs. The flowers are small and purple or white in color.	Various parts of this plant, such as the leaves and stem, are used in traditional medicine to treat various ailments, such as, fever, cough, wounds, and headaches. The leaves can serve as supplementary feed for livestock and as green manure.	

No	Plant Species	Local Name	Family	Morphology	Utilization	Picture
32.	*Hyptis capitata* Jacq.	Rumput knop	Lamiaceae	The stem is rectangular and hairy. The leaves are widely spaced and arranged in opposite directions with an oval in shape, serrated edges and pointed tips. The flowers are small in white or purple and arranged in round-shaped tubers.	his plant is used in traditional medicine to treat inflammation, eczema, skin itching, bloating, and diarrhe.	
33.	*Pandanus tectorius* Parkinson	Pandan duri	Pandanaceae	The stem is thorny, grows upright, and is branched. The leaves are long and narrow ribbon-shaped, with sharp serrated edges. The leaves grow densely around the stem.	Used as raw material for crafts and building materials. The fruit is used as jam or sweets. Some parts of the thorny pandan plant, such as the roots and leaves, are believed to have medicinal properties to treat various diseases, such as fever, stomach ache, and skin problems.	

The research results indicate that 14 of the 33 plant species identified in the Rumbia White Teak Agroforestry area (Table 2) have conservation status records with the *International Union for Conservation of Nature* (IUCN) under the Least Concern category. Additionally, 7 plant species—namely *Macaranga tanarius* (L.) Müll.Arg., *Ficus septica* Burm.f., *Scleria sumatrensis* Retz., *Blumea balsamifera* (L.) DC., *Colocasia esculenta* (L.) Schott, *Arenga pinnata* (Wurmb) Merr., and *Mimosa pudica* L—are reported by Powo (2024) to be distributed and grow within the Sulawesi region.

Table 2. Plant Species in White Teak Agroforestry Listed on the IUCN Red List

No.	Plant Species	Local Name	Genus	Family	IUCN
1.	*Colocasia esculenta* (L.) Schott	Talas/Taro	Colocasia	Araceae	Least Concern
2.	*Arenga pinnata* (Wurmb) Merr.	Aren/Enau	Arenga	Arecaceae	Least Concern
3.	*Ageratum conyzoides* L.	Bandotan	Ageratum	Asteraceae	Least Concern
4.	*Blumea balsamifera* (L.) DC.	Sembung	Blumea	Asteraceae	Least Concern
5.	*Scleria sumatrensis* Retz.	Rija-Rija	Scleria	Cyperaceae	Least Concern
6.	*Dioscorea villosa* L.	Ubi liar	Dioscorea	Dioscoreaceae	Least Concern
7.	*Macaranga tanarius* (L.) Müll.Arg.	Pohon Mara	Macaranga	Euphorbiaceae	Least Concern
8.	*Mimosa pudica* L.	Putri Malu	Mimosa	Fabaceae	Least Concern
9.	*Gmelina arborea* Roxb. ex Sm.	Jati putih	Gmelina	Lamiaceae	Least Concern
10.	*Ficus septica* Burm.f.	Awar-awar	Ficus	Moraceae	Least Concern
11.	*Pandanus tectorius* Parkinson	Pandan duri	Pandanus	Pandanaceae	Least Concern
12.	*Piper aduncum* L.	Kayu sirih	Piper	Piperaceae	Least Concern
13.	*Leersia virginica* Willd.	Rumput Putih	Leersia	Poaceae	Least Concern
14.	*Stachytarpheta jamaicensis* (L.) Vahl	Pecut kuda	Stachytarpheta	Verbenaceae	Least Concern

The White Teak agroforestry area is dominated by the white teak plant itself. The white teak in the research location was deliberately planted for rehabilitation purposes in the area. The White Teak agroforestry is located in the buffer zone of the protected forest area to protect the conservation area. This plant was chosen as a rehabilitation plant because the rapid growth. This statement is supported by Nguyen et al., (2017) who stated that white teak is a fast-growing plant with good wood quality for various purposes, suitable for agroforestry systems. Furthermore, Krisnawati et al. (2011) stated that white teak has a very fast growth rate, with a height that can reach 20-30 meters in the first 6-8 years. The growth rate of the diameter of white teak reaches 3.65 cm per year, which contributes to an increase in carbon sequestration capacity.

4. CONCLUSION

Research on plant species composition and utilization in agroforestry areas shows that agroforestry systems have significant potential in supporting environmental sustainability and community welfare. A total of 33 plant species were identified, 23 of which are distributed across various regions in Indonesia, including the islands of Sumatra, Java, Kalimantan, Sulawesi, the Sunda Islands, Maluku, and Papua

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