

Selection of *Ficus* spp. species for rehabilitation of degraded land in Kuningan District, West Java, Indonesia

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Abstract. Hendrayana Y, Adhya I, Kosasih D, Widhiono I, Alfahri FF, Apriantika IS, Vaines S. 2025. Selection of *Ficus* spp. species for rehabilitation of degraded land in Kuningan District, West Java, Indonesia. *Biodiversitas* 26: 3199-3208. Land degradation is an environmental problem caused by various factors, including unsustainable land use, deforestation, and harmful agricultural practices. An effective method to overcome this problem is through land rehabilitation by replanting trees in the degraded areas. Therefore, this study aimed to select *Ficus* tree species for the rehabilitation of critical lands in Kuningan District, West Java, Indonesia. Data was collected using a field survey by making observation plots to document the presence of *Ficus* tree species in three land use types in the district, namely sand excavation area (Cidahu, Ciawigebang, and Japara Sub-districts), community gardens (Ciniru, and Hantara Sub-districts), and secondary forests (Selajambe, Subang, Cilebak Sub-districts). Vegetation analysis was conducted to calculate the importance value index and species similarity index. The results showed that there were 16 *Ficus* tree species across the surveyed locations with six species were found simultaneously in all three land uses, including *F. benjamina*, *F. fistulosa*, *F. septic*, *F. variegata*, *F. ampelas*, *F. virens* var. *glabella*. Other species included *F. annulata*, *F. callosa*, *F. elastica*, *F. fulva*, *F. gibbosa*, *F. hispida*, *F. microcarpa*, *F. racemosa*, *F. sinuata*, and *F. subulata*. Thus, the six species are recommended for the rehabilitation of degraded lands in Kuningan District.

Keywords: Land degradation, rehabilitation, sand excavation, secondary forest

INTRODUCTION

Land degradation is a serious environmental problem across the world which can be caused by various factors including forest fires, excessive logging, and inappropriate land use, resulting in the decline of soil quality (Pravalie 2021; Rahmawaty et al. 2022). Degradation often occurs due to human pressures in the form of intensive agricultural practices, land abandonment, urban expansion, and excessive tourism (Bajocco et al. 2012). The increasing pressure on available land and the continuous decline in land quality are the evident of degradation as indicated with the annual expansion of critical lands (Smiraglia et al. 2016). One effective approach to addressing this issue is the restoration of degraded land through tree planting, which helps to recover the ecological functions of landscape (Löf et al. 2019). In addition, tree planting has been reported to play an essential role in ecosystem restoration efforts (Mansourian et al. 2017).

Previous studies suggest that *Ficus* species (Moraceae) are often used for restoration efforts due to its unique and beneficial properties. Apart from its ability to maintain water reserves and protect slopes, the plant has a fertile canopy that can absorb CO₂ (Cottee-Jones et al. 2016; Hao et al. 2016; Hendrayana et al. 2021) and serves as a food source and habitat for various fauna (Kuaraksa and Elliott

2013; Yelastri et al. 2023). *Ficus* plants have also been reported to have other beneficial functions, including being used as animal feed, firewood, and ornamental plants (Shi et al. 2018). In the medical field, some *Ficus* species are used to treat ailments. For instance, *F. rasemosa* is used in Ayurvedic healing methods and traditional Sri Lankan medicine as an anti-convulsant therapy and anti-Parkinson's disease (Bopage et al. 2018). It also has cytotoxic and antioxidant (Salehi et al. 2021) along with the ability to improve bone health (Idrus et al. 2018) and treat cancer (Lansky et al. 2008).

Previous studies have explored the ecology, threats, and conservation of *Ficus*. The plants from this genus have interactions with animals, such as pollinators, seed spreaders, and predators, which are both helpful and harmful (Bain et al. 2016). Kumar et al. (2022) showed the loss of *Ficus* in ecosystem has various negative impacts. Many *Ficus* plants are threatened by habitat loss and degradation, fragmentation, and overexploitation (Islam et al. 2021). Several studies have used various methods, such as identifying geographical distribution and population, and assessing genetics to determine their existence in the future (Pederneiras et al. 2020). Other studies also examined areas with high concentrations of *Ficus* population and determine priority conservation zones by considering environmental, cultural, and economic factors. Techniques such as field

experiments, modeling, and remote sensing are used to assess how climate change impacts these species and their associated ecosystems (Shen et al. 2022).

Kuningan District is an administrative region located in the eastern part of West Java Province, Indonesia, directly bordering Central Java Province. There are currently development activities happening in Kuningan, causing negative impacts to environment, including land degradation (Hendrayana et al. 2019). Land degradation is primarily caused by sand mining activities, especially in the eastern and northern parts of Kuningan District (Waniatri et al. 2022). This condition is also due to changes in land use for agriculture especially in the boundary of forest (Kafy et al. 2021) and the development of a tourist spot in the western part of the district (Rahayu et al. 2021). In villages bordering the Mount Ciremai National Park (TNGC), damage has occurred due to changes in land use and cover (Kusumoarto and Hidayat 2018). Several land rehabilitation activities have been carried out, including planting legumes in former sand excavations (Setiawan and Suhirman 2023), and other trees such as *sengon* (*Paraserianthes falcataria*), acacia (*Acacia mangium*), mango (*Mangifera indica*), and *salam* (*Eugenia pholyantha*) (Ristanu et al. 2022).

In addition to the plants mentioned above, efforts to restore critical land in Kuningan can be carried out using plant species from the genus *Ficus* because these plants have various ecological functions. This type of plant is evenly distributed from lowlands to highlands (Kumar et al. 2021). Especially in Kuningan District, this plant grows in various types of ecosystems ranging from bushes,

gardens, mixed forests, and secondary natural forests (Hendrayana et al. 2022a) and can grow at various levels of soil fertility (Hendrayana et al. 2025). However, the ability of plants to survive and grow on critical land is one of the considerations in selecting plant types (Fanni et al. 2022). Therefore, this study aims to select *Ficus* tree species for critical land rehabilitation in Kuningan District. The results of this study are expected to provide useful information for the government and the community in determining the types of rehabilitation plants in various degraded land locations.

MATERIALS AND METHODS

Study area

This study was conducted in July 2023 in Kuningan District, West Java, Indonesia, which is geographically located at 108°41'00"-108°47'00" East Longitude and 6°47'00"-7°12'00" South Latitude (Figure 1). *Ficus* data collection was carried out in 8 sub-districts and 34 villages with diverse vegetation conditions. The northern region (Ciawigebang, Japara, Cidahu Sub-districts) features low elevation, flat to undulating topography, and sand excavation areas, while the central region (Ciniru, Hantara Sub-districts) has higher elevation with community gardens and small extent of secondary forest. The southern region (Selajambe, Subang, Cilebak Sub-districts) is the highest with steep terrain and comprised large extent of secondary forests, and community gardens.

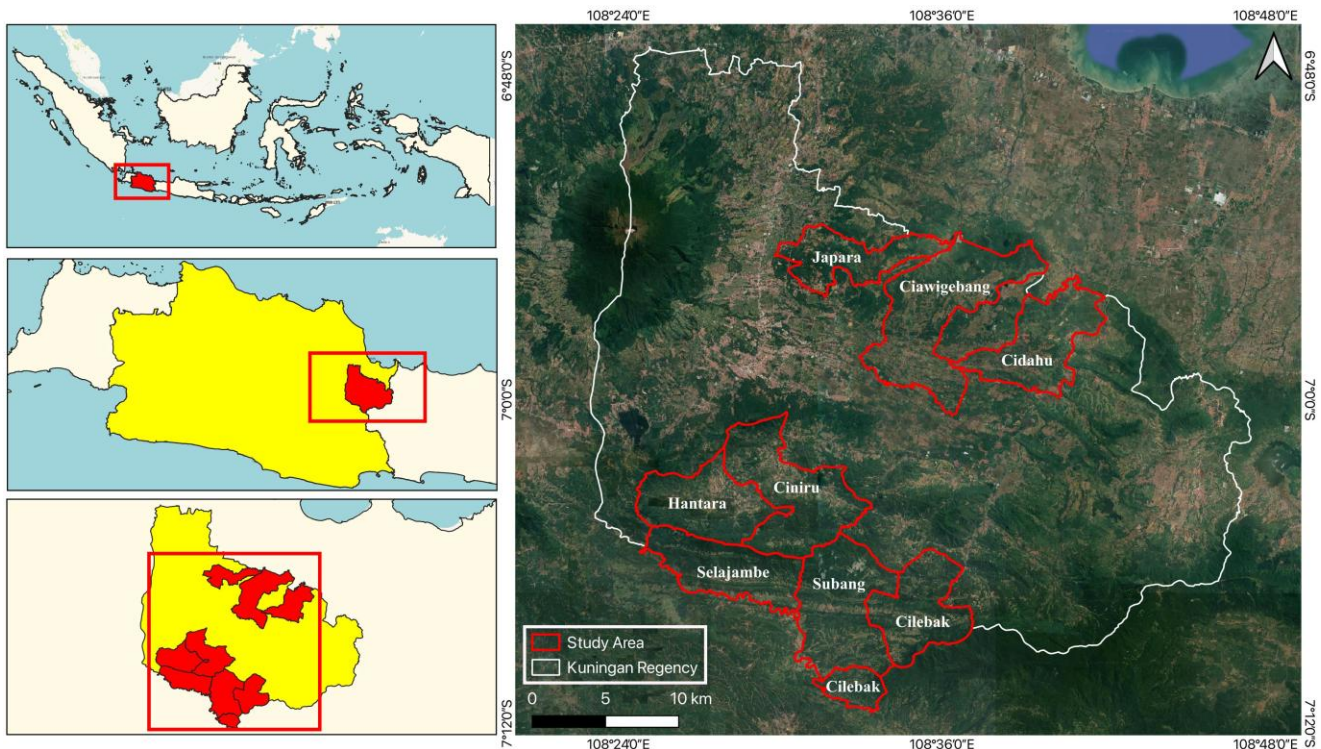


Figure 1. Map of research location in Kuningan District, West Java Province, Indonesia

Research procedures

Data collection in this study began with the creation of sample plots with each plot measuring 0.04 hectares on three different types of land use, namely sand excavations, community gardens, and secondary forests. The sand excavations had an area of 72 hectares, the community gardens covered an area of 84 hectares, while the secondary forest covered an area of 188 hectares. To meet sampling intensity of 1% (Barabesi and Fattorini 1998), the number of sample plots determined for each type of land use was 18 plots for sand excavations, 21 plots for community gardens, and 47 plots for secondary forests. The placement of these sample plots was done selectively using the purposive sampling method in accordance with the approach proposed by Campbell et al. (2020). This method was chosen because it can consider local environmental conditions and research objectives, especially to obtain relevant information on the object being studied. Each plot was used as a unit of observation for various vegetation variables, including the species of plants found, the number of species, the number of individuals of each species, and measurement of diameter at breast height (dbh). The main focus of observation was trees from the genus *Ficus*, which have an important role in the ecosystem. For spatial analysis, each plot containing *Ficus* trees had its geographic coordinates recorded using a Global Positioning System (GPS) tool. These coordinates were then mapped to determine the spatial distribution of *Ficus* trees in the three types of land use. Identification of the species was done by validating the scientific name and updating the accepted name based on the Plants of the World Online Website (POWO 2021).

Data analysis

Data analysis in this study included three main components, namely tree species density, species dominance, and species diversity. Tree species density was calculated by dividing the number of individuals of each species found in the plot by the total area of all sample plots to identify tree species dominance. Species dominance was determined based on basal area which was calculated based on the tree diameter at breast height (dbh), which reflects the contribution of a species to the stand structure. Species diversity was analyzed to determine the variation of tree species found in each type of land use. Furthermore, to determine the importance of each tree species in the ecosystem, the Importance Value Index (IVI) analysis was used, which was the sum of three ecological parameters, namely Relative Density (RD), Relative Dominance (RDo), and Relative Frequency (RF) referring to the concept explained by Rahmawati et al. (2022). Each component reflects the relative role of a species in the plant community. Relative density shows the proportion of the number of individuals of a species compared to the total number of individuals, relative frequency reflects how often a species appears in a plot, and relative dominance shows the contribution of basal area of a species in a plot. This analysis was carried out separately for each type of land use, so that differences in vegetation structure and composition that arise due to differences in land use activities can be identified.

$$\text{Density (D)} = \frac{\text{Number of individual of a species}}{\text{Area of whole plot (ha)}}$$

$$\text{Relative Density (RD)} = \frac{\text{Density of a species}}{\text{Density of all species}} \times 100\%$$

$$\text{Dominance (Do)} = \frac{\text{Area basal areal of a species (m}^2\text{)}}{\text{Area of whole sample plot (ha)}}$$

$$\text{Relative Dominance (RDo)} = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100\%$$

$$\text{Frequency (F)} = \frac{\text{Number of plots found a species}}{\text{Total of plots}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency off a species}}{\text{Frequency of all species}} \times 100\%$$

The species similarity index was used to determine the similarity of *Ficus* species found in different land cover types. The species similarity index (SJ) ranges from 0 to 1 where value of 1 means that the two land covers has exactly similar species of *Ficus*. The species similarity index was calculated as follow:

$$\text{SJ} = c / (a + b + c)$$

Where,

a : Number of species found only in land cover A

b : Number of species found only in land cover B

c : Number of species found in land cover A and B

RESULTS AND DISCUSSION

Diversity of *Ficus* species in Kuningan District

The study recorded 16 species of *Ficus* in across the study locations in Kuningan District, namely *F. ampelas*, *F. annulata*, *F. benjamina*, *F. callosa*, *F. elastica*, *F. fistulosa*, *F. fulva*, *F. gibbosa*, *F. hispida*, *F. microcarpa*, *F. racemosa*, *F. septica*, *F. sinuata*, *F. subulata*, *F. variegata*, and *F. virens* var. *glabella* (Table 1).

In the sand excavation sites in 12 villages and 3 sub-districts, 9 species of *Ficus* were found, namely *F. ampelas* found in Jatimulya Village at an altitude of 47 m asl, *F. benjamina* found in Mekarjaya, Legok, Datar, Kalimati Village, Cieurih, Cihirup, Ciawigebang and Cigarukgak. Furthermore, at an altitude of of 51-262 m asl, *F. fistulosa* was found in Legok, Datar, and Sukadana Villages at an altitude of 72-2252 m asl, *F. macrocarpa* was only found in Legok Village at an altitude of 146 m asl, *F. racemosa* was found in Jatimulya Village at an altitude of 47 m asl, *F. septica* in Legok, Cieurih, and Cihirup Villages at an altitude of 134-153 m asl. Others included *F. subulata* in Purwasari Village at an altitude of 319 m asl, *F. variegata* in Jatimulya, Cikeusik, and Cieurih Villages at 47-152 m asl. Most of the *Ficus* found in the villages at this location were in active or inactive sand excavations. The growth level of fig trees varied from saplings, poles, and trees, however, tree level dominated.

Table 1. Location and species of *Ficus* found in Kuningan District, West Java Province, Indonesia

Sub-district	Village	Number of species	Species name
Cidahu	Legok	4	<i>F. septica</i> , <i>F. microcarpa</i> , <i>F. benjamina</i> , <i>F. fistulosa</i>
	Cieurih	3	<i>F. variegata</i> , <i>F. septica</i> , <i>F. benjamina</i>
	Jatimulya	3	<i>F. racemosa</i> , <i>F. ampelas</i> , <i>F. variegata</i>
Ciawigebang	Datar	3	<i>F. virens</i> var. <i>glabella</i> , <i>F. fistulosa</i> , <i>F. benjamina</i>
	Mekarjaya	1	<i>F. benjamina</i>
	Cihirup	2	<i>F. benjamina</i> , <i>F. septica</i>
	Ciawigebang	1	<i>F. benjamina</i>
	Cigarukgak	1	<i>F. benjamina</i>
Japara	Sukadana	1	<i>F. fistulosa</i>
	Kalimati	1	<i>F. benjamina</i>
Ciniru	Purwasari	1	<i>F. subulata</i>
	Cipedes	5	<i>F. fistulosa</i> , <i>F. subulata</i> , <i>F. variegata</i> , <i>F. benjamina</i> , <i>F. racemosa</i>
Hantara	Pinara	3	<i>F. ampelas</i> , <i>F. virens</i> var. <i>glabella</i> , <i>F. benjamina</i>
	Gunungmanik	2	<i>F. septica</i> , <i>F. racemosa</i>
	Tundagan	3	<i>F. subulata</i> , <i>F. benjamina</i> , <i>F. septica</i> ,
	Cikondang	3	<i>F. subulata</i> , <i>F. variegata</i> , <i>F. septica</i>
Selajambe	Pasiragung	3	<i>F. fistulosa</i> , <i>F. ampelas</i> , <i>F. septica</i>
	Citapen	3	<i>F. septica</i> , <i>F. fistulosa</i> , <i>F. gibbosa</i>
	Padahurip	2	<i>F. benjamina</i> , <i>F. gibbosa</i>
	Jamberama	2	<i>F. benjamina</i> , <i>F. virens</i> var. <i>glabella</i>
	Bagawat	5	<i>F. virens</i> var. <i>glabella</i> , <i>F. ampelas</i> , <i>F. fistulosa</i> , <i>F. benjamina</i> , <i>F. hispida</i>
Subang	Ciberung	4	<i>F. virens</i> var. <i>glabella</i> , <i>F. benjamina</i> , <i>F. ampelas</i> , <i>F. variegata</i>
	Kutawaringin	5	<i>F. virens</i> var. <i>glabella</i> , <i>F. fistulosa</i> , <i>F. hispida</i> , <i>F. ampelas</i> , <i>F. benjamina</i>
	Gunungaci	4	<i>F. virens</i> var. <i>glabella</i> , <i>F. variegata</i> , <i>F. ampelas</i> , <i>F. benjamina</i>
	Situgede	2	<i>F. septica</i> , <i>F. benjamina</i>
	Subang	3	<i>F. fulva</i> , <i>F. fistulosa</i> , <i>F. benjamina</i>
Cilebak	Jalatrang	5	<i>F. hispida</i> , <i>F. virens</i> var. <i>glabella</i> , <i>F. ampelas</i> , <i>F. fulva</i> , <i>F. macrocarpa</i>
	Pamulihan	4	<i>F. septica</i> , <i>F. hispida</i> , <i>F. ampelas</i> , <i>F. benjamina</i>
	Cilebak	5	<i>F. fistulosa</i> , <i>F. annulata</i> , <i>F. ampelas</i> , <i>F. fulva</i> , <i>F. benjamina</i> ,
	Bungurberes	6	<i>F. virens</i> var. <i>glabella</i> , <i>F. ampelas</i> , <i>F. hispida</i> , <i>F. benjamina</i> , <i>F. septica</i> , <i>F. fistulosa</i>
	Legokherang	5	<i>F. virens</i> var. <i>glabella</i> , <i>F. sinuata</i> , <i>F. ampelas</i> , <i>F. benjamina</i> , <i>F. elastica</i>
Mandapajawa	Jatisari	3	<i>F. benjamina</i> , <i>F. callosa</i> , <i>F. virens</i> var. <i>glabella</i>
	Mandapajawa	4	<i>F. variegata</i> , <i>F. hispida</i> , <i>F. ampelas</i> , <i>F. sinuata</i>

In the community gardens in 7 villages and 2 sub-districts, 9 species of *Ficus* were found, including *F. ampelas* in Pinara and Pasiragung Villages, *F. benjamina* in Cipedes, Tundagan and Pinara Villages at an altitude of 269-606 m asl. Furthermore, *F. fistulosa* was found in Cipedes Village, Pasiragung, and Citapen at an altitude of 277-408 m asl, *F. gibbosa* was only found in Citapen Village at an altitude of 394 m asl, *F. racemosa* was found in Cipedes and Gunungmanik Villages at an altitude of 270-647 m asl. Others included *F. septica* which was found in Citapen Village, Pasiragung, Cikondang, and Tundagan at an altitude of 366-463 m asl, *F. subulata* was found in the villages of Cipedes, Cikondang, and Tundagan at an altitude of 298-454 m asl, *F. variegata* was found in the villages of Cipedes and Cikondang at an altitude of 304-399 m asl, and *F. virens* var. *glabella* was only found in Pinara Village at an altitude of 632 m asl. At this location, there was every level of growth starting from seedlings, saplings, poles, and trees, however, the tree level dominated.

In the secondary forests in 15 villages and 3 sub-districts, 14 species of *Ficus* were found, including *F. ampelas* found in the villages of Ciberung, Mandapajaya, Kutawaringin, Bagawat, Pamulihan, Bungurberes, Cilebak,

Jalatrang, Gunungaci, and Legokherang at 301-790 m asl. *Ficus annulata* was found only in Cilebak at an altitude of 610 m asl, *F. benjamina* was found in the villages of Ciberung, Subang, Kutawaringin, Bagawat, Jamberama, Pamulihan, Situgede, Padahurip, Cilebak, Bungurberes, Jatisari, Gunungaci, and Legokherang at an altitude of 301-773 m asl. Furthermore, *F. callosa* was found in Jatisari Village at an altitude of 701 m asl, *F. elastica* was found in Legokherang Village at an altitude of 771 m asl, *F. fistulosa* was found in the villages of Kutawaringin, Subang, Bagawat, Mandapajaya, Bungurberes, and Cilebak at an altitude of 458-614 m asl. *Ficus fulva* was found in Subang, Cilebak, and Jalatrang Villages at an altitude of 430-647 m asl. *Ficus gibbosa* was only found in Padahurip Village at an altitude of 460 m asl, *F. hispida* was found in the villages of Pamulihan, Mandapajaya, Kutawaringin, Bagawat, Bungurberes, and Jalatrang at an altitude of 396-670 m asl. *Ficus macrocarpa* was found in Jalatrang Village at an altitude of 545 m asl, while *F. septica* in Pamulihan, Bungurberes, and Situgede Villages at an altitude of 396-636 m asl. Furthermore, *F. sinuata* was found in Legokherang and Mandapajaya Villages at an altitude of 450-678 m asl, and *F. variegata* was found in Ciberung, Gunungaci, and Mandapajaya Villages at 301-

773 m asl. *Ficus virens* var. *glabella* was found in the villages of Ciberung, Jamberama, Mandapajaya, Gunungaci, Bagawat, Jamberama, Bungurberes, Kutawaringin, Jalatrang, Legokherang, and Jatisari at an altitude of 323-724 m asl. At this location, there was every level of growth, but the tree growth level dominated.

Distribution and composition of *Ficus* in Kuningan District

In the sand excavation sites in Kuningan District (Figure 2) with sloping to undulating topography, the most found fig trees were *F. benjamina*, *F. variegata*, and *F. septica* and *F. fistulosa*. In the community gardens, the most found were *F. septica*, followed by *F. subulata*, and *F. fistulosa*, *F. benjamina* and *F. ramosa*. Meanwhile, *F. gibbosa*, *F. ampelas*, and *F. virens* var. *glabella* were only found in one location each.

In the secondary forests (Figure 2), three species of *Ficus* most found were *F. benjamina*, *F. virens* var. *glabella*, and *F. ampelas*. On the other hand, *F. gibbosa*, *F. macrocarpa*, *F. elastica*, *F. callosa*, and *F. annulata* were each only found in one location. In the sand excavation sites, *F. benjamina* was the dominant tree with an IVI value of 19.10, followed by *F. septica* 10.83, *F. fistulosa* 7.67, *F. variegata* 5.22 and *F. virens* var. *glabella* 3.93 (Table 2). Meanwhile, in the community gardens, the results showed species with the highest IVI was *F. septica* 13.78, *F. benjamina* 12.91, *F. fistulosa* 5.29, *F. subulata* 4.29 and *F. variegata* 2.41. In the secondary forests, the top IVI ranking was *F. benjamina* 15.49, *F. ampelas* 11.18, *F. virens* var. *glabella* 10.45, *F. hispida* 7.20 and *F. fistulosa* 5.56.

The similarity of *Ficus* in Kuningan District

A total of 8 species of *Ficus* were found at the sand excavation and community garden locations, while at the sand excavation and secondary forest locations as well as community gardens and secondary forests, 7 of the same species were found. However, there were 6 species found in the three locations, namely *F. benjamina*, *F. fistulosa*, *F. septica*, *F. variegata*, *F. ampelas*, and *F. virens* var. *glabella* (Table 3).

Based on the results of the similarity analysis, the value of similarity index (SJ) between the sand excavation sites and the community garden was 0.800, while the sand excavation sites with secondary forest and community garden with secondary forest had the same index value, i.e., 0.437 (Table 4).

Discussion

This study revealed that there were 6 tree species from the genus of *Ficus* that had a good ability to live on various types of land, namely *F. benjamina*, *F. fistulosa*, *F. septica*, *F. variegata*, *F. ampelas*, and *F. virens* var. *glabella*. This finding was very important because it showed the great potential of these *Ficus* species in efforts to rehabilitate degraded land in Kuningan District, especially in sand excavation areas, community gardens, and secondary forests. The 6 species of *Ficus* identified in this study showed excellent adaptability to different environments. Consequently, these species exhibit resilience in adverse

land conditions, including degraded land and nutrient-poor soil. *Ficus* species possess deep, extensive root systems that enable access to water and nutrients from deeper soil layers. This adaptability allows survival in environments with limited water and nutrients, as well as in both shaded and open conditions, demonstrating tolerance to varying light intensities (Pothasin et al. 2016).

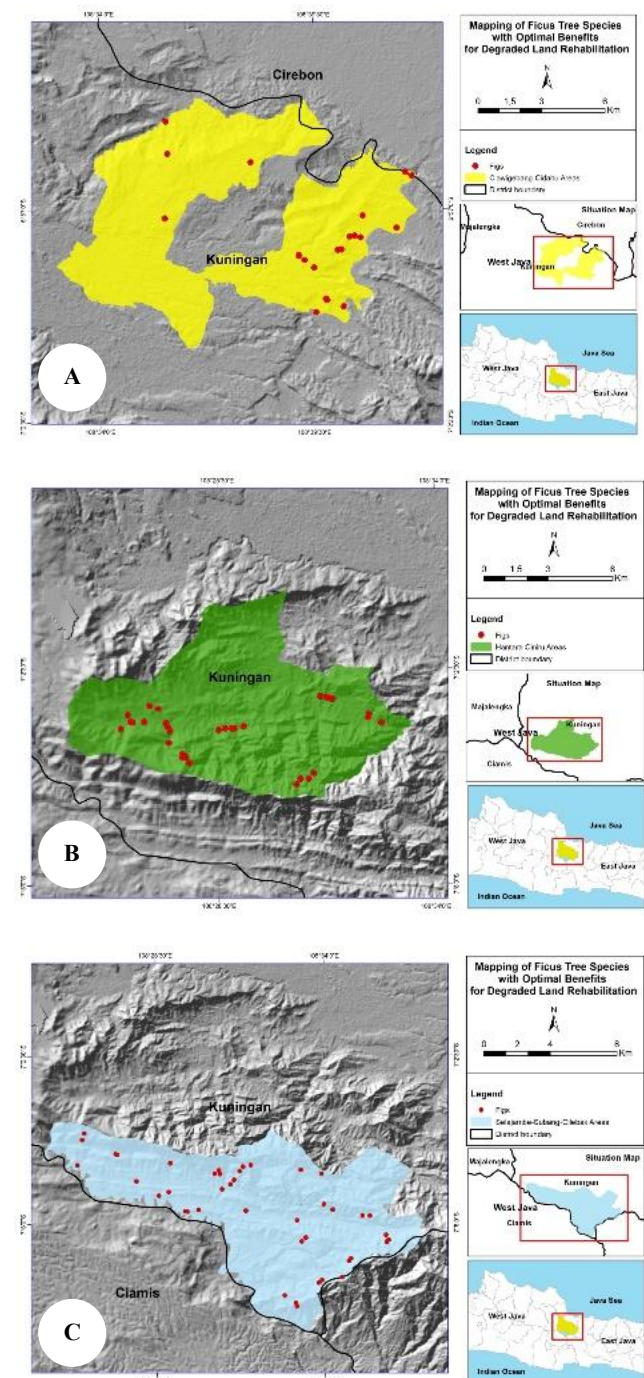


Figure 2. Map of *Ficus* distribution in Kuningan District, West Java Province, Indonesia. A. Sand excavations site, B. Community gardens site, C. Secondary forests site

Table 2. Density, frequency, dominance, and important value index of *Ficus* species in Kuningan District, West Java Province, Indonesia

Species	D (ind.ha)	RD (%)	F	RF (%)	Do (m ² /ha)	RDo (%)	IVI (%)
Sand excavation site							
<i>Ficus benjamina</i>	6.08	34.78	0.44	34.78	6.08	43.43	113.00
<i>Ficus septica</i>	3.73	21.74	0.28	21.74	3.73	26.61	70.09
<i>Ficus fistulosa</i>	1.65	13.04	0.17	13.04	1.65	11.74	37.83
<i>Ficus variegata</i>	1.26	8.70	0.11	8.70	1.26	8.97	26.36
<i>F. virens</i> var. <i>glabella</i>	1.39	4.35	0.06	4.35	0.46	3.32	12.01
<i>Ficus racemosa</i>	1.39	4.35	0.06	4.35	0.46	3.32	12.01
<i>Ficus ampelas</i>	1.39	4.35	0.06	4.35	0.17	1.21	9.91
<i>Ficus microcarpa</i>	1.39	4.35	0.06	4.35	0.09	0.64	9.34
<i>Ficus subulata</i>	1.39	4.35	0.06	4.35	0.10	0.74	9.44
Community garden							
<i>Ficus septica</i>	8.33	28.00	0.33	28.00	4.20	30.46	86.46
<i>Ficus benjamina</i>	7.14	24.00	0.29	24.00	3.48	25.22	73.22
<i>Ficus fistulosa</i>	3.57	12.00	0.14	12.00	1.38	9.98	33.98
<i>Ficus subulata</i>	3.57	12.00	0.14	12.00	1.50	10.88	34.88
<i>Ficus variegata</i>	2.38	8.00	0.10	8.00	1.16	8.39	24.39
<i>Ficus racemosa</i>	1.19	4.00	0.05	4.00	0.68	4.92	12.92
<i>Ficus ampelas</i>	1.19	4.00	0.05	4.00	0.72	5.24	13.24
<i>F. virens</i> var. <i>glabella</i>	1.19	4.00	0.05	4.00	0.40	2.89	10.89
<i>Ficus gibbosa</i>	1.19	4.00	0.05	4.00	0.28	2.03	10.03
Secondary forest							
<i>Ficus benjamina</i>	6.91	22.03	0.28	22.03	2.98	23.84	67.91
<i>Ficus ampelas</i>	5.32	16.95	0.21	16.95	2.46	19.66	53.56
<i>F. virens</i> var. <i>glabella</i>	4.79	15.25	0.19	15.25	1.97	15.79	46.30
<i>Ficus hispida</i>	3.19	10.17	0.13	10.17	1.57	12.55	32.88
<i>Ficus fistulosa</i>	2.66	8.47	0.11	8.47	1.11	8.87	25.82
<i>Ficus variegata</i>	1.60	5.08	0.06	5.08	0.80	6.38	16.55
<i>Ficus septica</i>	1.60	5.08	0.06	5.08	0.78	6.22	16.39
<i>Ficus fulva</i>	1.60	5.08	0.06	5.08	0.67	5.35	15.52
<i>Ficus sinuata</i>	1.06	3.39	0.04	3.39	0.06	0.48	7.26
<i>Ficus microcarpa</i>	0.53	1.69	0.02	1.69	0.03	0.22	3.61
<i>Ficus gibbosa</i>	0.53	1.69	0.02	1.69	0.02	0.18	3.57
<i>Ficus annulata</i>	0.53	1.69	0.02	1.69	0.02	0.18	3.57
<i>Ficus elastica</i>	0.53	1.69	0.02	1.69	0.02	0.14	3.53
<i>Ficus callosa</i>	0.53	1.69	0.02	1.69	0.02	0.14	3.53

Note: D: Density, RD: Relative Density, F: Frequency, RF: Relative Frequency, Do: Dominance; Rdo: Relative Dominance; IVI: Important Value Index

Ficus spp. generally have excellent adaptability to various environmental conditions, making it one of the plant genera that is widely distributed in tropical and subtropical regions. *Ficus* species can grow in various types of habitats, such as lowland forests, mountain forests, secondary forests, riverbanks, even in areas that have been disturbed by human activities, such as open land or urban areas (Peniwidiyanti et al. 2022). This adaptability reflects high ecological flexibility, both in terms of variations in elevation and soil type. According to Yusuf (2011), *Ficus* spp. is able to grow from lowlands to areas with an altitude of up to 2,000 m asl, showing wide tolerance to differences in temperature and humidity. This is in line with the research results of Hendrayana et al. (2019) which noted that *Ficus* species are often found in the altitude range between 500 and 1,000 m asl, especially in areas that still have sufficient vegetation cover. The presence of *Ficus* in various elevations and habitats makes it an important component in the ecosystem, both as a food provider for wildlife and as a buffer in the natural forest regeneration system.

Land degradation remains a significant challenge, particularly in areas affected by activities, such as sand

extraction, agricultural expansion, and deforestation, which leave forests being disturbed. The loss of soil structure and nutrients hinders ecosystem recovery, making restoration efforts difficult. Land disturbed by sand extraction is especially prone to erosion and damage, complicating replanting efforts. *Ficus* species play a crucial role in mitigating these issues due to their strong and deep roots (Telak et al. 2020). Additionally, the accumulation of leaf litter and decaying roots enriches the soil with organic matter, improving its fertility (Al-Alam et al. 2023). In agricultural settings, *Ficus* serves as a shade plant and provides protection against excessive sunlight and wind. Furthermore, its fruit is important feeding sources of various animals, including birds and small mammals, which also act as natural pest control in gardens (Hendrayana et al. 2022b). In secondary forests, *Ficus* is vital for ecological restoration to promote forest regeneration after disturbances (Peniwidiyanti et al. 2022). The ability to thrive in harsh conditions supports the growth of other plants, accelerating vegetation recovery. By fostering nutrient cycling and enhancing wildlife habitats, the presence of *Ficus* significantly contributes to the restoration of ecosystem functions (Wijaya and Delfiani 2021).

In the local language, *Ficus benjamina* is known as 'caringin.' This species is found across various environments, including sand excavation sites, community gardens, and secondary forests (Hendrayana et al. 2022a). Widespread throughout Indonesia, *F. benjamina* thrives in tropical and subtropical regions across many countries. In Indonesia, it is commonly found and demonstrates strong adaptability to diverse habitats, including primary and secondary forests, agricultural lands, and urban areas. It grows from lowland regions to highlands, reaching elevations of up to 1,500 m asl (Mardiastuti et al. 2021). A typical *F. benjamina* tree reaches a height of 20-25 meters and exhibits a taproot system. The trunk is blackish brown, upright, round, and rough in texture, with aerial roots hanging from the branches. The leaves are simple, oppositely arranged, oval-shaped, with a smooth texture and pointed-flat edges.

Table 3. The similarity of *Ficus* species in sand excavation sites, community gardens, and secondary forests

Sand excavation sites and community gardens		
Sand excavation sites	Community gardens	Sand excavations and community gardens
<i>F. microcarpa</i>	<i>F. gibbosa</i>	<i>F. benjamina</i> <i>F. septica</i> <i>F. fistulosa</i> <i>F. variegata</i> <i>F. racemosa</i> <i>F. ampelas</i> <i>F. subulata</i> <i>F. virens var. glabella</i>

Sand excavation sites and secondary forests		
Sand excavation sites	Secondary forest	Sand excavation sites and secondary forests
<i>F. racemosa</i>	<i>F. hispida</i>	<i>F. benjamina</i>
<i>F. subulata</i>	<i>F. fulva</i>	<i>F. septica</i>
	<i>F. sinuata</i>	<i>F. fistulosa</i>
	<i>F. gibbosa</i>	<i>F. variegata</i>
	<i>F. annulata</i>	<i>F. virens var. glabella</i>
	<i>F. elastica</i>	<i>F. ampelas</i>
	<i>F. callosa</i>	<i>F. microcarpa</i>

Community gardens and secondary forests		
Community gardens	Secondary forest	Community gardens and secondary forests
<i>F. subulata</i>	<i>F. hispida</i>	<i>F. septica</i>
<i>F. racemosa</i>	<i>F. fulva</i>	<i>F. benjamina</i>
	<i>F. sinuata</i>	<i>F. fistulosa</i>
	<i>F. microcarpa</i>	<i>F. variegata</i>
	<i>F. annulata</i>	<i>F. ampelas</i>
	<i>F. elastica</i>	<i>F. virens var. glabella</i>
	<i>F. callosa</i>	<i>F. gibbosa</i>

Table 4. Similarity index of *Ficus* species between land uses in Kuningan District, West Java Province, Indonesia

Land use	Sand excavation sites	Community gardens	Secondary forests
Sand excavations	-	-	-
Community gardens	0.8	-	-
Secondary forests	0.437	0.437	-

Other defining characteristics include pinnate leaf venation, flowers emerging from the leaf axils, a dense and smooth crown, and small round fruits (*buni*), which transition from green to red when ripe. The seeds are hard, round, and white. Among the various *Ficus* species, *F. benjamina* and *F. variegata* are particularly widespread, occurring in mountainous (Hendrayana et al. 2019), lowlands and urban areas (Peniwidiyanti et al. 2022). In contrast, species such as *F. microcarpa*, *F. racemosa*, *F. ampelas*, *F. virens var. glabella*, and *F. subulata* were each restricted to a single known location in this study. Despite its limited distribution, *F. macrocarpa* is recognized as an invasive species due to its ability to thrive in environmentally harsh conditions. Its high fruit production attracts various dispersal agents, including birds, bats, and rodents, contributing to its rapid spread (Fiorenza et al. 2022).

Ficus fistulosa in the local language is known as *beunying*. This species had 2 variations based on the color of the fruit, namely green and brownish red. This species with brownish-red fruit was rarer than the green ones, growing at altitudes below 300 m asl (Wijaya and Delfiani 2021). Furthermore, this tree can grow up to 20 meters high, 20-25 cm in diameter with white stem. Stipules about 10 mm long, hairless leaves alternate, simple, 1 to 3 veins, glabrous. Figs measure 10 mm in diameter, yellow-brown, round, fleshy, arranged in groups with twigs and stems, *F. fistulosa* produces fruit in both axillary and cauliflorous forms. The axillary fruits are larger than the cauliflorous fruits and has a depressed-globose shape, while the cauliflorous fruits are globose. Adult trees only produce cauliflorous fruits, while axillary fruits appear in both juvenile and adult/mature stages of growth (Wijaya and Delfiani 2021).

Ficus septica in the local language is known as *kiciat*. The habitus is tree or shrub with height up to 10 meters and diameter up to 20 cm. The base of the stem is rounded, sharp tip, a flat edge, an upper surface of dark green, light green below, single leaf, and fruits are flattened, 2 cm in diameter, green. This species is widespread in South Asia, east to South China, Hainan, Formosa (Taiwan), and Japan, western Malesia east to east to Australia, and many locations in the Pacific Islands. In Southeast Asia, this species is recorded in the southern part of Sumatra, Java, East Kalimantan, the Philippines, Sulawesi, the Lesser Sunda Islands, the Maluku Islands, and New Guinea. This species grows in lowlands to sub-mountains or higher to montane forests at altitudes up to 1800 m asl and on primary and secondary vegetation. In Malesia, this species is more often found in river ecosystems, and this also adapted to urban ecosystems including urban forests (Harrison 2005). *Ficus septica* produces fruit quickly (Wijaya and Delfiani 2021). *Ficus subulata* is a climbing plant that has some unique interactions with its host. The bottom part of the tree is often in the shade, making a small canopy under its host. *Ficus subulata* canopy serves as a shelter for fruit-eating animals (Zhang et al. 2020). The study by Wijaya and Delfiani (2021) found that the *F. septica* was found everywhere, so it could adapt to all kinds of land use, like sand excavations, community gardens, and secondary forests.

Ficus variegata in the local language is known by the name *kondang*. This is a large pioneer tree with prominent hair, and the bark is pale pinkish brown (sometimes the tree was reddish-brown). The leaves are thin, heart-shaped, and has toothed edges, and grow in dense clusters on the stem (Kuaraksa et al. 2013). It has tree habitus up to 30 meters high and 70 cm in diameter, single leaf, spiral, oval, base rounded, pointed tip, serrated edge, green upper surface, and light green lower surface. The fruit is round, yellowish-green, or red when ripe, 3-5 cm in diameter. *Ficus variegata* could be found in many areas across Indonesia, including Bukit Barisan, Karangsari Research Station, Mount Tilu, and the bush area of Gunung Ciremai National Park (Hendrayana et al. 2022a). This strengthens the opinion that this species could adapt to various types of land use.

Ficus virens var. *glabella* in the local language is known as *Kiara bunut*. This has tree habitus, up to 15 meters high, and 30 cm in diameter, single leaf, spiral, lanceolate, blunt base, blunt to rounded tip, flat edge, green upper surface, yellowish green lower surface, and fruit, the color varies from cream to pink. Furthermore, this is one of the most interesting *Ficus* fruit-eating species (Shanahan et al. 2001). This species could be found in coastal forests, monsoon forests or savannas, on cliffs and also in secondary rainforests (Berg and Corner 2005), in lowland and hilly forests (Hendrayana et al. 2019) but could be used as ornamental and shade plants in Australia and China (Jim and Liu 2001). It has dust retention capabilities such as intercepting heavy metal pollutants from the atmosphere (Qiu et al. 2009). In other study (e.g., Hendrayana et al. 2022a), this type was only found in a location, namely Mount Tilu. In contrast, our study revealed that *F. virens* var. *glabella* was found in all land use locations, and it could be said that *F. virens* var. *glabella* has high adaptability. Additionally, this species could be used for rehabilitation efforts, as demonstrated by the study of Qin et al. (2024), which highlighted its positive impact on water absorption.

Ficus ampelas is characterized by oval leaves with sharp tips and blunt bases. Its small fruit changes color from yellowish green to orange when ripe. This species is commonly found in community gardens and secondary forests (Hendrayana et al. 2019) and has also been reported in Kalimantan (Sukmawati 2019). *Ficus callosa* and *F. fulva*, which are typically found near rivers, play an important role in protecting riverbanks, reducing flooding, and providing shelter and food for wildlife (Pothasin et al. 201). Yelastri et al. (2023) observed *F. ampelas* at an elevation of 36 m asl, demonstrating its ability to thrive in lowland areas. Meanwhile, other study (Hendrayana et al. 2019) recorded it at 500 m asl, further confirming the species' adaptability to a wide range of elevations. These findings suggest that *Ficus* species are versatile and can grow in various environments, with the six species examined showing great potential for land rehabilitation. The strategic use of these trees could greatly contribute to environmental restoration and sustainability initiatives in Kuningan District. The Importance Value Index (IVI) with a high percentage indicates that a plant species has a very

dominant role in a vegetation community. The high IVI reflects that the species has a high frequency of occurrence, large individual density, and significant spatial dominance compared to other species in the same location. This means that the plant is not only abundant, but also widespread and has a major influence on the structure of the ecosystem. This influence can be in the form of providing shade, changing soil moisture, and becoming the main food source for wildlife. Therefore, species with high IVI values are generally considered key species or important indicators in maintaining the balance and dynamics of the ecosystem in which they grow.

In conclusion, this study identified 16 *Ficus* species across different land uses in Kuningan District. Analysis revealed that six species, *F. benjaminam*, *F. fistulosa*, *F. septica*, *F. variegata*, *F. ampelas* and *F. virens* var. *glabella*, thrived in three land types: sand excavation sites, community gardens, and secondary forests. These six species are recommended as primary candidates for rehabilitating degraded land in Kuningan District. Planting the right *Ficus* trees could enhance environmental conditions and support conservation and sustainability efforts.

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