

Prioritizing Native Tree Species for Post-Coal Mining Revegetation via Stem-Cutting Potential in South Sumatra

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ABSTRACT

Post-coal mining lands are highly degraded ecosystems that require effective revegetation strategies to restore ecological functions. The use of native species with high ecological importance and favorable propagation characteristics may improve the success of revegetation programs. This study aimed to identify native tree species with potential for post-coal mining revegetation based on vegetation dominance and stem-cutting propagation potential. Vegetation inventories were conducted in natural areas surrounding coal mining concessions in South Sumatra, Indonesia. Species dominance was evaluated using the Importance Value Index (IVI), while propagation potential was assessed through a scoring approach based on vegetative regeneration capacity, shoot production ability, propagation material availability, tolerance to marginal site conditions, and supporting literature. The results identified 13 tree species, with *Dillenia pentagyna* (IVI = 53.73%) and *Peronema canescens* (IVI = 45.04%) showing high ecological importance and strong propagation potential. *Hibiscus tiliaceus* was also identified as a complementary species because it showed high stem-cutting propagation potential despite lower ecological dominance. The integration of IVI and stem-cutting propagation scores provides a practical basis for prioritizing native species for nursery development and operational post-coal mining revegetation.

Keywords: Ecological index, vegetative propagation, coal reclamation, tree dominance.

INTRODUCTION

Post-coal mining lands are degraded ecosystems that experience a substantial loss of ecological functions due to vegetation removal, soil structure deterioration and disruption of hydrological processes (Pratiwi et al., 2021). These disturbances contribute to increased soil erosion and biodiversity decline. Reclamation is therefore required to restore ecological functions and improve ecosystem stability (Yuningsih & Ibrahim, 2021). Revegetation is widely recognized as one of the most effective reclamation approaches and its success depends largely on the selection of plant species capable of adapting to the harsh

environmental conditions commonly found in post-mining landscapes, including low soil fertility and multiple ecological stresses (Hermansyah et al., 2022).

Native plant species play an important role in supporting ecosystem-based post-coal mining revegetation (Cross et al., 2021; Gairola et al., 2023). Species originating from surrounding ecosystems have naturally adapted to local environmental conditions, including acidic soils, nutrient limitations and climatic variability (Adesipo et al., 2021). Their utilization improves revegetation success while conserving local genetic resources and restoring ecosystem

structure and function in accordance with ecological restoration principles (Gairola et al., 2023). Limited seedling availability remains a major constraint to the large-scale application of native species in reclamation programs. Stem-cutting propagation provides a rapid, uniform and cost-effective method for producing planting materials to meet revegetation demands. Several native species exhibit high vegetation regeneration capacity, making them suitable for propagation through stem cuttings. This propagation technique reduces the need to collect planting materials from natural populations while supporting the sustainable production of native seedling for post-coal mining revegetation (Kettenhuber et al., 2023).

Lahat and Muara Enim Regencies in South Sumatra Province are among the major coal mining regions in Indonesia and contain extensive post-mining areas requiring reclamation (Maharani & Kundarto, 2024; Yuningsih & Ibrahim, 2021). Soil in these regions is generally characterized by acidic conditions and low fertility, creating significant challenges for revegetation efforts (Pratiwi et al., 2021). Natural vegetation surrounding mining areas provides valuable information for identifying species that are tolerant of such environmental constraints. Vegetation inventories conducted within and around mining landscapes can therefore serve as an important basis for selecting native species with high potential for reclamation purposes (Maharani & Kundarto, 2024).

Research focusing on native species with propagation potential through stem cuttings remains limited, particularly in post-mining ecosystems of South Sumatra (Hermansyah et al., 2022; Yuningsih & Ibrahim, 2021). Previous revegetation studies have predominantly emphasized plant growth performance while giving less attention to vegetation

propagation as a practical strategy for large-scale seedling production (Juniarto et al., 2025). This study aims to identify native plant species with high potential for revegetation of post-coal mining lands through stem-cutting propagation. The findings are expected to provide a scientific basis for developing effective, adaptive and sustainable reclamation strategies that utilize local biological resources and support long-term ecological restoration (Pratiwi et al., 2021).

The novelty of this study lies in the integration of vegetation dominance analysis and stem-cutting propagation assessment to prioritize native tree species for post-coal mining revegetation in South Sumatra. Unlike previous studies that mainly focused on vegetation composition or reclamation success, this study links ecological importance with practical seedling production potential to support operational-scale restoration. Unlike previous studies focusing solely on vegetation structure or growth performance, this study introduces an integrated prioritization framework combining Importance Value Index (IVI) and vegetative propagation scoring to select operational native species.

MATERIAL AND METHOD

Study Area

The study was conducted from January to May 2026 in Lahat and Muara Enim Regency, South Sumatra Province, Indonesia. Sampling sites were established within natural vegetation areas surrounding coal mining concession areas operating under Mining Business Permits. Site selection was performed purposively based on environmental characteristics and proximity to post-mining areas targeted for revegetation. The geographical distribution of the study sites is presented in Figure 1.

The study employed sampling plots measuring 20 x 20 m. Each study

site consisted of five systematically distributed sampling plots to represent the vegetation conditions at the respective locations. Information regarding the number of sampling plots, plot distribution across Lahat and Muara Enim Regencies, geographic coordinates and the status of each study site (natural vegetation, buffer area, reclamation area or vegetation surrounding the concession) is provided to enhance methodological transparency and ensure the reproducibility of the study.

Vegetation Sampling

Vegetation inventory was conducted at the tree growth stage using sample plots established within the selected study sites (Kent, 2011). Data collected included species identity, number of individuals, frequency of occurrence and diameter at breast height (DBH). The ecological importance of each species was assessed using the Importance Value Index (IVI), calculated as the sum of relative density, relative frequency and relative dominance (Dewiyanti et al., 2023). Species with high IVI values were considered dominant compared to the vegetation community and were prioritized as potential candidates for revegetation. The use of DBH greater than 20 cm should also be justified, for example as a criterion for focusing the inventory on established tree individuals that represent the dominant woody vegetation structure at the study sites.

The IVI components should be presented explicitly as follows: Relative Density = (number of individuals of a species / total number of individuals of all species) x 100; Relative Frequency = (frequency of a species / total frequency

of all species) x 100; Relative Dominance = (basal area of a species / total basal area of all species) x 100; and IVI = Relative Density + Relative Frequency + Relative Dominance (Dewiyanti et al., 2023).

Species Selection and Assessment

Species selection was performed based on IVI rankings. Species exhibiting the highest IVI values were subjected to further evaluation to determine their suitability for stem-cutting propagation. The assessment considered vegetative regeneration capacity, shoot production ability, availability of propagation materials, tolerance to marginal environmental conditions and evidence of successful vegetative propagation reported in scientific literature and field observations. Each criterion was assigned a score to classify species into low, moderate or high propagation potential categories (Massante et al., 2023).

The stem-cutting propagation potential of selected species was evaluated using a scoring system based on five criteria: vegetative regeneration capacity, shoot production ability, availability of propagation materials, tolerance to marginal site conditions and evidence of successful stem-cutting propagation reported in the literature (Massante et al., 2023; Meli et al., 2014). Each criterion was assigned a score ranging from 1 to 3, where higher scores indicated greater suitability for vegetative propagation.

The scoring category should be clarified. For example, a total score of 5-7 may be classified as low, 8-11 as moderate, and 12-15 as high propagation potential, provided that this classification is consistently applied to all selected species (Meli et al., 2014).

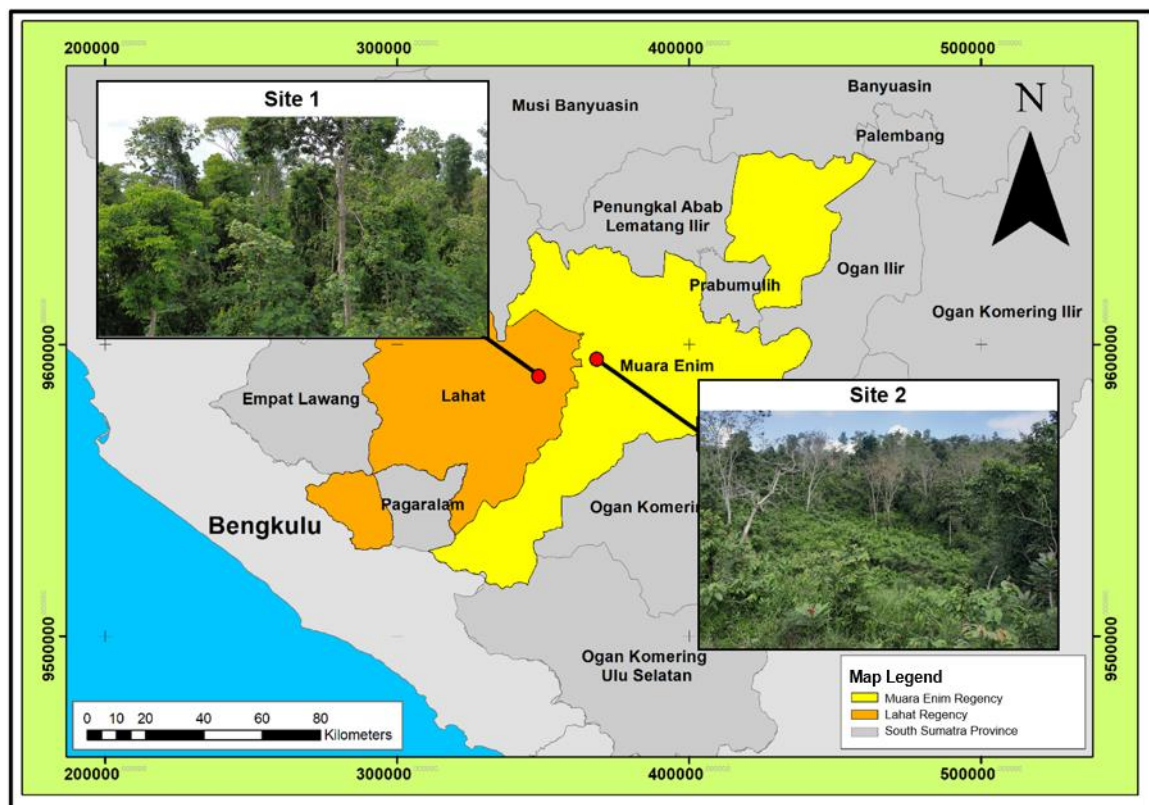


Figure 1. The geographical distribution of the study sites with sampling points, coordinates, scale bar, north arrow, administrative boundaries, and legend clearly displayed in the final figure

Data Analysis

Vegetation data were analysed using descriptive and quantitative approaches. IVI values were used to identify ecologically important and dominant species within the vegetation community (Dewiyanti et al., 2023). Results of the stem-cutting potential assessment were integrated with IVI values to determine priority native species suitable for post-coal mining revegetation. Species exhibiting both high ecological importance and high propagation potential were recommended as revegetation candidates.

RESULT AND DISCUSSION

Vegetation inventory conducted within natural areas surrounding the mining sites identified 13 tree species with stem diameters greater than 20 cm. The recorded species included *Acacia mangium*, *Aporosa isabelline*, *Cassia* sp.,

Dillenia pentagyna, *Endospermum malaccense*, *Endiandra* sp., *Fagraea fragrans*, *Gluta renghas*, *Hibiscus tiliaceus*, *Macaranga* spp., *Peronema canescens*, *Schima wallichii* and *Syzygium polyanthum* (Table 1 and Figure 2). The presence of these species indicates that the natural areas surrounding the mining concessions still support a relatively diverse tree community (Yuningsih & Ibrahim, 2021). The vegetation community observed at the study site reflects the capacity of native species to adapt to local environmental conditions characterized by acidic soils and low nutrient availability (Hermansyah et al., 2022).

Table 1. Relative Density, Relative Frequency, Relative Dominance, Importance Value Indeks (IVI) and Mean Stem-Cutting Scores of Native Tree Species.

No	Species	Relative Density		Relative Frequency		Relative Dominance		IVI		Mean Value
		A	B	A	B	A	B	A	B	
1	<i>Acacia mangium</i>	9%	23%	10%	11%	14%	20%	33%	54%	44%
2	<i>Aporosa isabellina</i>	5%	0%	5%	0%	14%	0%	24%	0%	12%
3	<i>Cassia</i> sp	9%	8%	10%	11%	14%	20%	33%	39%	36%
4	<i>Dillenia pentagyna</i>	14%	23%	14%	22%	14%	20%	42%	65%	54%
5	<i>Endospermum malaccense</i>	5%	0%	5%	0%	0%	0%	9%	0%	5%
6	<i>Endiandra</i> sp	0%	8%	0%	11%	0%	20%	0%	39%	19%
7	<i>Fagraea fragrans</i>	5%	0%	5%	0%	0%	0%	9%	0%	5%
8	<i>Gluta reinghas</i>	5%	0%	5%	0%	0%	0%	9%	0%	5%
9	<i>Hibiscus tiliaceus</i>	9%	8%	10%	0%	14%	0%	33%	8%	20%
10	<i>Macaranga</i> spp	5%	0%	5%	0%	14%	0%	24%	0%	12%
11	<i>Peronema canescens</i>	18%	15%	14%	22%	0%	20%	32%	58%	45%
12	<i>Schima wallichii</i>	14%	15%	14%	22%	14%	0%	42%	38%	40%
13	<i>Syzygium polyanthum</i>	5%	0%	5%	0%	0%	0%	9%	0%	5%
Total		100%	100%	100%	100%	100%	100%	300%	300%	300%

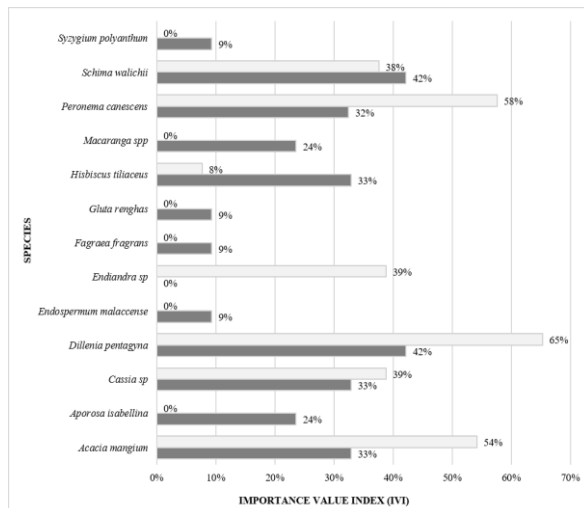


Figure 2. IVI of species recorded at the study site. Species names and IVI values should be displayed clearly and consistently.

The vegetation characteristics observed at the study site provide valuable information for the selection of species suitable for post-mining revegetation programs (Wijayanti et al., 2020). Species that can grow and develop naturally in areas surrounding mining

sites generally exhibit greater tolerance to environmental stress than species originating from outside the local ecosystems (Rios et al., 2023). The occurrence of these species under existing site conditions highlights the importance of natural vegetation as a reference for identifying suitable reclamation candidates (Suhati et al., 2025). The use of locally adapted species also supports ecosystem restoration efforts by promoting the establishment of vegetation that is compatible with the biophysical characteristics of the surrounding environment (Komara et al., 2016).

Importance value index (IVI) analysis revealed that *Dillenia pentagyna*, *Peronema canescens*, *Acacia mangium*, *Schima wallichii* and *Cassia* sp. were the most dominant species within the vegetation community (Table 1 and Figure 2). High IVI values indicate that these species contribute substantially to the structure and ecological function of the community at the study sites. Species

dominance of these species suggests that there is a high level of ecological suitability, making them promising candidates for post-coal mining revegetation programs (Dewiyanti et al., 2023).

The integration of IVI values and stem-cutting propagation provides a practical basis for selecting native species for post-coal mining revegetation (Table 2). *Dillenia pentagyna* and *Peronema canescens* exhibited both high ecological importance and high propagation potential, indicating their suitability as priority species for revegetation programs. High IVI values suggest that these species are well adapted to local environmental conditions and play important roles within the natural vegetation community. High propagation scores further indicate their potential for efficient large-scale seedling production through vegetation propagation (Kettenhuber et al., 2019).

This integrated approach is important because high ecological dominance alone does not automatically indicate suitability for operational revegetation. Species selected for post-mining restoration must also be practical for nursery production, locally adapted, and compatible with native-species-based restoration objectives.

The high capacity of *Dillenia pentagyna* and *Peronema canescens* to develop adventitious roots and shoots indicates their strong potential for vegetative propagation through stem cuttings. Both species possess physiologically active stem tissues that promote the formation of adventitious roots and new shoots after cutting. High meristematic activity facilitates cell division and differentiation at the basal portion of the cuttings, thereby accelerating root development. Endogenous auxin in stem tissues is likely to promote the initiation and development of adventitious roots during

the early stages of stem-cutting establishment (Olatunji & Verstraeten, 2017). Rapid root formation subsequently enhances water and nutrient uptake, thereby supporting shoot growth and improving the overall regeneration success of the cuttings. These characteristics support the rapid and efficient production of planting materials required for large-scale post-coal mining revegetation programs.

Hibiscus tiliaceus demonstrated high propagation potential despite its lower IVI value compared with the dominant species (Dewiyanti et al., 2023; Gairola et al., 2023). This finding suggests that the species may serve as a complementary component in revegetation programs, particularly where rapid seedling production is required. The ability of *Hibiscus tiliaceus* to establish through stem cuttings may provide operational advantages during large-scale reclamation activities (Juniarto et al., 2025).

Table 2. Priority native species for post-coal mining revegetation based on ecological importance and stem-cutting propagation potential.

Species	Mean IVI (%)	Ecological Importance	Propagation Potential	Revegetation Priority
<i>Dillenia pentagyna</i>	53,73	High	High	Very High
<i>Peronema canescens</i>	45,04	High	High	Very High
<i>Hibiscus tiliaceus</i>	20,30	Moderate	High	High
<i>Endospermum malaccense</i>	4,65	Low	Moderate	Moderate
<i>Accacia mangium</i>	34,54	High	Unsuitable	Not Recommended
<i>Schima wallichii</i>	39,91	High	Unsuitable	Not Recommended
<i>Cassia</i> sp.	35,85	High	Unsuitable	Not Recommended

Documentation from the nursery demonstrates the successful establishment of *Dillenia pentagyna*, *Peronema canescens* and *Hibiscus tiliaceus* through stem-cutting propagation (Figure 3). The successful

development of these species under nursery conditions supports the results of the propagation potential assessment and confirms their suitability for vegetative propagation (Gairola et al., 2023; Juniarto et al., 2025). Healthy shoot development and survival of propagated individuals indicate that these species possess favorable regenerative characteristics for seedling production. The ability to produce planting materials through stem cuttings provides a practical advantage for large-scale revegetation programs, particularly in post-coal mining areas where a continuous supply of seedling is required (Maharani & Kundarto, 2024).

Hibiscus tiliaceus should be positioned as a complementary revegetation species. Its high stem-cutting propagation potential can support rapid seedling production, but its lower IVI value indicates that it should be combined with ecologically dominant native species rather than used as the main restoration species.

Although *Acacia mangium*, *Schima wallichii*, and *Cassia* sp. showed relatively high IVI values, they were not prioritized in this study because the selection objective emphasized native-species-based restoration and practical stem-cutting propagation. Therefore, species with high dominance but limited

suitability for the intended ecological restoration approach were excluded from the priority recommendation (Suding et al., 2015).

This study has several limitations that should be considered when interpreting the findings. The assessment of stem-cutting propagation potential was based on evidence available in the scientific literature and has not yet been experimentally validated for all identified species. Root and shoot development may vary among species depending on several factors, including the physiological condition of the donor plants, the age of the cuttings, the growing medium, the application of plant growth regulators and environmental conditions during the propagation process. The study was also limited to vegetation inventories conducted in Lahat and Muara Enim Regencies, which may restrict the generalizability of the findings to post-coal mining areas with different ecological characteristics. Future research should include nursery-based propagation trials and long-term field validation to confirm the effectiveness of vegetative propagation and to evaluate the growth performance and adaptability of priority species under a range of reclamation conditions.



Figure 3. *Dillenia pentagyna* (a), *Peronema canescens* (b) and *Hibiscus tiliaceus* (c) propagated through stem cuttings under nursery conditions; the final manuscript should report cutting age, media, observation period, and survival or rooting indicators.

CONCLUSION

This study identified 13 tree species in natural vegetation surrounding coal mining areas in South Sumatra. The IVI analysis showed that *Dillenia pentagyna*, *Peronema canescens*, *Acacia mangium*, *Schima wallichii*, and *Cassia* sp. were dominant species in the study sites. By integrating ecological importance and stem-cutting propagation potential, *Dillenia pentagyna* and *Peronema canescens* were identified as the highest-priority native species for post-coal mining revegetation. *Hibiscus tiliaceus* may serve as a complementary species due to its high propagation potential. These findings provide a practical basis for native-species-based revegetation and nursery planning in post-mining restoration programs.

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