Published online on the page : https://journal.makwafoundation.org/index.php/edusains

Journal of Education and Science
(E D U S A I N S)

| ISSN (Online) 3030-8267 |

Evaluating Revegetation Techniques and Plant Growth Dynamics in Post-Coal Mining Reclamation

Anbya Ranindolla[1], Rudy Anarta[2*], Ichsan Invanni[3], Heri Prabowo[4]

[1,2,3,4] *Padang State University, Padang,* Indonesia

Article Information

Article History:
Submit : March 28, 2026
Revision : 04 April, 2026
Received : 17 May, 2026
Published: June 30, 2026

Keywords

growth dynamics, Falcataria moluccana, post-mining reclamation, ecological restoration, survival rate, revegetation techniques

Correspondence

E-mail: rudyanarta@ft.unp.ac.id*

A B S T R A C T

Post-mining land rehabilitation often faces challenges due to high vegetation mortality resulting from the degradation of soil's physical and chemical properties and the use of suboptimal silvicultural techniques. This study aims to evaluate the implementation of technical revegetation stages and measure plant growth dynamics in a coal mine reclamation area during the 2023–2024 period. A quantitative descriptive approach was applied to analyze the relationship between silvicultural stages—ranging from seedling propagation, land preparation, to stand maintenance—and the parameters of survival rate, height, and stem diameter of the plants. The results showed improved stand performance, with survival rates ranging from 65.63–98.48% in 2023 and increasing to 74.39–97.33% in 2024. Among the observed species, the Moluccan mahogany (Falcataria moluccana) exhibited the most adaptive growth performance, with an average height of 7.19 m and a diameter of 32.54 cm in 2023, and 6.49 m and a diameter of 40.80 cm in 2024. Variations in survival and growth among species underscore the importance of physiological adaptability to environmental stresses at mine sites. These findings highlight that consistent silvicultural management and the selection of appropriate pioneer species are key factors in accelerating the restoration of ecological functions on tropical post-mining lands.

1. Introduction

Coal mining activities with open-pit mining systems massively alter the landscape, trigger the loss of natural vegetation cover, and reduce the physical and chemical quality of the soil (Iskandar, Suryaningtyas, Baskoro, Budi, Gozali, Suryanto, et al., 2022). To restore ecological stability and site productivity, reclamation through revegetation is an imperative restoration stage (Hartati & Sudarmadji, 2022). Ideally, the effectiveness of revegetation in the post-mining landscape is not only measured by the smooth seedling planting stages, but is determined by the persistence of adaptability, the level of survival (*survival rate*), and the dynamics of sustainable stand growth (Bruno Rocha Martins et al., 2020). The achievement of the restoration requires the implementation of a series of planned and sustainable silvicultural treatments (Narendra et al., 2021), including seedling selection and propagation, improvement of root media, planting, embroidery, directed fertilization, and intensive maintenance (Sarah E. Rothman, C. Andrew Cole, Mary Ann Bruns, 2021).

Although the principles of silviculture have been widely adopted, empirical data in the field show considerable fluctuations in stand success between species and between sites (Gastauer et al., 2021). Previous research by Irianto (2024) documented the variation in the survival of marine sengon (*Falcataria moluccana*) between 74.99% and 82.71% in two different treads, which is accompanied by a disparity in high ripple and stem diameter (Zahar et al., 2024). On the other hand, Wulandari (Wulandari et al., 2025) affirms that the precision of technical execution (Hartati & Sudarmadji, 2024)—

from site preparation to stand maintenance—is a key determinant of rehabilitation success. However, most published reclamation evaluations are still partial: some studies report only numerical biometric data of stands without tracking the history of technical interventions applied, while operational studies often report technical stages without quantitatively linking them to the growth dynamics of multisession vegetation. The absence of an integrated synthesis between silvicultural compliance and plant biometric responses is the knowledge gap (*knowledge gap*) significant empirical (Fang et al., 2020).

In order to overcome these limitations, this study aims to comprehensively evaluate the implementation of revegetation techniques while measuring the dynamics of plant growth in the reclamation area of tropical coal mines during the 2023–2024 monitoring period. The silviculture parameters evaluated include the stages of nurseries, planting, embroidery, and structured maintenance, which are then linked to the metrics of survival percentage, high accumulation, and increase in plant stem diameter. The integration of these two evaluation domains is expected to not only provide an objective assessment of the restoration status of the study site (Ossanna et al., 2023), but also produced a prescriptive contribution in the form of a model of the relationship between gradual silvicultural interventions and the adaptability of pioneer vegetation on tropical degraded lands (Sierra T. Lauman, Catherine G. Fontana, Elise S. Gornish, 2026).

2. Method

This study uses a multisessional field monitoring design (*multitemporal field monitoring*) with an integrated quantitative approach (David J. Woodbury, Ishak Yassir, Arbainsyah, Danica A. Doroski, Simon A. Queenborough, 2019). The research was carried out in the post-coal reclamation area of PT Wahana Baratama Mining located in Tanah Bumbu Regency/South Kalimantan with location coordinates of 3°44′16.24" S and 115°17′50.44" E. The characteristics of the site are characterized by overburden rock accumulation material (*overburden*) with undulating topography. The climatic conditions of the study area include a wet climate with an average rainfall of around 2,307 mm/year. The evaluation was focused on revegetation planting units for the 2023 and 2024 planting years with a monitoring area of 3.24 ha each.

2.1. Sample Drawing Design and Survey Plot Allocation

Vegetation data collection was carried out using the example survey tile method (*sample plots*) (Vivi Novianti, Rob H. Marrs, Devi N. Choesin, Djoko T. Iskandar, 2018) which were placed by purposive sampling, to represent the variation of the microsite of the reclamation site. In each block of the planting year (2023 and 2024), as many as 10 measuring plots with dimensions of 40 m × 25 m were made with a sampling intensity of 15.43%. The initial planting distance applied to the site was 3 m × 3 m.

2.2. Technical and Biometric Data Collection Procedures

2.2.1. Evaluation of Silviculture Technical Implementation:

The assessment of the technical stages of revegetation—including the provision and seeding of plants, land preparation, planting, embroidery, watering, fertilization, and maintenance of the stand—is carried out through structured field observation (Dipita Ghosh, 2021) Using an operational compliance checklist that refers to the standard standards for mine reclamation, supported by a review of the revegetation operational logs for the 2023–2024 period.

2.2.2. Growth Biometric Measurement:

Vegetation parameters are measured censusally within the entire sample survey plot (Di Carlo et al., 2019). The observed parameters include:

- Number of live and dead plants per tree type (Vidal-Macua et al., 2020).
- The total height of the plant (*H*), measured from the base of the stem above the ground level to the top of the highest crown using a scale measuring pole with an accuracy of 0.1 m.
- Stem diameter (*D*), measured at the base of the root collar for seedling or chest height (diameter at breast height / DBH, 1.3 m from ground level) using a diameter tape with an accuracy of 0.1 cm.
- The analysis of the percentage of plant survival rate data was calculated by comparing the number of individuals alive during the inventory to the total seedlings planted on the survey plot, which was formulated as follows:

$$T = \frac{\sum hi}{\sum Ni}\ x\ 100\%$$

Description:

T = percentage of plant survival on plot i (%)

hi = individual number of plants that survived at the time of inventory

Ni = total seedlings planted on observation plot i

Height and diameter growth data were analyzed statistically descriptively to obtain the mean, standard deviation, and distribution range for each plant type. To compare the differences in growth between species and the dynamics between planting years (2023 and 2024), the data were analyzed using statistical tests that were in accordance with the characteristics and distribution of data at a significance level of $\alpha = 0.05$. Data analysis was carried out using IBM SPSS Statistics 22 software. All data acquisition permits have been approved by the concession management in accordance with compliance with the mining Environmental Occupational Safety and Health (K3L) protocol.

3. Results

3.1. Compliance Evaluation of Revegetation Technical Implementation

The technical implementation of revegetation in the post-coal mining reclamation area for the 2023 and 2024 planting periods is evaluated based on six stages of integrated silviculture: provision of seedlings, maintenance of seedlings in nurseries (*Nursery*), preparation of planting media, planting in the field, embroidery (*blanking/infilling*), and postplantation care (Iskandar, Suryaningtyas, Baskoro, Budi, Gozali, Saridi, et al., 2022).

Figure 1. Plant Preparation and Nurturing Activities of PT. WBM

Figure 2. Plant seed maintenance activities of PT. WBM

Figure 3. Condition of reclaimed land before planting

Figure 4. Planting activities on the reclaimed land of PT. WBM

Figure 5. Plant embroidery activities on the reclaimed land of PT. WBM

The land preparation stage is focused on the arrangement of the slope of the embankment and the placement of the topsoil layer (*topsoil spreading*) with a standard planting distance of 3 m × 3 m. Corrective activities in the form of embroidery are applied systematically to replace seedling mortality in the initial adaptation phase (Ahirwal & Maiti, 2018). In addition to periodic fertilization and watering, stand maintenance focuses on weed control and selective felling of competitor vegetation around the pioneer plant disc to minimize competition for growing space, light radiation, and nutrient uptake (Ahirwal, Maity, & Satyanarayana Reddy, 2017).

3.2. Survival Dynamics and Biometric Differentiation of Stands

The results of biometric monitoring showed significant variations in survival *rate*, average total height, and increase in stem diameter between planted species.

Table 1. Reclamation Crop Growth Data in 2023 & 2024

Year of Reclamation	Plant Type	Live Plants (%)	Average Height (m)	Average Diameter (cm)
2023	Sengon Laut	**97,31**	**7,19**	**32,54**
	I scar	**98,48**	**2,80**	**13,49**
	Durian	**65,63**	**1,32**	**4,39**
	Nangka	**84,13**	**1,84**	**7,26**
	Johar	**88,99**	**4,20**	**12,79**
2024	Sengon Buto	**97,33**	**3,39**	**11,61**
	Sengon Laut	**95,41**	**6,49**	**40,80**
	Mahoni	**84,64**	**2,40**	**7,06**
	Petai	**74,39**	**1,92**	**5,08**
	Nangka	**77,70**	**1,77**	**5,16**

In the 2023 planting block, survival rate ranged from 65.63% to 98.48%, where randu and sea sengon recorded the highest survival rate, while durian showed the lowest adaptation performance. In the 2024 planting block, the survival rate was stable between 74.39% to 97.33%, with sengon buto and sea sengon dominating the survival of the upright, while petai recorded the lowest number. In terms of vegetation structure accumulation, sea sengon (*Falcataria moluccana*) consistently exhibited the superior growth performance in both planting cohorts (Ahirwal & Maiti, 2017). In the 2023 block, sea sengon reached an average height of 7.19 m and a diameter of 32.54 cm, far surpassing other types such as johar (height 4.20 m; diameter 12.79 cm) and durian (height 1.32 m; diameter 4.39 cm). A similar trend was confirmed in the 2024 block, where sea sengon recorded the highest crown and stem dimensions (height 6.49 m; diameter 40.80 cm), followed by sengon buto (height 3.39 m; diameter 11.61 cm) and mahogany (height 2.40 m; diameter 7.06 cm). In contrast, the local fruit tree groups (durian, jackfruit, and petai) persistently showed a slow rate of riveting with the structural dimensions lagging behind.

4. Discussion

4.1. Ecophysiological Mechanisms of Variation in Growth Response Between Species

The findings of this study underscore the existence of a pronounced polarization of adaptability between groups of fast-growing pioneer trees (*fast-growing pioneers*) and fruit tree groups/local climaxes in post-mining soil media (Jitendra Ahirwal, Adarsh Kumar, 2018). Superior success of the sea sengon (*Falcataria moluccana*) and sengon buto in maintaining survival above 95% and spurring ripples of up to >30–40 cm in diameter are rooted in the physiological capacity of the Leguminosae group to adapt to the edapical stress of marginal land (V.C.P. Jitendra Ahirwal, 2020). In open-pit coal post-mining land, the root medium is generally characterized by high soil mass density, low porosity, and a deficiency of available nitrogen and phosphorus. The ability of pioneer legume species to form a symbiosis of free nitrogen anchoring and an aggressive root biomass allocation strategy allow for efficient nutrient and water uptake despite being on the backfill substrate (*overburden*) that have not yet matured. In contrast to the performance of pioneer legumes, low survival and biometric riap in durian (*Durio zibethinus*), shoulders (*Parkia speciosa*), and such as (*Artocarpus heterophyllus*) reflects the ecological incompatibility of the species in the early stages of revegetation (S. K. M. Jitendra Ahirwal, 2021). Fruit tree and semi-climactic species require adequate availability of soil organic matter, stable micro-moisture, and partial crown shade in the early seedling growth phase. Direct planting of this species (*direct planting*) in post-mining open sites without a sheltering stand exposing seedlings to extreme thermal radiation stress and high evapotranspiration rates, which in turn suppresses cambium cell differentiation and triggers stagnation of growth and seedling mortality (Ahirwal, Maiti, & Singh, 2017).

4.2. Reclamation Significance of Silvicultural Continuity and Implications of Reclamation Management

This evaluation proves that the success of post-mining reclamation is an interactive function between gradual silvicultural compliance and appropriate species selection (Ahirwal et al., 2020). The implementation of intensive maintenance, particularly intervention to cut down competitors' wild vegetation around the pioneer tree disk, has proven crucial in eliminating competition for nutrients and space (Domínguez-Haydar et al., 2019).

Figure 6. Plant care activities on the reclaimed land of PT. WBM

Invasive weeds on post-mining land often develop faster than tree seedlings, so without periodic selective weeding, revegetation plants are prone to dwarfing (*stunted growth*) (Wang et al., 2021). These findings provide important practical implications for tropical mine restoration design: revegetation strategies should not apply random mixed planting schemes simultaneously, but should instead adopt a two-phase gradual succession model (*two-stage planting strategy*) (G. Li et al., 2022). Pioneer phases (such as sengon) must be purely functional during the first 2–3 years to form a shade canopy, modify the microclimate, and improve soil litter before local or commercial fruit species are introduced as insert crops (*enrichment planting*) (J. Li et al., 2020).

4.3. Study Limitations and Future Research Recommendations

This study has limitations in a relatively short monitoring evaluation period (2023–2024 chronosequence), so the recorded data reflect the dynamics of initial adaptation and have not captured the stability of the stand structure to the climax maturity level. In addition, below-surface environmental parameters, such as soil pH evolution, hydraulic conductivity, and post-planting rhizosphere microbiome activity, have not been analyzed in an integrated manner with stand biometric data. Further research is recommended to model the interaction between the physical-chemical dynamics of the landfill and the accumulation of standing biomass carbon stocks longitudinally, in order to establish scientific *thresholds* for the sustainability of post-mining forest ecosystems permanently.

5. Conclusion

This study proves that the success of post-coal land restoration is determined by the consistency of the implementation of sustainable silviculture technical stages and the ecophysiological suitability of the planted tree species. The growth dynamics of stands show significant differentiation between species: fast-growing pioneer legume species, especially Falcataria moluccana, show the highest adaptability and biometric performance in both survival rates and high ripple accumulation and trunk diameter. In contrast, local fruit trees show depressed performance due to open environmental stress on the initial planting medium. In practical terms, this study recommends the need for a transition from simultaneous mixed planting methods to a two-stage succession model, in which pioneer stands are first used as facilitators of microclimate and soil structure restoration prior to the introduction of climactic vegetation types. Further research is needed to evaluate the interaction of the biogeochemical properties of the landfill soil with the productivity of stand biomass on a long-term monitoring scale.

Declarations

Author Contribution Statement

To be completed by the authors before submission in accordance with EDUSAINS authorship policy.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data Availability Statement

The bibliographic dataset was derived from Google Scholar through Publish or Perish version 8. The cleaned RIS file and keyword thesaurus used for the bibliometric analysis in this study are available from the corresponding author upon reasonable request.financial interests/personal relationships, which may be considered as potential competing interests.

Declaration of Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Additional Information

Correspondence and requests for materials should be addressed to Anbya Ranindolla, anbyaranindolla95@gmail.com

ORCID
Anbya Ranindolla 0009-0003-0893-2101
Rudy Anarta 0009-0003-0933-2714
Ichsan Invanni 0000-0002-3307-3818
Heri Prabowo 0000-0002-2474-6451

References

Ahirwal, J., Kumar, A., & Maiti, S. K. (2020). Effect of fast-growing trees on soil properties and carbon storage in an afforested coal mine land (India). *Minerals*, *10*(10), 1–15. https://doi.org/10.3390/min10100840

Ahirwal, J., & Maiti, S. K. (2017). Assessment of carbon sequestration potential of revegetated coal mine overburden dumps: A chronosequence study from dry tropical climate. *Journal of Environmental Management*, *201*, 369–377. https://doi.org/10.1016/J.JENVMAN.2017.07.003

Ahirwal, J., & Maiti, S. K. (2018). Development of Technosol properties and recovery of carbon stock after 16 years of revegetation on coal mine degraded lands, India. *CATENA*, *166*, 114–123. https://doi.org/10.1016/J.CATENA.2018.03.026

Ahirwal, J., Maiti, S. K., & Satyanarayana Reddy, M. (2017). Development of carbon, nitrogen and phosphate stocks of reclaimed coal mine soil within 8 years after forestation with Prosopis juliflora (Sw.) Dc. *CATENA*, *156*, 42–50. https://doi.org/10.1016/J.CATENA.2017.03.019

Ahirwal, J., Maiti, S. K., & Singh, A. K. (2017). Changes in ecosystem carbon pool and soil CO2 flux following post-mine reclamation in dry tropical environment, India. *Science of The Total Environment*, *583*, 153–162. https://doi.org/10.1016/J.SCITOTENV.2017.01.043

Bruno Rocha Martins, W., Douglas Roque Lima, M., de Oliveira Barros Junior, U., Sousa Villas-Boas Amorim, L., de Assis Oliveira, F., & Schwartz, G. (2020). Ecological methods and indicators for recovering and monitoring ecosystems after mining: A global literature review. *Ecological Engineering*, *145*, 105707. https://doi.org/10.1016/J.ECOLENG.2019.105707

David J. Woodbury, Ishak Yassir, Arbainsyah, Danica A. Doroski, Simon A. Queenborough, M. S. A. (2019). Filling a void: Analysis of early tropical soil and vegetative recovery under leguminous, post-coal mine reforestation plantations in East Kalimantan, Indonesia. *Land Degradation & Development*.

Di Carlo, E., Boullemant, A., & Courtney, R. (2019). A field assessment of bauxite residue rehabilitation strategies. *Science of The Total Environment*, *663*, 915–926. https://doi.org/10.1016/J.SCITOTENV.2019.01.376

Dipita Ghosh, S. K. M. (2021). Biochar-assisted eco-restoration of coal mine degraded land to meet United Nation Sustainable Development Goals. *Land Degradation & Development*.

Domínguez-Haydar, Y., Velásquez, E., Carmona, J., Lavelle, P., Chavez, L. F., & Jiménez, J. J. (2019). Evaluation of reclamation success in an open-pit coal mine using integrated soil physical, chemical and biological quality indicators. *Ecological Indicators*, *103*, 182–193. https://doi.org/10.1016/J.ECOLIND.2019.04.015

Fang, L., Xinju, L., Le, H., & Anran, S. (2020). A long-term study on the soil reconstruction process of reclaimed land by coal gangue filling. *CATENA*, *195*, 104874. https://doi.org/10.1016/J.CATENA.2020.104874

Gastauer, M., Sarmento, P. S. de M., Caldeira, C. F., Castro, A. F., Ramos, S. J., Trevelin, L. C., Jaffé, R., Rosa, G. A., Carneiro, M. A. C., Valadares, R. B. da S., Oliveira, G., & Souza Filho, P. W. M. (2021). Shannon tree diversity is a surrogate for mineland rehabilitation status. *Ecological Indicators*, *130*, 108100. https://doi.org/10.1016/J.ECOLIND.2021.108100

Hartati, W., & Sudarmadji, T. (2022). *The dynamics of soil carbon in revegetated post-coal mining sites : A case study in Berau , East Kalimantan , Indonesia*. *23*(10), 4984–4991. https://doi.org/10.13057/biodiv/d231004

Hartati, W., & Sudarmadji, T. (2024). *Soil depth constraints in the revegetation of reclaimed coal mine land*. *25*(4), 1838–1845. https://doi.org/10.13057/biodiv/d250454

Iskandar, I., Suryaningtyas, D. T., Baskoro, D. P. T., Budi, S. W., Gozali, I., Saridi, S., Masyhuri, M., & Dultz, S. (2022). The regulatory role of mine soil properties in the growth of revegetation plants in the post-mine landscape of East Kalimantan. *Ecological Indicators*, *139*, 108877. https://doi.org/10.1016/J.ECOLIND.2022.108877

Iskandar, I., Suryaningtyas, D. T., Baskoro, D. P. T., Budi, S. W., Gozali, I., Suryanto, A., Kirmi, H., & Dultz, S. (2022). Revegetation as a driver of chemical and physical soil property changes in a post-mining landscape of East Kalimantan: A chronosequence study. *CATENA*, *215*, 106355. https://doi.org/10.1016/J.CATENA.2022.106355

Jitendra Ahirwal, Adarsh Kumar, M. P. & S. K. M. (2018). Reclamation of coal mine spoil and its effect on Technosol quality and carbon sequestration: a case study from India. *Environmental Science and Pollution Research*, *25*, 27992–28003.

Jitendra Ahirwal, S. K. M. (2021). Restoring coal mine degraded lands in India for achieving the United Nations-Sustainable Development Goals. *Restoration Ecology*.

Jitendra Ahirwal, V. C. P. (2020). Restoration of mine degraded land for sustainable environmental development. *Restoration Ecology*.

Li, G., Hu, Z., Li, P., Yuan, D., Feng, Z., Wang, W., & Fu, Y. (2022). Innovation for sustainable mining: Integrated planning of underground coal mining and mine reclamation. *Journal of Cleaner Production*, *351*, 131522. https://doi.org/10.1016/J.JCLEPRO.2022.131522

Li, J., Yan, X., Cao, Z., Yang, Z., Liang, J., Ma, T., & Liu, Q. (2020). Identification of successional trajectory over 30 Years and evaluation of reclamation effect in coal waste dumps of surface coal mine. *Journal of Cleaner Production*, *269*, 122161. https://doi.org/10.1016/J.JCLEPRO.2020.122161

Narendra, B. H., Siregar, C. A., Turjaman, M., Hidayat, A., Rachmat, H. H., Mulyanto, B., Maharani, R., Rayadin, Y., & Prayudyaningsih, R. (2021). *Managing and Reforesting Degraded Post-Mining Landscape in Indonesia : A Review*.

Ossanna, L. Q. R., Serrano, K., Jennings, L. L., Dillon, J., Maier, R. M., & Neilson, J. W. (2023). Progressive belowground soil development associated with sustainable plant establishment during copper mine waste revegetation. *Applied Soil Ecology*, *186*, 104813. https://doi.org/10.1016/J.APSOIL.2023.104813

Sarah E. Rothman, C. Andrew Cole, Mary Ann Bruns, M. H. (2021). The influence of soil amendments on a native wildflower seed mix in surface mine restoration. *Restoration Ecology*.

Sierra T. Lauman, Catherine G. Fontana, Elise S. Gornish, J. W. N. (2026). Impacts of reclamation approaches on plant establishment in an arid environment during copper mine revegetation. *Restoration Ecology*.

Vidal-Macua, J. J., Nicolau, J. M., Vicente, E., & Moreno-de las Heras, M. (2020). Assessing vegetation recovery in reclaimed opencast mines of the Teruel coalfield (Spain) using Landsat time series and boosted regression trees. *Science of The Total Environment*, *717*, 137250. https://doi.org/10.1016/J.SCITOTENV.2020.137250

Vivi Novianti, Rob H. Marrs, Devi N. Choesin, Djoko T. Iskandar, D. S. (2018). Natural regeneration on land degraded by coal mining in a tropical climate: Lessons for ecological restoration from Indonesia. *Land Degradation & Development*.

Wang, K., Bi, Y., Cao, Y., Peng, S., Christie, P., Ma, S., Zhang, J., & Xie, L. (2021). Shifts in composition and function of soil fungal communities and edaphic properties during the reclamation chronosequence of an open-cast coal mining dump. *Science of The Total Environment*, *767*, 144465. https://doi.org/10.1016/J.SCITOTENV.2020.144465

Wulandari, M. N., Gunawan, R., Wardani, E., Studi, P., Mining, T., Cordova, U., Studi, P., Mining, T., Engineering, F., Southeastern, U. S., Land, B., & Drilling, B. (2025). *M i n e t e c h*. *4*(109), 69–83.

Zahar, W., Tampubolon, G., Nurdiansyah, F., & Yulanda, Y. A. (2024). *Evaluation of the Growth and Development of Sengon Plants (Albizia chinensis) on Former Coal Mine Reclaimed Land*. *24*(1), 42–50.