UDC 631

SUCCESS RATE OF BIOCHAR AND COW MANURE ON REVEGETATION OF SHOREA PARVIFOLIA PLANTS IN POST-MINING LAND

Sopan Mohamad*
Postgraduate Program, Study Program of Land Resources and Environmental Management, University of Lambung Mangkurat, Banjarbaru, Indonesia

Achmad Basir
Study Program Land and Environmental Resources Management, University of Lambung Mangkurat, Banjarbaru, Indonesia

Kissinger
University of Lambung Mangkurat, Banjarbaru, Indonesia

Ichriani Gusti Irya
Laboratory of Soil Biology, Department of Soil Science, Faculty of Agriculture, University of Lambung Mangkurat, Banjarbaru, Kalimantan Selatan, Indonesia

Darmawan Mohammad Akbar Ogy
Post Mining Coal Soil Rehabilitation, PT. Asmin Bara Bronang, Kapuas, Indonesia

*E-mail: sopanmuhamad01@gmail.com

ABSTRACT
On post-mining soils, revegetation efforts are very difficult; only 49.74 percent of local plants survive. A native plant species called Shorea parvifolia dominates in the original forest of the study site at PT ABB. The strategy to improve the quality of post-mining soil as a planting medium for Shorea parvifolia seeds is the use of biochar as an ameliorant. This study aims to analyze the Success Rate of Biochar and Cow Manure on the Revegetation Success of Shorea Parvifolia Plants in Postmining Land. A completely randomized design (RBD) approach was used in this study to determine the percentage of biochar and manure that would survive and be suitable as soil planting media on post-mining land and in the natural habitat of Shorea parvifolia. The research was conducted in PT ABB's nursery and studied five levels of post-mining soil treatment, manure and biochar mixture, namely (B1) 90%+10%+0%; (B2) 80%+15%+5%; (B3) 70%+20%+10%; (B4) 60%+25%+15%; and (B5) 50%+30%+20%, with untreated post-mining soil (B0) and forest soil from Shorea parvifolia habitat as controls (B0+). In the study unit, 97.3% of the seeds survived. The growth of seedling stem diameter at treatment level B2 is a research variable that is significantly different from the control (B0) with a p value of 0.005, but not significantly different from other growth variables.

KEY WORDS
Biomass, biochar, manure, post-mining, revegetation.

This mining system is carried out by opening a layer of soil covering the coal reserves underneath after previously clearing the forest. Efforts to revegetate post-mining land face many obstacles due to high nutrient extraction and not followed by nutrient additions and the formation of acid mine drainage. The results of laboratory analysis of the physical and chemical conditions of the soil from post-mining land show that there has been a decrease in soil fertility. Decline in soil quality which is a sign of soil degradation in PT Asmin Bara Bronang (PT ABB) post-mining land is known from the results of soil laboratory tests on the nutrient quality of post-mining soil.

Laboratory examination results showed that there was a decrease in the quality of chemical nutrients in post-mining soil compared to the nutrient quality of soil from natural forests, including: reduced organic matter content, namely only 0.793%; C-organic content 0.46%. cation exchange capacity (CEC) 15.04 me/100 g soil; The degree of acidity of the soil at the study site is considered acidic with a soil pH of 5.49 (Oksana et al., 2012). The addition of granular type organic fertilizer as additional soil nutrition and the provision of aquasorb which is a synthetic ameliorant acts as a water reserve storage around the root area is also carried out. During the period from 2013 to 2020, the company has revegetated 393 ha of post-mining land. The company managed to get approval from 3 governments in returning 128 ha of post-mining land in 2021.

The company's success in handing back post-mining land after extra effort was due to the fact that most of the local plant species did not grow, so they had to replace/plant new plant seeds several times. The average success of growing local plant species is only 49.74% (Source of data from the self-assessment report on the success of growing PT ABB's reclamation plants, 2020). This growth percentage according to the success category of post-mining land revegetation activities is still in the failed category (Shofiyah, 2005 in Gunawan et al., 2016). Increasing the percentage of successful growth for planting activities on post-mining land requires efforts to rehabilitate soil on post-mining land. Dry land management that does not follow soil and water conservation principles causes damage and reduces productivity (Situmeang, 2020). Post-mining land is dry land because this land is never inundated with water throughout the year.

Rehabilitation efforts are aimed at improving soil quality, including physical, chemical and biological properties. The use of ameliorant or biochar soil enhancer is an effort to improve soil quality. The addition of organic compost fertilizer and inorganic phonska fertilizer to biochar applications can meet sufficient and balanced nutrients (Situmeang, 2020). The potential for unutilized logged-over wood can be a source of raw material for biochar, amounting to 2,503 m3 (71% of the total cut) based on PT ABB Equipment's log report data in 2020. If this log is not managed, it can endanger activities. mining work that can cause accidents to employees. This study aims to analyze the success rate of biochar and cow manure on the success of revegetation of Shorea parvifolia plants in post-mining land.

MATERIALS AND METHODS OF RESEARCH

The study was carried out on soil from post-mining land of PT ABB Blok Prestasi which is at the ordinate point 50 204187 E 9890393 S. Soil from post-mining land was taken and then taken to the PT ABB company's revegetation plant nursery facility located in Barunang Village, Kapuas Tengah District, Kabupaten Kapuas. Map of research locations in the following figure:

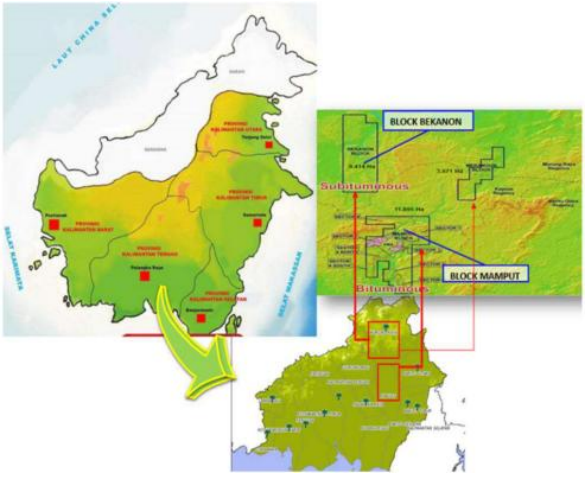

Figure 1 – Map of Research Locations

Biochar is made using forest wood biomass from logging residue from land clearing that is no longer marketable. Wood biomass processed into biochar through a pyrolysis process consists of keruing wood (Dipterocarpus grandiflorus), kempas wood (Kompassia malaccensis), and meranti wood (Shorea sp). Wood biomass is broken into pieces measuring approximately 10 x 15 cm and then fired by pyrolysis in a pyrolysator furnace at 462 °C for 3–4 hours. Biochar from pyrolysator combustion of three different types of woody biomass was analyzed in a coal laboratory, and it was found that biochar from keruing wood biomass had the lowest total moisture content, the highest calorific value, low ash content, and high carbon content. so biochar from fermented biomass was chosen as research material (Elisabeth, 2006; Iskandar and Rofiatin, 2017).

Table 1 – Summary of biochar analysis laboratory reports

Sample Name	Mass Received (Kg)	total humidity (%)	Humidity (%)	Ash (or %)	Fixed carbon (or %)	Calorie value (ar Kcal/kg)
Kruing Biochar	11,35	6,2	3,8	2,7	70,2	6993
meranti Biochar	12,44	7,0	3,9	3,0	70,4	6855
kempas Biochar	10,99	7,8	4,3	2,0	67,3	6739

Source: Secondary data from biochar analysis report from PT ABB laboratory operated by PT Geoservices.

The cows The manure used in this study came from cattle breeders of the lemosin type in North Loktabat village, Banjarbaru. _ Comparison of the content of C (carbon) and the content of N (nitrogen) in cow dung 15.5. The ratio of low carbon content to high nitrogen content means that organic matter contains a lot of nitrogen, and high nitrogen content will facilitate decomposition (Shiga, 1997; Muanawar, 2011). Report on the results of analysis by laboratory testing of the Banjarbaru Swampland Agricultural Research Institute on the nutrient quality of the cow dung used in this study shows that the ratio of carbon to nitrogen is 9.55 (Table 2).

Table 2 – Results of the analysis of the organic matter quality of cow manure

NO	No. Example	Code	pH	C org	N	P	K	Mg	Na	S	Fe
							%				ppm
1	90	Cow dung	6,45	12,61	1,32	0,47	0,17	0,29	0,06	0,29	5431

Primary Data Source: Primary data report on the results of examining the nutritional quality of organic cow dung from the Laboratory of Soil, Plants, Fertilizers and Water, Agency for Agricultural Research and Development, Testing Laboratory of the Banjarbaru Swamp Agricultural Research and Development Center (2021).

Planting media and soil for research materials were taken from the former coal mining area of PT ABB which had been revegetated with the pioneer plant Paraserianthes falcataria. Soil was brought to the research location at PT. Asmin Bara Bronang nursery, and the stones are cleaned by sifting. As a treatment it is mixed with cow dung and biochar from keruing wood biomass (Dipterocarpus grandiflorus). Treatment levels included five different levels (B1 to B5), and two treatments served as controls: untreated post-mining soil (B0) and soil habitat for seeds of the local plant species Shorea parvifolia as positive controls (B0 +). The five treatment proportions on post-mining land with the addition of manure and biochar as seed planting media, the research units are: 1) 90%+10%+0% (B1); 2) 80%+15%+5% (B2); 3) 70%+20%+10% (B3); 4) 60%+25%+15% (B4 ; and 5) 50%+30%+20% (B5). The total number of samples consisted of seven treatment groups. Each treatment unit consisted of five plants, then each treatment unit was repeated three times, so that the number of plants in the study unit was 105 stems.

The seeds of the local plant species Shorea parvifolia used in this study were produced from natural fallen seedlings in the Takaras Natural Forest, Manuhing District, Gunung Mas Regency, Central Kalimantan, and had been sown in the previous planting medium for approximately 11 months. The research seeds were selected to obtain physical uniformity before being randomized into the research unit seeds. Seedlings selected at random and applied as a study unit were cut and left with the same number of leaves as all seedlings in that unit.

The study was conducted using a completely randomized design. PT ABB's revegetation seed nursery facility as a research location has a paranet cover with 70% shading intensity. The research seeds that had been planted in all the research unit planting media were placed in the seedling rack with a lid for four weeks, and in the fifth week the research unit seed planting medium was transferred to the seedling rack without a lid. The research process was carried out for 12 weeks, and during that time the research unit received treatment in the form of watering twice a day in the morning and evening and spraying fungicide once. Observation and measurement of research variables was carried out after the research process passed 12 weeks of age. The main variable in this study was the growth of the seedlings of the local plant species Shorea parvifolia, which included stem height and diameter (cm), number of leaves (strands), fresh weight, and dry weight (g). Research data was analyzed using the IBM SPSS 23 software application using analysis of variance (ANOVA) to determine the effect of treatment on research variables.

RESULTS AND DISCUSSION

The results of the 12th week of research showed that the survival rate of the study unit at the overall treatment level was 97.3%. In the research unit, there were two seeds that died, namely the B5 treatment group. The B5 research unit group is a mixture of 50% post-mining soil, 30% cow dung, and 20% biochar. The results of laboratory analysis of the nutrient quality of the B5 research unit planting media samples and compared with the B0 (control) research unit planting media (Table 3) were significantly different based on the sign test through the IBM SPSS 23 software application (Table 4). The increase in soil nutrient content occurred at the following levels: total N content from 0.05% to 0.29%; C-organic from 0.47% to 4.82%; organic matter from 0.81 to 8.3; pH from 5.63 to 7.28; CEC from 9.06 me/100 g of soil to 12.09; and P2O5 particles available from 4.3 to 462.88.

Table 3 – Summary of soil nutrient analysis laboratory reports

Parameter	Mineral Soil Fertility Criteria (Subowo, 2010)			Sample Treatment Group		
	Low	Medium	High	B0+	B0	B5
Sand Soil Texture (%)				10	36	53
Dust (%)				25	24	20
Clay (%)				65	40	27
Soil texture classification				Clay	Clay loam	Sandy loam soil
N-Total (%)	0,1-0,2	0,21-0,5	0,51-0,75	0,26	0,05	0,29
C-Organic (%)	1- 2	2,01 - 3	3,01 - 5	4,29	0,47	4,82
Organic materials				7,4	0,81	8,31
P_2O_5 (mg/100 g)	15-20	21-40	41-60	22,74	11,7	154,48
K_2O (mg/100 g)	10-20	21-40	41-60	12,48	8,97	160,92
P_2O_5 tsd (particle)				12,55	4,3	462,88
pH (H_2O)	4,5-5,5	5,6–6,5	7,6–8,5	4,39	5,63	7,28
pH (KCl)				3,55	3,81	5,77
Ca-dd (me/100 g)	2 - 5	6 - 10	11 - 20	0,58	1,55	9
Mg-dd (me/ 100 g)	0,4-1	1,1–2,0	2,1-8	0,15	0,29	3,7
Na-dd (me/ 100 gr)	0,1–0,3	0,4–0,7	0,8 -1	< 0,06	0,1	< 0,06
K-dd (me/ 100 gr)	0,1–0,3	0,4–0,5	0,6-1	0,15	0,1	1,65
KTK (me/100g)	5-6	17-24	25-40	15,71	9,06	12,09
Al-dd (me/ 100 g)				7,86	3,8	< 0,05
H-dd (me/ 100 g)				1,29	0,6	0,41
C/N ratio	5-10	11-15	16-25	16,5	9,4	16,6

Source: Soil Quality Analysis Report, Soil Laboratory, PT. Indonesian Biotechnology Biodiversity.

The availability of P 2 O 5 particles that is too high, and soil pH conditions which tend to be alkaline cause the amount of phosphorus (P) to decrease. absorbed more. Increased P uptake is accompanied by increased Ca, Mg, and K uptake by plants for load balance. Too much phosphorus in the soil can also cause Zn or Fe deficiency. The death of two seedlings in the research unit group B5 was related to the deficiency of Zn and Fe elements. The occurrence of Zn deficiency can be seen from the condition of the seedlings before dying, including stunted plants, shortened stem segments, wasting and adjustment of leaves, and

chlorosis of young leaves. Fe deficiency experienced by plants will affect their ability to compose chlorophyll, proteins, and enzymes and interfere with the formation of chloroplasts (Mindari *dkk.*, 2018, hlm. 36, 40, 77–84).

Table 4 – Conclusion of the test results for the quality sign of nutritional content

Sample pair	Σ Negative Difference	Σ Positive Difference	Tie	Total	Right Sig (2-tile) / P value	Conclusion
B0 – B1	3	16	0	19	0,004	Very different
B0 – B2	3	16	0	19	0,004	Very different
B0 – B3	3	16	0	19	0,004	Very different
B0 – B4	4	14	1	19	0,031	Very different
B0 – B5	5	14	0	19	0,064	Very different

The criteria for rejecting or not rejecting Ho based on the p value are as follows:

- *If the P-value (Sig) is less than 0.05 then H0 is rejected;*
- *If the P-value (Sig) is greater than (= 0.05), then H0 is accepted.*

The P-Value (Exact Sig) above is for 2-party testing. Because this test is a one-tail test, the P-Value (Exact Sig) must be divided by two.

The portion of the addition of biochar and manure as ameliorant of ex-mining soil is most suitable for the growth of Shorea parvifolia. Differences in the growth of research unit seedlings based on observational data of the main research variables in the 12th week of the local plant species Shorea par vi if olia were tested by analysis of variance (ANOVA). A classic test is required before the data is analyzed with ANOVA to ensure that the data is normally distributed and homogeneous (Faradiba, 2020, p. 27). The results of the classic test using the IBM SPSS 23 software application on the observation data of the main research variables show that the variables are normally distributed and homogeneous. The normality of the data is known from the Skewnes and Kurtosis ratio values in the range of values between +2 and -2 (Nihayah, 2019). The homogeneity of the observation data for the research variables was tested by Levene's test with a sig value > 0.05. The results of the ANOVA test on the observation data of the primary research variables showed that the calculated F value for the growth variable of the stem diameter (cm) of Shorea parfivolia was 3.347, while the F table value was 2.10 (Table 5). The calculated F value based on the results of the ANOVA test is known to be greater than the table F value. The results of the ANOVA test also showed a sig value of 0.005, which means much smaller than 0.01, so it can be concluded that the growth variable in the diameter of the seedlings of the Shorea parvifolia type plant was very significantly different, while other growth variables, plant stem height, number of leaves, fresh weight , and dry weight, were not significantly different.

Table 5 – Results of analysis of variance (ANOVA) of observational data

		Sum of Squares	df	Mean Square	F	Sig.	
Stem height	Between Groups	51.901	6		8.650	,592	,736
	In Groups	1314.137	90		14.602		
	Total	1366.038	96				
Stem Diameter	Between Groups	,045	6		,007	3.347	,005
	In Groups	,212	95		,002		
	Total	,257	101				
Number of leaves	Between Groups	91.117	6		15.186	1.221	,302
	In Groups	1156.354	93		12.434		
	Total	1247.471	99				
Gross weight	Between Groups	13.775	6		2.296	,575	,749
	In Groups	379.063	95		3.990		
	Total	392.838	101				
Dry weight	Between Groups	1.718	6		,286	,538	,778
	In Groups	49.482	93		,532		
	Total	51.201	99				

The calculation of the degree of authenticity or the coefficient of diversity of the research data on the growth of stem diameter in the research unit was 11.825%, so that a further test of multiple comparison differences was carried out using the Poshoc DMRT

(Duncan's Multiple Range Test) Test of 5% (Hanafiah, 2000, p. 32). The results of the 5% DMRT post hoc test showed that the difference in the growth of the stem diameter of the research unit seedlings which was significantly different from the control (B0) was the growth in the diameter of the research unit plant seeds at the B0+ and B2 treatment levels (Table 6).

Table 6 – Results of the analysis of the effect of all levels of the treatment group on the growth of the stem diameter (cm) of Shorea parvifoliawith 5% DMRT test

Care Code	Treatment description	Stem diameter at 12 weeks of observation (cm)
B0+	100% ground forest habitat of the Shorea parvifolia species	0,415 c
B2	80% ex-mining land + 15% cow dung + 5% biochar	0,399 SM
B4	60% ex-mining land + 25% cow dung + 15% biochar	0,379 abc
B5	50% ex-mining land + 30% cow dung + 20% biochar	0,374 ab
B1	90% ex-mining land + 10% cow dung + 0% biochar	0,366 ab
B0	100% ex-mining land + 0% cow dung + 0% biochar	0,359a
B3	70% ex-mining land + 20% cow dung + 10% biochar	0,352a

Note: Numbers in the parameter column followed by the same letters do not show significant differences in the 5% DMRT test.

Soil fertility is the status of a soil that shows its ability to provide essential elements, both non-mineral (C, H, and O) and essential mineral elements (N, P, S, K, Ca, Mg, Fe, Mn, and Cu)), in sufficient quantities for plant growth without toxic concentrations of any elements so that plants can complete their life cycle normally (Foth and Ellis, 1997; Munawar, 2011, p. 2).

The results of laboratory analysis of post-mining soil nutrients from the planting media samples at treatment level B2 were significantly different from the nutrient quality of post-mining soil at control level B0, based on the results of the sign test through the application of the IBM SPSS 23 software. The condition of the nutrient quality of the soil in the planting medium with levels of B2 treatment is closest to the condition of the nutrient quality of the planting media soil habitat of Shorea parvifolia as a positive control (B0 +) (Table 7). The growth habitat of a plant species shows the suitability of the available nutrients in the soil with the needs or growing conditions of the plant.

Table 7 – Summary report on the results of laboratory analysis of soil nutrient quality in the treatment group B0+; B0; & B2

NO	Parameter	Mineral soil fertility criteria (Subowo, 2010)			Sample Treatment Group		
		Low	Medium	High	B0	B2	B0+
1	Sand (%)				36	30	10
	Dust (%)				24	29	25
	Clayey (%)				40	41	65
	Soil texture classification				Loamy clay	Clay	Clay
2	N-Total (%)	0,1-0,2	0,21-0,5	0,51-0,75	0,05	0,1	0,26
3	C-Organik (%)	1- 2	2,01 - 3	3,01 - 5	0,47	1,35	4,29
4	Organic Ingredients				0,81	2,33	7,4
5	P_2O_5 (mg/100 g)	15-20	21-40	41-60	11,7	68,85	22,74
6	K_2O (mg/100 g)	10-20	21-40	41-60	8,97	63,85	12,48
7	P_2O_5 tsd (particle)				4,3	105,22	12,55
8	pH (H_2O)	4,5-5,5	5,6–6,5	7,6–8,5	5,63	6,11	4,39
9	pH (KCl)				3,81	4,19	3,55
10	Ca-dd (me/100 g)	2 - 5	6 - 10	11 - 20	1,55	5,22	0,58
11	Mg-dd (me/ 100 g)	0,4-1	1,1–2,0	2,1-8	0,29	1,82	0,15
12	Na-dd (me/ 100 g)	0,1–0,3	0,4–0,7	0,8 -1	0,1	0,11	< 0,06
13	K-dd (me/ 100 g)	0,1–0,3	0,4–0,5	0,6-1	0,1	0,55	0,15
14	KTK (me/100g)	5-6	17-24	25-40	9,06	12,85	15,71
15	Al-dd (me/ 100 g)				3,8	0,51	7,86
16	H-dd (me/ 100 g)				0,6	0,29	1,29
17	C/N ratio	5-10	11-15	16-25	9,4	13,5	16,5

Source: Soil Quality Analysis Report, Soil Laboratory, PT. Indonesia's Biotechnology Biodiversity, 2022.

The levels of several nutrient components in the soil samples of the planting medium at the B2 treatment level increased and were similar to the nutrient quality conditions of the

soil in the B0+ planting medium (positive control), namely: nitrogen content (N) from 0.5% to 1%; C-organic content from 0.47% to 1.35%; soil organic matter content (BOT); P2O5 particle content from 4.3 to 105.22; cation exchange capacity from 9.06 to 12.85 me/100 g soil; and soil pH from 5.63 to 6.11 (Table 7).

The survival rate of a plant in a growing medium is the same as the habitat of a plant species. The survival rate is determined by the suitability of land conditions with plant growth conditions (Setiadi, 2011; Kissinger and Yani, 2020). A significant difference in one of the main research variables, namely the stem diameter growth of the local Shorea parfivolia plant in the planting medium at the B2 treatment level, indicates that this treatment level is in accordance with the growing needs of the local plant species. The suitability of the conditions of the planting media at the B2 treatment level was proven by the results of the soil nutrient analysis report of the planting media from the laboratory which showed the similarity of soil nutrient levels in the positive B0+ planting medium. control. The soil in the B0 + planting medium is the same soil that was included in this study as a positive control, namely the planting medium from coastal soil. habitat of parvifolia species found in the study area. The level of B2 treatment in this study was a mixture of 80% post-mining soil, 5% biochar, and 15% cow manure.

CONCLUSION

The wood biomass left over from felling of keruing forest trees (Dipterocarpus grandiflorus) resulting from land clearing before open pit mining activities can be used as biochar through pyrolysis with little or no oxygen. Biochar from kruing wood biomass can be used as a post-mining soil amendment along with cow dung. The proportion of addition of post-coal mining soil up to 5% biochar and 15% cow dung is the most suitable proportion as a growing medium for local Shorea plant species. parvifolia.

Soil nutrient levels in ex-coal mining land treated with the addition of 5% biochar and 15% manure increased and approached the nutrient quality conditions in the soil habitat of local Shorea plant species. parvifolia. The increased levels of these nutrients were: nitrogen (N) content from 0.5% to 1%; C-organic content from 0.47% to 1.35%; soil organic matter content (BOT); P2O5 particle content from 4.3 to 105.22; cation exchange capacity from 9.06 to 12.85 meq/100 g soil; and soil pH from 5.63 to 6.11.

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