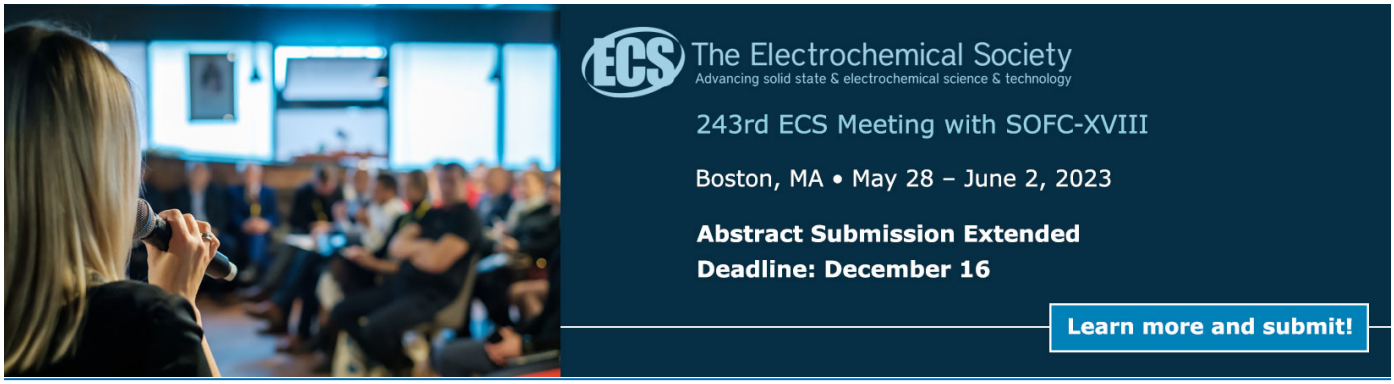
Potential and value of utilization of community forest logging waste in Cenrana Baru Village, Cenrana District, Maros Regency



Potential and value of utilization of community forest logging waste in Cenrana Baru Village, Cenrana District, Maros Regency

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Abstract. This study aims to determine the potential and value of using logging waste in community forests in Cenrana Baru Village, Cenrana District, Maros Regency. This research was carried out from August 2019 – January 2022 in a community forest. Based on the results of the study, it was found that the largest waste potential of the average volume of waste in acacia trees is 0.28 m^3 (30.39%), stump waste 0.06 m^3 (11.21%), waste above branch free 0.07 m^3 (8.89%), branch waste 0.04 m^3 (4.79%), while in the candlenut tree the largest waste is the main trunk 0.80 m^3 (35.87%), stump waste 0.14 m^3 (6.75%), branch waste 0.13 m^3 (6.41%), waste above branch free 0.09 m^3 (4.83%). Community forest logging waste is used by the community for making garden fences and making charcoal from acacia wood, this waste has a price value of IDR 15,000 per stem. while in the candlenut tree, the largest waste is the main trunk 0.80 m^3 (35.87%), stump waste 0.14 m^3 (6.75%), branch waste 0.13 m^3 (6.41%), the above waste is free to branch 0.09 m^3 (4.83%).

1. Introduction

Until now, the utilization of wood in Indonesia has not been effective and efficient because the amount of wood used is generally still low compared to the volume of wood that is cut. Tree parts such as stumps, branches, twigs and defective trunks are generally left in the forest and become waste [1]. Harvesting waste is a part of the trunk or part of a tree that is allowed to be cut but is not utilized based on the current utilization pattern and is left in the forest. This harvesting waste can come from stumps, branch-free stems, upper stems and branches. The results of research conducted by Mujetahid [2] show that utilization of waste will increase the supply for the needs of the wood processing industry which is still lacking. The need for logs for the industry in 2015 reached ± 63.4 million m^3 but log production was only ± 35.1 million m^3 resulting in a shortage of supply of 28.3 m^3[3]. Nurrochmat [4], stated that the installed capacity of the wood processing industry is estimated to lack the need for logs to reach ± 40 million m3/year.

Research on logging waste is mostly done on the wood waste that occurs in industrial plantation forests, but research on logging waste using wood processing in community forests has not been widely carried out so not much information is available. Research is needed on the potential and utilization of community forest logging waste. One of the potential community forests in South Sulawesi Province, especially Maros Regency, has a large enough potential that is around 15,000 ha, based on data from the Forestry and Plantation Service of Maros Regency in 2011. The potential of wood will have economic value if it has been removed from the forest to be industrial or industrial.

The purpose of this research is to determine the potential of community forest logging waste and the value of utilizing the waste generated in Cenrana Baru Village, Maros Regency.

2. Research Methods

This research was conducted from August 2019 - January 2022 in the Community Forest area in Cenrana Baru Village, Cenrana District, Maros Regency, South Sulawesi Province. The tools and materials used in this study were a rolling meter and tape meter used to measure the length and circumference of the logs and the diameters that could be utilized or in the form of waste from logging, calculators, writing instruments, tally sheets and haga meters. The materials used are acacia and candlenut trees which are ready to be cut down. Data collection is done through observation and recording in the field. The data collected was then processed using the formula for measuring the diameter and calculating the volume of waste with a total sample of 20 trees.

2.1. Data analysis

The data collected is then analyzed quantitatively using the formula:

2.1.1. Diameter measurement. Measure the diameter of the log using the equation below:

$$D = \frac{Dp+Du=\frac{1}{2}(d1+d2)+\frac{1}{2}(d3+d4)}{2} \quad (1)$$

Where:

D = Diameter of the log (cm)
Dp = The average diameter of the base bounty in multiples of one full cm, obtained from the shortest diameter (d1) and the longest diameter (d2) through the center of the bounty (cm).
Du = The average diameter of the tip bounty in multiples of one full cm, obtained from the shortest (d3) and longest (d4) diameters through the center of the bounty as well (cm).

2.1.2. Waste volume calculation. The calculation of the volume of waste consists of the waste stump, main stem, branches and above without branches using the Brereton metric formula, according to the following instructions for measuring and determining the contents of logs in Indonesia [5]:

$$V = 0.7854 \times D^2 \times L \quad (2)$$

Where:

V = volume or volume of logs (m^3)
L = log length (m)
D = diameter of log (cm)
0.7854 is the number of = x 3.1416

To calculate the total volume of wood, the following formula is used:

$$VTK = VKpb + VLpb \quad (3)$$

Where :
VTK = Total volume per tree (m^3)
VKpb = Volume of felled wood (m^3)
VLpb = Volume of felling waste (m^3)

To calculate the total volume of waste, the following formula is used:

$$VTL=VLtg + VLbu + VLcb + VLdbc \quad (4)$$

Where:
VTL = total volume waste per tree (m^3)
VLtg = volumestump waste (m^3)
VLbu = volume main stem waste (m^3)
VLcb = volume branch waste (m^3)
VLdbc = volume waste above branch free (m^3)
Calculation of the percentage of waste wood

$$PL = \frac{VTL}{VTK+VTL} x\ 100\% \quad (5)$$

Where:
PL = Percentage of waste wood in percent (%)
VTL = total volume of waste per tree (m^3)
VTK = total volume of usable wood per tree (m^3)

3. Results and Discussion

3.1. Potential logging waste

Forest harvesting always leaves the wood in the forest which is called harvesting waste. Logging has the potential to produce waste in the form of stumps and broken stems. Cutting the canopy (topping) and cutting branches and twigs (debranching) have the potential to produce waste in the form of branches and twigs. Meanwhile, bucking has the potential to produce waste in the form of short pieces, as well as defective wood waste such as rotting wood waste and rotten liver/*gerowong*. The definition of waste in this study, namely the part of the wood or tree that is cut down and still possible to use because it has a diameter that still meets the requirements for sawn wood for ingredients for local villagers' houses or raw material for furniture by industries in the city. If it is not utilized as much as possible by the residents, a lot of wood waste that is left or not utilized is left to rot in the forest which results in even greater carbon emissions resulting from the decaying process of wood waste at the logging location [6]. The general definition of waste as described previously is that felling waste is a part of wood from a tree due to defects, damage, or breakage, too small a diameter and a length that does not meet the requirements for a particular purpose. Based on this understanding, the following research results were obtained. The stages of forest harvesting that have the potential to produce the largest waste wood are tree felling activities [7].

3.2. Logging process

The felling team consisting of one chainsaw operator and one helper plays an important role in feller activities. Based on the experience carried out by loggers with the ability to cut trees and divide trunks an average of five trees per day. This community forest logger uses a logging team consisting of one chainsaw operator assisted by one helper. The helper is usually appointed by just anyone because it does not require special skills. In this study, the person who acts as a helper is the owner of the wood itself. This helper is in charge of helping determine the direction of the tree's fall and cleaning up disturbing things around the tree. Determination of the direction of fall is carried out by the operator by taking into account the direction of skidding, the place for the stem and avoiding breakage to a minimum.

The next stage is the division of stems which is carried out by stem-by-stem management, namely the size of the cutting starting from the base to the tip while taking into account the quality of the wood on the branches that can be used for carpentry. Before dividing the trunk, measurements were made on the stem according to the specified size using wood that had been previously oiled. Logs are cut according to the marking path that has been made into a specific bearing or sortiment. The wage system used at the time of felling is per tree and per sortimen size. For the calculation per tree, one tree is calculated IDR. 100,000 - IDR. 200,000 depending on the size of the tree, while for the count per size sortiment, for a pole with a size of 10 cm as much as IDR. 10,000/pole. For blocks with a size of 4

x 6 cm as much as IDR. 4,000/beam and size 3 x 12 cm as much as IDR. 7,000/beam and for the size of the board with a size of 2.5 x 20 cm as much as IDR. 5,000/board. Experienced chainsaw operators can produce high felling productivity [8]. Matangaran and Anggoro [9], stated that logging has the potential to produce waste in the form of the stump and broken stems, while the division of stems has the potential to produce waste in the form of short pieces, as well as defective wood waste such as rotted and rotten wood waste or gerowong.

3.3. Arrear waste

The measurement of the height of the stumps above the ground level up to the highest limit of the former ballast notch created by the volume of stump waste that occurred from the logging of acacia and candlenut wood for each tree can be seen in Table 1.

Table1. Length, diameter and volume of acacia and candlenut stumps in community forest logging activities in Cenrana Baru Village, Cenrana District, Maros Regency

Tree Name	Arrears Height	Diameter (cm)	Tree Volume (m^3)	Solid Waste Volume (m^3)	Percentage (%)
Acacia	39	56.45	1.10	0.10	7.68
	54	44.72	0.97	0.08	2.98
	21	41.79	0.66	0.03	9.84
	59	37,40	0.47	0.06	6.61
	24	40.67	0.47	0.03	8.36
	30	40.76	0.67	0.04	7.12
	45	36.79	0.60	0.05	7.91
	29	45.49	1.03	0.05	4.29
	31	42.66	1.00	0.04	15.96
	65	55.82	1.56	0.16	41.30
Amount			8.52	0.64	
Average	39.7	44.26	0.85	0.06	11.21
Hazelnut	58	68.58	2.68	0.21	8.00
	50	72.38	3.32	0.21	6.18
	31	60.83	2.15	0.09	4.18
	35	52.71	1.23	0.08	6.18
	40	63.32	2.22	0.13	5.68
	46	59.15	1.99	0.13	6.34
	38	53.74	1.40	0.09	6.15
	80	62.69	1.71	0.25	14.47
	28	53.92	1.55	0.06	4.13
	51	69.25	3.13	0.19	6.13
Amount			21.38	1.43	
Average	45.7	61.65	2.14	0.14	6.75

Table 1 shows the results of felling acacia and candlenut with an average diameter of 44.26 cm and 61.65 cm and an average stump height of 39.7 cm and 45.7 cm, respectively. The average volume of acacia waste is 0.06 m^3 and candlenut 0.14 m^3. This indicates that the chainsaw operator performs logging with an average stump height of 35 cm. The determination of the height of the stump only considers the technical ease of the feller. Cowl waste that is left behind or not used is left as waste

because the community and local industry do not yet have the knowledge to process cowpea waste into useful raw materials.

3.4. Main trunk waste

The main stem waste was measured in length and the diameter of the tip and base. This waste occurs as a result of making the wrong notch and trimming the base, tip and middle of the stem that is defective/damaged. Dimensions measured were base diameter, tip diameter and stem length.

Table 2. Length, diameter and volume of acacia and candlenut main trunk waste in community forest logging activities in Cenrana Baru Village, Cenrana District, Maros Regency

Tree Name	Length (m)	Diameter(cm)	Tree Volume (m^3)	Main Stem Waste Volume (m^3)	Percentage (%)
Acacia	6.1	74.97	1.10	0.55	49.60
	7.25	74.20	0.97	0.23	23.53
	5.25	53.22	0.66	0.14	21.92
	4.3	56.02	0.47	0.17	37,10
	3.25	52.21	0.47	0.12	24.66
	4.1	51.97	0.67	0.14	20,19
	4	30.22	0.60	0.18	30.01
	4.6	67.09	1.03	0.21	20.57
	4	35,30	1.00	0.28	28.04
	11	166.93	1.56	0.75	48.32
Amount				8.52	2.77
Average	5.39	66.21	0.85	0.28	30.39
Hazelnut	7.2	98.95	2,676	1.02	38.11
	10.23	154.04	3,324	1.42	41.63
	6.07	90,70	2,153	0.49	22.25
	8.08	75.00	1,235	0.55	44.58
	12.32	127.55	2,216	0.95	41.82
	5.6	89.35	1,992	0.42	20.57
	6.05	80.81	1,401	0.53	36.73
	9.19	116.96	1,705	0.72	41.02
	6.18	84.04	1.546	0.41	26.07
	10.1	155.75	3,130	1.48	45.94
Amount			21.379	8.00	
Average	8.10	107.32	2,138	0.80	35.87

Table 2 shows the average main stem length is 5.39 m in acacia and candlenut trees 8.10 m, the average diameter is 66.21 cm and 107.32 cm, the average volume is 0.29 m^3 and 0.80 m^3. Even distribution of the base of the tree is minimal because the wage system is calculated per sortimen where the loggers tend to cut the logs to even out the diameter, so the logger operator maximizes the length of the main trunk so that the wages obtained are even greater. This is in accordance with the statement of Indrawati [10] which states that the amount of main stem waste from logging activities is due to the large diameter of the main stem waste and the length of the waste. Another factor causing the high percentage of waste in addition to the diameter and length of the wood is how large the volume of unused wood is compared to the total volume of trees.

3.5. Waste above branch free

The waste above is free of branches, namely the main stem from the top of the stump or buttress to the first branch. This waste is in the form of short pieces or logs. The dimensions measured include the diameter of the base, the diameter of the tip and the diameter of the base.

Table 3. Length, diameter and volume of waste on free acacia and candlenut branches in Community Forest Logging Activities in Cenrana Baru Village, Cenrana District, Maros Regency

Tree Name	Length (m)	Diameter(cm)	Tree Volume (m3)	Main Stem Waste Volume (m3)	Percentage (%)
Acacia	6.53	13.54	1.10	0.09	8.51
	4.3	11.40	0.97	0.04	4.54
	3.68	7.29	0.66	0.02	2.33
	3.3	9.08	0.47	0.02	4.52
	5.2	9.87	0.47	0.04	8.50
	8	7.87	0.67	0.04	5.78
	7.4	14.65	0.60	0.12	20.92
	7	17.64	1.03	0.17	16.57
	8.5	13.79	1.00	0.13	12.74
	3.9	15,13	1.56	0.07	4.49
Amount				8.52	0.75
Average	5.78	12.03	0.85	0.07	8.89
Hazelnut	4.3	14.33	2.68	0.07	2.59
	2.4	15,19	3.32	0.04	1.31
	3.1	15.61	2.15	0.06	2.75
	3.1	19.52	1.23	0.09	7.51
	2.83	18,50	2.22	0.08	3.43
	7.53	20.06	1.99	0.24	11.95
	3.72	16.82	1.40	0.08	5.89
	4.1	14.49	1.71	0.07	3.96
	3.26	17.52	1.55	0.08	5.08
	3.78	20.06	3.13	0.12	3.82
Amount			21.38	0.93	
Average	3.81	17.21	2.14	0.09	4.83

Table 3 shows that the average length of waste above free branches is 5.78 m and 3.81 m, with a diameter of 12.03 cm and 17.21 cm, a volume of 0.07 m^3 and 0.09 m^3. Branch waste occurs because in branch cleaning activities not all branches are taken. After all, they are considered to have small diameters. The amount of waste above branch-free shows that logging activities are caused by the large diameter of the waste above branch-free and the length of the waste, as well as the large volume of total wood that can be utilized.

3.6. Branch waste

Branch waste is part of the stem from the first branch to the crown which is an extension of the main stem. Dimensions measured include base diameter, tip diameter and stem length.

Table 4. Length, diameter and volume of acacia and candlenut branch waste in community forest logging activities in Cenrana Baru Village, Cenrana District, Maros Regency

Tree Name	Length (m)	Diameter (cm)	Tree Volume (m^3)	Main Stem Waste Volume (m^3)	Percentage (%)
Acacia	12.9	28.06	1.10	0.08	7.33
	14.7	31.91	0.97	0.09	9.15
	12	24.49	0.66	0.03	4.73
	5.4	11.50	0.47	0.01	1.68
	10.9	15.92	0.47	0.03	6.54
	5.6	14.27	0.67	0.02	2.29
	9.4	24.62	0.60	0.03	5.22
	8.3	15,19	1.03	0.02	1.74
	10.1	16.72	1.00	0.06	5.14
	14.2	34.17	1.56	0.06	4.05
Amount				8.52	0.43
Average	10.35	21.68	0.85	0.04	4.79
Hazelnut	11.4	28.66	2.68	0.08	3.06
	23.8	46.66	3.32	0.30	8.99
	12.41	27.55	2.15	0.09	4.36
	11.3	32.42	1.23	0.11	8.55
	9.6	35.06	2.22	0.10	4.73
	21.8	46.21	1.99	0.25	12.32
	15.9	31.91	1.40	0.10	6.93
	11.5	31.82	1.71	0.10	6.04
	7.8	30.89	1.55	0.07	4.39
	16.4	43.44	3.13	0.15	4.68
Amount			21.38	1.34	
Average	14.19	35.46	2.14	0.13	6.41

Table 4 shows that the average length of branch waste is 10.35 m and 14.19 m, with a diameter of 21.68 cm and 35.46 cm, a volume of 0.04 m^3 and 0.13 m^3. This waste is so large that the logger operator also cuts the tip of the tree into several long pieces. The occurrence of branch waste is caused by felled trees generally have many shoots/tips, but have a small diameter so that a lot of them become waste. The results of this study are in line with the research of Erajaa et al [11], which said that the majority of waste wood due to logging is wood that comes from the tree canopy and has a small diameter.

3.7. Waste volume recapitulation

The results of measuring the diameter and length of the potential for acacia and candlenut logging waste can be obtained by recapitulating the composition of the average volume and percentage of four types of waste as shown in Table 5.

Table 5. Recapitulation of average volume and percentage of waste in logging activities of community forest acacia tree species in Cenrana Baru Village, Cenrana District, Maros Regency

Tree Name	Waste Composition	Average Volume (m^3/tree)	Percentage (%)
Acacia	Arrear Waste	0.06	11.21
	Main Trunk Waste	0.28	30.39
	Waste Above Branch Free	0.07	8.89
	Branch Waste	0.4	4.79
Total		0.45	55.28
Hazelnut	Arrear Waste	0.14	6.75
	Main Trunk Waste	0.80	35.87
	Waste Above Branch Free	0.09	4.83
	Branch Waste	0.13	6.41
Total		1.16	53.86

Table 5 shows that the largest waste wood comes from the main stem waste with an average waste percentage of 30.39% and 35.87%, the average volume is 0.28 m^3 and 0.80 m^3 of the total waste. This happens because the length does not meet the requirements requested so it is left in the forest as waste. The occurrence of this waste is also caused by topping activities, loggers tend to cut the ends of the wood at the boundary where the relative diameter is still close to the base diameter, as a result, there is a log residue between the topping limit and the first branch in the form of waste wood.

Second order of wood stump waste, namely 11.21% and 6.75%, volume 0.06 m^3 and 0.14 m^3 of the total waste, while in candlenut wood the waste sourced from above is free of branches with an average percentage of 10.20% and volume 0.129 m^3. The occurrence of this waste is caused by topping activities, loggers tend to cut the ends of the wood at the limit where the relative diameter size is still close to the base diameter, as a result, there are residual logs between the topping limit and the first branch in the form of waste wood and the large percentage of the waste is because the wood located on the branch has a small diameter and long. Because operators who are not able to process small size wood will be left in the felling plot in the form of waste because they only use wood with a certain diameter and are used by residents only.

The third order of waste sourced from the above section is free of branches with an average percentage of 8.89% and a volume of 0.07 m^3 of the total waste in acacia wood while candlenut wood comes from branches with an average percentage of 6.41% and a volume of 0.13 m^3. The large percentage of the waste is because the wood located on the branches has a small diameter and length. Because operators who are not able to process small size wood will be left in the felling plot in the form of waste because they only use wood with a certain diameter size and are used only by residents. Because operators who have not been able to process small sizes of wood will be left in the felling plot in the form of waste because they only use wood with a certain diameter size and are only used by residents and loggers tend to cut the ends of the wood at the limit where the relative diameter is still close to the diameter of the base.

The fourth order of acacia wood waste is sourced from branch waste with an average percentage of 4.79% with a volume of 0.04 m^3, The large percentage of the waste is because the wood located on the branches has a small diameter and length. Because the operator is not able to process small size wood, it will be left in the felling plot in the form of waste because it only uses wood with a certain diameter

size, while candlenut wood is sourced from above branch-free waste with a percentage of 4.83 with a volume of 0.09%. This happens because the logger operator does the logging without considering the size of the waste, but based on the position of the felling which makes logging easier, the cutting time is faster because the logging fee is based on the volume of the felled wood. When applying the lowest possible logging, the time used is longer.

3.8. Waste utilization

Harvesting of forest products can be defined as a series of forestry activities that convert trees or other biomass into forms that can benefit the economic and cultural life of the community. Timber harvesting has several purposes that are not only economically beneficial but not ecologically damaging, so a system for its utilization is needed. Based on the results of research in the field, the potential for acacia wood waste that is utilized by local communities can be seen in table 6.

Table 6. Utilization of acacia wood logging waste in Cenrana Baru Village, Cenrana District, Maros Regency

No.	Logging Section that Becomes Waste	Waste Average Volume (m^3/tree)	Waste Utilization	Parties who use waste
1.	Arrears	0.06	Not used	Not used
2.	Main Trunk	0.28	Garden Fence	Residents
3.	Above Branch Free	0.07	Charcoal and Garden Fence	Residents
4.	Branch	0.04	Charcoal and Garden Fence	Residents

Table 6 shows that residents in Cenrana Baru Village, Cenrana Subdistrict, use logging waste for daily needs and market it to residents and the city. Residents use the waste from the main stem and branch-free as material for fence posts, waste from above is branch-free and branch waste is the raw material for making charcoal and firewood. Branch waste and branch-free waste above can be utilized so these two wastes are referred to as logging waste. Wood waste that has a minimum length of 2 m with a diameter of < 30 cm, the community uses for making garden fences and wood charcoal for IDR. 15,000 per stem. The community also uses charcoal for their daily needs and is traded at a price per sack weighing 50 kg for IDR. 100,000,-. This is in line with research [8], which suggests that people use harvesting waste as a trading commodity and as fuel for their own needs. The candlenut wood waste is not utilized by the community.

4. Conclusion

Based on the results of data analysis obtained from observations and measurements of community forest logging activities in Cenrana Baru Village, Maros Regency, several conclusions can be obtained as follows are the largest potential waste volume of waste in acacia trees is main trunk waste of 0.28 m^3 (30.39%), stump waste 0.06 m^3 (11.21%), waste above branch free 0.07 m^3 (8 .89%), branch waste 0.04 m^3 (4.79%), while in candlenut tree the largest waste was the main trunk 0.80 m^3 (35.87%), stump waste 0.14 m^3 (6.75%), branch waste 0.13 m^3 (6.41%), waste above branch free 0.09 m^3 (4.83%). Waste that can be used as raw material for making garden fences is the main stem, while branch waste and above-free branches are used as charcoal from acacia wood, this waste has a price value of IDR. 15,000 per stem.

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