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Analysis of the effect of the number of blades on the palm frond counter tool on the counting results

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Abstract: The growth of oil palm plantations in Indonesia, especially in Kalimantan and Sumatra, has resulted in an increase in palm oil waste from harvesting and tree care, both in the form of liquid waste and solid waste. As waste, palm fronds and leaves experience natural decomposition for about 4 months, which can cause a very large buildup and become a nest for pests to inhabit before decomposing. Designing an oil palm frond and leaf shredding machine involves designing special blades mounted on a rotating shaft, as well as a strong support structure to handle tough fiber materials, such as oil palm fronds and leaves, by producing flakes that can be used as organic fertilizer or ingredients. Animal feed. This research aims to create and test testing machines for chopping palm fronds and leaves showing that different blades can chop quite fine parts of the leaves with a chop length of between 20 mm and 50 mm, and the hardest part, palm fronds, can also be chopped finely. The amount of time spent is 1 minute and can chop 3 palm fronds. In 5 repetitions, an average time of 1 minute was obtained to chop the fronds. Based on the effective capacity of 5 repetitions on 19 blades, the average result was 1.45 kg/minute. Meanwhile, for effective capacity from 5 repetitions on 24 blades, the average result was 1.57 kg/minute, and for effective capacity from 5 repetitions on 26 blades, the average result was 1.76 kg/minute.

Keywords: Blades; waste; fronds and palm leaves; capacity

1. INTRODUCTION

One of the agricultural commodities that generates the most foreign exchange in the development of the Indonesian economy is palm oil. Palm oil plantations grew very rapidly in Indonesia from the 1970s to the 1980s, especially on the islands of Kalimantan and Sumatra. In 1980, the area of palm oil plantations was only 294,000 ha, but in 2009 the area reached 7.32 million hectares, with 47.81% coming from large private plantations, and 43.81% coming from government plantations [1]. With the continued increase in oil palm plantations in East Kalimantan, the waste produced by oil palms is also increasing, where liquid and solid waste continues to increase every year.

Waste is residual material from industrial and household production. According to Law Number 18 of 2008 concerning waste management, waste is the remains of daily human activities or natural processes. Waste consisting of solid and liquid substances Waste that cannot be broken down is referred to as something that is no longer useful [2].

Palm oil waste is the unused residue from the main product of the oil palm plant. An oil palm plant can produce 40-50 fronds per year, as well as solid waste such as husks, stalks, empty fruit bunches, fibers (coir), and leaves. In addition, oil palm leaves and fronds are obtained from plant residues. The natural decomposition process of oil palm leaves takes 4 months [3].

The palm fronds and leaves must be chopped into 1-2 cm pieces to be used as fertilizer, which is the ideal size for use as composting material [4]. The size of the chopped results is very important during the composting process because the smaller the chopped results, the easier it is for rotting bacteria to spread into the chopped oil palm frond media [5].

The increasing amount of waste will certainly have an impact on the environment. To reduce waste, the 3R method can be used, namely reducing/reducing, using/reusing, and recycling. The purpose of this method is to minimize inorganic waste, which reduces environmental pollution and generates

economic benefits for the community that processes it [6]. Waste utilization is very important, especially in handling organic waste that is easily rotten. Organic waste can be used as compost, which is beneficial to the environment [7].

The palm frond shredder is a tool for shredding palm fronds and leaves that will be used as fertilizer. There are several components or machine elements used in this shredder, namely electric motors, pulleys, v-belts, bearings, axles, frames, and cutting blades. This tool also has many functions besides shredding palm fronds and leaves, it can also shred other materials such as grass, vegetables, fruits, and banana leaves. The main purpose of this tool is a machine for shredding palm fronds and leaves [8].

Palm leaf and palm frond shredding machine for cattle farmers in pancar gading village, tapung district, Kampar Regency - Riau. This study uses an experimental method. The existence of this shredder makes it easier for farmers to meet the very large daily cattle feed needs [9]. The Merpati Putih Foundation hopes to make more money from their current cattle business by getting more college education. The cattle feed shredder machine is designed to meet the needs of cattle breeders and farmers. This machine must be durable, easy to maintain, easy to get spare parts, and use common and cheap fuels such as diesel. The shredder machine is made with 2 processes at once, namely, the raw materials are ground to avoid solids or melting and then chopped. The shredder machine uses a Mitsubishi 100PS engine with a 4-cylinder configuration and a capacity of 3,800 cc which is driven by diesel fuel. This machine can produce between 4,000 and 5,000 kg of animal feed per hour. This study concluded that the shredder machine can produce pieces of coconut leaves and fronds. The shredder machine can produce smaller pieces of oil palm leaves and fronds so that livestock can easily eat and farmers are helped to be able to spend less time providing feed because so far it has been manual so that livestock can easily eat and farmers are helped to be able to spend less time providing feed because so far it has been manual.

Design and construction of elephant grass chopping machine with 373-watt power using a blade with a 45° angle using stainless steel 304 material. The experiment is the approach used in this study. The results of the analysis show that the variation of the 4-blade with a speed of 1550 RPM is the best method for chopping elephant grass because it can produce 238.1 kg/hour. In conclusion, the best rotation speed to produce chop is with the Blade 4 variation [10].

Design and construction of grass and oil palm frond shredding machine with gasoline motor driven as animal feed. Observation [8], literature review, experimental, and design are the methods used in this study. According to the study, the shredder designed and built has a shredder space of 36 x 36 x 49 cm, a blade of 27 x 5 x 1 cm, and a 5.5 HP gasoline motor. This machine also uses a pulley and V-belt transmission type A-45. The results of the shredder machine on three types of raw materials for animal feed: grass, oil palm fronds and leaves, trees, and banana leaves. The machine rotates for twenty minutes with an average rotation of 2100 rpm and shreds 5.75 kg for oil palm fronds and leaves, and 19.25 kg for banana trees and leaves. In addition, oil palm fronds and leaves are shredded, which produces 5 kg with a length of shredded results between 3 to 6 cm.

Palm oil leaves and stems shredding machine for goat feed in Puding Besar village. This study uses an experimental method. The community in this goat farmer group in general is to improve the quality and capacity of livestock production, where the initial condition before this machine the number of livestock was 2 per member, it is expected to increase to 3 times, namely 6 per member. This machine can shred palm oil leaves and stems to a minimum size of 2 cm. Based on the results of interviews with farmers, this size is a size that can be chewed or processed by goats when eating. From the level of time effectiveness, farmers and cattle breeders are helped by this machine, because this shredding machine requires 1 process, and it can produce as much as 5 kg in 5 minutes [11].

Making a prototype of a shredder machine as a processor of organic waste for compost and animal feed. The experiment is the method used in this study. The type of testing with a reducer and without a reducer differentiates the capacity of the shredded results. The types of waste that are shredded are vegetables, organic skins, and tubers. With a reducer, vegetable waste can be shredded with a capacity of 16.5 kg/hour, organic skin waste 8.7 kg/hour, and tuber waste 26.13. The prototype of the shredder machine without a reducer can shred vegetable waste with a capacity of 111.84 kg/hour, and organic skin waste 93.72 kg/hour. When the cassava waste material is inserted, the cassava waste material is thrown back out of the input hopper. The prototype without a reducer cannot shred tuber waste [12].

Analysis of blade variation on coconut shell shredder machine. This study uses an experimental method. Blade 18 shreds the largest amount of coconut shell 1.78 kg, with a short shredding time of 747 seconds, or 12 minutes 27 seconds. Blade 12 shreds the smallest amount of coconut shell 1.328 kg from 2 kg, and its short shredding time is 17 minutes 40 seconds. It is concluded that the amount of shredded

coconut fiber produced is influenced by the number of blades. To get better results, increase the number of blades [13].

The blade is the main component of the palm frond and leaf waste shredding machine. During the design process, the selection of materials and proper heat treatment to make the blade are often overlooked, although these factors greatly affect the cutting performance results and life of the blade. Therefore, this study found the steps of the process of making a blade that meets the requirements of hardness, toughness, wear resistance, and corrosion resistance. The blade must be made with the right angle to be sharp and hard. In addition to choosing the right material and providing proper heat treatment, the design and angle of the blade are very important. The ideal angle for the blade is between 35 and 45 degrees; the smaller the angle, the sharper the blade, which means fewer cuts are used [14].

Based on this background, the purpose of the study was to determine the effect of the number of blades used in the process of chopping oil palm leaves and fronds. The blades used are spiral-type blades by comparing the number of blades in previous studies to obtain optimal results.

2. METHOD

Blade modification design

This study used ready-made blades. The blade modification design in this study only changed the number of blades in the previous study which was 24 [15] into 19-blades and 26-blades. The reduction and addition of blades aim to determine the difference in the capacity of the chopped results can be seen in Figure 1. A design using 19 blades is shown. In this study, the number of blades is also added, which can be seen in Figure 2. A design using 26 blades is shown and the blades can also be seen in Figure 3 below as follows. A design using 24 blades is shown to optimize the performance of the oil palm frond and leaf-chopping machine. The following equation formula can be used to calculate the capacity of the machine:

$$Tool\ capacity = \frac{Mass\ of\ oil\ palm\ fronds\ (kg)}{Time\ (hour)} \quad (1)$$

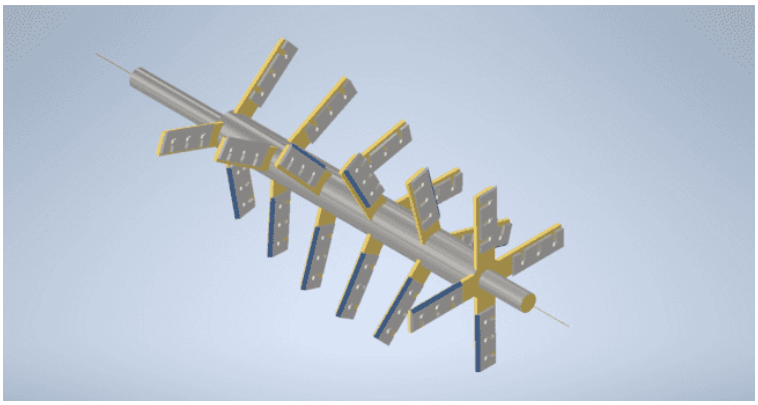

Figure 1. Design with 19 blades

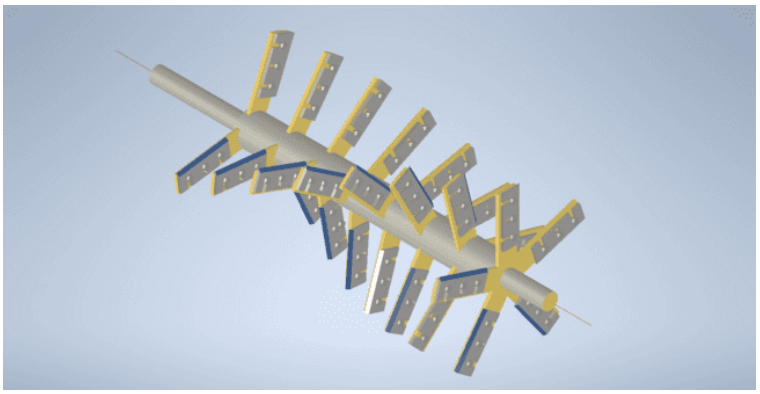

Figure 2. Shredder design with 26 blades

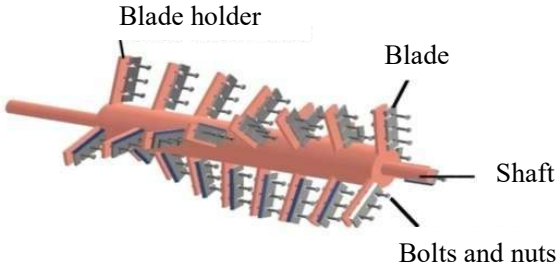

Figure 3. Shredder design with 24 blades.

Tools and materials

The tools used in making the shaft and blade holder are as follows:

a) Lathe Machine: Lathes are used to slice or shape work objects that are rotated on the main axis. The cutting stage is carried out by arranging the cutting chisel attached to the holder, and then bringing it close to the rotating work object.
b) Welding Machine: A welding machine is a machine device used to join two or more metal materials by heating them until they reach a melting point, then cooling them so that they can be joined.
c) Drilling Machine: This is a device used to make holes in a workpiece. The cutting tool is rotated in the direction of the drill bit feed through the movement machine.
d) Measuring tools: A measuring tool in the form of a ruler is used to measure the length or distance of an object. Rulers are generally made of hard materials and have scales or numbers that allow users to read the measurement results with precision.
e) Crab Eyes: The planer blade is part of a hand tool known as a planer. Its function is as a cutter and is usually made of materials such as stainless steel or other hard materials, aiming to provide resistance to friction and wear during the use process.
f) ST 37 steel axle size 1': Steel shaft used as a mounting tool for the shredder blade holder.
g) Angle iron measuring 40 mm x 40 mm: Angle iron, which is usually used in construction to provide strength and stability to building structures, has a right angle shape with two sides meeting to form a 90-degree angle.
h) Bolts and nuts: Bolts and nuts are two fastening components in construction processes and mechanical work, to connect two or more parts.

3. RESULTS AND DISCUSSION

Results of the calculation

After designing and making the blade, a trial was carried out and the research results can be seen in Table 1. The following equation can be used to determine the machine's capacity.

Table 1. Results of the calculation

Experiment	Time (minutes)	Material Weight (kg)	Shredded Result (kg)	Remaining Material (kg)	Unchopped Materials (kg)	Effective Capacity of the Tool kg/min)
Blade 19	1	2,5	1,45	0,54	0,49	1,45
Blade 24	1	2,5	1,57	0,68	0,17	1,57
Blade 26	1	2,5	1,76	0,32	0,29	1,76

Table 2. Previous research enumeration results [16]

Test	Input of stem (stem)	Time (hour)	Material weight (kg)	Weight of chopped results (kg)	Weight of remaining material (kg)	Effective capacity of the device (kg/hour)
1	4	0,0175	3.325	3.125	0.112	190
2	4	0,0152	3.100	2.862	0.1	203
3	4	0,0152	3.385	3.275	0.113	218
4	4	0,015	3.450	3.237	0.125	230

Test	Input of stem (stem)	Time (hour)	Material weight (kg)	Weight of chopped results (kg)	Weight of remaining material (kg)	Effective capacity of the device (kg/hour)
5	4	0,0175	3.387	3.225	0.15	193
Total	20	0,0804	16.647	15.724	0.6	1.034
Average	4	0,0160	3.329	3.144	0.12	206

The tests in Table 1 were carried out 5 times with each palm frond and leaf weighing 2.5 kg and the time used was 1 minute for each experiment. Experiments on blade 19 produced an average chopping yield of 1.45 kg/minute with material left in the machine weighing 0.54 kg and material that had not been chopped weighing 0.49 kg. Experiments on blade 24 produced an average chopping yield of 1.57 kg/minute with material left in the machine weighing 0.68 kg and material that had not been chopped weighing 0.17 kg. Experiments on blade 26 produced an average chopping yield of 1.76 kg/minute with material left in the machine weighing 0.32 kg and material that had not been chopped weighing 0.29 kg. In previous research, Table 2 shows the results of research with 5 repetitions, where many fronds were counted each time. The results of the study showed that the shredder machine had an average yield of 206 kg/hour and required an average time of 0.0160 hours to shred four palm fronds [16].

Discussion of the results of the census

Comparison of the shredding capacity produced by this oil palm frond shredding machine to find out which of the blades 19, 24, and 26 produces the highest capacity. For the shredding process use oil palm frond waste. Figure 4 shows the difference in the shredding capacity of the shredding blade variations.

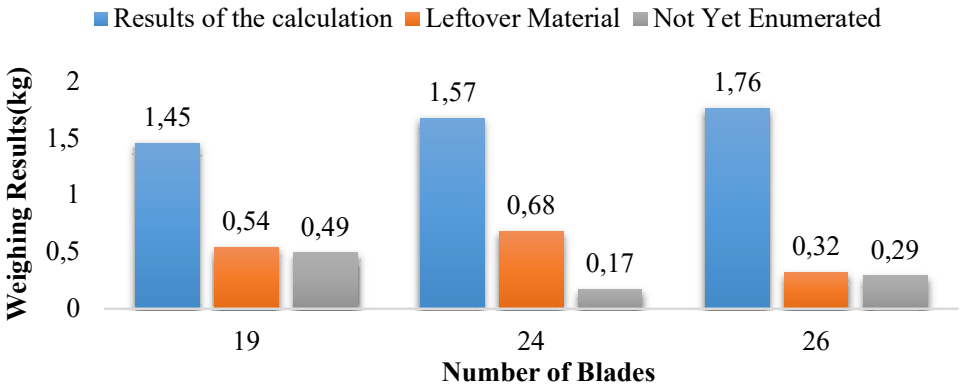

Figure 4. The capacity of shredded results in variations in the number of blades

The results of the chopping of 19 blades have an average chopping result of 40-70 mm. In the blades totaling 24, the average length of the chopping results ranges from 20-40 mm. While in the blades totaling 26, the average chopping results obtained are between 30-50 mm. The more blades used on the chopping machine, the more coconut skin is chopped. This is because the number of blades used allows the machine to chop coconut skin faster and more evenly. In comparison with previous research (M. Fakhriansuah, 2022) namely with 12 blades, the lowest chopping result was 1.328 kg, and with 18 blades, the heaviest chopping result was 1.78 kg.

The number of blades used in this study ranged from 19, 24, and 26 so the number of gaps in the chopping chamber affected by the blades was reduced, resulting in more even and larger chopping results.

After trying to chop the palm fronds, and leaves and testing them, then cut them into small pieces. However, there are some palm fronds and ribs wrapped around the blade shaft because the input hopper is not so tight with the blade shaft. As a result, if there are leaves that are not hit by the blade when the fronds are inserted into the shredder, the leaves will be wrapped around the blade shaft. As shown in Figure 5, after the palm fronds, and leaves are finely chopped with the blade, some of the chopped results

are left in the sieve section. This is a problem because the size of the chopped results is still very large, so it cannot fall directly into the output hopper.

Figure 5. Results of the calculation

Figure 6 gets optimal results in further research, it is recommended to increase the density of the output hopper with the blade shaft by providing bearings on the blade shaft so that there is no more winding of palm leaves on the blade shaft.

Figure 6. Stuck chopped results

4. CONCLUSION

After this research was completed, the effective results of the variation in the number of blades on the shredder machine were obtained. The results showed that on the 19 blades, the effective capacity reached 1.45 kg/minute. Meanwhile, on the 24 blades, the effective capacity was also 1.57 kg/minute. On the 26 blades, the effective capacity reached 1.76 kg/minute. In addition, in shredding oil palm fronds and leaves using 3 fronds, the average time required was 1 minute based on the results of 5 repetitions. The results of the shredded size on the 19 blades were 40-70 mm, on the 24 blades the average shredded length was 20-40 mm and on the 26 blades it was 30-50 mm. In this study, some oil palm leaves were wrapped around the blade shaft because the input hopper was not tight with the blade shaft. When the fronds are inserted into the shredder, the leaves that are not hit by the blade will be wrapped around the blade axis. This study was conducted to determine the level of effectiveness of chopping from the number of blades in this study and previous studies. The process of making this shredder blade is expected to reduce the amount of oil palm frond waste in farmers' gardens so that the waste can be processed into fertilizer or animal feed.

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