Feasibility Study of Production of Double Blade Grass Cutting Machine

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Abstract

Most breeders generally feed their livestock only with grass, but for the grass itself it will be food that is easily found and is mostly given to livestock. However, most people still use machetes or sickles to cultivate grass, therefore SMEs have emerged in dealing with grass processing. The tool made is a grass chopper machine, the machine that was created also has several variations, one of which is a double knife chopper machine made by one of the students of the Nusa Cendana University Kupang, namely Stenly Naitboho. Therefore, this research was conducted to assess the performance of the chopper machine based on a feasibility study, in terms of the percentage length of the chopped material and the consumption of fuel used along with the production costs of this tool. In completing this research, several methods are needed to launch it, namely literature study and observation. After using the method used, the results of the chopping can be found, namely the percentage of the length of the chopped material measuring < 5 cm (W1) obtained an average of 54.62%, while the average percentage of the length of the chopped material measuring > 5 cm (W2) is 45.28%. For the size of the good chopped results is 2-5 cm in accordance with SNI 7785.1:2003 concerning the requirements for the results of forage chopping machine. Another result in this study is the consumption of fuel used during the census obtained an average of 0.6 /hour. Based on SNI 7580:2013 the requirements for chopper work for fuel consumption of this machine are in category A. Production costs are obtained at a price of Rp. 4,122,200/unit.

Keywords: Consumption, Fuel, Shredded, Production

1. Introduction

Most breeders feed their cattle solely grass, but in order to enhance sales and body weight, supplementary feed must be provided. However, the grass itself will be a readily available source of food for livestock. Because grass fed to cattle will almost probably be more than additional feed, the community processing procedure will influence the amount of grass feed created through enumeration. The farmer's lack of a grass chopper will effect the time it takes to feed the cattle, as well as the farmer's physical tiredness. Because the tools employed are still manual in the form of machetes and sickles, the enumeration time will be very long and will also need considerable energy (people). The volume of feed produced and the time required are also determined by the cutting tool's sharpness. As a result of the concerns described above, many SMEs in the industrial sector have emerged to address issues with manually handling feed, and the solutions encountered in the industrial sector take the shape of a grass chopper. There are several factors to consider during the grass chopper production process, including material selection, production cost calculation, and repair and maintenance cost calculation (Lehtomäki et al., 2008; Nizami, A. S., & Murphy, 2010; Martianis, E., & Gafur, 2019; Streikus et al., 2019; Tilvikiene et al., 2019). As a
result, the practicality of the tools generated must also be examined in order to give the user with information about the machines being produced. Many SMEs in the industrial sector have emerged to overcome challenges in manually handling feed, and the solutions encountered in the industrial sector are in the form of a grass chopper (AlQadiri et al., 2016; Rowan, N. J., & Galanakis, 2020). There are several factors to consider during the grass chopper manufacturing process, including material selection, production cost calculation, and repair and maintenance cost calculation. As a result, the practicality of the tools generated must also be examined in order to give the user with information about the machines being produced. Many SMEs in the industrial sector have arisen as a result of the aforementioned challenges in manually handling feed, and the solutions encountered in the industrial sector are in the form of a grass chopper. There are several factors to consider during the grass chopper manufacturing process, including material selection, production cost calculation, and repair and maintenance cost calculation. As a result, the practicality of the tools generated must also be examined in order to give the user with information about the machines being produced. As a result, the practicality of the tools generated must also be examined in order to give the user with information about the machines being produced. As a result, the practicality of the tools generated must also be examined in order to give the user with information about the machines being produced.

According to Suliyanto, a business feasibility study is a study with the objective and purpose of determining if a business idea is possible or not to be implemented. A business idea is said to be practicable to pursue if it can give greater advantages to all parties (stakeholders) than the negative impact caused by the business idea's initiators (Suliyanto, 2013).

According to Kasmir and Jakfar, a business feasibility study is an activity that is used to research in depth a business or business that is already being operated, in order to assess whether or not the firm is practicable (Ioan, 2010; Kasmir, 2013; Khmara, Y., & Kronenberg, 2018; Litamurni, F. A., & Chumaidiyah, 2021; Hutasoit, et al., 2021; Budiarty et al., 2022; Yuniarsih et al., 2022).

A twin knife chopper is one of the agricultural machines used for chopping. This machine was created by mechanical engineering students at the University of Nusa Cendana Kupang in East Nusa Tenggara and is used to chop livestock feed. However, it has not been used in farmers' conventional enumeration efforts. Because this machine has an economic life of more than five years, it is required to test the chopper tool or machine and examine aspects of the basic cost as well as provide an overview of the chopper's feasibility.

The quantity of costs that must be incurred during the creation of this tool is determined using economic analysis. The application of engineering economic concepts is required not only for the examination of the economic feasibility of engineering projects, but it can also help in making personal decisions that will have a financial influence in the future (Salengke, 2012). The goal of this study was to evaluate the performance of an animal feed chopper (chopper), including engine capacity, percentage of chopped material length, and fuel consumption, as well as to calculate the tool's production cost.

2. Methodology
 Research tools and time
 The feasibility study was conducted on three cattle farms located in the Nasipanaf village, Kupang, East Nusa Tenggara. The tool used is a double knife crusher machine with tool specifications as shown in the table below:

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Table 1. Specifications of double blade chopper

<table>
<thead>
<tr>
<th>No</th>
<th>Machine Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Axis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power (Pd)</td>
<td>4.7 kw</td>
</tr>
<tr>
<td></td>
<td>Moment (T)</td>
<td>1271.6 kg/mm</td>
</tr>
<tr>
<td></td>
<td>Shear stress</td>
<td>7.31 kg/mm²</td>
</tr>
<tr>
<td></td>
<td>Diameter (ds)</td>
<td>25 mm</td>
</tr>
<tr>
<td>2</td>
<td>pulley</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Driven pulley diameter (Dp)</td>
<td>300 mm</td>
</tr>
<tr>
<td></td>
<td>Drive pulley diameter (dp)</td>
<td>70 mm</td>
</tr>
<tr>
<td></td>
<td>Drive pulley rotation (n1)</td>
<td>3600 rpm</td>
</tr>
<tr>
<td></td>
<td>Pulley rotation is driven (n2)</td>
<td>840 rpm</td>
</tr>
<tr>
<td></td>
<td>Shaft axis distance (C)</td>
<td>470 mm</td>
</tr>
<tr>
<td>3</td>
<td>Belt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Belt length</td>
<td>1677 mm</td>
</tr>
<tr>
<td></td>
<td>Belt linear speed (v)</td>
<td>13.2 m/s</td>
</tr>
</tbody>
</table>

In carrying out this research, of course, using research methods to expedite the research process including observation and action methods.

**Ingredients**
The materials used are kolonjuno grass, elephant grass and the fuel is talait.

**Research procedure**
Performance Test and Cost Analysis per one Animal Feed Counting Machine includes the following tests:

**Calculating the percentage of chopped length**
Taking a sample of the output of chopped material as much as 100 g, 3 replications.

a) Separate the chopped material from the sample into 2 (two) parts, the first part which is 1 cm shorter in length and the second part which is 1 cm longer in length.

b) Weigh the two parts of the sample that have been separated.

c) The percentage of chopped material output length can be calculated by the formula:

\[
Ppk = \frac{W1}{W1 + W2} \times 100\%
\]

Information:

- **Ppk**: Percentage of the length of the chopped output material (%)
- **W1**: Output weight of chopped material less than 5 cm (g)
- **W2**: Output weight of chopped material which is more than 5 cm (g) in length

**Calculating Fuel Consumption**
The fuel consumption during the counting process is calculated by the following equation:

\[
FC = \frac{FV}{t2}
\]

Information:

- **FC**: Fuel consumption (ℓ/hour)
- **FV**: The volume of fuel used (ℓ).
- **T2**: Motor operating time (hours).
**Production cost**

Production costs are seen from the costs incurred directly. The total cost can be calculated by adding up the total fixed costs and the total variable costs according to Equation

\[ BP = BT + BV \]

With:
- \( BP \) = production cost (Rp/year)
- \( BT \) = fixed cost (Rp/year)
- \( BV \) = variable cost (Rp/year)

- **Fixed cost**
  
  Fixed costs are costs that must be incurred on a regular basis. The components of the fixed costs of operating a double-blade chopper include:

1) **Cost of depreciation**

Depreciation costs are costs that must be periodically incurred as a consequence of a decrease in engine performance. The amount of depreciation expense can be calculated using the following equation (Kastaman, R. 2001):

\[ D = \frac{P - S}{N} \]

**description:**
- \( D \) = Depreciation cost
- \( P \) = Machine price (Rp)
- \( S \) = Final machine value (Rp)
- \( N \) = engine life (Years)

2) **Repair and Maintenance Cost**

Repair and maintenance costs are costs that must be periodically incurred to repair damaged machine components. The calculation of the average repair and maintenance costs is calculated through the following equation:

\[ R = P \times \frac{m}{100} \]

**Information:**
- \( R \) = Cost of maintenance and repair (Rp/year)
- \( P \) = Machine price (Rp)
- \( m \) = Average percentage of maintenance and repair costs

3) **Capital Interest**

Capital interest is a manifestation of money based on its time value. Calculation of capital interest requires the borrower to pay more than the original loan. Payments are made periodically according to the length of the loan. Calculation of capital interest can use the following equation:

\[ I = \frac{P - S}{2} \times r \]

**Information:**
- \( I \) = Capital interest (Rp/year)
- \( r \) = Bank interest rate (%/year)
- \( P \) = Pricemachine (Rp)
- \( S \) = Valueend (Rp)

Fixed costs per year are calculated using the following equation:

\[ BT = D + R + I \]

**Information:**
- \( BT \) = Fixed costs (Rp/year)
D = Depreciation cost (Rp/year)
R = Cost of repair and maintenance (Rp/year)
I = Capital interest (Rp/year)

4) Variable cost

Variable costs can be interpreted as costs that are directly related to production because the amount is determined by how large the volume of production is. The variable cost per year of this machine can be calculated using the following equation:

\[ \text{BTT} = (\text{BL} + \text{BO}) \]

Information:

\( \text{BTT} = \) Variable costs (Rp/day)
\( \text{BL} = \) Electricity cost (Rp/day)
\( \text{BO} = \) Operator fee (Rp/day)

3. Results and Discussion

3.1 Result

This performance test is to determine the ability and capacity of the engine in carrying out its performance and also to chop the grass while it is still long into small pieces. In addition, to determine the capacity of the machine and the time obtained and to find out the results of the count and the benefits of the machine. The capacity of the lawn mower is largely determined by the amount of rotation (rpm). Several revolutions in the study include 199,420,892 rpm.

The percentage of the length of the count is obtained by doing several ways, namely:

Taking a sample of the output of chopped material as much as 100 g, 3 replications. Then measured and weighed for the size of the pieces <5 cm (W1) and >5 cm (W2).

\( \text{Dick} : \ W1 = 56.9 \) grams
W2 = 41.9 grams

So:

\[ Ppk = \frac{W1}{W1 + w2} \times 100\% \]

\[ Ppk_1 = \frac{56,9}{56,9 + 41,9} \times 100\% = 56,2\% \]

\[ Ppk_2 = \frac{44,9}{56,9 + 41,9} \times 100\% = 43,7\% \]

Calculating fuel consumption was repeated three times and the fuel used was 200 ml. When the grass was chopped for 2 minutes the fuel used reached 20 ml, as well as in subsequent experiments. Therefore, to calculate the fuel consumption used can be known by the formula:

\[ FC = \frac{FV}{t_2} \]

Is known:

\[ FV = 20 \text{ ml} \]

\[ T_2 = 2 \text{ minutes} \]

\[ FC = \frac{20 \text{ ml}}{2 \text{ menit}} = 10 \text{ ml/menit} \]

Production cost

In making this grass chopper, it takes 27-28 working days with a maximum of 8 hours/day. Therefore, to determine the production costs of this tool, it is necessary to know what costs are incurred in making this grass chopper.

For the selling price of this chopper, if it is calculated from the results of the purchase of materials to the processing process, it can be sold at a selling price of Rp. 3,094,000 / unit. Therefore, it will be known the production calculation of the double blade grass chopper machine from the annual production cost.

1. Fixed cost

Before determining fixed costs, the depreciation cost of this counter will be sought first with the formula:

\[ D = \frac{P - S}{N} \]

Where:

D : Fixed Cost/ Year

P (machine price) : Rp. 3,094,000/ Unit

S (final machine value): Rp. 2,500,000

N (machine age) : 5 years

\[ D = \frac{3,094,000 - 2,500,000}{5} \]

\[ = 118.800 \text{ /Tahun} \]

The fixed costs also need to be calculated for repair and maintenance costs within one year. Therefore, the cost of maintenance and repairs will be sought in a period of one year with the formula:

\[ R = P \times \frac{m}{100} \]

Is known:

\[ P = \text{Rp. 3,094,000} \]

\[ M = 10\% \text{ / Year} \]
\[ R = 3.094.000 \times 10 \% = \]
\[ Rp.309.400 \text{ /Year} \]

Therefore, the fixed costs that will be incurred in 1 year for 1 unit of this double knife chopper are:

\[ BT = D + R \]
\[ BT = 118.800 + 309.400 = Rp.428.200/Tahun \]

2. Variable cost

Variable costs can include several factors in the manufacture of this chopper and its operation. These variable costs are in the form of:

- Electricity fee: Rp. 100,000 /unit
- Operator fee: Rp. 500,000 / unit

\[ BTT = 100.000 + 500.000 = Rp.600.000/unit \]

So for the production cost of this double blade lawn mower is:

\[ BP = BT + BV + P \]
\[ BP = 428.200 + 600.000 + 3,094.000 \]
\[ = Rp.4.112.200/unit \]

3. BEP (Break Even Point)

Calculating the break-even point will be calculated using the formula:

\[ BEP = \frac{500.000}{3,000.000 - 600.000} = 0.208 \text{ Kg/Year} \]

3.2 Discussion

A discussion section which should describe the relationships and generalizations shown by the results and discusses the significance of the results making comparisons with previously published work. Because of the nature of some studies, it may be appropriate to combine the Results and Discussion sections into a single section to improve clarity and make it easier for the reader.

- Capacity : 186 Kg/hour
- Dimension : 80cm x 60 cm x 80 cm
- drive : 6.5 HP
- Number of blades : 6 pieces
- Tool life : 5 yrs

The measurement of the working capacity of the chopper machine is by dividing the weight of the chopped material by the output time of the chopped material. According to (Hidayat, M, Harjono, Marsudi, and A Gunanto. 2006), the capacity of the animal feed chopper machine is largely determined by the amount of rotation (rpm). The capacity will be directly proportional to the increase in the rotation of the cutting blade, but the quality of the chopping results does not meet the desired requirements because there are still many that are not chopped. If the rpm is too high then the material will come out quickly and not cut, on the other hand if the rpm of the carrier plate is too low, the chopping results are quite good but the capacity decreases. The type of plant that was chopped was elephant grass.

The study was conducted five times with the same replication where each replication used several kg of elephant grass with different engine rotation speeds as shown in the table.
Table 2. Measuring the working capacity of the chopping machine

<table>
<thead>
<tr>
<th>No</th>
<th>round (rpm)</th>
<th>Grass Weight (kg)</th>
<th>Time (Minute)</th>
<th>Minced size (cm)</th>
<th>Fuel (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>199</td>
<td>8</td>
<td>3.83</td>
<td>4-7</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.81</td>
<td>5-7</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.80</td>
<td>5-7</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.83</td>
<td>4-7</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.90</td>
<td>4-7</td>
<td>39</td>
</tr>
<tr>
<td>2</td>
<td>420</td>
<td>8</td>
<td>3.3</td>
<td>2-5</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.3</td>
<td>2-5</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.3</td>
<td>2-4</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.2</td>
<td>2-6</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.3</td>
<td>2-5</td>
<td>33</td>
</tr>
<tr>
<td>3</td>
<td>892</td>
<td>8</td>
<td>2.03</td>
<td>1-5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2-4</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2-4</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1-5</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1-5</td>
<td>20</td>
</tr>
</tbody>
</table>

From the table above, it can be seen that in five rounds of testing, the performance of the chopper machine is affected. At 199 rpm, it shows that the count requires a longer time to chop and the resulting results also have a length of more than 5 cm. As for the 420 rpm rotation, it produces chunks weighing 8 kg in 3 minutes and produces a chop length measuring 2-5 cm. For the third experiment, namely the 892 Rpm cycle, it showed good results in the results of chops measuring 1-5 cm and in less time compared to the first and second experiments. However, at 892 rpm it also has a problem which is indicated, namely the vibration of the engine that is very disturbing to the counting process.

The results of the census showed that the average time needed to chop elephant grass was 3.3 minutes. From the results of the tests carried out, the average effective capacity of the elephant grass chopper (chopper) was 152.4 kg/hour. For the recommended rotation, which is 420 rpm, you can chop as much as 152.4 kg / hour and for 254 kg / liter. In accordance with the working requirements of the elephant grass chopper machine in SNI 7580:2013 that the effective capacity
of the tool is divided into 3 classes, namely class A with a capacity of <600 kg/hour, class B with a capacity of 600-1500 kg/hour and class C with a capacity of >1500 kg/hour. So that the capacity of the animal feed count belongs to class A.

**Table 3. Requirements for SNI 7785.1:2003 [23]**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Moments</th>
<th>Enumeration Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enumeration Capacity</td>
<td>Kg/ Hour</td>
<td>Class A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300-800</td>
</tr>
</tbody>
</table>

a. Long percentage count

Testing the percentage of chopped grass length (chopper) using rotating speed 199, 420, 892 rpm. The results of the percentage length of chopped material measuring < 5 cm (W1) obtained an average of 54.62%, while the average percentage length of chopped material measuring > 5 cm (W2) was 45.28%. For the size of a good chopped yield is 2-5 cm in accordance with SNI 7785.1:2003 concerning the requirements for the results of the forage chopping machine. The size of the chopped 2-5 cm is said to be good because it can make it easier for livestock to consume feed and facilitate the digestive process of livestock. According to Situmorang, manual census is very different from census using a combustion engine, where the enumeration results in relatively faster time.

b. Fuel consumption

At the research stage for fuel consumption, several experiments were carried out for several rounds. In the first 199 rounds, 120 ml of fuel was added to chop 8 kg of grass for 2 minutes, after finishing the counting and measuring again the fuel used was 100 ml left. Likewise, in the second and third experiments, the use of fuel consumed 20 ml in each repetition, therefore it can be concluded that for every two-minute round it can consume 20 ml or per second the fuel used is 10 ml. For the enumeration of 240 kg of grass, the fuel used is 600 ml/hour. The results of the fuel used during the census obtained an average of 0.6 /hour. Based on SNI 7580:2013 the requirements for chopper work for fuel consumption are grouped into 3 classes, namely class A with consumption <2 /hour, class B with consumption 2-3 /hour and class C with consumption >3 /hour. So that the fuel consumption of the elephant grass chopper (chopper) is grouped in class A.

− Economic Analysis

The application of the principles of engineering economics is not only needed in the analysis of the economic feasibility of engineering projects but can also help in making decisions for personal matters that will have a financial impact in the future. The production process aims to convert raw materials into finished products through a series of processes so as to obtain added value.

− Production cost

To find out the cost of production, first look for costs that are included in fixed costs including depreciation costs, capital and insurance interest costs, tax costs and garage or warehouse costs. In the manufacture of a double blade grass chopper included in the fixed costs are depreciation costs, maintenance and repair costs. For this tool, there is no building rental fee and a loan from the bank, so no calculations are made for these costs. Therefore, the fixed cost for this one tool is Rp.428,200/year and the fixed costs consist of depreciation expense of Rp.118,800/year and maintenance and repair costs of Rp.309,400/year.

Costs that are included in variable costs include fuel costs, lubricant costs, operator and operator costs. For more details regarding the breakdown of non-fixed costs, the operator fee for making one counting machine is Rp. 500,000/unit and also the cost of electricity used to manufacture one unit is Rp. 100,000/unit. Therefore, the production cost for 1 unit of this chopper is Rp.4.122.200/unit.

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4. Conclusion

Based on the results of the research that has been done, it can be concluded:
The percentage of chopped length of grass with a size of less than <5cm (W1) obtained an average of 54.62%, while the percentage of chopped length of elephant grass with a size of >5cm (W2) obtained an average of 45.28%. So it can be concluded that this double knife chopper produces 2-5 cm more chop sizes. For the size of a good chopped yield is 2-5 cm in accordance with SNI 7785.1:2003 concerning the requirements for the results of the forage chopper machine. The average fuel consumption used by the double blade grass chopper is 0.6 /hour. For the feasibility study of the production of this enumerator, it is said to be feasible because it fulfills the scope of the feasibility study study on the theories put forward. The production cost for one enumerator is Rp. 4,122,200/unit.

5. Acknowledgment

This paper and the research behind it would not have been possible without the exceptional support of my supervisor. His enthusiasm, knowledge and exacting attention to detail have been an inspiration and kept my work on track from my first encounter with to the final draft of this paper.

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