Technical analysis and performance test of chopper machines for composting rice straw

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Abstract. Nutrients diminishing become one of the low productivity of rice. Treatment of straw burned and the ashes as fertilizer remove nutrients contained therein. Composted rice straw so that the soil nutrient enhanced by the provision of rice straw compost continuously. Rice straw compost necessary optimal cutting rice straw with a length of 5 cm to 10 cm to accelerate the composting process. Paddy straw chopper is able to produce the chopped length, but the lack of data and the technical feasibility test engine performance so that the necessary research. The experiment was conducted in March-May 2016 in Bumiwangi Village, Cipayung, Bandung West Java and Agriculture Equipment dan Machine Laboratory Faculty of Agriculture Industrial Technology University of Padjadjaran. The method used descriptive analysis, namely making measurements, observations, calculations, and analyses so that the data obtained eligibility machine. Results of analysis techniques, namely the need for locomotion 1.83 HP, unit transmission with 4 belts, shaft diameter 23 mm, the diameter of the pin cylinder enumerator 7.58 and pin diameter motor of 7.40 mm, the size of the spi (9 × 9 × 27) mm, bearing life 6,740.64 h, the deflection order of 1.3 × 10⁻³ mm and the weld strength 44,660 N and 57,417.07 N meets the technical feasibility than the number of belts. The results of the performance test, the density 128.78 kg/m³, the theoretical capacity 41.91 HP, enumeration yield 88.302%, the percentage of chopped chunks of 46%, the noise 97.5 dB and vibration of 21.6 mm/s as a whole meets the performance specifications except the cut length, noise and vibration

Keywords: compost, performance test, rice straw, rice straw chopper, technical analysis

1. Introduction
Ciparay is the one of subdistrict in the area south of Bandung regency. The district is located in the major subdistrict in Bandung, namely subdistrict Majalaya and subdistrict Baleendah. Ciparay subdistrict has extensive rice fields, thus become one of the centers of the rice seed industry in Bandung.

Ciparay subdistrict consists of 14 villages and each village has farmers groups combined, especially the Bumiwangi Village has farmers groups comprising 10 farmers groups. Each group of farmers cultivates 30 hectares of rice fields. Each one-hectare rice paddy yields of 6 tons/ha in the rainy season and 5 tons/ha in the dry season.
Straw generated each harvest of 1.4 fold of harvest. In the rainy season earned 8.4 tons/ha of straw and dry season 7 tons/ha of straw. The straw potential is not utilized optimally by farmers. Straw is usually burned and the rest of the combustion propagated in paddy fields as fertilizer. In fact, burning of straw resulting emission of carbon dioxide (CO₂), energy waste, dead soil organisms and nutrients in the hay on fire so it does not greatly affect the soil organisms and nutrients in the hay on fire so it does not greatly affect the soil when sown as a fertilizer [1].

Farmers also add chemical fertilizers to reduce nutrients in the soil due to chemical elements in chemical fertilizer accumulated in the soil. Less of nutrients are obstructed from crop production and decreasing fertility soil. Composting increases crop productivity and soil fertility of physical, chemical, and biological [2].

One of the compost that can be used farmers is rice straw compost. The rice straw contained some useful nutrients for plants, among others, nitrogen (N) and potassium (K). Compost is organic fertilizer from weathering plant materials or organic waste to the decomposition process and stabilization of organic material by microorganisms under controlled conditions [2].

Composting can be accelerated by addition microorganisms decompose (e.g. Trichoderma harzianum) and reduce the size of compost material, for example using rice straw chopper machine. Size finer must be better because it helps the decomposition, flow of air and accelerates the Trichoderma harzianum growth on the surface of the substrate [2].

Long pieces of rice straw for decomposition is 5-10 cm [1]. Rice straw chopper machines can produce these sizes. Laboratory Equipment and Agricultural Machinery Faculty of Agriculture Industrial Technology, Padjadjaran University has developed a chopper machine to chops rice straw. The chopper machine has been applied in the Bumiwangi Village, Ciparay Subdistrict, Bandung Regency. However, the engine performance and technical specifications are not yet.

Therefore, research is needed regarding the analysis techniques and test the performance of the engine to determine the feasibility of the machine and its ability to produce standard chopper rice straw. Rice straw chopped be used decomposition the composting process.

2. Methodology
In this study technical analysis and performance test of chopper machine used raw material rice straw from the Bumiwangi Village, Ciparay Subdistrict, Bandung Regency as much as 80 kg for preliminary research and composting in the Bumiwangi Village and 52.48 kg for research in the Laboratory of Metal, Wood and Rattan Faculty of Agriculture Industrial Technology, University of Padjadjaran. Additional materials used be water as much as 24 L and 80 g activator based calculation composting needs.

The tools used in this study, the scales electric meter, stopwatch, tachometer, sound-level meter, vibration meter and a ruler to technical analysis and testing engine performance, while the tool used for composting, i.e, measuring cups, buckets, stir bar, shoe boot, tarpaulins, and rope.

The method used in this research is descriptive analysis method, measurement, observation and calculation of the chopper rice straw and then analysis the data to obtain the data feasibility machine by comparing data calculation results with actual size in addition to analyzing the performance of a chopper straw and comparing the result with quality standards and performance test for chopper.

The stage of the research is divided into two, engineering analysis performed the driving power requirements, analysis of transmission unit, analysis of shaft, analysis of pin, analysis of spi, analysis of bearing, analysis of power and analysis of framework presented in figure 1.
2.1. **Dimensional measurement of rice straw counting machines**

Measure the dimensions of the components of rice straw chopper includes hopper, counter space, the cylinder counter, a component unit of the transmission, the frame and the overall rice straw chopper, then make a technical drawing rice straw chopper using AutoCad software.

2.2. **Technical analysis and data processing**

Engineering analysis performed by measuring a specific component in the straw chopper and the chopper cylinder rotating speed or rotary speed of the motor is required in the calculation parameter analysis techniques.

1. The need for locomotion requires the measurement of the diameter, length and mass, and diameter of the cylindrical counter; diameter and length of counter space. The calculations were performed, among others, tangential force and torque moment so that the theoretical power value obtained during enumeration.

2. Analysis of the shaft requires measurement of the actual diameter and length axis enumerators. It was calculated torque moment, deflection torsion, theoretical diameter shaft and the countershaft rotational speed-critical.

3. Analysis of the pin requires measurement of the radius of the cylinder chopper pulley and drive motor as well as the actual diameter of the pin. The calculations were performed, among others, the moment of torque, tangential force and diameter of the pin.
4. Analysis requires measurement spi-finger shaft enumerators, width and length of the actual spi. The calculations were performed, among others, the moment of torque, tangential force, spi shear stress, shear stress allowable, width and length spi.

5. Analysis of bearings needs to measure the pulleys and cylinder enumerators. The calculations were performed, among others, radial loads and bearing life.

6. Analysis of the strength of the framework requires a sustained load measurement framework and dimensions of the frame. The calculations were performed, among others, the moment of inertia, deflection order, permit deflection, and critical load.

7. Analysis of the weld strength requires measurement of the thickness and length of the field of welding. It was calculated weld strength of actual and theoretical.

2.3. Benchmarking results against actual data analysis techniques
The results of the analysis of rice straw chopper technique compared with actual data dimensions rice straw chopper and the standard size used farm machinery in order to know the feasibility of construction and durability of rice straw chopper machine during operation.

Stages second study, the performance test conducted, among others, the measurement of water content, density rice straw, the theoretical capacity, capacity actual, efficiency of chopping, fuel consumption, power requirements theoretically, the efficiency of specific chopping, the level of noise and vibration levels are presented in figure 2.

2.4. Moisture and density measurement rice straw
Measurements were performed before and after the enumeration, rice straw samples taken later testing using water content based on Standard Nasional Indonesia [3] samples were tested in laboratory testing services, Industrial Technology Faculty of Agriculture, University of Padjadjaran. Density measurements made with rice straw to make a tank measuring 1 m × 0.3 m × 0.3 m without cover. Rice straw is inserted into the tank to the brim, then weighed and counted rice straw to five times the density measurement to obtain the average density rice straw [4].

2.5. Preparation of rice straw counting machines, measuring and rice straw
Components of rice straw chopper checking so hopefully not interfere with the operation of the machine, in addition to the need for diesel fuel and tarps to accommodate chopped rice straw needs to be prepared. Rice straw chopper expected in decent condition, especially the checking part of the enumeration area. Measuring instruments used for the performance test conducted checking battery and calibration before used. Rice straw to be chopped divided to five repetitions and weight.

2.6. Measurement performance test counting machines rice straw
a. Cylinder rotary speed counter and drive motor is measured using a measuring instrument by directing a laser tachometer photo of a tachometer to the counter shaft and the motor that has been marked with black tape. Measurements were made when the machine is turned on without the inclusion of rice straw and rice straw chopping time.

b. The noise level of the rice straw chopper was measured using a measuring instrument with a direct microphone sound level meter sound level meters from the position of observer 2 m tall ears to the sound source based International Organization for Standards [5]. Measurements were made when the machine is turned on without the inclusion of rice straw and rice straw chopping time.

c. Vibration levels of rice straw chopper using a vibration meter was measured by putting parts of the accelerator meter to the center point of the vibration, the hopper, counter space and order. Measurements were made when the machine is turned on without the inclusion of rice straw and rice straw chopping time.

d. Weighing rice straw chopped engine results using electric scales.
2.7. Data processing

a. The water content expressed in percentage by weight of the wet and calculated by the equation:

\[
\text{water content (\% WB)} = \frac{W_2}{W_1} \times 100
\]  

(1)
b. Density rice straw is taken from the average data calculated using the equation:
\[ \rho_j = \frac{m_j}{V_b} \] (2)

c. The theoretical capacity is calculated using equation [6]:
\[ K_t = \frac{\rho_j A_t L_t \lambda_k n_c}{6 \times 10^6} \] (3)

d. Actual capacity is calculated using equation [5]:
\[ K_a = \frac{m_{out}}{t} \] (4)

e. Counting efficiency is calculated using the equation:
\[ \eta = \frac{K_a}{K_t} \times 100\% \] (5)

f. Fuel consumption was measured when the machine is turned on in a state without the inclusion of rice straw and time of chopping, calculated using the equation:
\[ FC = \frac{VC}{t} \] (6)

g. Power consumption can be calculated by using the theoretical fuel consumption data are converted into units of power using the equation:
\[ P_{ap} = FC \times NK \] (7)

h. The specific energy engine chopping calculated using equation [7]:
\[ E_{sp} = \frac{P_{ap} \times 3600}{K_a} \] (8)

i. The yield of chopped engine results calculated using equation [7]:
\[ \mu = \frac{m_{out}}{m_{in}} \times 100\% \] (9)

j. The percentage of a sample taken from the chopped shredded and sorted by 5-10 cm long chopped then calculated using equation [5]:
\[ P_{pc} = \frac{m_c}{m_{tot}} \times 100\% \] (10)

k. The noise level can be used to determine the length of working hours for working operator, calculated using the equation:
\[ T = \frac{8}{2 \left( \frac{L - 90}{5} \right)} \] (11)

l. Obtained from the vibration level measurements are averaged and analyzed the level of safety of the operators work.

2.8. Benchmarking performance against standards test results
Results from testing of rice straw chopper performance compared to the International Organisation for Standard (ISO 7580-2010) for the quality and test thrasher fertilizer materials [5], SNI 16-7063- 2004 for threshold values for noise [8] and ISO 2372 guidelines for the amount of engine vibration [9], so unknown rice straw chopper performance during operation and provides a solution to address performance deficiencies as well as the level of safety for operators working.

The stages of decomposition of rice straw is presented in figure 3.
2.9. Composting rice straw
   a. Chopping rice straw by using straw chopper machine. So that got chopped straw with a length of 5-10 cm.
   b. Setting up a bucket and water to dissolve the activator according to the dosage required (800 g activator + 24 L water for 80 kg of rice rapids).
   c. Setting up a tarp as a decomposition of rice straw and cover. Size tarp used according to the number of rice straw to be composted.
   d. Incorporating straw layer by layer into the mold compost.
   e. Sprinkle evenly over the surface activator straw. Each layer stacks with an activator watered sufficiently.
   f. Tamp each layer haystack.
   g. To repeat the stages 4-6 until the rice straw exhausted.
   h. Closing the pile of rice straw using plastic and tied with a rope.
   i. Fermentation/incubation for one month.

Figure 3. Flowchart composting.
3. Results and discussion

3.1. Analysis techniques
Paddy straw chopper is a method of feeding a machine with a throw-in, that is done by removing feed rice straw into the space enumeration. This machine has overall dimensions of 1918.76 mm × 793 mm × 1128.09 mm and using the motor with power 8 HP and a maximum rotational speed 2600 rpm.

a. Power Requirement
The driving force theoretically required of 1.83 HP and actual force with 8 HP shown in table 1.

| Parameters      | Theoretical | Actual | Provision | Exp.      |
|-----------------|-------------|--------|-----------|-----------|
| Power engine    | 1.83 HP     | 8 HP   | Theoretical power < Actual power | Qualify   |

In table 1, the theoretical power from the combustion engine already meets the power requirements needed for thrasher rice straw. Cylinder chopper engine rice straw in the room had a large mass, so categorized into the equation of flywheels for the great mass of the cylinder chopper can save energy of rotation that occurs during engine operation. Rice straw chopper using propulsion from the combustion engine with a power of 5968 W (8 HP) are classified as Class B thrasher by SNI 7580-2010 [5].

b. Analysis of the transmission unit
The transmission unit used on rice straw chopper, namely pulleys and belts V type B 23 (figure 4) with the cross-sectional area 137.5 mm² [10]. The result of the calculation of a belt length of 1.4 m and a mass of 0.24 kg belt. A comparison of the number of theoretical belts compared to the actual number is presented in table 2.

| Parameters      | Theoretical | Actual | Provision | Exp.      |
|-----------------|-------------|--------|-----------|-----------|
| Number of belt  | 4 belt      | 2 belt | Theoretical < Aktual | Qualify   |

Based on the calculations, tight voltage and the voltage obtained belt slack distributed power per HP belt is 2.53. It can be seen in table 2, the theoretical number of belts to deliver as much power as four belts, but the actual number of belts amounts to 2 pieces. That's because the power of motor fuel used by 8 HP who need more than two belts to supply power to the counter cylinder. Therefore, required the addition of a belt or change the belt cross-sectional area greater part of the transmission unit so that the machine can be operated optimally.
c. Analysis of shaft
The actual diameter of shaft that used by 36 mm (figure 5), deflection torsion which occurs on the shaft after calculation of 0.116°, while the allowable deflection torsion between 0.25° to 0.30° [10]. The average of the rotational speed of five measurements at 1,185 rpm when no load of hay and 1,108 rpm when there is a load of hay. Based on the technical parameters comparison of theoretical and actual axle are presented in table 3.

![Figure 5. Shaft.](image)

| Parameters               | Theoretical | Actual | Provision                   | Exp.  |
|--------------------------|-------------|--------|-----------------------------|-------|
| Diameter shaft           | 23 mm       | 36 mm  | Theoretical < Actual        | Qualify |
| Deflection of torsion    | 0.116°      | -      | 0.25° - 0.30°               | Qualify |
| Critical rotational speed| 5019 rpm    | 1.185 rpm | 80% critical rotational speed | Qualify |

In table 3, the diameter of the shaft used feasible and safe to use because it has a larger size than the theoretical diameter. The critical rotating speed of calculation of 5,019 rpm, according to [10] rotational speed must be less than 80% critical rotational speed, which amounted to 4,015 rpm. Three technical parameters of the shaft in table 3 are eligible for the safety and feasibility of the rice straw chopper machine.

d. Analysis of pin
In rice straw chopper, pin cylinder chopper used on pulleys and drive motor. The position of the pin on the cylinder pulleys enumerator seen in figure 6, while the pin diameter size comparison of theoretical and actual is shown in table 4.

![Figure 6. Position pin of cylinder chopper.](image)
Table 4. Comparison of technical specifications with theoretical currents pin.

| Pin Positions      | Theoretical | Actual | Provision | Exp.       |
|-------------------|-------------|--------|-----------|------------|
| Cylindrical chopper | 7.58 mm     | 8 mm   | Theoretical < Actual | Qualify |
| Driving force      | 7.40 mm     | 8 mm   | Theoretical < Actual | Qualify |

In Table 4, the theoretical diameter of the pin is smaller than the actual diameter so that when the rice straw chopper operated, the pin capable of locking the pulley from being shifted or damaged.

e. Analysis of spi

Spi used rice straw thrasher is spi is a rectangular cross-sectional shape and are prismatic and tapered head for easy retraction. Spi position on the machine invaders rice straw is in the cylinder axis enumerator, which can be seen in Figure 7. Based on the calculations, resulting in spi theoretical dimensions shown in Table 5.

Figure 7. Position spi of cylinder chopper.

Table 5. Comparison of technical specifications with theoretical currents spi.

| Parameters | Theoretical | Actual | Provision                  | Exp.   | Allowable |
|------------|-------------|--------|----------------------------|--------|-----------|
| Lengthy spi | 27-54 mm    | 30 mm  | 0.75-1.5 diameter of the shaft | Qualify | -         |
| Large spi  | 9-12.6 mm   | 10 mm  | 25%-35% diameter of shaft   | Qualify | -         |
| Shear stress | 11.76 N/mm² | -      | Theoretical < Allowable    | Qualify | 43.33 N/mm² |

According to Sularso and Suga (1997) width and length spi have standardized, so if there is a load caused by a large force should be solved by adjusting the length of spi [10]. However, spi that are too long cannot withstand the pressure evenly on the surface. Besides the dimensions spi, spi shear stress must be smaller than the allowable voltage so spi undamaged and able to withstand the cylinder enumerator during enumeration.

f. Analysis of bearings

Rice straw chopper sustained load is an axial load of pulleys, belt tension cylinder and the counter of 258.62 kg. The load is supported by the bearing type P 208 (Figure 8) with a nominal capacity of 2,380 kg specific dynamic [10]. Based on calculations, the theoretical bearings life values obtained are presented in Table 6.
According to Sularso and Suga (1997), the nominal bearings life must be greater than the nominal life permitted for agricultural machinery, in the amount of 2,000 to 4,000 hours [10]. Thus, bearings used hay thrasher feasible and safe to use.

g. **Analysis strength of the framework**
The machine frame using iron U with a size of 44 mm × 79 mm × 44 mm and 7 mm thick. Frame straw chopper can be seen in figure 9. Frame counter space bears the weight of the cylinder counter, bearings, pulleys and shafts of 574.47 N and order hopper bear the weight of 102.96976 N. Imposition cause horizontal and vertical deflection on the frame, Calculation deflection caused and allowable deflection can be seen in table 7.
Table 7. Comparison of the theoretical framework with deflection permit.

| Parameters          | Theoretical | Allowable | Provision         | Exp.  | Critical |
|---------------------|-------------|-----------|-------------------|-------|----------|
| Horizontal deflection | $1.11 \times 10^{-2}$ mm | 1.88 mm   | Theory < Allow    | Qualify | -        |
| Vertical deflection  | $1.30 \times 10^{-2}$ mm | 2.5 mm    | Theory < Allow    | Qualify | -        |
| Hopper deflection    | $1.72 \times 10^{-3}$ mm | 3 mm      | Theory < Allow    | Qualify | -        |
| Load                | 574.47 N     | 9,456,730.7 N | Theory > Critical | Qualify |         |

The results of the calculations in table 7 show that the framework is able to bear the weight and experienced a smaller deflection of the deflection critical. Thus, it can be concluded that the framework of rice straw chopper has a strong foundation to withstand the engine components on it during enumeration, besides the ergonomic dimensional framework allows an operator in the introduction of rice straw.

h. Analysis strength of joint

Type of weld joints that are used are welding angle (filled) that can withstand the pressure, pull, shear, torsion and bending (figure 10a), but it is also used intersection welding (butt) that can withstand the pressure and pull (figure 10b). Welding treatment is applied aims to connect the metal framework relating to the composition. Weld strength is taken into account in order to withstand the load of the engine components, the weld strength calculation results are presented in table 8.

![Figure 10. Joint Connection: (a) fillet; (b) butt.](image)

Table 8. Comparison of the theoretical strength of the joint frame with actual expenses.

| Parameters          | Theoretical | Actual  | Provision         | Exp.  |
|---------------------|-------------|---------|-------------------|-------|
| Strength of butt joint | 44,660 N    | 574.47 N | Theoretical > Actual | Qualify |
| Strength of fillet joint | 57,417.07 N | 574.47 N | Theoretical > Actual | Qualify |

Based on the calculation results in table 8, the load that supported framework capable retained by the weld strength. According to Hall et al (1993), weld strength can sustain the load order if the weld strength is greater than the forces acting on the chassis [11]. It can be concluded that the weld strength of the rice straw chopper frame can withstand the machine construction time of enumeration.

3.2. Performance test

a. Density

Density was measured by weighing the mass of rice straw is inserted into the receptacle (figure 11) as much as five repetitions. Rice straw is put in a position parallel to fulfill all parts of the tank. Based on the calculation of average density Kamba amounted to 128.78 kg/m³. Density value indicates that rice
straw requires storage space and hopper machine that is wide enough for the process of entering into to counter space.

![Figure 11. Sump rice straw.](image)

Large density shows rice straw requires a large storage space. The greater the density, it is expected that large-capacity machines. Density also is used as a baseline in the design and mechanism of action of agricultural machinery.

b. Water content
Treatment of rice straw into compost is withering for ± one day to obtain the optimum moisture content approaching 60%. Based on the measurement of water content with the test method SNI 01-2891-1992, the water content of rice straw before chopped of 67.54% and 69.74% after chopped. The measurement results exceeded the optimal standard for composting material, due to experiencing respiratory straw hay resulted in increased water content. Therefore, the environmental condition testing, hay storage and testing time should be considered to obtain the optimum moisture content. However, rice straw can still be used as composting material.

c. Theoretical capacity
The calculations show the capacity of the rice straw chopper of 336.20 kg/hour. Based on ISO 7580-2010 for thrasher organic fertilizer, the capacity of less than 600 kg/hour is included in the classification of Class A. thrasher feed speed to get the theoretical capacity of 4.62 m/s.

d. Actual capacity
Massa chopped rice straw average of 10.50 kg in five repetitions spend the time of 9 minutes 22 seconds. Testing of rice straw chopper in a chopping produces an actual capacity of 304.68 kg/hour. Based on ISO 7580-2010 for organic fertilizer thrasher, thrasher included in the classification of Class A with a capacity of less than 600 kg/hour.

e. Efficiency of chopping
Rice straw chopper based on calculations have chopped high efficiency due to comparison with a theoretical capacity of the actual capacity of 90.62%. Chopped efficiency of this engine has been qualified minimum efficiency of the engine, is by 80%.

f. Fuel consumption
Measurement of engine fuel in the motor is done manually, so we get the result of calculation of 2.52 liters/hour when there is no income and amounted to 3.19 liters/hour when the income of rice straw. SNI 7580-2010 based on the classification of motor fuels are included in Class B and corresponds with the recommended requirements for engine fuel consumption, which is between 2-3 liters/hour.

g. Theoretical power consumption
The theoretical power consumption of rice straw chopper without income amounted to 33.10 HP straw and rice straw with revenues amounting to 41.91 HP. If the available power of 8 HP motor fuel compared with the theoretical power motor fuel obtained thermal efficiency of 19.09% and 24.17%.
The percentage of the value of eligible thermal efficiency to internal combustion engines with gasoline, which ranged from 15% to 35%.

h. Specific energy of chopping
Chopping specific energy is the energy required to do the chopping of rice straw. The calculations show that the energy required in the chopping of 273.62 kJ/kg. This demonstrates the ability of a specific energy-cylinder chopper on a rice straw chopper.

i. The yield of chopped
The yield is the percentage of rice straw has been chopped compared with rice straw before chopped, and therefore the yield may show a loss of material during the chopped process. Based on the calculations, counting machines yield of 88.30%. High yield value indicates that rice straw chopper operates properly

j. Percentage of chopped
According to Yuwono et al (2013) chopped a good length for composting is 5 cm to 10 cm [1]. Intake of five samples from five chopped counted, so the percentage obtained long chopped 46%. This percentage does not meet the minimum standard length chopped percentage SNI 7580-2010, namely 80%. Due to the characteristics of rice straw were wilted, not continuous feed and cylindrical counter rotating speed is low. To overcome this, the chopping can be optimized by adding a clamp roller in front of the counter so that the rice straw before bouncing out of the counter space is thrust into space by a lap counter roller clamp.

k. Noise level
Based on the measurements, the noise level when the machine is turned on without the inclusion of rice straw at 86.4 dB smaller than the threshold value OSHA noise by 90 dB, but greater than 85 dB according to SNI 16-7063-2004. But according to ISO 7580-2010 for thrasher organic fertilizer does not exceed 90 dB, the noise without load is still considered a safe level of noise. Noise during enumeration of 97.5 dB exceeds OSHA noise threshold value, SNI 16-7063-2004 and SNI 7580-2010. Thus, the necessary changes of operator with long working hours to 2.67 hours/day. According to the Keputusan Menteri Tenaga Kerja No.51/MEN/1999 long hours of work for the noise level 97 dB 30 minutes [12]. In addition, the operator is required earplugs to drown out the noise.

l. Vibration level
Measurement of vibration on the hopper, counter space and order when the machine is turned on without the inclusion of rice straw averaged 33.4 mm/s and during the enumeration of 21.6 mm/s. According to ISO 2372 as a guide to the amount of vibration on the engine, vibration levels at the three measurement points exceeds the minimum vibration is not permitted for the engine with a power of less than 15 kW, is 4.5 mm/s and included in the hazardous category. To minimize vibrations can use a rubber vibration dampers in the bottom frame of rice straw chopper machine.

4. Conclusions
The conclusion in this study are as follows:
   a. The engine power requirement of 1.83 HP from the total available motor power of 8 HP
   b. Theoretical transmission units (belts and pulleys) the number of belts is 4, but the actual number of belts is 2
   c. The actual shaft diameter is 36 mm mm
   d. The theoretical pin diameter of 7.58 The bearing life of 280,538.56 hours, the theoretical capacity of 336.20 kg/hour
   e. The actual capacity of 304.68 kg/hour
   f. Fuel consumption 3.19 liters/hour
g. The noise level during chopper 97.5 dB
h. Vibration level of 21.6 mm/s
i. The result rice straw chopper became compost after decomposition for 30 day

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