Husker performance on small rice milling unit

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Abstract. The post-harvest process very much determines the quality and quantity of rice. The utilization of agricultural machinery in rice milling is one solution in maintaining rice quality. The most commonly used husker machine is a rubber roll type. This study aims to calculate the efficiency of huskers and the quality of rice. The parameters measured to analyze the efficiency of the milling machine and the quality of rice are the weight of unhulled rice to be milled, the weight of milled rice, and the time for milling the grain to become rice. The results showed that the husker efficiency at 1,237 rpm rotation speed was 46.3%, at 1,354 rpm was 46.7% and at 1,395 rpm was 46.6%. The quality of rice produced at a rotation speed of 1237 rpm, 70.03% whole grains, 3.58% broken grains, 1.51% groats. For 1,354 rpm, the rotation speed is 67.75%, broken grains 5.16%, and groats 2.89%. While at the rotation speed of 1,395 rpm, the percentage of broken grains was 56.26%, broken grains 4.80%, groats 1.27%.

1. Introduction

Rice is a commodity that farmers in Indonesia widely cultivate. This is because rice is a source of raw material for rice which is the staple food for Indonesians. Therefore, the program to increase rice production has received top priority from the government to achieve food security and farmer welfare. The quality that is produced from rice to become rice will significantly affect the selling price of rice.

Loss of agricultural products occurs in the post-harvest handling process [1]. Post-harvest handling of rice is a very strategic effort to support increased rice production [2]. One of the efforts made by farmers to improve rice quality is by using agricultural tools and machines such as the Rice Milling Unit (RMU). RMU is an agricultural machine tool that is used to grind grain into the rice. Using the RMU, the milling of unhulled rice is faster than the manual method or pounded.

There are two important factors to obtain high quality and yield of milled. First, the quality of rice grains include moisture content, the amount of dirt, the number of cracked or broken grains, the number of young unhulled rice, the number of damaged unhulled rice, and the number of other varieties of grain. The second factor, namely the mechanical means or rice milling machines used, especially the type of machine and working mechanism and the composition or configuration of the machine. In addition, the yield and quality of milled rice are closely related to machine justification [3].

The big problem for farmers is loss of yield, low quality, and fluctuating prices which tend not to provide incentives to them, are very much felt and need an immediate solution. The high demand for rice has caused the need for agricultural machine tools to increase to meet the need for post-harvest rice processing. One of the post-harvest rice processing machines widely available in the community is a rice grinder or Rice Milling Unit (RMU).
RMU technology with a peeler and booster system equipped with a cylinder, a rubber-roll husker, and a chaff blower using a blower to obtain a yield of about 63% and a higher percentage of head rice. Rice milling as an agricultural base plays an authentic role in advancing national rice to support self-sufficiency and national food security. Rice mills absorb and process unhulled rice from farmers into the rice. If there is no rice milling, the number of rice availability figures cannot be calculated because unhulled rice cannot be processed into rice optimally and circulated in the market.

In general, the machines used in the rice mill service industry are husk breaker machines (huller or husker), brown rice separators, boiling machines or polishers. The grain shelling machine that is widely used today is a rubber roll type. Nowadays, the rubber roll system is often found in the grain grinding machine unit. Each factory makes a model with certain specifications. This type of machine has two rubber rolls that rotate in opposite directions. One registration is in a fixed position called the high-speed main roll and low-speed auxiliary roll, whose position can be adjusted to get the distance between the two rolls as desired.

This study aimed to calculate the efficiency of the huskers and determine the quality of the rice and the yield produced from the huskers.

2. Materials and methods
The tools used in this study were a rubber roll type rice milling unit, a scale, a stopwatch, a moisture tester, a tachometer. The material used in this study was grain from the ciharang variety.

2.1. Research procedure
This research was carried out in several stages, including the stage of collecting tools and materials. Parameters for analyzing milling capacity, rice quality, and rice yield were observed for grain weight to be milled, the weight of milled rice, and time to grind grain into rice.

According to SNI (1989), the equations used for peel capacity, milled yield, stripping efficiency, stripping quality, grain cleanliness degree, average BPK state of grain, and circumference speed are in accordance with the following procedure:

2.1.1. Peel capacity
1. Provide 20 kg of unhulled rice per one mill.
2. Grain is put into the tool in a closed hopper.
3. After the pulping machine has run at operating speed, the hopper is opened, and the rollers are reset to the position where the stripping force is highest.
4. After the stripping power runs smoothly and stably, the BPK is accommodated in a certain time unit (depending on the machine's capacity to be tested) and then weighed.

Calculation:

\[
\text{Peel capacity } K = \frac{B_k}{t} \tag{1}
\]

where:
- \( K \) : peel capacity (kg/hr);
- \( B_k \) : the resulting BPK weight (kg);
- \( t \) : time taken (hours) Milled Rendement.

Calculation:

\[
R (\%) = \frac{BTB_{\text{dihasilkan}}}{BGKG} \times 100\% \tag{2}
\]

where:
- \( BTB \text{ produced} \) : Total weight of rice produced (kg);
- \( BGKG \) : Weight of milled dry grain (kg).
2.1.2. Stripping efficiency
Calculation:

\[
\text{Stripping efficiency} = \frac{\text{BPK weight}}{\text{BPK weight} + \text{Rice weight}} \times 100\%
\]  

(3)

2.1.3. Grain cleanliness degree
1. Take a sample of 100 grams of grain.
2. Peel the grain sample.
3. Separate between lime grains, damaged/yellow grains, foreign grains, and green grains.
4. Weigh each part.
Calculation:

\[
B_s = \frac{B_m}{B_c} \times 100\%
\]

(4)

where:
- \(B_s\) = percentage of each share (%);
- \(B_m\) = weight of the component concerned (grams);
- \(B_c\) = sample weight (gram).

3. Results and discussion

3.1. Degree of cleanliness
The results showed that the average percentage yield in the sample 1,2,3 was 2.71% green grains, 2.98% yellow grains, 1.98% damaged grains, 0.20% foreign grains, 0 lime grain percentage, 62%, 32.43% husk, and the remaining rice grains 59.06%. In the sample of 4,5,6, the average percentage of green grains, yellow grains, and damaged grains increased to 3.21% green grains; 4.57% yellow grains; 3.76 broken grain; the ratio of foreign grains 0.16%; lime grains 1.44%; husk 30.41%; and the remaining rice grains as much as 56.42%.

For the sample 7,8,9, the average yield of green grains was 2.71%; percentage of yellow grains 2.40%; broken grains 4.13%; foreign grains 0.16%; lime grains 1.26%; husk 30.37%; and the remaining 58.95% rice grains. The occurrence of grain fermentation due to the delay in the drying process causes the resulting milled rice to contain lime, brownish yellow, and black spots.

Based on the study of rice, green grains are categorized as III quality, yellow grains are IV quality, damaged IV quality, foreign IV quality grains, and lime grains are classified as quality II [5].

3.2. Peel capacity
Determination of the peel capacity, namely determining how long it takes during the milling process and the capacity or weight of broken rice (B) produced after milling. One of the things that must be considered during the grain milling process is that the grain that is put into the hopper must be closed so that when the peeler is turned on, the hopper is then opened at the same time as the timing is calculated.

There is only one type of grain used in this study, namely ciherang grain. Research has been carried out three times at each engine rotation speed using engine rotation speed of 1,237 rpm, 1,354 rpm, and 1,395 rpm.

Based on the first test results using a rotation speed of 1,237 rpm, the average time needed is 51.3 seconds, and the stripping capacity is 1,364 kg/hour. In the second test, the engine rotation speed of 1,354 took an average of 34.8 seconds to obtain a stripping capacity of 1,962 kg/hour. Then at 1,395
rpm, the average time needed is 29.7 seconds to obtain a stripping capacity of 2,183 kg/hour. At the engine rotation speed of 1,395 rpm, the time needed is shorter in carrying out the stripping process so that the resulting stripping capacity increases, on the other hand, at the engine rotation speed of 1,237 rpm, the required stripping process time is longer, so that the resulting peel capacity is less. This is influenced by the engine rotation speed and the distance between the two rubber rolls.

The research results by [6] show that the smaller the distance between the rubber rollers, the more broken or peeled rice is. And if the distance between the rubber rollers is getting bigger, the grain will also be produced. At 1,354 rpm, the average BPK weight was 17.5 kg, and the average CPC weight at 1395 rpm decreased to 17.4. This happens because, at the rotation speed of 1,354 rpm, it has much empty or unfilled grain. This is following the results of the milled yield, where the yield value at the rotation speed of 1,354 rpm is higher than the rotation speed of 1,395 rpm.

3.3. Yield of milled rice
The percentage of milled yield value obtained an average of 86.5%. In the second treatment, at a rotation speed of 1,354 rpm, the percentage of yield increased to 87.7%, and in the third treatment using an engine rotation speed of 1,395 rpm the average yield of milled was 87.3. %.

For the engine rotation speed of 1,237 rpm, the value is much different than the percentage of the engine rotation speed of 1,354 rpm and 1,395 rpm. This is because the engine rotation speed in the first treatment has not been running continuously, so the result of the percentage of the rotation speed of 1,237 rpm, the yield value is very different from 1,354 rpm and 1,395 rpm.

The research results by [7] show that the yield of milled is highly dependent on the raw grain material, variety, degree of maturity, pre-handling method, and the type and configuration of the grinding machine. Whereas at the engine rotation speed of 1,354, the yield value was 87.7%, after the rotation speed was increased, the percentage yield decreased to 87.3%. According to [8], the engine rotation speed affects the yield, this is following the effect of rotation on yield because the faster the engine rotation, the greater the pressure on the grain. The faster the rotating speed of the machine, the smaller the contact time with the grain, so that the peel of the peel is not so much.

3.4. Stripping efficiency
The stripping efficiency value shows the percentage of unhulled rice that was successfully peeled during the milling process by calculating the BPK weight and grain weight before testing. It is known that at the engine rotation speed of 1,237 rpm the average percentage of stripping efficiency is 46.3%, at 1354 rpm the average stripping efficiency is 46.7%, and at the engine rotation speed of 1,395 rpm the average percentage of stripping efficiency is 46.6%.

The value of stripping efficiency at 1,354 rpm and 1,395 rpm is not much different, because the engine rotation speed is also not significantly increased. The thing that affects the stripping efficiency is the distance between the two rolls and the engine rotation speed. This is supported by the results of [9] research that the faster the engine rotation, the higher the efficiency of stripping, but on the one hand, the higher the percentage of broken rice. The decrease in the value of the stripping efficiency at a rotation speed of 1,395 rpm is due to the higher the engine's rotation speed, the less time it is in contact with the grain, so the process of breaking the husks is brief.

4. Conclusion
The conclusions obtained from this study are:
1. Milled yield is better if you use an engine rotation speed of 1,354 rpm.
2. The stripping efficiency is higher if the engine rotation speed is 1,354 rpm than the engine rotation speed of 1,237 rpm and 1,395 rpm.
3. The degree of grain cleanliness should use an engine rotation speed of 1,237 rpm compared to 1,354 rpm and 1,395 rpm.
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