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DESIGN AND BUILD OF CUTTING AND GUIDE UNITS RICE HARVESTING MACHINE WITH HARVEST SLIDER TYPE IN DARMARAJA DISTRICT, SUMEDANG REGENCY

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ABSTRACT

Agricultural land with terraces and having an area per plot of less than 0.1 ha, is difficult to reach by large-sized and large-capacity agricultural machines. The Harvest Slider type rice harvester is an agricultural machine that can be used on small land and terraces. The purpose of this study was to design a cutter and guide unit for a rice harvesting machine that is easy to use on small land and terraces. The machine observation parameters measured were the effective field capacity, the effectiveness of the cutting unit, the effectiveness of the steering unit, fuel consumption and harvested rice loss. The work results show the effectiveness of the cutting unit is 99.56% and the steering unit is running well, which is indicated by the percentage of the effectiveness of the directing unit is 100%. The results of the performance test showed that the KLE for harvesting this machine was 0.05 ha/hour, fuel consumption was 1.2 l/hour, grain loss during harvesting was 2.1%. This shows that the Harvest Slider type rice harvester is on terraced and small land that cannot be reached by large harvesters.

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1. INTRODUCTION

Rice plants are included in the Gramineae plant group, namely plants with physical characteristics in the form of stems composed of several segments. Rice plants in their breeding are clumped which means this plant will grow from one shoot to 20-30 or more tillers / new shoots (Siregar, 1981); (Chandra Nath et al., 2017); (Purusottam Sahoo, Sugar Land & (US); Shane M. Richard, Deer Park, Magnolia, 2005). After going through several stages in rice cultivation, the rice plant will reach the harvest stage, the harvest stage is the final stage of rice cultivation (L. Musthofa,dkk); (Jahangiri Mamouri & Bénard, 2018); (Liu et al., 2020); (Chandrajith et al., 2016).

At the harvest stage, harvesting techniques are needed, in harvesting techniques can be done in a traditional or modern way. The application of traditional and modern harvesting techniques actually has the same goal, namely to obtain the final result of rice cultivation, namely grain with low yield losses. Based on the results of a survey by the Central Statistics Agency (BPS, 2007), it shows that the loss of rice yields in Indonesia is still quite high, at 11.27 percent which occurred at harvest (1.57 percent, threshing (0.98 percent), drying (3.59 percent), milling (3.07 percent), storage (1.68 percent), and transportation (0.38 percent).The development of technology in harvesting techniques is actually aimed at increasing the convenience of farmers in working, which in turn can improve the welfare of the majority of farmers and national and local food security, in other words the rice harvesting system remains the same but the process in it changes due to technological developments (Sulistiadji ,2007); (Zareiforoush et al., 2016).

The harvesting process can be done in two ways, namely traditional and modern methods. Harvesting is traditional (manual) using tools such as ani-ani and sickle, while in a modern (mechanical) use mower machine, reaper machine and combine harvester (Sulistiadji, 2007); (Susanto, 2018); (Alizadeh et al., 2007). The ani-ani and sickle harvesting tools consist of two main parts, namely the knife and nanum wood, which have different shapes and operations. (Sulistiadji, 2007). Harvesting techniques using ani-ani and sickles are still widely applied by Indonesian farmers, the reason being that Indonesian farmers still use these tools because of the unavailability of machines that are suitable for land conditions and the economic capabilities of Indonesian farmers.

The land in question is the condition of land in Indonesia which is narrow with steep and sloping topography conditions so that integrated machines such as combine harvesters are not yet possible to use and the economic capability in question is that many Indonesian farmers have not been able to procure integrated machines in the application of harvesting techniques. modern (Scheithauer et al., 2018); (L. Musthofa, dkk); (Chen et al., 2020); (Lin, 2018). Harvesting techniques in the traditional way applied by Indonesian farmers still have several weaknesses, such as the need for large manpower in harvesting per hectare, grain loss at harvest time is relatively high compared to mechanical equipment, low working comfort, low working capacity and relatively low cost of harvesting per hectare. higher than the mechanical (Hasan et al., 2018); (Al-Saeedi & Hossain, 2015); (Hossain et al., 2015); (Mansaray et al., 2020). Weaknesses in traditional harvesting techniques can be overcome with modern harvesting techniques, by using an integrated machine in the form of a combine harvester which has better work efficiency and time, but modern harvesting techniques also have several weaknesses such as very large initial investment costs, resources Human resources (HR) for operation are still few and machine mobility is limited (Sulistiadji, 2007); (Woodruff et al., 2017); (Hunter et al., 2020); (Jahangiri Mamouri & Bénard, 2018).

Weaknesses in traditional harvesting include operations that require more labor, low work comfort and long time in the harvesting process. In addition, seeing from the weaknesses that exist in the mechanical or modern harvesting process which requires large costs and does not support land in Indonesia, especially terraced land, the idea emerged to develop a simple rice harvesting machine with smaller dimensions, easy to carry so that it has mobility. high and in accordance with land conditions in Indonesia. The purpose of this research is to design a cutting unit and a steering unit on a rice harvesting machine that can be used on small and terraced land, and calculate the performance of this design machine.

2. METHOD

2.1 Place and time of research

This research was conducted in two stages, namely the stage of making the tool and the stage of testing the tool. The manufacture of the tools was carried out at the PTM Unsap Sumedang Machining Laboratory, starting from February 2020 to July 2021 and the testing of the tools was carried out in one village, namely the Tarunajaya Village area, Darmaraja, Sumedang.

3.1 Materials and tools

The materials used in the design and testing process are raw materials consisting of, 2 HP power lawn mower, 600 x 20 x 1.4 mm stallbus iron, 3 mm steel plate, 2 mm iron plate, 260 mm rotary knife, cylinder iron 6000 x 8 mm, ass length 500 x 19 mm, ass length 500 x 17mm, bolts and nuts 12 mm, bolts and nuts 10 mm, bolt nut 6 mm, bicycle wheel 20 inches, shock absorber 200 mm, bearing 20 mm , 17 mm bearing, 17 mm boss, 50 inch cylindrical iron and ready-to-harvest rice plants. The tools used in the design and testing are raw materials consisting of a Rhino 120 Ampere welding machine, a Bosch hand grinder and a seated grinder, an electric drill, a 12, 14, 17 pass wrench, pliers, hammer, screwdriver, work table, drill bit, electrode, stop whact, ruler, scale.

4.1 Performance Test

Performance tests were carried out to find out and get the results of rice cuts that were in line with expectations. In this case, it is expected that the performance of the machine can produce even pieces of rice and lay flat pieces of rice in one direction without any pieces of rice being thrown when it is cut. The performance tests carried out included: effective field capacity, harvesting road speed, percentage of harvesting loss, percentage of cut rice stalks, percentage of uncut rice stalks, effectiveness of steering performance and engine fuel consumption.

5.1 Effective Field Capacity

Calculating Effective Field Capacity as follows:

$$KLE = \frac{AFV}{t}$$

Description:
KLE : Effective field capacity (Ha/hour) A : Rice harvested area (Ha)
t : Total harvesting time (hours)

6.1 Percentage of Harvesting Loss

Calculate the percentage of grain loss during harvesting as follows:

$$WL = \frac{W\alpha\%W\tau}{F} X\ 100\%$$

Description :
WL: percentage of harvest loss (%)
W1: weight of unharvested rice (g/m2) W2: weight of rice that has fallen off due to harvesting (g/m2)
Y: weight of rice produced from tiles (g/m2)

7. Fuel Consumption

To calculate fuel consumption as follows:

$$FC = \frac{FV}{t\&}$$

Description:
FC : Fuel consumption (liters/hour) FV : Fuel volume (liters)
t2 : Working time of driving motor (hours)

3. RESULTS AND DISCUSSION

3.1 Drive Motor Unit

The source of driving force for the blades uses a gasoline motor with a capacity of 2 PK with a maximum rotational speed of 1100 rpm. The transmission of power from the driving source to the blade is in the form of a steel cable system and cylindrical steel, a steel cable with a length of 60 cm and a steel cylinder in the form of an axle with a diameter of 2 cm mm. In this system there is a reduction in rotation (1110 rpm motor rpm, 600 rpm cutting unit rpm).

3.2 Cutting Unit

The cutting unit is in the form of a round knife with a circular diameter of 26 cm with the outer side of a cutting tooth with a tooth length of 2 cm. The blade has a thickness of 5 mm and is made of steel. The size of the blade length and density on the cutting unit is technically capable of cutting every single clump of rice in one rotation, besides that the blade material in the form of steel can be sharpened as needed so as to ensure the effectiveness of the rice clump cutting process. The cutting unit is mounted on the front of this Harvest Slider machine, with a distance of 2 mm from the guide unit. The distance between the cutting knife and the guide unit is the ideal distance so that the cut rice stalks do not slip on the knife, and so that there is no friction between the cutting knife and the guiding unit..(Jawalekar & Shelare, 2020); (Li et al., 2017). The function of the first harvesting machine is to cut the stems of the rice plant. This cutting function is carried out by a rotary blade disc which gets power from the combustion engine through the transmission (Simon Ka’ka dkk. 2017); (Rustad et al., 2017); (Busato, 2015).

The working mechanism of the cutting unit to ensure the efficiency and quality of the work of this unit are:

a. The gasoline motor which is the driving force source is turned on causing the engine shaft to rotate, the shaft rotation is transmitted to the blade rotation. The rotation of the knife at 600 rpm is able to cut the whole rice stalk
b. The cutting knife rotates counterclockwise, with the cutting technique by slicing the rice stalks little by little. The knife process cuts the rice stalks due to the rotation of the blade and the overall advance of the machine. Cutting with this technique aims so that the results of the pieces of rice do not scatter.
c. The rotation of the cutting blade also helps to drive the cut to the outside of the machine

3.3 Steering Unit

The guiding unit consists of 2 shapes, namely a triangular prism shape in the front to the center point of the cutting unit, then an S-shaped letter in the middle of the cutting blade to the back along the 35 cm length. The ideal cutting blade tilt is 30o, the tilt of the steering unit can be adjusted as needed during the rice stalk cutting process.

The triangular prism shape guide works to direct, feed and lay the rice stalks to the left side. This results in making it easier for the cutting unit to reach the rice stalks in the initial cutting process, so that the effectiveness of the process is maximized. The process of working the steering unit as a result of the overall advance of the machine when it operates to cut rice stalks.

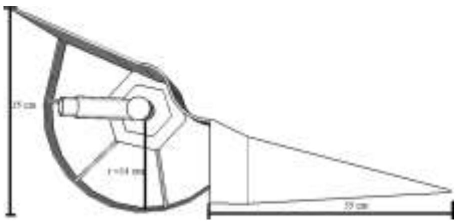

Figure 1. Steering Unit

3.4 Main Frame Unit

The main frame is made of galvanized iron 4 x 2 x 0.2 cm, the dimensions of the main frame are 80 x 10 cm. The main frame consists of the central axle supporting the steering unit and the wheel chassis layout frame. The center axle structure of the frame is designed to be able to adjust the tilt of the steering unit and the width of the wheel chassis frame structure is designed so that it is not more than the average distance between rice clumps.

The center of gravity of this machine is on the wheel chassis, all the load rests on that point. To reduce the load at that point, a suspension is added in the form of a shock beaker. Such frame construction is able to support all parts of the machine and maintain the balance of the machine, so that when the machine is operated there is no force bending that causes the machine to be unbalanced and maintains the safety of the operator.

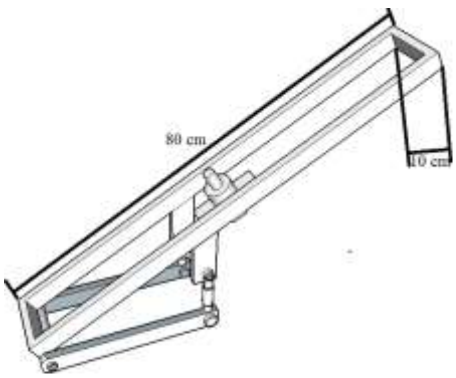

Figure 2. Main Frame Unit

3.5 Effective Field Capacity

The effective field capacity of the tool is obtained by dividing the harvested area cut by the time of cutting. The result of the research that has been done is that the effective field capacity of the rice harvesting machine is 0.05 Ha/hour, while the effective manual method is 0.025 Ha/hour. This shows that this tool can increase the work of 2 times compared to cutting rice manually. The performance of this machine is lower than the performance of the harvesting machine designed by Simon Ka'ka (2017), the working capacity of the machine designed by Simon Ka'ka is 0.041 Ha/hour. In addition, this capacity is also lower than the combine harvester type machine (Iqbal Maksudi et al. 2018); (Gao et al., 2018); (Rao & Saroj, 2017).

The rice stalk cutting system by the design machine is one groove in each track with the machine speed according to the speed of people walking (3.6 km/hour). The performance of the parts of the machine in the form of a driving force source, steering unit, cutting blades that are assembled on the frame are able to synergize well in carrying out the rice harvesting process by cutting the rice stalks of the clump in one process. Overall, the design machine remains balanced as long as the machine is operated to cut a clump of rice stalks, so that when harvesting time, this machine is used. (Table 1) is shorter than harvesting manually using sickles (Table 2). This can be seen from the number of uncut rice stalks in one clump which amounted to 0 – 2.6% (Table 3).

Table 1. Effective Field Capacity for Mechanical Harvesting

Ulangan	Luas lahan pemanenan (Ha)	Waktu pemanenan			Kapasitas lapang efektif (Ha/Jam)
		Detik	Menit	Jam	
1	0,01	792	13,43	0,22	0,045
2	0,01	725	12,08	0,20	0,050
3	0,01	667	11,12	0,19	0,053
		Rata-rata			0,05
		SD			0,004
		CV (%)			8.19

Dari Tabel diatas menujukan bahwa ada peningkatan nilai kapasitas lapang efektif selama 3 kali ulangan. Rata-rata nilaiKapasitas Lapang Efektif 0,05 ha/jam

Table 2. Effective Field Capacity for Manual Harvesting.

Ulangan	Luas lahan pemanenan (Ha)	Waktu pemanenan			Kapasitas lapang efektif (Ha/Jam)
		Detik	Menit	Jam	
1	0,01	1404	23,4	0,39	0,026
2	0,01	1548	25,8	0,43	0,023
3	0,01	1440	24	0,40	0,025
		Rata-rata			0,025
		SD			0,002
		CV (%)			6.19

3.6 Cutting Unit Performance Effectiveness

Table 3 shows that the effectiveness of the cutting unit performance is very good with an average value of 99.56 ± 1.01%. This percentage shows that all the clumps in the field have been cut off and left a little residue on the uncut in one clump as much as 0 – 2.6%, as previously disclosed. Loss left in the Mini Combine harvester machine is 1.44% ± 0.40% (Valentines et al. 2016). The serrated blade rotating at a speed of about 600 rpm is very effective in cutting the clumps of rice stalks, because the centrifugal force generated from the rotation of the blade combined with the forward motion of the machine is able to do the job of cutting the clumps of rice stalks. In addition, the knife material with sharp serrations greatly supports the performance of cutting rice stalks.

3.7 Effectiveness of Steering Unit Performance

Table 4 shows that the average value of directed rice stalks has all been directed according to the design, the number of rice stalks is perfectly directed or 100%, with a variance value of 0 which indicates that the driving performance is constant and good when operated. The steering unit is able to work very optimally with the overall forward movement of the engine at a forward speed in accordance with the running speed of the engine operator. The Harvest Slider machine uses a groove construction directing system, where this construction is made to follow the flow of the fall of the rice pieces, this final stage construction is better than the previous construction, so the results of this final stage design can exceed the effective field capacity of conventional harvesting. specifications as follows:

Figure 3. Results of Rice Harvesting Machine Design

3.8 Fuel Consumption

Fuel consumption per hour is 1.2 liters, fuel consumption is influenced by the amount of engine power released. The greater the engine power and the smaller the field capacity, the less effective the use of fuel. The alternative to increase the efficiency of fuel use is done by setting the engine power used at 2 PK.

4. Conclusion

The performance effectiveness of the cutter and guide unit works well, with the percentage of the effectiveness of the cutting unit being 99.56% and the steering unit being 100%. The effectiveness of mechanical harvesting using a Harvest Slider is greater than that of manual harvesting. The effective field capacity of mechanical harvesting reached 0.05 ha/hour, compared to manual harvesting which only reached 0.025 ha/hour.

5. Suggestion

It is necessary to develop a design on the part of the steering unit, so that the rice that is directed can be collected properly in a container, so that it no longer picks up after cutting. The use of wheels needs to be developed so that it is easy to use on rice fields when they are ready to be harvested.

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