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Designing and Manufacturing of Grain Dryer Machine using Coconut Shell Fuel as an Alternative Heat Energy

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***Abstract*—Many problems in the process of drying grain with a solar heat source. One of the factors is the erratic weather, where the rainy season comes along with harvest time. To overcome these obstacles, a grain dryer was designed that uses a rotary system that is simpler and more efficient and uses coconut shells as an alternative fuel. This study aims to obtain fast and affordable grain drying results by farmers using a rotary system dryer with coconut shell fuel. The benefit of this research is to provide an alternative solution for the community in dealing with harvesting in the rainy season by reducing land for drying grain. Equipment preparation was carried out in particular by using standard equipment to cut and connect the seat frame including the use of silencers and gasoline-fueled motors as propulsion and other supporting equipment. The components of each unit of grain drying machine are assembled and tested in stages according to procedures and functions. The test results show that the use of coconut shell can reach drying temperatures faster than the use of LPG, coconut shell fuel is better at reducing the moisture content of grain than the use of LPG. Testing of coconut shell fuel is done by drying 30 kg of grain for 20 minutes and 15 minutes. It can be concluded that the use of coconut shell as an alternative fuel can achieve a faster drying temperature than the use of LPG fuel. The use of coconut shell fuel to dry 30 kg of grain and reach a moisture content of up to 12% requires an effective time of 15 minutes.**

Keywords—manufacturing;grain; dryer; coconut shell; fuel

I. Introduction

Indonesia, is the largest agricultural country in the world, has diverse natural resources and a wide area. Indonesia is also the third largest rice producing country in Southeast Asia [1]–[3]. In general, farmers rely more on solar heat to dry grain, due to limited technology and low costs. The obstacle faced in the solar heat drying system is the unpredictable weather in Indonesia where the rainy season coincides with harvest time. This kind of drying model results in rice not being able to dry perfectly, being easily contaminated with dust and dirt when dried in the sun. Imperfect drying causes the rice produced to be less good in quality and quantity, thus it has a low market value [4], [5]. One of the requirements for good dry grain quality is having a maximum moisture content of 14%. Moisture content is the amount of water content of grain expressed in percent of wet weight [3]. In a study conducted by Tamaria Panggabean with a rack-type grain dryer, it showed that the mass of evaporated grain water was higher than drying using solar energy [6]. Rice grain dryer box type is one of the effective tools for drying grain when viewed from the results of reducing water content [7]. Another study investigating the effect of air velocity and grain mass on grain drying speed, the use of a fluidized dryer showed that the higher the air velocity, the faster the drying process [8], [9]. A rotary system of grain dryer with rice husk fuel developed by Sattar Yunus [10]. This dryer can dry 50 kg of grain with an average time of 30 minutes. The rice dryer with a rotary dryer model developed by Hariyanto with a capacity of 2 tons with rice husk fuel can function properly with an average grain drying process of 6 - 7 hours at a temperature of 60 - 65°C [11]. The use of coconut shells as fuel in the drum dryer type grain dryer. The results showed that the time required to dry 1 kg of rice grain was 3.75 minutes [12]. Although the rotary system is one of the solutions in grain drying, the rotary system dryer with a large

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capacity still has an expensive price and the fuel required is also very large. Therefore, in this research, it will be designed with the concept of Appropriate Technology (TTG) to produce a rotary system grain dryer that is simpler and more efficient with alternative fuels using coconut shell.

The purpose of this study was to obtain fast and affordable grain drying results by farmers using a rotary system dryer with coconut shell fuel. The benefit of this research is to provide an alternative solution for the community in overcoming the harvest in the rainy season with the reduced land for drying grain.

II. Research Methodology

The initial method carried out in this study was to identify problems in the community to overcome the harvest in the rainy season with less land to dry grain. The next method is to design and manufacture a rotary system grain dryer with coconut shell fuel with the required planning of equipment specifications (such as: height, length, width, diameter of the stirrer shaft, power of the driving motor). So that it can be determined the effective time used to dry the grain.

Equipment preparation is carried out in particular using standard equipment to cut and connect the frame of the seat including the use of reducers and gasoline-fueled motors as propulsion and other supporting equipment. The components of each unit of the grain drying machine are assembled and tested in stages according to the procedures and functions. The installation of the grain drying machine test equipment is shown in Figure 1.

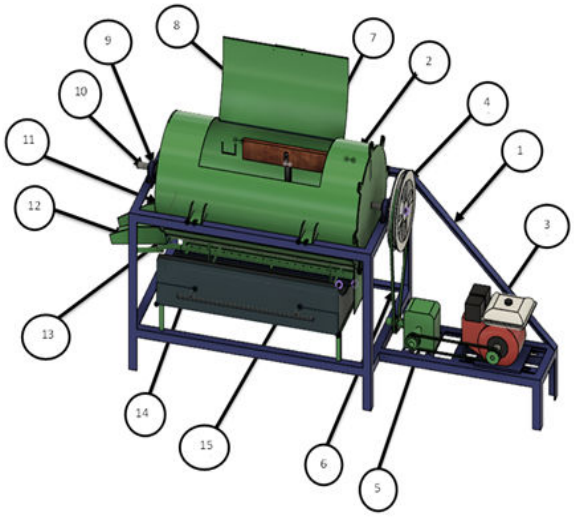

Figure 1. Design of grain dryer machine

Legend:

1. Frames
2. Cylinder tube
3. Drive motor
4. Pulley
5. Reducer
6. Belt
7. Stirrer
8. Cylinder door
9. Bearing
10. Shaft
11. Output
12. funnel
13. Tube lock
14. Stove
15. Burning rack

III. Results and Discussion

A. Manufacturing Result

The process of making the grain dryer machine was performed after going through the design process. The results of the design have provided the necessary data in the manufacturing process, namely the materials and tools used and the work process to be carried out, as shown in Table 1. The manufacturing result was shown in Figure 2.

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Table 1. Manufacturing process of grain dryer machine

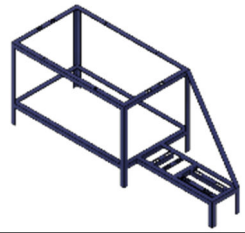
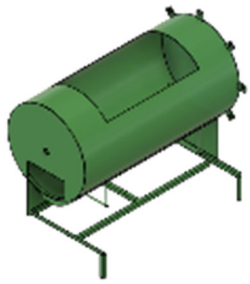
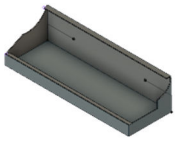
No.	Components	Tools	Materials	Manufacturing Process
1.	Main frame 	▪ Grinding machine, ▪ Welding machine ▪ Board marker ▪ PPE	Elbow plate 40 x 40 x 3 mm	▪ Measuring and cutting materials using a grinding machine according to the size made ▪ Connecting the pieces of iron pipe using an electric welding machine according to the working drawings. ▪ Making a hole according to a predetermined point using a hand drill with a drill bit size of 12mm
2.	Dryer cylindrical 	▪ Hand drilling machine ▪ Drill bit of M2 ▪ Plate rolling machine ▪ Grinding machine, ▪ Welding machine ▪ Board marker ▪ PPE	Plate steel (2 mm), elbow steel and steel bar dia. 6mm	▪ Measuring and cutting the iron plate according to the size of the working drawings, ▪ Rolling the plate to form a circle, connecting the two ends with a welding joint ▪ Making a hole using a hand drill with a diameter of 2mm, ▪ Installing the tube cover using welded joints and bolts, ▪ Cutting on the cylinder and cylinder cover ▪ Installing the iron plate on the cylinder using a welded joint,
3.	Stirring shaft 	▪ Bench drilling machine ▪ Drill bit M12 ▪ Welding machine ▪ Hand grinder machine ▪ PPE	Shaft with dia. 30 cm x 165 cm, wood, bolt and hollow steel	▪ Cutting the shaft that has been measured with a grinding machine, ▪ Cutting hollow iron that has been measured using a grinding machine, ▪ Making holes in wood and hollow iron according to the predetermined place points using a drill bit with a drill bit size M12, ▪ Connecting hollow iron to the shaft using electric welding, ▪ Installing wood in hollow iron using M12 bolts
9.	Burning components  	▪ Bench drilling machine ▪ Welding machine ▪ Hand grinder machine ▪ PPE	▪ Steel plate (thickness of 2 mm) ▪ Steel pipe dia. 20 mm	▪ Cutting the iron plate with a grinding machine according to the specified size, ▪ Cutting a steel pipe of 68 mm length with a grinding machine, ▪ Connect the steel plate to the steel pipe using an electric welding machine. ▪ Making holes in the steel pipe using a 3 mm drill bit.

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Figure 2. Manufacturing result of grain dryer machine

B. Testing Result

The process of testing the machine for data retrieval is carried out after the manufacturing process. Tests are carried out to determine the performance of the machine. The temperature used in data collection for heat sources from LPG gas cylinders is 57°C and for heat sources from coconut shells is 69°C. The test was carried out in three stages for the same initial weight of grain and different time durations in order to obtain accurate data. Furthermore, the drying results can be seen from the final weight of the grain obtained. The test data obtained from the grain drying machine and can be seen in Table 2.

Table 2. Testing results of grain dryer machine using fuel of LPG and coconut shell

No	Initial Weight (kg)	Final Weight (kg)	Duration (Minutes)	Drying Temp. (°C)	Fuel Type
1.	30,6	29,23	45	57	LPG
2.	30,6	28,93	60	57	LPG
3.	30,15	28,40	20	69	Coconut shell

C. Discussion

The grain drying machine is made to facilitate the grain drying process which is equipped with a control system and still uses solar heat. This machine is also designed and manufactured with the safety and comfort of the operator in mind so as to reduce the risk of work. The grain drying machine consists of various components, namely the engine frame, drying cylinder, shaft, stove, stirrer, and output funnel. The grain dryer machine has been made and assembled, then tested to determine the performance of the machine by using the engine power source comes from a gasoline motor with a power of 3 HP. This trial process was carried out 4 times to obtain accurate data.

The first test was carried out using 30.6 kg of grain with a fire setting on the stove and a temperature of 57°C. In the first stage of testing, the drying time required is 45 minutes; the final weight is lower than the initial weight due to a decrease in water content with the final result of grain weight 29.23 kg and a decrease in grain weight of 1.37 kg. The second test was carried out using 30.6 kg of grain with a fire setting on the stove and a temperature of 57°C. In this test, the drying time required was 60 minutes, and it was found that the final weight was lower than the initial weight due to a decrease in water content with a final grain weight of 28.73 kg and a decrease in grain weight of 1.87 kg. The third test was carried out using 30.15 kg of grain with coconut shell according to the test procedure and a temperature of 69°C. In this test, the drying time required was 20 minutes, and it was found that the final weight was lower than the initial weight due to a decrease in water content with a final grain weight of 28.40 kg and a decrease in grain weight of 1.75 kg.

Grain is considered good if the grain has undergone a drying process. The characteristics of good grain are the water content has decreased, the color is brownish, and the texture of the grains will be very different. Dry grain when pressed will be hard, while raw grain when pressed will feel soft. The difference between undried and dry grain can be seen in Figure 3.

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(a)

(b)

Figure 3. Appearance of grain before drying (a) and after drying (b) using a dryer machine

After doing 3 experiments, it can be stated that it takes 45 minutes to dry 30.6 kg of grain, 60 minutes for 30.6 kg of grain, and 20 minutes for 30.15 kg of grain. The results are quite satisfactory, and in the rainy season it will no longer be difficult to dry the grain. The grain drying process using coconut shell fuel obtained the best time for 20 minutes with a grain weight of 30 kg. Furthermore, if the drying time is calculated for 1 hour of the grain drying process, then the dryer will be able to dry 90 kg. The results of this drying can also minimize the drying time of the grain so that we conduct a more specific test using the measurement of the moisture content of the grain.

In order to ensure the desired test, the fourth test was carried out using 30.70 kg of grain with coconut shell according to the test procedure and a temperature of 67°C. The drying time required is 10-15 minutes with the moisture content of the grain in accordance with the logistics agency (BULOG) standard, which is 14-12 percent water content and is said to be dry. The result data was described in Table 3. The final weight was lower than the initial weight due to a decrease in water content with the final grain weight of 29.70 Kg and a decrease in grain weight of 1 kg.

Table 3. Test results of grain dryer machine using coconut shell fuel.

No	Drying Time (Minute)	Water content (%)	description
1	0	19,3	Not yet dry
2	5	14,2	Not yet dry
3	10	13,8	dry
4	15	12,4	dry

IV. Conclusion

Based on the results of the design and manufacture of a grain drying machine, the following conclusions can be drawn that this grain dryer can simplify the process of drying grain for 6-7 hours/day if done manually. The grain dryer machine is able to dry up to 30 kg of grain and is able to minimize the drying time of grain to 10-20 minutes using coconut shell fuel and 30-60 minutes with LPG gas fuel.

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