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Analysis of Thermal Conditions in a Simple Grain Dryer Building

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ABSTRACT: Drying buildings are really needed by farmers during the harvest season, the drying buildings that Merauke farmers often use are natural drying buildings whose heat source comes from the sun. The use of dryer buildings is considered more efficient when drying, this is because the farmers in Merauke have quite a hard time when the harvest arrives, when the harvest arrives the rainfall is still high. The purpose of this study was to determine the thermal conditions in a simple dryer building. This research type is experimental research. Temperature measurements were carried out for 1 week from 1 October 2022 – 6 October 2022. The results showed that inside the grain drying buildings the average temperature reached 34.2°C and the average humidity reached 73.9%. Meanwhile outside the building the average temperature reaches 31.8°C and the average humidity reaches 81%. During the measurement period, the highest temperature inside the building reached 43.4°C, causing the grain which was dried in the sun to dry quickly.

KEYWORDS: thermal, grain, dryer building

I. INTRODUCTION

As one of the centers of agricultural production with a comparative advantage in the form of fertile lands in various regions, it also has a competitive advantage, namely around 2,491,821.99 hectares (Ha) of fertile and wetlands which are alluvial soils resulting from river deposits ready to be utilized in Merauke Regency. This potential does not include the 1,474,061 Ha of dry land which can be turned into rice fields at any time considering the abundant water resources from several major rivers, such as: Maro, Bian, Kumbe and others [1].

Merauke is one of the areas that still uses conventional methods in agriculture, at certain times agricultural products are quite difficult to obtain, because during the rainy season, the rain intensity is very high, water conditions are abundant and it is difficult to channel it due to flat ground conditions, otherwise in the dry season the water is quite hard to come by. So that agricultural business does not run optimally throughout the year. In the rainy season some agricultural products are difficult to obtain, including vegetables, this is because the soil content is quite wet so that several types of plants such as vegetables do not grow optimally [2], besides that during the rice harvest the rain intensity is still high enough so that farmers difficult in the grain drying process.

Merauke's agriculture still depends on rain-fed agriculture, therefore many farmers have started planting before the rainy season actually takes place. So when the rainfall is still high, the rice planted is ready for harvest, the effect is that the grain yields are difficult to dry. Because the grain does not dry quickly, the quality of the grain becomes low and ultimately affects the quality of the rice. Currently, when the harvest is over and the rainy season is still going on, farmers usually air it in an empty room in the farmer's house. However, if the harvest is quite large, the pile of grain is very thick so that the existing grain does not dry quickly, even though the farmer is always turning the grain back and forth. Usually when there is a little light/heat the farmers try to dry the rice, but because the rain intensity is still quite high, the light/heat only lasts a few minutes. Because the heat doesn't last long, the farmers just open the tarpaulin without leveling it (if this lasts a few days, of course the paddy that is still wet during harvest will become moldy and rotten).

Basic Principles of Drying

Drying is a process of transferring heat and water vapor simultaneously, which requires heat energy to evaporate the water content transferred from the surface of the material being dried by the drying medium which is usually hot. The drying process is the process of taking or reducing the water content to a certain extent so as to slow down the rate of grain deterioration due to biological and chemical activities before the material is processed/used. The purpose of drying is to reduce the moisture content of the material to a point where the development of microorganisms and the activities of enzymes that can cause spoilage are inhibited or stopped. Thus, the dried material can have a long shelf life. There are two ways of drying [3].

a. Natural Drying

The advantages or disadvantages of natural drying are low energy costs, requires a lot of labor to spread, turn over and re-assemble, are very dependent on weather, require large

areas of land, difficult to regulate the temperature and rate of drying and are easily contaminated.

b. Artificial Drying

Artificial drying is an alternative way of drying rice when drying in the sun cannot be done. Broadly speaking artificial drying is divided into bed drying, continuous drying and batch drying which generally uses mechanical power [4].

Humidity

Humidity is a term relating to the content of water vapor. Air is said to have high humidity when the water vapor it contains is high, and vice versa. Conditions of temperature, pressure and moisture content of the air are known as air quality. Once the air quality is known, then we can assess the ability of the air to evaporate water in a material, because the material to be dried is always in a certain quality of air [5].

Solar Dryer

A solar dryer is the right choice because apart from its simple technology, it also saves energy and is free of pollution and the processed products are of good quality. Especially for drying superior rice seeds of seed breeder agricultural production. This machine is one of the applications of new technology that comes from renewable energy and can be said to be an alternative for future technology, because from day to day it cannot be renewed and is expensive [6].

Paddy Drying System

The method of drying grain that is commonly used by farmers in tidal swamps and lowland swamps is drying by direct drying in the sun. Grain is generally dried on woven bamboo or plastic sheeting, while in the rice mill unit the grain is dried on a cement floor or using a drying machine. Drying in the sun (sun drying) must pay attention to the intensity of the light, the drying temperature which is always changing, the thickness of the drying and the frequency of turning. The frequency of grain turning is usually every two hours to even out the grain moisture content as a whole. After drying it, it is allowed to stand for about two hours and then it is milled to avoid broken rice [7].

Dryer Energy Needs and Solar Energy Efficiency

The use of solar energy in natural drying systems is very important because it is the only source used as drying energy. There are two types of energy used in this drying process, the first is electrical energy and solar energy. Electrical energy is only used to drive the Exhaust fan to expel the material vapor in the dryer to the environment so as to reduce high humidity. The solar energy used in this tool serves to dry the material by increasing the temperature in the tool. The amount of solar energy that enters the dryer depends on the length of sunlight and the weather conditions during the drying process. The measurement of sunlight intensity is carried out with the help of a measuring instrument in the form of a Lux meter which is measured from 08:00 WITA to 17:00 WITA. The intensity of sunlight received by the dryer model during the drying process, the highest light intensity values obtained during the drying process starting from days (I-IV), namely: 770 W/m², 741 W/m², 787 and 733 W/m², with the average intensity of the sun per day is 508.9 W/m², with an irradiation duration of 10 hours/day. The average irradiation reaches its maximum point at 13.00, because at this time the position of the sun is perpendicular to the earth. And it continues to decrease until it reaches a point of 0 W/m² in the afternoon before sunset [8].

II. MATERIALS AND METHODS

The research was conducted in Yasa Mulya village, Tanah Miring District, Merauke Regency, South Papua Province. Thermal measurements were carried out for 1 (one) week starting from October 1st 2022 to October 6th 2022.

The dryer building material uses wooden beams, with a size of 161 m2 (7 m x 23 m), with a building height in the middle + 160 cm high, left and right sides + 100 cm high. for the center pillar using a beam of 5 cm x 10 cm, while the truss uses a beam of 5 cm x 5 cm. roof covering material using UV plastic.

The method of thermal measurement is to measure temperature, humidity and wind speed inside and outside the building. Measuring tools used include; 1). Krisbow brand environmental meter, 2). Anemometer, and 3) Measuring instrument for distance/meter. Thermal measurements start from 7.00 WIT – 16.00 WIT, measurement results are recorded every hour. After the thermal measurement data was obtained for 1 week, the data was averaged every hour, after which a graph was made and compared to the thermal conditions between the thermal conditions outside the building and inside the drying building.

III. RESULTS AND DISCUSSION

The simple drying building under study belongs to Mr. Marem, located on Teuku Umar Street, Yasa Mulya Village, Tanah Miring District. Building area 161 m^2 (7m x 23 m) east-west building orientation, building conditions between residential areas and the main road (Teuku Umar Street). Figure 1 shows the research location and Figure 2 shows the condition of the inside and outside of a simple rice dryer building.

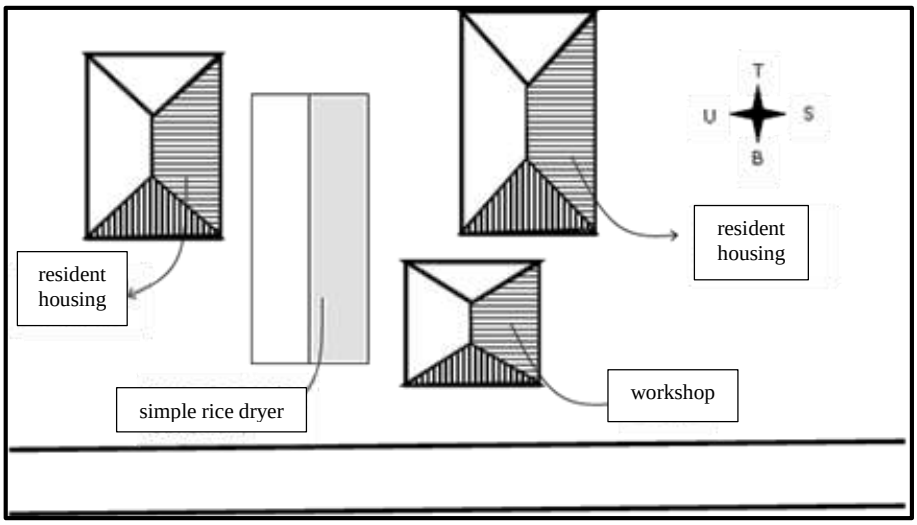

Figure 1. Research sites

Figure 2. The condition of the outside and inside of a simple rice dryer building

Thermal measurements were carried out for 1 (one) week starting from October 1st 2022 to October 6th 2022, from the results of the analysis that has been carried out the highest temperature in the drying building can reach the highest temperature of 40.7°C , the lowest temperature of 27.8C and average temperature measurement 34.2°C. Whereas for outside the building the highest temperature is 36.7C, the lowest temperature is 27.8°C and the average temperature 31,8°C. sedangkan untuk kelembaban dalam bangunan, kelembaban tertinggi 82,8%, kelembaban terendah 66 % serta kelembaban rata-rata 73,9 %. while for humidity in buildings, the highest humidity is 82.8%, the lowest humidity is 66% and the average humidity is 73.9%. Meanwhile outside the building the highest humidity is 89.5%, the lowest humidity is 74.2% and the average humidity is 81%. Because the farmers want the temperature in the building to be high, the left and right sides are designed to be low, with the aim; 1. Rainwater cannot enter the building, 2. Wind does not enter the building much. However, on this side it is rather difficult for farmers to turn over the image because the roof covering is getting weaker.

The highest temperature in the building can reach + 43.4°C, at this temperature the grain that is dried in the sun dries quickly, but according to the experience of the dryer building owner, high temperatures also make the grain not good for seeds or used as rice. If it is dry with high temperatures, the grain that will be used as seeds when it is sown will not grow 'dense' or much, while if it is milled, the grain tends to break (it becomes 'broken' rice and lots of groats).

Figure 3. The side of the dryer building with a height of ± 100 cm

Meanwhile, the wind speed inside the building is below 1 m/s (0.4 m/s), while the wind speed outside the building is also only 2.5 m/s. This is because there are many drying buildings among other buildings and there is a lot of large and medium vegetation around the building, the presence of these buildings and vegetation hinders the rate of air flow. Due to the farmer's goal of making a drying building to be able to create heat inside the building, therefore the wind speed in the 'cooling' category is certainly not very desirable.

Figure 4. The process of measuring wind speed, temperature, humidity in drying buildings

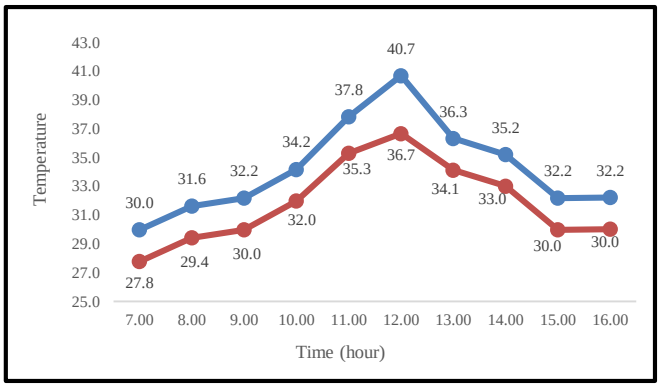

Figure 5. Temperature measurement results (The red line is temperature outside the building; the blue line is temperature inside the building)

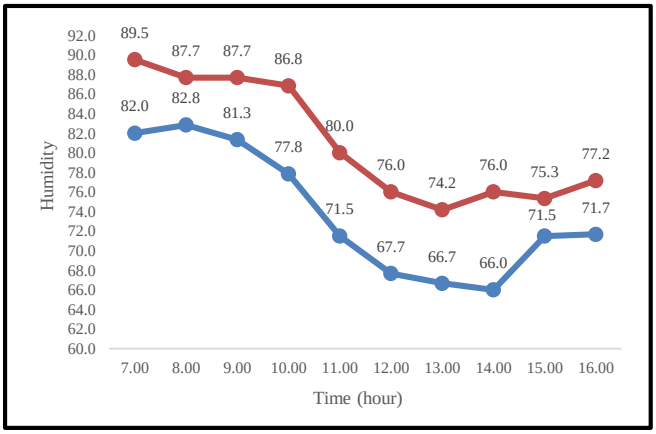

Figure 6. Humidity measurement results (The red line is humidity outside the building; the blue line is humidity inside the building)

From the results of interviews with the owner of the dryer building (Mr. Marem) the funds spent on building the dryer ± 5.000.000 rupiahs not including labor yet (the process is done by himself). With the construction of the dryer building, grain yields will be better compared to before having the dryer building, this is because grain from the paddy fields (wet conditions) can be aired directly without fear of rain. With an area of 161 m^2 the dryer building can accommodate 1 ton of wet grain, then gradually the grain is leveled for further processing drying (although relying on erratic sun conditions, because during the harvest there is still a lot of rain). The dryer building has a weakness in the roof covering (UV plastic), plastic can only last 3 (three) growing/harvesting seasons (± 1.5 years), the plastic becomes damaged/torn. To replace it by dismantling all beam clamps. Besides that, which is quite often damaged is at the joints between plastics. due to damage on this side when it rains, rainwater can enter the plastic joint.

CONCLUSIONS AND RECOMMENDATIONS

The thermal condition of the rice drying building, from the results of the analysis that has been carried out, the highest temperature in the drying building can reach an average highest temperature of 40.7°C , the lowest temperature is 27.8°C and the average measurement temperature is 34.2°C. As for outside the building, the highest temperature is 36.7°C, the lowest temperature is 27.8 □C and the average temperature is 31.8°C. while for humidity in buildings, the highest humidity is 82.8%, the lowest humidity is 66% and the average humidity is 73.9%. Meanwhile outside the building the highest humidity is 89.5%, the lowest humidity is 74.2% and the average humidity is 81%. Thermal measurements were carried out for 1 (one) week starting from 1 October 2022 – 6 October 2022. When the highest temperature measurement in the building reached + 43.4°C, at this temperature the grain that was dried in the sun did dry quickly, but according to experience dryer building owners, high temperatures also make the unhulled grain unfavorable for seeds or made into rice. If it is dry with very high temperatures, the grain that will be used as seeds when it is sown will not grow 'dense' or much, while if it is milled, the grain tends to break (it becomes 'broken' rice and lots of groats).

It is suggested that it is necessary to design a dryer building with a knockdown system so that the covering material (UV plastic) can be stored without being exposed to continuous heat which causes the plastic to be damaged (torn).

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