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Performance Evaluation of an Automatic Mixing Bed Dryer for Paddy Using Corncob Biomass Fuel

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ABSTRACT

Drying is an essential stage in post-harvest rice handling to reduce the moisture content to a safe storage level (≤14%). This study aimed to evaluate the field performance of a bed dryer automixing type rice dryer fueled by corncob biomass. The experiment was conducted at the Organic Rice Mill Tani Jaya II, Rowosari Village, Jember Regency, with three actual drying capacities of 1 ton, 1.2 ton, and 1.7 ton of paddy. The observed parameters included temperature distribution, moisture reduction, drying rate, and energy efficiency. The results showed that the highest temperature occurred in the lower layer of the paddy bed (35.5 - 41 °C), while the final moisture content in all treatments was below 14%. The drying rate fluctuated due to the mixing process and variations in hot air temperature, with the highest efficiency obtained at a capacity of 1.7 ton (58.32%). These findings indicate that the bed dryer automixing type rice dryer performs effectively under field conditions with varying load capacities and is suitable to be applied as a biomass based drying solution that can accelerate the drying process and operate effectively during the rainy season.

1. INTRODUCTION

Indonesia is an agrarian country with 28.18% of its population working in the agricultural sector (BPS, 2024). Paddy is the main commodity, yet improper postharvest handling, particularly during the drying stage, can cause yield losses of up to 21% and reduce the quality of both paddy and white rice (Tim Pustaka, 2017). Postharvest handling covers processes from harvesting to producing safe and consumable products (Awanis *et al*., 2022). For paddy, postharvest handling by farmers includes harvesting, threshing, drying, storage, and milling into rice (Molenaar, 2020). Drying functions to reduce paddy moisture content to a safe storage level. Freshly harvested paddy has a moisture content of 22-26%, which is far above the standard of 14% for dry unhusked paddy (BSN, 2020).

Drying is a critical stage in postharvest handling of paddy to reduce moisture content to below 14% (wet basis) as the safe storage threshold (BSN, 2020). This process directly affects rice quality, storage stability, and milling yield. Farmers in rural areas generally rely on traditional sun drying as the main method. However, this method is highly dependent on weather conditions. During the rainy season or when solar intensity is low, drying becomes slow or even stops. As a result, paddy moisture content is difficult to be controlled, leading to quality deterioration and increased postharvest losses (Sihombing *et al*., 2024).

As an alternative, mechanical dryers provide a solution to maintain drying continuity. Various drying technologies are now available in agriculture, including oven dryers, spray dryers, bed dryers, and rotary dryers. One widely used technology is the bed dryer, which is simple, easy to operate, and requires minimal maintenance (Tim Pustaka, 2017). The automatic mixing (automixing) bed dryer is equipped with an automatic turning system to achieve more uniform temperature distribution and moisture reduction. This machine can use different types of fuel, including biomass sources readily available in rural areas such as corn cobs, rice husks, or firewood (Hakim *et al*., 2017). The bed dryer operates by forcing hot air through a blower so that the heated air reaches the paddy being dried (Suhelmi *et al.*, 2022). As fuel, corn cobs offers advantages by utilizing agricultural waste and reducing dependence on fossil fuels.

The Agricultural Mechanization Development Center (BPMEKTAN) has conducted research and testing on automixing bed dryers as part of biomass based drying technology development in Indonesia (BPMEKTAN, 2021). Data and parameters obtained from BPMEKTAN serve as technical references and the basis for testing, particularly regarding drying temperature, moisture content, drying rate, and energy efficiency. However, factors influencing dryer performance, including drying load using specific biomass fuel such as corn cob have rarely been reported. Therefore, this study aimed to evaluate the performance of automixing bed dryers fueled by corn cobs based on BPMEKTAN technical references, with a focus on actual field testing at the farmer level. The observed parameters included temperature distribution in the plenum chamber and paddy stack, moisture reduction, drying rate, and energy efficiency. The results are expected to provide an overview of the real performance of biomass based dryers in the field and serve as a reference for effective drying technology application during the rainy season.

2. MATERIAL AND METHOD

2.1. Research Location and Period

Field trials were conducted from January to March 2024 at the Tani Jaya II Organic Rice Mill in Rowosari Village, Sumberjambe District, Jember Regency, East Java, in collaboration with local paddy drying entrepreneurs who had already adopted similar machines in their postharvest activities. The mill is a local business unit for rice drying and milling owned by local entrepreneurs who have utilized automixing bed dryers in their postharvest activities. The drying machine operates using biomass fuel, specifically local corn cobs that are easily obtained around the research area. The test materials consisted of paddy harvested from local farmers, while the fuel used was locally sourced corn cobs that were dried and prepared by the drying operators at the mill.

In field operations, the drying capacity of paddy loads often varied depending on farmers' harvests. The drying load affects the hot air distribution, temperature stability, and drying efficiency. Therefore, direct evaluation of the performance of automixing bed dryers in the field is necessary to determine the impact of capacity variations on actual drying performance. In this study, drying capacity was varied to 1 ton, 1.2 ton, and 1.7 ton, which reflected actual field operational conditions.

2.2. Research Tools and Materials

The primary equipment used in this study was an automixing bed dryer with a total capacity of 3.5 ton (Figure 1). The dryer was equipped with a combustion chamber, a hot air plenum chamber, a paddy stack chamber, and an automixing system designed to equalize temperature during the drying process. The machine operated using biomass fuel in the

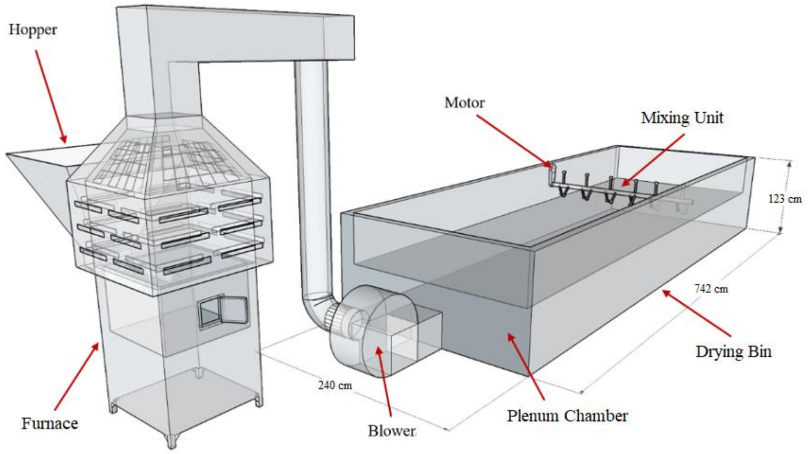

Figure 1. Fixed bed dryer with automixing for paddy

form of dried corn cobs. Supporting measurement instruments included digital scale to weigh the corn cob fuel, stopwatch, used to record drying time and data collection intervals (every 30 min), digital thermometer TPM-10 to measure hot air temperature in the plenum chamber and the temperature at three layers of the paddy stack (top, middle, and bottom), and digital grain moisture meter (Crown TA-5) to measure paddy moisture content (wet basis).

The test material consisted of freshly harvested dry paddy (GKP) obtained from farmers in Rowosari Village, Sumberjambe District, Jember Regency, with an initial moisture content ranging from 20% to 30%. The initial weight of the paddy to be dried was determined based on weighing data provided by farmers or local drying operators at the Tani Jaya II Organic Rice Mill. The fuel used was dried corn cobs harvested by local farmers, which were utilized directly without moisture content measurement.

2.3. Research Procedures

Prior to the drying process, inspections were carried out on the combustion system, hot air channels, and the automixing function to ensure that the machine was ready for operation. Drying began with ignition of the combustion chamber using corn cobs until the plenum chamber temperature reached 50-60 °C, after which paddy was loaded into the drying chamber according to the treatment capacity. The automixing system was operated periodically to equalize temperature and moisture content of the paddy during drying.

Temperature measurements were taken using a digital thermometer at three points in the paddy stack (top, middle, and bottom layers) and at one point in the plenum chamber. Moisture content measurements were conducted every 30 minutes using a moisture meter (Crown TA-5) with three readings per point, and the average value was recorded. Drying time was measured with a stopwatch, and the mass of corn cob fuel was weighed each time additional fuel was placed into the combustion chamber. Drying was terminated when the paddy moisture content reached below 14% (wet basis) in accordance with SNI 6128:2020 (BSN. 2020).

2.4. Observation Parameters

The observed parameters included temperature distribution, changes in moisture content, drying rate, evaporation energy, and energy use efficiency. Calculation formulas were adapted from related research journals, while performance test data from BPMEKTAN (2021) were used as comparative references for field conditions.

1) Drying Temperature (°C): Temperature was recorded at each measurement point using a digital thermometer TPM-10. Prior to measurement, calibration was performed on the machine thermostat to ensure data accuracy. The drying process of rice grain was carried out at a temperature range of 48-60 °C (Hamarung & Kadang, 2018).
2) Paddy Moisture Content (%): Moisture content in paddy kernels was expressed in percentage based on wet basis. Measurements were taken using a Digital Grain Moisture Meter (Crown TA-5) with the electrical resistance method. Samples were collected from each layer of the paddy stack (BSN, 2020).
3) Drying Rate (%/hour): Drying rate was defined as the amount of water evaporated or the reduction in moisture content per unit of time. The process continued at a constant rate until the surface moisture of paddy reached a critical point. The drying rate (LP, %/h) was calculated using the following equation (Usman *et al*., 2020).

$$Drying\ rate = \frac{M_1(\%) - M_2(\%)}{t\ (jam)} \tag{1}$$

where, M_1 is the initial moisture content (%), M_2 is the final moisture content (%), and t is the drying time (h).

4) Moisture Load (kg H_2O): Moisture load of paddy is the amount of water vapor that must be evaporated (M_u) to reach a certain moisture level. It was calculated using the following equation (Usman *et al*., 2020):

$$M_u = \frac{W_0(M_1 - M_2)}{(100 - M_2)} \tag{2}$$

where, M_u is the moisture load (kgH_2O), W_0 is the initial mass of paddy before drying (kg), M_1 is the initial moisture content (%), M_2 is the final moisture content (%). According to Usman *et al*. (2020) latent heat of vaporization can be calculated using the following equation:

$$H_{fg} = 2{,}502 - (2.3775T) \tag{3}$$

where, H_{fg} is the latent heat of vaporization (kJ/kgH$_2$O), and T is the paddy temperature (°C).

5) Energy Input of Paddy Dryer (Q_{input}): Fuel energy is the total energy supplied to the automixing bed dryer. The input energy consisted of electrical energy and fuel energy. Total energy was calculated from electrical energy for the motor and the calorific value of corn cobs 17.06 MJ/kg (Sucahyo *et al*., 2024). Input energy was calculated using the following equation (Sari *et al*., 2014) and (Nainggolan *et al*., 2013):

$$Q_{input} = (Q_L \times t) + (m.s \times Nbb) \tag{4}$$

where, Q_{input} is the input energy (kJ), Q_L is electrical energy (kJ), t is the duration of electricity use (hour), $m.s$ is the fuel mass (kg), Nbb is the calorific value of corn cobs (17.060 kJ/kg).

6) Energy Utilized (Q_{output}): To determine the total energy required for drying paddy, two factors must be considered, namely the energy used for water evaporation (Q_1) and the energy used for heating the material (Q_2). The total energy utilized during the drying process was calculated using the following equation (Sari *et al*., 2014):

$$Q_{output} = Q_1 + Q_2 \tag{5}$$

The energy required for water evaporation was calculated using the following equation (Nainggolan *et al*., 2013):

$$Q_1 = M_u \times H_{fg} \tag{6}$$

where, Q_1 is the energy for evaporation (kJ), M_u is the moisture load (kgH$_2$O), and H_{fg} is the latent heat of vaporization (kJ/kgH$_2$O).

Heating energy was used to raise the temperature of paddy during drying, thereby reducing its moisture content. According to Usman *et al*. (2020) the heating energy was calculated using the following equation:

$$Q_2 = \mathrm{m} \times C_p \times (T_2 - T_1) \tag{7}$$

where, Q_2 is the heating energy (kJ), m is the initial mass of paddy (kg), C_p is the specific heat of paddy (1,850kJ/kg°C), T_1 is the initial temperature (°C), and T_2 is the final temperature (°C).The specific heat capacity C_p was calculated using the Siebel equation:

$$C_p = 0.837 + 0.034m \tag{8}$$

7) Drying Efficiency: Drying efficiency was defined as the ratio between the energy used for heating and evaporating water in paddy and the input energy supplied to the dryer (Sari *et al*., 2014). The efficiency was calculated using the following equation (Sari, 2017):

$$Eff = \frac{Q_{output}}{Q_{input}} \times 100\% \tag{9}$$

where, Eff is drying efficiency (%), Q_{output} is the energy used for evaporation and heating (kJ), and Q_{input} is the input energy supplied to the drying chamber (kJ).

3. RESULTS AND DISCUSSION

3.1. Drying Temperature

Temperature measurement were conducted at four points, namely one point in the plenum chamber and three points in the paddy stack (top, middle, and bottom layers). The plenum temperature was used as the main reference to analyze changes in the paddy stack, since hot air from the combustion chamber first passed through the plenum before being distributed to the drying chamber. During the drying process, the plenum temperature was maintained at 50-60 °C through manual adjustment of corn cob fuel. Fuel was periodically added to maintain heat stability and prevent excessive temperature. The process was carried out with paddy loads of 1 ton, 1.2 ton, and 1.7 ton.

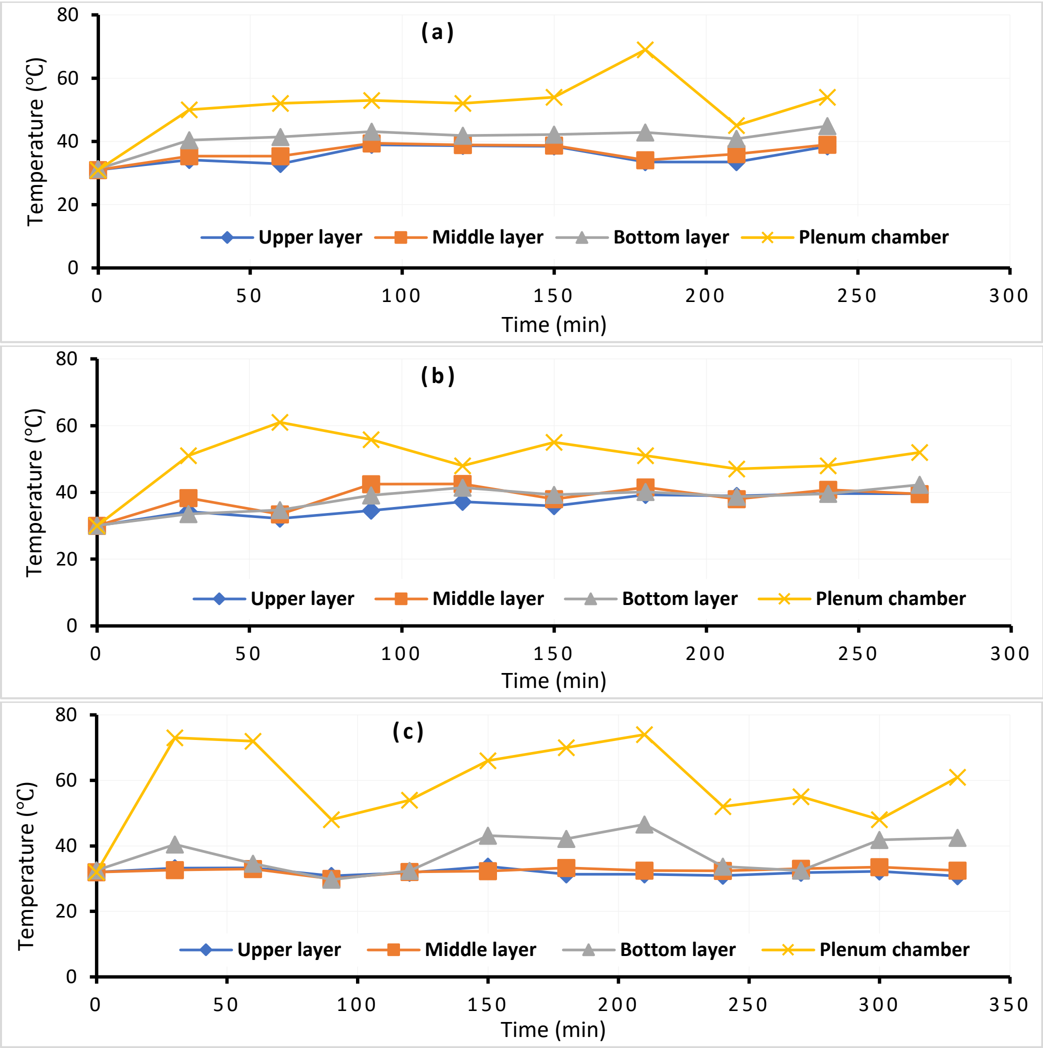

Figure 2. Temperature distribution of paddy drying based on drying load: (a) 1 ton; (b) 1.2 ton; (c) 1.7 ton

Based on Figure 2, the temperature distribution in the paddy stack was relatively stable with minor fluctuations caused by manual combustion. The bottom layer showed the highest temperature, followed by the middle and top layers, indicating convective heat transfer from bottom to top. The bottom stack received higher temperatures because it was closer to the plenum chamber. Heat energy naturally transfers when thermal energy moves from a region of higher temperature to a region of lower temperature (Hamarung & Kadang, 2018). This is consistent with Nainggolan *et al*. (2013) who stated that hot air received by the bottom stack is greater, and as the air flows upward to the middle and top layers, its temperature decreases. The temperature difference among layers became more evident at the 1.7 ton capacity due to increased airflow resistance with thicker paddy stacks.

At 1-ton load, the average temperature was 35.5 °C for the top stack, 36.4 °C (middle), and 41.0 °C (bottom). For 1.2 ton load, the average temperature was 36.2 °C, 38.5 °C, and 37.9 °C, respectively for the top, middle, and bottom stack. For the 1.7 ton load, the average temperature decrease to 32.0 °C, 32.4 °C, and 37.7 °C for the top, middle, and bottom stack. The temperature difference between the plenum and the bottom layer ranged from 5-10 °C depending on the load capacity. At 1 ton, the small difference indicated smoother air flow, while at 1.7 ton the larger difference was due to higher air resistance. After the automixing system was activated, the temperature among layers became more uniform. The stability of plenum temperature and the even heat distribution demonstrated that the convective heating mechanism of the automixing bed dryer operated effectively under field conditions with manual biomass feed control.

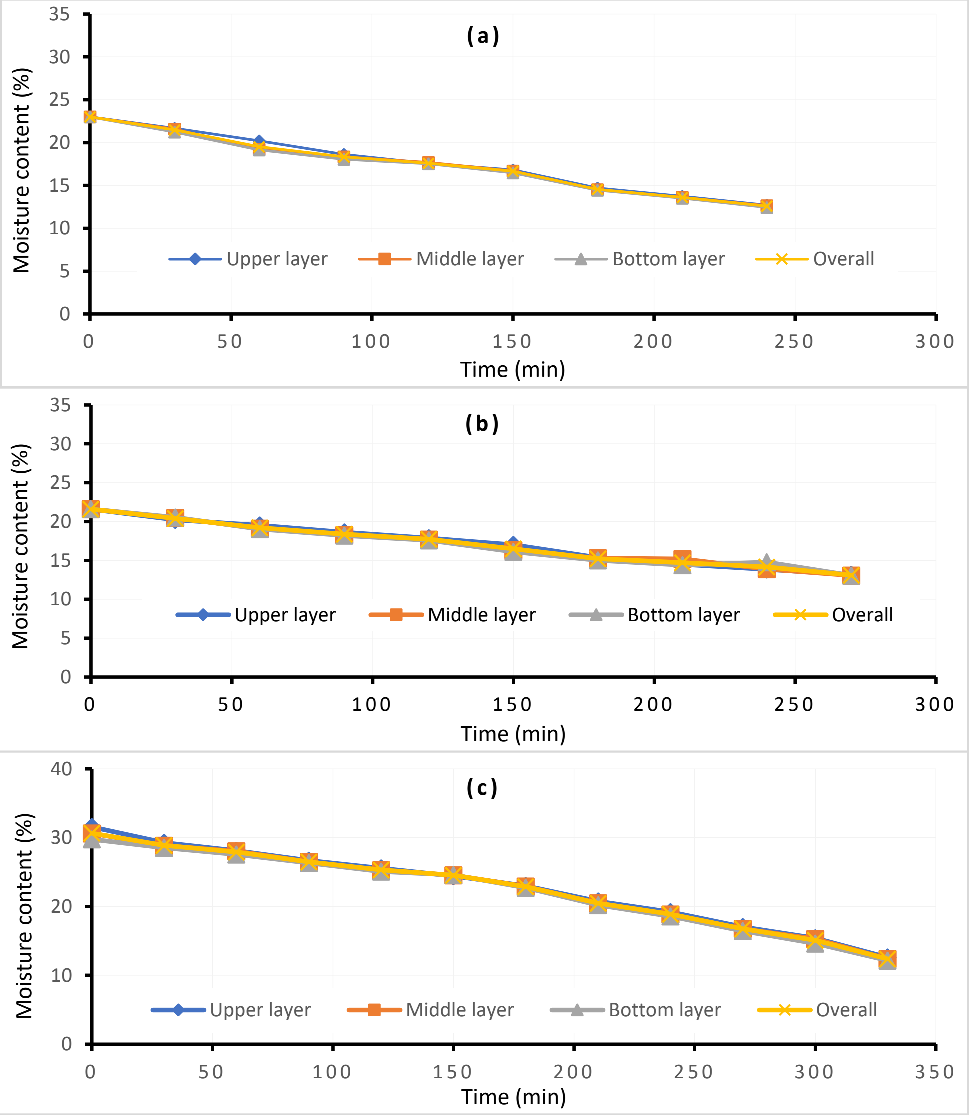

Figure 3. Moisture reduction during paddy drying based on drying load: (a) 1 ton; (b) 1.2 ton; (c) 1.7 ton

3.2. Moisture Content

Moisture content of paddy is the amount of water contained in the grain and is expressed in percentage. The measurement results at each stack point are presented in the following Figures 3. The measurement aims to determine the level of moisture content (Iswanto *et al*., 2018). Reduction of paddy moisture content was carried out using drying methods until a certain limit was reached (Syahrul *et al*., 2017). Moisture content in rice kernels was expressed in percentage on a wet basis and measured using an electric moisture meter, such as the Digital Grain Moisture Meter (Crown model TA-5) (BSN, 2020). Samples were taken at nine points (top, middle, and bottom), and measurement was considered complete when moisture content reached ≤14% (BSN, 2020).

Moisture content observations were conducted at three load capacities, namely 1 ton, 1.2 ton, and 1.7 ton. Field conditions showed that the initial moisture content of paddy varied depending on harvest time and farmers' storage practices before drying. This resulted in differences in drying duration and final moisture content across capacities. Therefore, the discussion of moisture content in this study was not intended to directly compare performance among capacities, but rather to evaluate the machine's ability to operate under actual conditions with varying initial moisture content and load sizes.

Figures 3 indicate that differences in moisture content among layers were relatively small. At the 1 ton capacity, initial moisture content of 23% decreased to 12.6% within 4 hours. At 1.2 ton, moisture content decreased from 21.6% to 13.1% within 4 hours 30 minutes. At 1.7 ton, moisture content decreased from 30.7% to 12.4% within 5 hours 30 minutes. The reduction pattern was consistent across capacities, showing that longer drying time resulted in lower paddy moisture content. This was influenced by drying temperature, as higher temperatures accelerated water evaporation (Ramli *et al*., 2017). Based on BPMEKTAN (2021), drying at the research site required slightly longer duration because the initial moisture content of paddy harvested in Rowosari Village was higher (up to 30%) compared to the paddy used in BPMEKTAN's study (17.6%). The automixing process contributed to faster evaporation and helped equalize moisture content among layers. At the 1.2 ton capacity, as shown in Figure 3b, moisture content fluctuated between 180 and 240 minutes due to the presence of green grains with higher moisture content (Mulyawan *et al*., 2018).

In theory, the rate of moisture reduction is influenced by drying air temperature, initial moisture content, and stack thickness. In this study, plenum chamber temperature was maintained relatively constant across capacities, but differences in initial moisture content and stack thickness caused variations in drying time. Higher initial moisture content and thicker stacks required longer drying durations to reach the same final moisture level. Nevertheless, the automixing system improved hot air circulation and equalized temperature within the stack, thereby accelerating moisture reduction. These findings demonstrate that the automixing bed dryer remained effective in reducing paddy moisture content to the safe storage threshold of approximately 14%, even under field conditions with varying initial moisture content and load capacities.

3.3. Drying Rate

Figure 4 presents drying rate of paddy using automixing bed dryer at three different drying load. Drying rate is defined as the amount of moisture evaporated or the reduction in moisture content per unit of time, which continues until the surface moisture reaches a critical point (Usman *et al*., 2020). In theory, at the same drying temperature (plenum chamber temperature), larger load capacities should result in lower drying rates because thicker paddy stacks create greater resistance to hot air flow. However, experimental results showed that at the 1.7 ton capacity the highest drying rate was obtained, as illustrated in. This condition does not entirely contradict the theory, since the tests were conducted under field conditions with different initial moisture contents for each capacity.

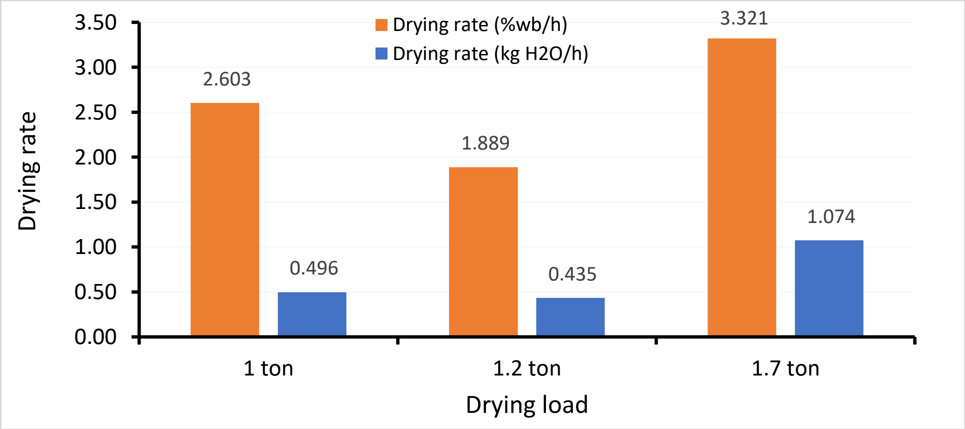

Figure 4. Effect of drying load on the drying rate of rice

Paddy with higher initial moisture content has greater potential for water evaporation during the early drying phase, which makes the drying rate appear higher even at larger capacities. In the 1.7 ton test, an initial moisture content of 30.7% created a significant difference in humidity between the material and the drying air, resulting in faster evaporation. In addition, the automixing system helped equalize temperature throughout the stack, ensuring effective heat distribution despite the larger amount of paddy.

The plenum chamber temperature was also maintained at a stable level through manual addition of corn cob fuel. This control kept the heat supply more consistent at higher capacities, thereby sustaining a high evaporation rate. As drying temperature increased, more hot air was absorbed by the paddy, which accelerated water evaporation (Ramli *et al*., 2017). Overall, these results indicate that the high drying rate at larger capacity was caused more by differences in initial moisture content and the ability of the automixing system to maintain effective heat transfer. The automixing bed dryer was thus able to perform well under varying load capacities and initial moisture conditions in the field.

Based on the drying rate measurements shown in Figures 5, the patterns tended to fluctuate. These fluctuations were influenced by several factors, one of which was temperature variation during the drying process (Usman *et al*., 2020). Such variations occurred when fuel was depleted, turned into ash, or when refueling was carried out. Higher drying temperatures increased the drying rate because greater thermal energy was absorbed by the paddy, resulting in more water being evaporated (Ramli *et al*., 2017).

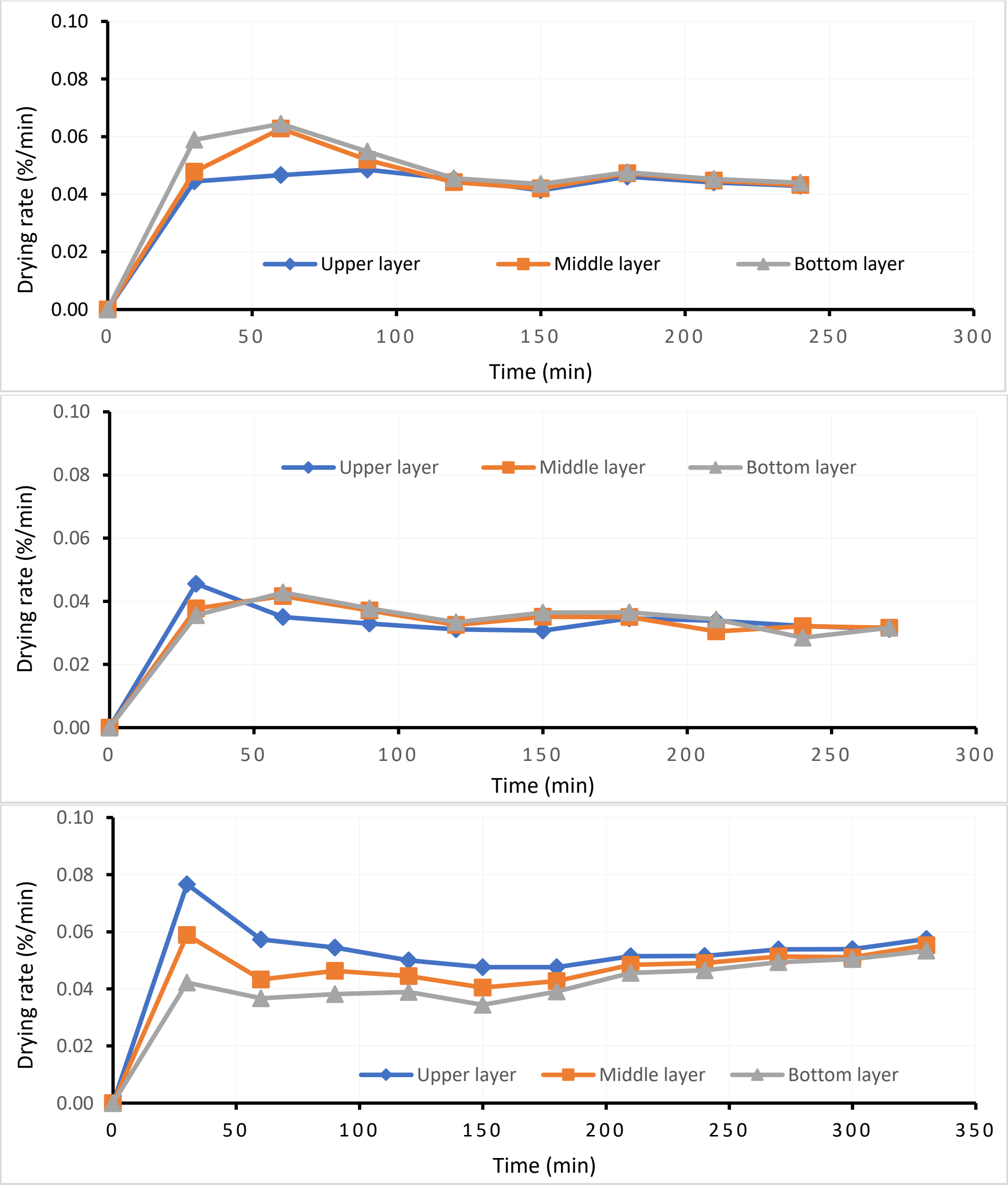

Figure 5. Drying rate of paddy over time at different load: (a) 1 ton; (b) 1.2 ton; (c) 1.7 ton

3.4. Energy Efficiency

3.4.1. Energy Input

Energy input (Q_{input}) refers to the energy consumed by the automixing bed dryer, consisting of electrical energy to drive the motor and thermal energy from corn cob combustion during the drying process. The total energy input for paddy loads of 1 ton, 1.2 ton, and 1.7 ton is presented in Table 1. The calculations show that drying 1 ton of paddy required 1,376,358.20 kJ, 1.2 ton required 1,571,007.48 kJ, and 1.7 ton required 1,991,184.63 kJ. The highest input energy was observed at 1.7 ton due to longer drying duration, indicating that extended drying time increases total energy consumption.

Table 1. Energy Input Used During the Drying Process

Treatment	**Electrical Energy (kWh)**	**Usage Time (hour)**	**Corn Cob Mass (kg)**	**Calorific Value (kJ/kg)**	**Energy Input (kJ)**
Paddy 1 ton	330.55	4.00	80.60	17,060.00	1,376,358.20
Paddy 1.2 ton	330.55	4.50	92.00	17,060.00	1,571,007.48
Paddy 1.7 ton	330.55	5.50	116.61	17,060.00	1,991,184.63

Table 2. Energy output used during the drying of rice grains

Treatment	**Latent Heat of Water Vapor (kJ/kgH_2O)**	**Energy for Evaporation (kJ)**	**Energy for Heating(kJ)**	**Energy Output (kJ)**
Paddy 1 ton	2,412.52	287,342.90	337,323.57	624,666.47
Paddy 1.2 ton	2,412.82	283,207.95	521,549.50	804,757.46
Paddy 1.7 ton	2,421.11	858,149.71	303,115.32	1,161,265.02

3.4.2. Energy Utilized for Drying

Drying energy (Q_{output}) is the energy used to evaporate water and heat paddy during the drying process. The value of (Q_{output}) was obtained by summing both components, as shown in Table 2. The results indicate that drying energy is the sum of heating energy and evaporation energy (Usman *et al*., 2020). The calculations show that output energy at the 1 ton capacity was 624,666.47 kJ, at 1.2 ton was 804,757.46 kJ, and at 1.7 ton was 1,161,265.02 kJ. Evaporation energy was influenced by the amount of water evaporated and the latent heat of vaporization. Since latent heat remained relatively constant at each drying temperature, differences in total evaporation energy were primarily determined by the mass of water to be evaporated. At the 1.7 ton capacity, the initial moisture content of paddy was higher than at the other two capacities, resulting in greater water evaporation during the drying process. This caused the total evaporation energy at 1.7 ton to be higher, even though plenum chamber temperature and drying duration were relatively similar. Thus, differences in evaporation energy among capacities were not due to calculation errors, but were a direct consequence of variations in initial moisture content and the mass of water evaporated in each treatment.

3.4.3. Drying Efficiency

Efisiensi Drying efficiency was used to evaluate the performance of the automixing bed dryer fueled by corn cobs. Efficiency was determined by comparing the energy used to heat the material and evaporate water in paddy with the total input energy supplied. The drying efficiency values are presented in Table 3. The comparison of drying efficiency at 1 ton, 1.2 ton, dan 1.7 ton showed different results. As presented in Table 3, the highest efficiency was achieved at 1.7 ton (58.32%), followed by 1.2 ton (51.23%), and 1 ton (45.39%). Higher efficiency indicated that more thermal energy from corn cob combustion was absorbed during drying, resulting in greater conversion of energy into water evaporation (Sari *et al*., 2014). Differences in efficiency values among capacities were influenced by several factors, including initial moisture content, plenum chamber temperature, and combustion stability. The 1.7 capacity had the highest initial moisture content, which intensified water evaporation and absorbed more thermal energy. In addition, longer drying duration at this capacity stabilized combustion, maintaining constant plenum chamber temperature. Conversely, shorter drying times and temperature fluctuations at 1 ton and 1.2 ton resulted in lower thermal efficiency (Usman *et al*., 2020). Based on BPMEKTAN (2021), drying efficiency values in this study were lower. This was expected since the trials were conducted under actual field conditions with partial loads and higher initial moisture content. BPMEKTAN conducted drying tests with full capacity of 3.5 ton under controlled laboratory conditions, which optimized heat distribution and evaporation rate. Nevertheless, the results of this study demonstrate that the automixing bed dryer is reasonably efficient under real farmer conditions and has the potential to achieve higher efficiency when operated at optimal capacity and stable plenum chamber temperature (Suhelmi *et al*., 2022).

Table 3. Drying efficiency of paddy using the bed dryer

Drying load	Energy Output (kJ)	Energy Input (kJ)	Drying Efficiency (%)
Paddy 1 ton	624,666.47	1,376,358.20	45.39
Paddy 1.2 ton	804,757.46	1,571,007.48	51.23
Paddy 1.7 ton	1,161,265.02	1,991,184.63	58.32

4. CONCLUSION

This study demonstrated that the automixing bed dryer fueled by corn cobs was capable of reducing paddy moisture content to the standard of milled dry paddy, with the best performance observed at the 1.7 ton capacity, achieving a final moisture content of 12.4% within 5.5 h and an efficiency of 58.32%. Efficiency values tended to increase with larger load capacities due to more optimal heat distribution and evaporation processes. Although the efficiency obtained was low, this was attributed to variations in field conditions, such as higher initial moisture content, fluctuations in plenum chamber temperature, and manual fuel combustion. Overall, the automixing bed dryer was considered effective and suitable for paddy drying at the scale of field application based on biomass energy.

AUTHOR CONTRIBUTION STATEMENT

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
SS	✓	✓	✓		✓	✓			✓	✓				✓
AFR						✓		✓	✓	✓	✓	✓		
NPL		✓		✓						✓				
RN				✓					✓		✓	✓		

C: Conceptualization
M: Methodology
So: Software
Va: Validation
Fo: Formal Analysis
I: Investigation
D: Data Curation
R: Resources
O: Writing - Original Draft
E: Writing - Review & Editing
Vi: Visualization
Su: Supervision
Fu: Funding Acquisition
P: Project Administration

REFERENCES

Awanis,A., Syarif, M., Qomariah, R., Lesmayati, S., & Amin, M. (2022). *Penanganan Pascapanen dan Pemasaran Hasil Pertanian*. Balai Pengkajian Teknologi Pertanian Kalimantan Selatan. https://repository.pertanian.go.id/handle/123456789/16404

BPMEKTAN (Balai Pengembangan Mekanisasi Pertanian). (2021). *Laporan Hasil Pengujian Mesin Pengering Tipe Bak Datar* (*Bed Dryer Automixing*). *Test Report Nomor: 521.31/270/PLT/Mektan/BDRY/2021*. Balai Pengembangan Mekanisasi Pertanian Provinsi Jawa Barat, Cianjur.

BPS (Badan Pusat Statistik). (2024). *Booklet Sakernas Agustus 2024 (No. Publikasi 04100.24026; ISSN 2714-853X)*. Badan Pusat Statistik. https://www.bps.go.id/id/publication/2024/12/20/145b7ca9b2e159c6c0493290/booklet-sakernas-agustus-2024.html

BSN (Badan Standardisasi Nasional). (2020). *SNI 6128:2020 - Beras*. Badan Standardisasi Nasional, Jakarta.

Hakim, E.Z.R., Hasan, H., & Syukriyadin. (2017). Perancangan mesin pengering hasil pertanian secara konveksi dengan elemen pemanas infrared berbasis mikrokontroler arduino uno dengan sensor DS18B20. *Jurnal Karya Ilmiah Teknik Elektro*, ***2***(3), 16–20. https://jurnal.usk.ac.id/kitektro/article/view/8325/0?utm_source=chatgpt.com

Hamarung, M.A., & Kadang, Y. (2018). Rancang bangun prototype mesin pengering padi bahan bakar sekam dengan pengaduk horizontal. In *Prosiding Seminar Nasional Universitas Cokroaminoto Palopo*, ***4***(1), 16–25.

Iswanto, P.H. Akbar, A.R.M., & Rahmi, A. (2018). Pengaruh kadar air gabah terhadap mutu beras pada varietas padi lokal Siam Sabah. *Jurnal Tugas Akhir Mahasiswa* (*JTAM*) *Inovasi Agroindustri*, ***1***(1), 12-23.

Molenaar, R. (2020). Panen dan pascapanen padi, jadung dan kedelai. *Eugenia,* ***26***(1), 17–28.

Mulyawan, D.P., Iqbal, I., & Munir, A. (2018). Uji kinerja mesin pemecah kulit gabah (*husker*) tipe rol karet pada penggilingan gabah kecil. *Jurnal AgriTechno,* ***11***(1), 40–48.

Nainggolan, S.R.M., Tamrin, T., Warji, W., & Lanya, B. (2013). Uji kinerja alat pengering tipe batch skala lab untuk pengeringan gabah dengan menggunakan bahan bakar sekam padi. *Jurnal Teknik Pertanian Lampung,* ***2***(3), 161–172.

Ramli, I.A., Jamaluddin, J., & Yanto, S. (2017). Laju pengeringan gabah menggunakan pengering tipe efek rumah kaca (ERK). *Jurnal Pendidikan Teknologi Pertanian,* ***3***, S158–S164.

Sari, I.N., Warji, W., & Novita, D.D. (2014). Uji kinerja alat pengering hybrid tipe rak pada pengeringan chip pisang kepok. *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering),* ***3***(1), 59–68.

Sari, L.J. (2017). Uji performansi alat pengering gabah tipe DMP-1 dengan penambahan batu alor hitam pada ruang kolektor dan ruang pengering sebagai penyimpan panas. *Jurnal Keteknikan Pertanian Tropis dan Biosistem,* ***5***(3), 257–264.

Sihombing, R., Basri, H., & Fatmawati, A. (2024). Perhitungan dan analisa konstruksi pada alat pengering gabah berkapasitas 70 kg/proses dengan menggunakan kompor gas dan sel surya sebagai sumber panas. *Media Jurnal Ilmiah Bina Teknik Mesin*, ***17***(1), 28–35.

Sucahyo, L., Dyah, & Zavira, S. (2024). Formulasi biopelet dengan campuran limbah tongkol jagung dan kayu sengon sebagai bahan bakar padat terbarukan. *Jurnal Agroekoteknologi dan Agribisnis,* ***8***(1), 33–49.

Suhelmi, M.F., Anjani, R.D., & Fauji, N. (2022). Perhitungan efisiensi pengeringan pada mesin pengering gabah tipe flat bed dryer di CV. XYZ. *Jurnal Rekayasa Mesin,* ***17***(1), 15-20. https://doi.org/10.32497/jrm.v17i1.2848.

Syahrul, S., Mirmanto, M., Romdani, S., & Sukmawaty, S. (2017). Pengaruh kecepatan udara dan massa gabah terhadap kecepatan pengeringan gabah menggunakan pengering terfluidisasi. *Dinamika Teknik Mesin: Jurnal Keilmuan dan Terapan Teknik Mesin*, ***7***(1), 54-59.

Tim Pustaka. (2017). *Inovasi Budi Daya Padi*. IAARD Press, Jakarta. https://repository.pertanian.go.id/handle/123456789/6119

Usman, U., Muchtar, A., Muhammad, U., & Lestari, N. (2020). Purwarupa dan kinerja pengering gabah hybrid solar heating dan photovoltaic heater dengan sistem monitoring suhu. *Jurnal Teknik Elektro,* ***12***(1), 24–32. https://doi.org/10.15294/jte.v12i1.24028