ComputeRice: Arduino-Based Automated Rice Drying System with Integrated Real-Time Process Monitoring

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ABSTRACT

This study presents ComputeRice: Arduino-Based Automated Rice Drying System with Integrated Real-Time Process Monitoring, designed to improve the efficiency of postharvest drying. The system uses a combination of sensors (DHT22, a capacitive moisture sensor, and an infrared proximity sensor), an Arduino Uno, and a controlled heating-and-airflow mechanism within a custom drying chamber. The software was developed using Java, C++, Java Swing, Model-View-Controller (MVC) Architecture, and MySQL.

The ComputeRice was tested using multiple rice samples. A semi-controlled experimental setup was used to evaluate system performance across load capacities of 3 kg, 5 kg, and 7 kg of rice, each tested in five replicates. The results showed a substantial reduction in drying time compared to traditional sun drying, with the system achieving a decrease of approximately 75%–77% while consistently reaching the target moisture content of 14%.

Energy consumption ranged from 0.8 to 1.5 kWh per batch, with improved efficiency at higher loads (0.21–0.27 kWh/kg). This corresponds to an estimated operating cost of ₱2.28–₱3.69 per kilogram. Despite the system requiring electrical energy, it provides faster, more consistent drying that is unaffected by weather conditions.

User evaluation with 10 local farmers indicated high usability and satisfaction, and consistent grain quality was observed across trials. The findings suggest that the system provides a reliable, climate-resilient alternative for small- to medium-scale rice drying. Future improvements may focus on integrating renewable energy sources to enhance sustainability.

Keyword: Automated Rice Drying, Real-time monitoring, Smart agriculture

INTRODUCTION

Rice is a vital grain that makes up 21% of all calories consumed. It provides sustenance for over two-thirds of the global population and is vital to food security, especially in densely populated areas. Nevertheless, the postharvest period can be fraught with challenges that lead to considerable losses between harvest and consumption. These losses are worse in places with unpredictable weather, such as the Philippines, which is especially vulnerable to climate change (Nebrida, A.P. 2024).

A crucial phase in the post-harvest management of rice is drying, which can affect its characteristics and, in turn, determine its nutritional and commercial value. The drying process is a technique used to prepare crops. It reduces water content, helping slow down harmful biological and chemical processes that affect crops such as rice (Sutrisno, 2021).

In Trinidad and other parts of Bohol, farmers have long relied on the sun's heat to dry their rice. Although this method is inexpensive and easy to use, it has some drawbacks. Its effectiveness depends on changing weather, it takes a long time, and the drying is not always even. As demonstrated by Nunes et al. (2022), inconsistent grain drying can lead to cracking, reduced milling recovery, and ultimately harm the overall quality. In this context, the study by Mahmood et al. (2024) suggested that conventional drying methods might lead to increased energy use, longer drying times, and unintentional quality loss. Preserving rice grain quality and extending its shelf life requires precise execution of the drying process. Moreover, fluctuations in moisture content during both drying and storage phases can substantially impact the internal structure of rice grains, as demonstrated by Atungulu et al. (2018).

To overcome these challenges, modern drying technologies have been created to enhance both efficiency and performance consistency. Mechanical dryers, such as mixed-flow and hot air models, are designed to control temperature and airflow during the drying process. Rice-husk-fueled dryers are considered a cost-effective option for smallholder farmers, as they use agricultural waste as a heat source (Mihret et al., 2022; Sutrisno, 2021). Furthermore, advanced drying methods, such as two-stage variable temperature drying, can help preserve grain quality and reduce damage during drying (Xu et al., 2022).

In recent years, the use of smart technology in agriculture has become increasingly common, further enhancing efficiency and accuracy. The use of microcontrollers, sensors, and automated systems allows real-time monitoring and control of drying conditions. Arduino-driven drying systems offer the potential to fine-tune temperature and humidity, mitigate human error, and enhance the efficacy of postharvest procedures (Nebrida, 2024). These technological advancements are particularly beneficial in rural areas, where farmers need solutions that are both affordable and reliable.

Despite these advancements, many farmers still face challenges, such as high equipment costs, limited access to modern technologies, and inconsistent drying results. Therefore, an efficient, affordable, easy-to-use, and adaptable system is crucial.

An automated rice drying system with integrated real-time process monitoring and sensor capabilities was constructed for this study to address these issues. This method reduces labor requirements, increases productivity, and ensures consistent product quality.

OBJECTIVES OF THE STUDY

The study aimed to create, build, and evaluate the ComputeRice: Arduino-Based Automated Rice Drying System with Integrated Real-Time Process Monitoring to improve the efficiency, usability, and quality of postharvest rice drying for small to medium-sized farms.

Specific objectives:

1. To design and develop an automated rice drying system using Arduino technology, sensors, and actuators to control temperature, humidity, and moisture levels.
2. To develop a software interface that allows for real-time monitoring, data logging, and visualization of critical drying parameters such as temperature, moisture, and drying time.
3. Under controlled conditions, compare drying periods and output of the system to traditional sun-drying methods to determine its efficiency in drying rice.
4. Assess the system's usability to collect feedback on user experience, interface clarity, and ease of use from both technical evaluators and farmers.
5. Examine the system's dried rice for uniformity, texture, and appearance, and then compare it to rice dried using traditional methods.
6. Pinpoint areas needing enhancement to facilitate future system upgrades and scalability, drawing insights from testing results and user input.

METHODOLOGY

Research Design

Developmental research methodology was used in order to develop and test the functionality of the ComputeRice: Arduino-Based Automated Rice Drying System with Integrated Real-Time Process Monitoring. It is appropriate for this development as it will provide a method to develop and test a fully functioning system that includes both hardware and software components.

ComputeRice has addressed several major limitations present in the use of traditional methods for drying rice, such as dependency on weather conditions, inconsistency in drying rice, and lack of real-time monitoring.

A combination of sensors, an Arduino-based control unit, and a monitor interface has been incorporated into the system to automatically regulate the drying process.

User assessments were performed during controlled tests of the system's performance. Tests were conducted to determine the drying time, moisture loss, and cost of operation efficiency under varying loading conditions. In addition, a structured survey was given to a sample of users to measure the system’s output quality, usability, and efficiency. Descriptive statistical analysis was utilized using descriptive statistics, notably the mean and standard deviation, to assess the system’s overall performance.

Participants and Data Collection

A purposive sampling strategy was employed to choose ten (10) rice farmers who had prior experience utilizing traditional drying techniques. Although the sample size is small, it is adequate for an initial usability and performance study. Therefore, the results obtained from this research can only be treated as preliminary, and additional studies employing larger samples should be conducted to improve the reliability of the results.

Two data collection strategies were employed. First, a series of controlled experiments was performed by the researchers to assess the operational characteristics of the system. Specifically, drying times, reductions in moisture content, and overall operations were measured under different load conditions. Additionally, a participant-based survey was administered to each respondent after they utilized the ComputeRice system themselves. The participant-based survey was designed to elicit subjective feedback regarding the usability and performance characteristics of the ComputeRice system relative to their own experiences with traditional sun drying. This mixed-methods approach provides both measurable performance data and user-specific feedback, allowing for the identification of potential areas for future improvements in the development of the system.

A structured survey questionnaire was developed to gather usability and performance data on the ComputeRice system. The questionnaire was distributed to ten (10) respondents who were selected based on their low levels of technical sophistication and their status as local farmers. The questionnaire was developed using a Likert-type scale (i.e., 1-5) to allow respondents to provide their perceptions concerning three major criteria: efficiency, usability, and quality. The “efficiency” section of the questionnaire requested respondents’ perceptions regarding the perceived drying rates and consistency of the ComputeRice system relative to traditional sun-drying. Respondents were also asked questions within the “usability” section of the questionnaire, which addressed their ability to use the system easily, including how well they understood any instructions provided, whether or not they found the operation of the system easy to understand, and generally how satisfied they were with their overall experience when operating the system. Respondents were also asked to provide their perceptions regarding the quality of the dried rice produced by the ComputeRice system, including their assessments regarding: texture, moisture content, grain uniformity, and appearance. In addition, each of these categories included several individual items, which ensured that all aspects of each category would be thoroughly examined. The results from the survey instruments were analyzed using percent analysis. In addition to being reviewed by experts in order to ensure that the items included in each category were clear, relevant and appropriate for individuals who do not have extensive knowledge of technology, a methodological framework for conducting surveys has been established so that qualitative and quantitative information collected via a survey will result in reliable measures of user satisfaction with a product or service’s usability and performance.

Software Requirements

The ComputeRice: Arduino-Based Automated Rice Drying System with Integrated Real-Time Process Monitoring software component was developed to enable users to track and monitor drying conditions, such as temperature and moisture, in real time. It also controls the logic that automates the drying process through the microcontroller.

The system is built using the following technologies:

- **Back-end:** Java and C++
- **Front-end:** Java Swing
- **Coding Pattern:** Model-View-Controller (MVC) Architecture
- **Database Server:** MySQL

Software Development Process

1. **Embedded Programming for Arduino**

   The microcontroller was programmed using C++ in the Arduino IDE. This code reads real-time data from the DHT22 sensor, the Capacitive Moisture Sensor, and the Infrared Proximity sensor, and activates the fan and heat gun based on predefined conditions.

2. **Back-end Development**

   Java was used to handle back-end processes, including communication with the Arduino board and database operations. It manages system logic, data processing, and storage of readings and logs into a MySQL database.

3. **Front-end Interface**

   A graphical user interface (GUI) was developed using Java Swing. This interface displays real-time temperature and humidity readings, system status, and a history of drying sessions. Users can view and interact with the data conveniently.

4. **System Architecture**

   The software follows the Model-View-Controller (MVC) design pattern to promote separation of concerns, making the system more organized and maintainable. The Model handles the data and logic, the View presents the user interface, and the Controller connects the two.

5. **Database Integration**

   MySQL was used as the database server to store logs, timestamps, and drying status for analysis. This allows the system to keep a historical record of drying sessions.

6. **Testing and Debugging**

   The software was tested for data accuracy, real-time responsiveness, user interface clarity, and proper triggering of hardware components via the control logic.

Development of the Hardware

The hardware component of ComputeRice was designed to automate rice drying by controlling temperature and moisture. It includes a rice-drying tank equipped with heating and ventilation systems, sensors, and an Arduino microcontroller for automation.

Essential Hardware Components

- **Arduino Uno** – This is the main microcontroller that processes data from all sensors and controls the drying system.
- **DHT22 Sensor** – Measures the temperature and humidity inside the drying tank in real-time.

- **Capacitive Moisture Sensor** – Detects the moisture content of the rice to help determine the drying status and effectiveness.
- **Infrared Proximity Sensor** – Detects the presence or absence of rice trays in the drying chamber for safety and automation purposes.
- **Relay Module** – Controls the electrical switching of high-power components like the heater and fan.
- **Heating Element (Heat gun)** – Provides consistent heat to remove moisture from the rice.
- **Exhaust or Cooling Fan** – Facilitates air circulation and helps release moisture from the drying chamber.
- **Rice Drying Tank** – A custom-built tank where rice is placed for drying.
- **Wiper Motor** – To rotate the rice tank forward and reverse.

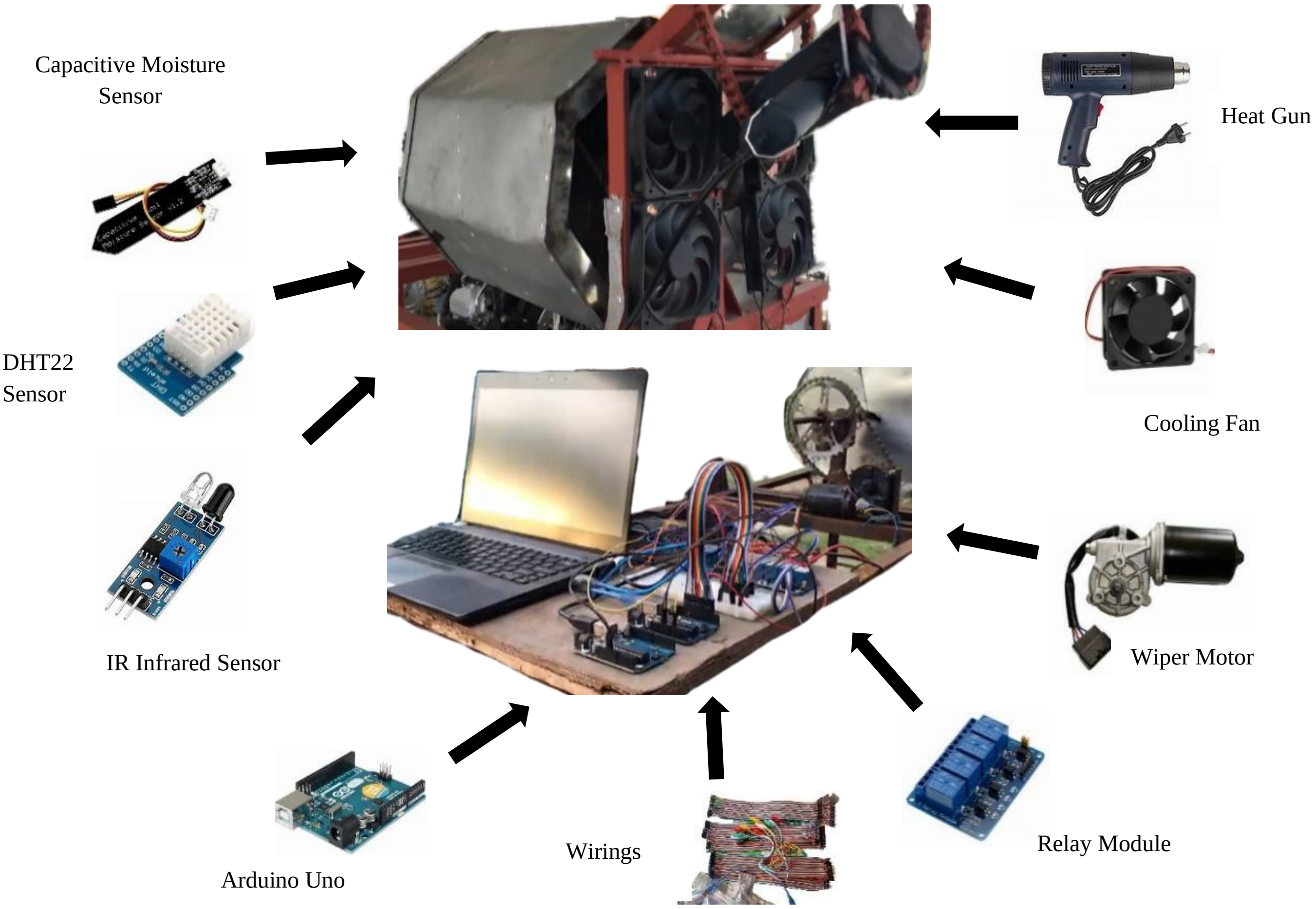

Fig. 1. Hardware Components

Hardware Development Process

Design and Planning

The layout of the rice drying tank was sketched, with the positions of sensors, fans, and heating elements identified.

Component Assembly

The Arduino, relays, sensors, heat gun, and fan were wired according to a circuit schematic. Components were mounted securely inside and around the drying tank.

Integration and Testing

After wiring and installation, the components were integrated and tested to ensure they responded correctly to temperature and moisture changes.

Calibration

The sensor readings and control logic were calibrated to trigger the heating and ventilation systems at desired thresholds to maintain optimal drying conditions.

System Integration

Once both hardware and software components were developed, the system was integrated into a working prototype. The Arduino continuously processed the sensor data and the drying environment using the heat gun and fan. Monitoring tools allowed real-time tracking of the system performance.

Testing Tools and Environment

Testing was conducted in a semi-controlled environment to examine efficiency, usability, and output quality. The initial moisture content of the rice was measured through oven-dried analysis. At 105°C, until a stable weight was achieved. Five samples per batch were taken. Average moisture content was determined as being 17.5% (±0.8%), establishing a baseline for moisture reduction.

Air flow control to the chamber was dynamic; i.e., the fan would turn on and off as needed, depending upon chamber temperature, to prevent excessive cooling of the chamber. Three different rice load sizes were examined (i.e., 3 kg, 5 kg, and 7 kg). Drying continued until the moisture content of the rice had reduced below 14%. All tests were run consistently throughout the study.

Prior to conducting testing, the moisture sensor was calibrated. Calibration involved analyzing rice samples that had previously been accurately analyzed for their moisture content (i.e., 14%). Analysis of readings from these calibration samples produced a linear calibration curve that converted the raw output of the sensor into the actual moisture percentage. In addition, additional rice samples were utilized to validate the accuracy of the sensor over this same range of values.

The amount of electrical energy consumed during drying cycles was monitored utilizing a digital power meter. The total amount of energy utilized by the power source was tracked to measure efficiency and allow comparison with sun drying. All testing was conducted by the researchers themselves to ensure consistent results and monitor processes in real time.

A benchmark of traditional sun drying methods compared to the ComputeRice automated systems was evaluated to provide a controlled and consistent basis for the evaluation. Rice samples that had been wetted to a comparable initial moisture content (17.4%-17.7%) were dried by exposing them to natural sunlight at ground surface in the open air using typical farmer practices. Thus, the environmental conditions in which this experiment occurred were variable due to the presence of changing sunlight and natural atmospheric conditions. In contrast to idealized laboratory environments, this represents a practical comparison and allows for an assessment of how the automated system performs when compared to the methods used in field operations. The drying process was completed on clean drying mats, and the samples were manually rotated during the drying cycle so as to replicate the common practice of rotating samples while they are drying. Samples were removed from drying when their moisture content reached the approximate 14% threshold required for storage. No artificial control over environmental parameters such as solar radiation, humidity, or airflow was applied to the drying process; however, the goal was to assess the behavior of the sun-dried rice as it would behave in a typical farming operation. Observations were made contemporaneously with those occurring in the ComputeRice trial evaluations, utilizing the same mass values for each sample set (3 kg, 5 kg, and 7 kg). Time records were kept of when the samples were spread out to begin drying and then again upon reaching a final moisture content that equaled the desired threshold. Therefore, this method is representative of the methods commonly practiced in field operations and provides an opportunity to directly compare the relative performance characteristics of the automated system with these methods.

RESULTS AND DISCUSSION

Efficiency Results

Three efficiency test cases (EFF-01 to EFF-03) were conducted using varying quantities of wet rice (3 kg, 5 kg, and 7 kg) with five (5) replicate trials per load. The use of five replicate trials (n = 5) is consistent with standard practice in small-scale experimental system validation, where repeated measurements are used to assess consistency and minimize random error while maintaining experimental feasibility. The goal was to measure the total drying time of the automated system and compare it to typical traditional drying durations.

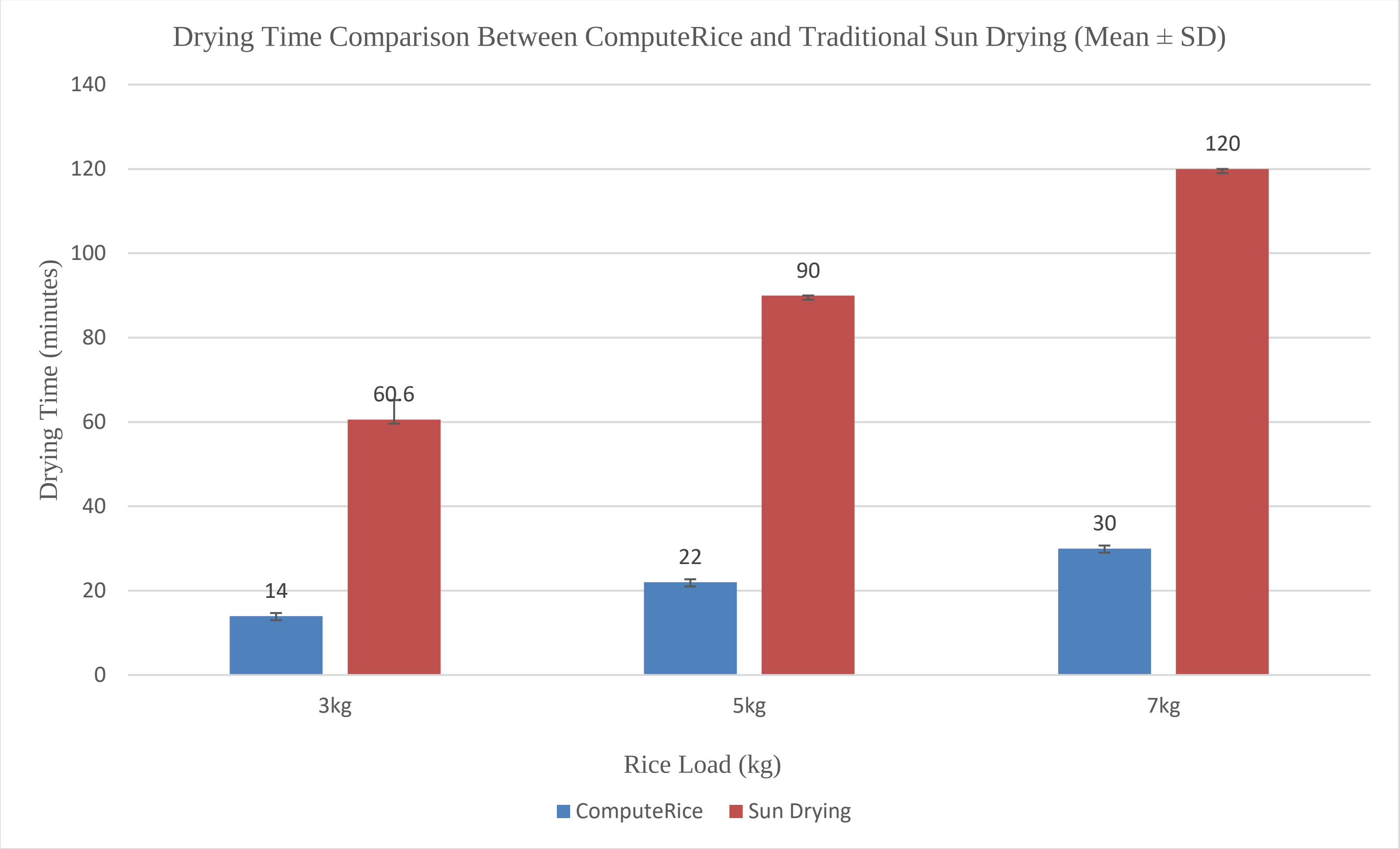

Fig. 2. Drying Time Analysis (ComputeRice vs. Sun Drying)

A comparison of the two methods showed that the ComputeRice method took much less time than sun drying, as shown graphically as mean ± SD (Figure 2). Sun drying resulted in an extended processing time compared to the ComputeRice method. The average processing time using sun drying was about 60.6 ± 4.6 minutes for 3 kg, 90 ± 0.0 minutes for 5 kg, and 120 ± 0.0 minutes for 7 kg of wet rice. In contrast, the ComputeRice system processed those same drying loads in approximately 14, 22, and 30 minutes, respectively, which is equivalent to a 75%-77% decrease in drying time compared to each load.

There was high variability in the data from sun drying; this variability most likely occurred due to variations in environmental parameters such as solar radiation and ambient humidity. Conversely, there was low variability in the data from the automated method, which would be attributed to controlled heat and air flow, thus illustrating one of the advantages of the automated system.

Drying Mechanism Analysis

Improved drying performance in the ComputeRice system may be attributed to both the enhanced heat transfer rates achieved using forced convection with a controlled source of energy and fan-induced flow, and the improved mass transfer rates associated with reduced boundary layer thicknesses. As mentioned above, the primary mechanism controlling drying efficiency is the rate at which moisture diffuses out of the interior of the rice grain to its surface, where it evaporates into the ambient atmosphere. Traditional sun-drying techniques are slow processes dependent upon available environmental energy, thus limiting and generally resulting in inefficient and variable rates of convective heat transfer.

Alternatively, the ComputeRice system utilizes forced convection applied via an energy-controlled heat source and a fan-induced flow to decrease the boundary layer resistance over the surface area of individual rice grains. Thus, the rate of evaporation of surface moisture is increased while simultaneously increasing the diffusion of internal moisture toward the surface by maintaining a constant thermal gradient between the ambient air and the rice grains. A controlled temperature environment (approximately 50 °C) ensures that sufficient energy is provided to sustain evaporation without overheating, thereby preserving quality characteristics of the grains.

Finally, the automated control system (based on Arduino) dynamically controls the flow of air based on measured temperature feedback, thereby reducing thermal fluctuation(s) normally contributing to lower drying efficiencies. Thus, implementing a closed-loop system control strategy for achieving uniform heat distributions throughout the chamber, this allows for consistent reductions in moisture content throughout various quantities of batches.

The relatively linear relationship between drying time and load size suggests that the system is operating in a thermally stable regime with minimal saturations occurring during the drying process; therefore, indicating that heat transfer efficiency has been maintained regardless of mass increase. Therefore, this supports the fact that there have been no significant loss-of-scaling impacts to the system's operation, allowing for medium-scale use in post-harvest processing applications.

Estimated Daily Drying Capacity

Assuming an average drying cycle of 22 minutes and a 10-hour operational window per day (600 minutes), the system can complete approximately:

$$\frac{600 \text{ minutes}}{22 \text{ minutes/batch}} = 27 \text{ batch/day}$$

If each batch processes 5kg of rice on average:

$$27 \text{ batches} * 5 \text{ kg} = 135 \text{ kg/day}$$

Thus, the automated dryer can handle 130–140 kg of rice per day, demonstrating significant efficiency gains and potential scalability for farm use.

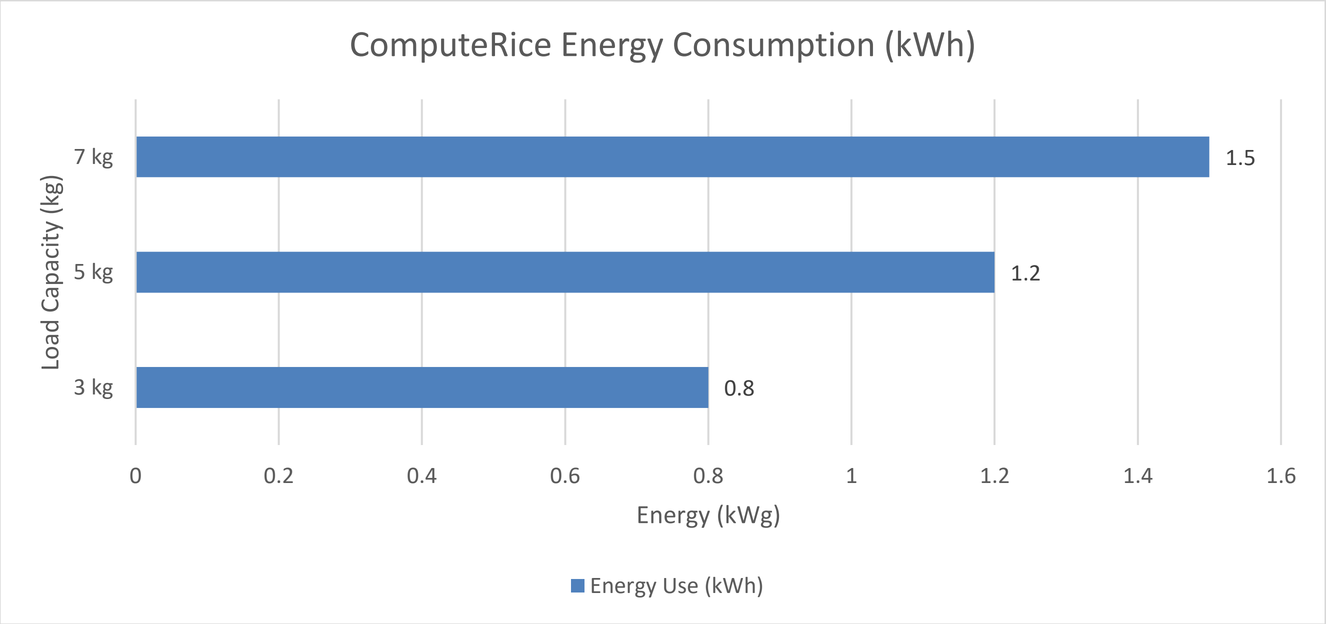

Fig. 3. Energy Consumption (kWh)Across Different Load Capacities

Figure 3 shows the energy consumption behavior of the ComputeRice system across different load capacities (3 kg to 1.5 kWh (7 kg)), with total energy use increasing from 0.8 kWh to 1.5 kWh as the load size increases. This trend is expected because larger rice volumes require longer heating times and sustained airflow to achieve the target moisture content of approximately 14%.

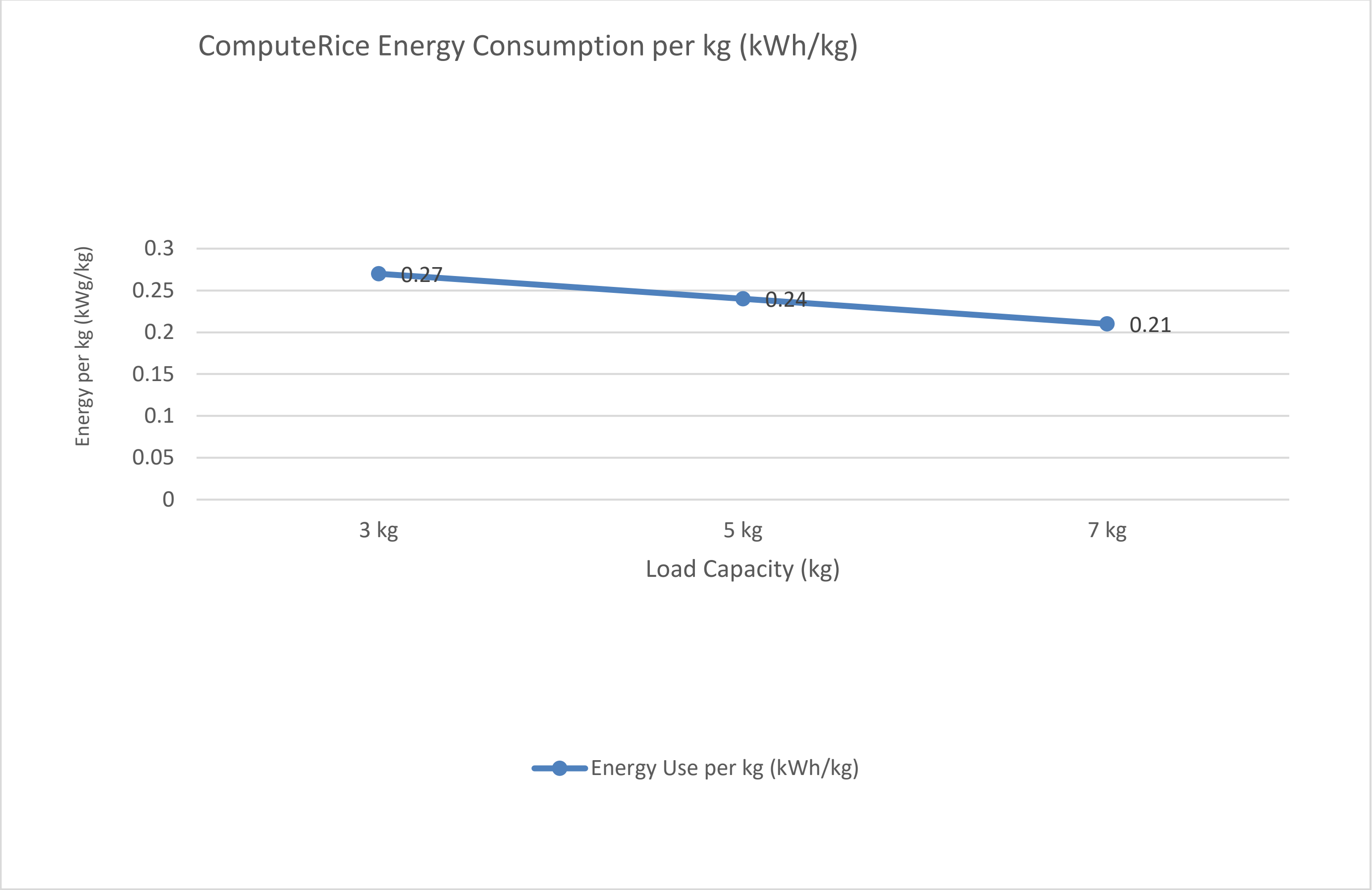

Fig. 4. Specific Energy Use per kg (kWh/kg) Across Different Load Capacities

When normalized per unit mass, the system consumes approximately 0.27 kWh/kg for 3 kg, 0.24 kWh/kg for 5 kg, and 0.21 kWh/kg for 7 kg (Figure 4), indicating improved energy efficiency at higher loads while maintaining faster and more controlled drying performance. This suggests that the system operates more efficiently near its optimal capacity, likely due to better heat utilization and reduced relative energy loss per kilogram of rice processed.

Using current residential electricity rates in the Philippines (₱10.63–₱13.82 per kWh), the estimated operating cost per batch ranges from ₱8.50–₱11.06 for 3 kg, ₱12.76–₱16.58 for 5 kg, and ₱15.95–₱20.73 for 7 kg. On a per-kilogram basis, this corresponds to approximately ₱2.83–₱3.69/kg, ₱2.55–₱3.32/kg, and ₱2.28–₱2.96/kg, respectively, further confirming that larger batch processing is more cost-efficient. Although traditional sun drying does not incur direct electricity costs, it requires significantly longer drying times and is highly dependent on weather conditions, which may lead to delays and inconsistent results. In contrast, the ComputeRice system provides a controlled and repeatable drying process with predictable energy costs, making it a more reliable and scalable alternative for post-harvest rice processing.

The observed energy consumption of the ComputeRice system (0.21–0.27 kWh/kg) is comparable to or lower than values reported in similar small-scale mechanical rice dryers. Previous studies on hot-air and mixed-flow drying systems have reported energy consumption ranging from approximately 0.3 to 0.6 kWh/kg, depending on system design and operating conditions (Mihret et al., 2023; Sutrisno, 2021). This indicates that the ComputeRice system operates within an efficient range, particularly at higher load capacities where energy utilization is optimized. Compared to conventional mechanical dryers, which often require larger infrastructure and higher energy input, the proposed system demonstrates a favorable balance between energy efficiency, cost, and operational simplicity.

Survey Feedback on Efficiency

User responses aligned with observed results. Of the ten (10) respondents, nine (9) rated drying time as much faster than traditional methods; all ten (10) found the process very or somewhat consistent, and all rated the system as efficient, with six (6) rating it as very efficient. These responses validate the system's capacity to improve drying speed and operational reliability in real farm conditions.

Usability Results

The system's usability was tested by allowing respondents with limited technical backgrounds (i.e., local farmers) to operate it using basic instructions.

USB-01: The respondents successfully operated the system with minimal guidance within 5 minutes. The user interface, built with Java Swing, enabled intuitive control over the machine's core functions, such as start, monitor, and stop.

The observation confirmed that the machine is user-friendly, even for individuals with minimal technical experience.

Survey Feedback on Usability

All respondents reported a positive experience; seven (7) found handling the dried rice very easy, while three (3) rated it easy. Seven (7) were very satisfied with the performance, three (3) were satisfied. These findings suggest that the system’s design is accessible even to users with limited technical backgrounds.

Quality Results

Rice quality was assessed based on texture, moisture content, and grain uniformity. Experts compared machine-dried samples with traditionally dried rice. The expected moisture level is 14%; the actual results met expectations with no burnt grains or inconsistencies, and the quality was found to be equivalent to or better than traditional drying.

Table 1. Moisture Content Analysis (Initial and Final Content)

Test Cases	Rice Loads	Trial	Initial Moisture (%) (Mean ± SD)	Final Moisture (%) (Mean ± SD)	Moisture Reduction (%) (Mean ± SD)
EFF 01	3 kg	5	17.4 ± 0.1	13.9 ± 0.1	3.46 ± 0.17
EFF 02	5 kg	5	17.6 ± 0.1	14.0 ± 0.1	3.58 ± 0.16
EFF 03	7 kg	5	17.6 ± 0.1	14.0 ± 0.1	3.62 ± 0.18

Initial moisture levels were evaluated against the final moisture levels using the Mean ± Standard Deviation (Table 1), as each load (3 kg, 5 kg, 7 kg) had been tested in 5 separate trials. Overall results indicated that initial moisture content varied little among tests (between 17.4% and 17.6%) and therefore there were no significant variations in starting conditions throughout the various trials. Moisture levels at completion of drying were all approximately 14.0% for each test conditions of varying load, thereby achieving the target for safe storage.

Small Standard Deviations for both the initial and final moisture levels illustrate a very low variance and high repeatability; therefore, demonstrate good consistency on an ongoing basis within the testing environment. Therefore, it is shown that the ComputeRice System consistently performs well regardless of the Load Size. Additionally, the consistent loss of moisture across all Loads illustrates that the ComputeRice System consistently dries equally and does not sacrifice Quality in doing so.

Survey Feedback on Quality

User ratings of rice quality were favorable: six (6) rated uniformity as very uniform, and three (3) as somewhat uniform. Nine (9) felt the moisture content was just right. Six (6) rated appearances as excellent, four (4) as good. These findings suggest that the system consistently produces high-quality dried rice that meets both functional and aesthetic standards.

KEY SUMMARY FINDINGS

The evaluation of the ComputeRice system provided the following major findings: Moisture content levels were decreased by the system from approximately 17.4-17.7% to the desired 14% for each of the three loads used in this study (load weights of 3 kg, 5 kg, and 7 kg) using relatively consistent data throughout the trials which suggests consistency and repeatability of system function. Drying times of the system are greatly decreased relative to those of sun drying; 75-77% decrease in drying time occurred on average for each of the load sizes (14-30 min vs. 60-120 min) that were utilized, therefore illustrating great improvement in efficiency when utilizing controlled environmental conditions. Energy usage ranges from 0.8 kWh to 1.5 kWh per batch, and there is some indication of improving energy efficiency at larger load sizes, thus providing normalized energy consumption rates of approximately 0.21-0.27 kWh/kg and estimating operational costs to be ₱2.28-₱3.69/kg. Data illustrate a scalable response to increases in load size, i.e., drying time appears to increase nearly linearly with increasing load size while maintaining stability in heat transfer behavior, thus not degrading system efficiency. Usability studies demonstrated high usability acceptance from farm user testers, as all testers were able to operate the system correctly after a maximum of five minutes and indicated ease of operation and satisfaction with system performance. Quality assessments demonstrated that the dried rice produced through the ComputeRice system has quality characteristics that meet or exceed those established for sun-dried rice products in terms of moisture content, grain uniformity, and appearance.

CONCLUSION AND RECOMMENDATION

The ComputeRice: Arduino-Based Rice Drying System with Integrated Real-Time Process Monitoring demonstrated a strong performance as an alternative to traditional rice drying methods and performed well as one. It also shortened the drying time of the rice and maintained a consistent level of dryness (moisture) in each load, regardless of the load size. Although it did introduce some increased energy cost, this is paid back through its ability to produce dried rice at faster rates than other systems, more reliably and independently of local weather patterns.

The user feedback also confirmed that the system can be used by those farmers who have minimal knowledge about technology. There are many ways that farmers could use the integrated systems to monitor and control rice drying in the field. For example, using an integrated system that uses automation and real-time monitoring will provide a way to help farmers dry their rice better than what has been possible before. In the future, enhancements should focus on developing ways to optimize energy consumption and integrate renewable energy sources as a means to make the system sustainable over time.

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