

Smart Automatic Solar -Assisted Grain Drying System

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Abstract

Post-harvest grain losses remain a significant challenge in agriculture, primarily due to inefficient and uncontrolled drying methods. Conventional techniques such as open sun drying are highly dependent on environmental conditions and require continuous manual intervention, often resulting in non-uniform drying, moisture retention, fungal contamination, and degradation of grain quality. Furthermore, existing mechanical drying systems are often expensive and designed for single-grain applications, limiting their suitability for small-scale and rural farmers.

This paper presents a Smart Solar-Assisted Multi-Grain Drying System that integrates sensor-based monitoring, automated control, and renewable energy utilization. The proposed system enables user selection of different grain types and automatically adjusts drying parameters based on predefined moisture and temperature requirements. Real-time sensing

ensures effective regulation of heating and airflow mechanisms, leading to uniform and efficient drying. The incorporation of solar energy reduces dependency on conventional power sources, making the system cost-effective and suitable for energy-constrained rural environments.

Experimental results demonstrate that the proposed system improves drying efficiency, reduces manual effort, and minimizes post-

harvest losses. The integration of automation, multi-grain adaptability, and sustainable energy provides a practical and scalable solution for enhancing grain drying and storage practices in modern agriculture.

Keywords - Smart Grain Drying, Solar-Assisted System, Multi-Grain Processing, Sensor-Based Control, Automated Moisture Monitoring, Renewable Energy, Post-Harvest Loss Reduction

1. INTRODUCTION

Agriculture plays a crucial role in the economy, and proper post-harvest processing is essential to maintain grain quality. Drying is a key step, as excess moisture in grains can lead to spoilage, fungal growth, and reduced storage life. In many rural areas, traditional methods such as sun drying are still widely used. However, these methods are highly dependent on weather conditions, require manual effort, and often result in uneven drying.

Although mechanical drying systems are available, they are often expensive and limited to specific grain types, making them less suitable for small-scale farmers. Therefore, there is a need for an efficient and affordable solution that ensures uniform drying.

This paper presents a Smart Solar-Assisted Multi-Grain Drying System that uses sensor-based monitoring and automatic control to regulate temperature and moisture levels. The system also supports multiple grain types and utilizes solar energy, making it suitable for rural and energy-limited areas. The proposed approach improves drying efficiency, reduces manual effort, and helps in minimizing post-harvest losses.

2. LITERATURE REVIEW

Several studies have focused on improving grain drying techniques using modern technology. In [1], a solar-based grain drying system was developed to reduce reliance on conventional energy sources. The study showed that solar drying is economical and suitable for rural areas,

but it lacks precise control over temperature and moisture conditions.

In [2], an IoT-based agriculture monitoring system was introduced to track environmental parameters such as temperature and humidity in real time. While the system improved monitoring efficiency, it mainly focused on data collection and did not provide automated control of the drying process.

A moisture sensing system for grains was presented in [3], which helped in detecting moisture levels to avoid spoilage. Although the system offered accurate measurement, it did not include mechanisms to automatically adjust drying conditions.

In [4], an automatic grain drying system using controlled heating and airflow was proposed. The system improved drying performance; however, it was limited to specific grain types and required continuous electrical power.

From the above studies, it is observed that most existing systems focus on individual aspects such as solar energy, sensing, or automation. There is a lack of an integrated solution that combines all these features along with multi-grain capability. Therefore, the proposed system aims to develop an efficient and cost-effective drying solution by integrating sensor-based control, solar energy, and adaptability for different grains.

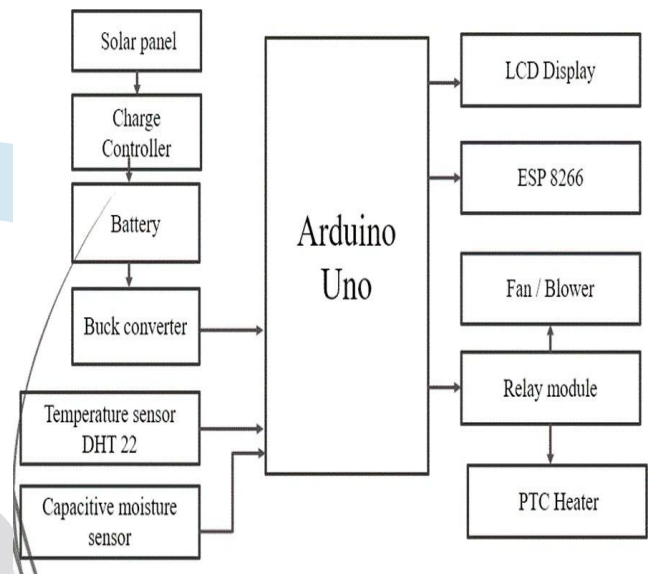
3. SYSTEM DESCRIPTION & BLOCK DIAGRAM

The proposed Smart Solar-Assisted Multi-Grain Drying System is designed to improve grain drying efficiency using automation and renewable energy. It utilizes temperature and moisture sensors to continuously monitor conditions inside the drying chamber.

A microcontroller processes the sensor data and controls the heating element and airflow system to maintain appropriate drying conditions. The system adjusts its operation based on moisture levels, ensuring uniform drying while preventing over-drying.

It also supports multiple grain types by applying predefined drying parameters, making it flexible for different agricultural needs. The use of solar energy reduces power consumption and makes the system suitable for rural areas.

Overall, the system provides an efficient, cost-effective, and reliable solution for reducing post-harvest losses and improving grain quality.



1. Solar Panel

Converts sunlight into electrical energy and provides power to the system.

2. Charge Controller

Regulates the voltage from the solar panel and safely charges the battery, preventing overcharging.

3. Battery

Stores electrical energy and supplies power to the system when sunlight is not available.

4. Buck Converter

Reduces the battery voltage to a stable level required for the Arduino and other components.

5. Arduino Uno

Acts as the main controller. It receives data from sensors and controls the heater, fan, and display accordingly.

6. Temperature Sensor (DHT22)

Measures temperature (and humidity) inside the drying chamber and sends data to the Arduino.

7. Capacitive Moisture Sensor

Detects the moisture level of grains and helps determine whether drying is needed or complete.

8. LCD Display

Displays important information like temperature, moisture level, and system status.

9. ESP8266

Provides wireless communication (Wi-Fi), which can be used for remote monitoring or data transmission.

10. Relay Module

Works as a switch controlled by Arduino to turn ON/OFF the heater and fan.

11. PTC Heater

Generates heat to dry the grains. It operates when high moisture is detected.

12. Fan / Blower

Circulates hot air inside the chamber to ensure uniform drying of grains.

4. THE STEPS OF PROPOSED WORK AS GIVEN BELOW:

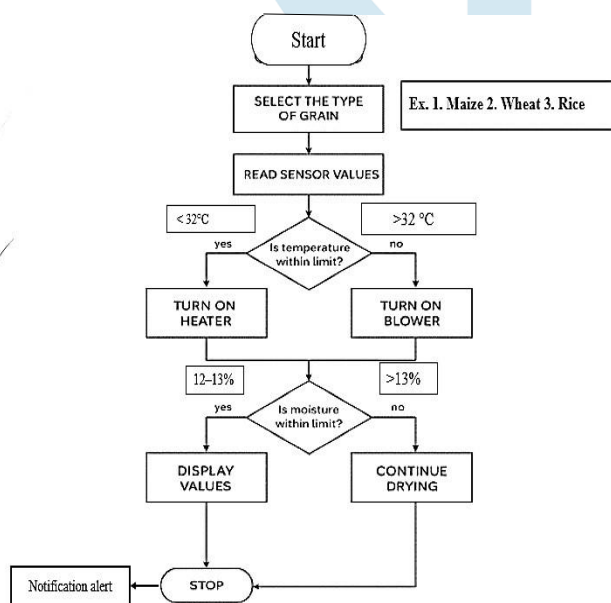


Fig. Flowchart of Smart Grain Drying

The system operation begins with the initialization process, where the user selects the type of grain such as maize, wheat, or rice. Based on the selected grain, predefined drying parameters are set in the system.

After selection, the sensors start reading real-time values of temperature and moisture from the drying chamber. The system first checks whether the temperature is within the required limit. If the temperature is below the set

threshold (less than 32°C), the heater is turned ON to increase the temperature. If the temperature exceeds the limit (greater than 32°C), the blower is activated to regulate and reduce excess heat.

Once the temperature is controlled, the system evaluates the moisture content of the grains. If the moisture level is within the safe range (around 12–13%), the system displays the values on the LCD and stops the drying process. A notification alert is also generated to indicate completion.

If the moisture level is still higher than the desired limit, the system continues the drying process by maintaining appropriate heating and airflow until the required condition is achieved.

5. RESULTS



1. MOISTURE & TEMPERATURE



6. CONCLUSION

In conclusion, this project successfully shows how modern technology can be used in agriculture to solve real problems faced by farmers. The system provides accurate moisture detection, automatic temperature control, and energy-efficient drying, which reduces manual effort and improves grain quality. Since the model has been successfully implemented and tested, it proves that uniform and controlled drying is possible using a smart approach. With further improvement and large-scale testing, this system can be developed into a practical and commercially useful solution for sustainable grain drying in rural areas.

7. REFERENCES

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