

Farmer Friendly Maize Humidity Level Testing Machine

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Abstract— The Maize Humidity Level Detector is a project aimed at improving crop yield and quality in maize fields. It uses sensor technology to continuously measure humidity levels, providing real-time insights to farmers. The data is then transmitted wirelessly to a central monitoring station, allowing for timely corrective actions. A user-friendly interface is developed to make the system accessible to farmers. The system also sends alerts or notifications when humidity levels deviate from the optimal range, enabling timely corrective actions. The Maize Humidity Level Detector contributes towards precision agriculture by promoting efficient water management, minimizing water wastage, and preventing overirrigation or under-irrigation. This aligns with the growing demand for sustainable and technology-driven agricultural practices, offering a reliable and cost-effective solution for farmers to make informed decisions and improve the efficiency and sustainability of maize cultivation.

Index Terms— Maize, Humidity Detector, Precision Agriculture, Sensor Technology, Real-time Monitoring.

I. INTRODUCTION

Maize, a vital crop for global food security, relies heavily on environmental factors, including humidity, which is crucial for crop health and yield. Precision agriculture, a modern approach, uses technology to optimize farming practices. The transpiration, water intake, and physiological activities of plants are influenced by humidity, and crop yield, disease control, and plant health depend on maintaining the proper humidity levels. Traditional humidity monitoring methods often lack precision and real-time data. A maize humidity level detection system aims to revolutionize farmers management by providing continuous and real-time data on humidity variations. This system aims to address the limitations of traditional monitoring methods and revolutionize maize cultivation. The Maize Humidity Level Detector project aims to create a cost-effective, real-time monitoring solution for maize humidity during storage, utilizing sensor technology, data analysis, and a user-friendly interface for accurate measurements and moisture content insights.

By optimizing maize storage conditions through sensor technology and data analysis, the Maize Humidity Level Detector project has the potential to completely transform agricultural operations. This program seeks to lower the danger of moisture damage, improve productivity, and encourage sustainable distribution and production. By bridging the gap between technology and agriculture, it hopes to improve both the lives of farmers and the security of the world's food supply.

II. LITERATURE SURVEY

Published by Z.G. Weinberg, Y. Chen, et al., "The effect of moisture level on high moisture maize under hermetic storage conditions" [1]. A research looked at how moisture content affected the quality of maize grains stored hermetically. After being conditioned for 28 days at varying moisture levels, the maize was kept in sealed containers at 30°C for a maximum of 75 days. The rate at which O₂ depleted accelerated with increasing moisture content. The largest dry matter losses, lowest germination rates, and highest counts of bacteria and yeast were observed in the maize at 20 and 22% m.c. Maize may be adequately preserved under sealed settings, offering protection against microorganism damage, according to in vitro investigations. To assess if high-moisture maize storage is economically feasible, further extensive studies are required.

Yaisys Blanco Valdes et al.'s "The effect of temperature and humidity on maize grains conservation" [2] A greater air gap between grains that have been kept as a result of the higher moisture content increases airflow resistance. Because of interstitial air movement, the migration of moisture grains takes longer, requiring more time for the grain's water content to stabilize.

"Design and implementation of a maize moisture measurement system based on NIR spectroscopy" by Gao, et.al [3] Direct methods, like gravimetric and chemical, remove water from grain, while indirect methods like optical and dielectric measure moisture properties, are faster and more convenient but require expensive equipment.

Yonglin W. et al.'s "Design of moisture content detection system" [4] The authors provide a brand-new technique that yields an accuracy of $\pm 2\%$ for determining grain moisture content utilizing a capacitive sensor and a single chip microcontroller.

"Review of Near-Infrared Spectroscopy for Maize Moisture Content Determination" by X. He et al. [5] The writers talk about how near-infrared (NIR) spectroscopy may be used to measure the moisture content of maize, emphasizing how quick, accurate, and high-speed it can be. They also go over calibration techniques and factors influencing NIR readings.

"Application of Near-Infrared Spectroscopy in the Determination of Moisture Content of Maize" written by W. Lu et al. [6] The study contrasted conventional techniques like oven drying and chemical treatments with the use of NIR spectroscopy for figuring out the moisture level of maize. The results demonstrated that NIR spectroscopy was a more practical and dependable approach for determining the moisture content of maize, since it was both more accurate and time-efficient.

"Near-Infrared Spectroscopy for Maize Moisture Content Prediction: A Review" by S. Chen, et.al [7] The study examines the use of NIR spectroscopy for predicting maize moisture content, highlighting its advantages like its nondestructive and rapid nature. Challenges include sample composition and environmental factors, but the authors conclude that NIR spectroscopy is a promising tool for maize moisture content prediction.

Y. Zhang et al.'s paper "Application of Near-Infrared Spectroscopy (NIRS) in Maize Moisture Content Determination" [8]. The authors concluded that NIRS is a practical technique for determining the moisture content of maize after developing an NIRS calibration model that showed excellent accuracy when evaluated using independent test samples.

J. Zhao and colleagues' "Review of Near Infrared Spectroscopy for Maize Quality Control" [9] The study covered the application of NIR spectroscopy for quality control of maize, emphasizing its benefits and its ability to evaluate moisture, protein, and starch content.

Leandro S. Oliveira et al.'s "Application of Near-Infrared Spectroscopy in Food Quality Evaluation: A Review" [10] The utilization of NIR spectroscopy in food quality evaluation is discussed in the article, with an emphasis on its principles and applications across a range of food industries.

W. J. McCarthy and colleagues' "Review of Near Infrared Spectroscopy for the Determination of Moisture Content in Grains" [11] The authors go over the concepts, applications, and variables influencing measurements and calibration techniques of near-infrared spectroscopy (NIR) as a means of assessing the moisture content of grains.

R. W. Brereton et al.'s paper "Use of Near Infrared Spectroscopy for the Determination of Moisture Content in Agricultural Products" [12] This paper examines and discusses the benefits and drawbacks of using NIR spectroscopy to measure the moisture content of agricultural crops, such as maize.

"Deterioration parameters' effects on maize storage" by Suleiman, R.A., Rosentrater, K.A., et al. [13] In Africa, Latin America, and Asia, maize is a staple crop and the world's third most important cereal grain. But a big problem is that it is rapidly deteriorating in tropical areas because of warm, humid weather. Moisture content, temperature, relative humidity, storage conditions, fungal development, and insect pests are some of the factors causing this degradation. Hot, humid weather promotes the growth of fungi, especially *Aspergillus flavus* and *Fusarium* sp.,

which produces mycotoxins. In order to preserve superior quality corn for both short- and long-term storage, it has to be shielded from environmental factors, insect development, and microorganisms. The purpose of this study is to pinpoint and stop these factors in order to stop maize from degrading.

"Methodology for measuring moisture in agricultural silos" by M. S. M. Abdullah, M. H. F. Rahiman, and others [14] Grain wetness meters, drying, and other grain variables that affect insulator qualities all show a considerable range in grain condition. To comprehend how these characteristics affect grain condition content throughout acquisition, storage, and technique, more study is required. When creating a grain condition instrument, the ideal frequency ranges and most effective insulator qualities should be determined. For a sample holder for different commodities, the selection and use of circuits are essential. Grain condition devices also need to be lightweight, accurate, consistent, precise, and responsible. There are drawbacks to indirect approaches for assessing grain condition. For example, they rely on the "standard wetness determination method" which necessitates the collection of all measurable electrical data. For studying the effectiveness and precision of localizing moisture distributions in agricultural silos using a tomography approach and utilizing a Gaussian algorithm for data analysis, the RF sensor network technology is advised. By ensuring food storage, minimizing grain damage, and determining the silo's total moisture content, this would help the agriculture industry.

M. S. Uddin, P. R. Armstrong, et al. "Accuracy of grain moisture content prediction using temperature and relative humidity sensors" [15] The two most important parameters for safe grain storage are grain temperature and moisture content (MC). Thermocouples make it simple to monitor temperature inside grain masses, but the availability of sensors limits the monitoring of MC. Grain moisture content (MC) may be predicted based on temperature and relative humidity (RH) using equations for moisture content (EMC), such as Modified Henderson, Chung-Pfost, or Oswin. Although these models are restricted to quasi-static thermodynamic circumstances, they offer a way to forecast MC using readily available commercial sensors. To calculate the inaccuracy in grain MC prediction caused by sensor error, error analysis was carried out using EMC relationships for wheat. It was discovered that the EMC prediction errors ranged from 0.65% to 0.25% MCdb between 20% and 70% RH. The prediction error significantly increased with increasing RH levels. For error analysis, sensor error was set at 2% RH and 0.4C. The amount of prediction error resulting from sensor error was equivalent to the standard errors of regression models created for wheat. After sensor accuracy tests were made, it was discovered that temperature accuracy was lower than quoted accuracy, while RH accuracy was determined to be within or greater than rated manufacturer requirements. Regardless of whether equations were employed to forecast moisture, sensor error led to EMC prediction between around $\pm 0.25\%$ to $\pm 0.65\%$ MCdb for ERH circumstances between 20% and 70%. Compared to RH error, temperature error has very little impact on EMC prediction.

Ishimwe Viviane, et al.'s "IoT-Based Real-Time Crop Drying and Storage Monitoring System" [16] Particularly in Rwanda, where traditional techniques of drying and storing grains are still in use, grain temperature and moisture content are critical components of safe grain storage. Monitoring environmental factors that impact the quality of maize and flour production as well as food security is not possible using traditional approaches, such as those that rely on temperature, humidity, and light sensors. Using a worldwide system for mobile communication module, this research leverages the ThingSpeak platform to assist farmers in monitoring drying and storage conditions in real-time. The platform shows graphs of temperature, humidity, and light in real-time. Grain moisture content can be predicted using EMC equations such as Modified Henderson, Chung-Pfost, and Oswin, however the accuracy of these formulas is dependent on the availability of sensors. Temperature accuracy is lower than quoted accuracy, however sensor accuracy for RH is on par with or higher than manufacturer requirements. Particularly in Rwanda, where traditional techniques of drying and storing grains are still in use, grain temperature and moisture content are critical components of safe grain storage. The platform shows graphs of temperature, humidity, and light in real-time. Grain moisture content can be predicted using EMC equations such as Modified Henderson, Chung-Pfost, and Oswin, however the accuracy of these formulas is dependent on the availability of sensors. EMC prediction errors are influenced by sensor error, with the Modified Oswin exhibiting the highest error. Temperature accuracy is lower than quoted accuracy, however sensor accuracy for RH is on par with or higher than manufacturer requirements.

Paddy Likhayo et al.'s article "Maize grain stored in hermetic bags" [17] For smallholder farmers to provide food security in their households, maize is an essential food crop. Insect pests causing postharvest grain losses during storage are a serious problem. The utilization of hermetic storage technology can reduce these losses by raising the amounts of carbon dioxide and decreasing oxygen inside the container. For 180 days, maize grain was kept in either hermetic or open-weave polypropylene bags to compare how well the grain was preserved at various moisture levels and during *Sitophilus zeamais* infestations. Polypropylene bags lost moisture content whereas hermetic bags retained it. *Prostephanus truncatus* populations were largest in moist grains and insect densities were

lowest in them. In hermetic bags with reduced oxygen and greater carbon dioxide levels, discolored grains were more prevalent. According to the study, the storage of damp grains in hermetic bags may be harmful to your health since the fungal growth that produces mycotoxins might discolor the grains. More research is required in certain circumstances.

III. CONCLUSIONS

Revolutionizing maize storage procedures is the goal of the ground-breaking Maize Humidity Level Detector project. It monitors humidity levels during storage by combining cutting-edge sensor technologies, a microprocessor, and an intuitive user interface. In addition to maintaining the quality of stored corn, this method helps provide food security, economic stability, and farmer access to technology. Proactive steps to lessen contamination and spoiling are made possible by real-time monitoring capabilities. By supplying a steady supply of high-quality food items for both domestic consumption and industrial use, the initiative improves the quality and safety of maize, so contributing to global food security. Because of the project's dedication to making technology accessible, this breakthrough will be advantageous to both small-scale farmers and major agricultural organizations.

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