IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

IOT Driven Smart Agriculture Storage System for Onion Preservation

Mrs. Priti Sudhakar Gund Pujari[1], Miss. Medha Jha[2], Mr. Meghraj Sonawane[3], Miss. Muthe Aishwarya[4], Mr. Murnar Hariom[5]
Assistant Prof. Electronic & Telecommunication Engineering Department,
Adsul's Technical Campus, Ahilyanagar, India [1]
Student,AIDS Engineering Department, Adsul's Technical Campus, Ahilyanagar, India[2,3,4]
Students, Electronics & Telecommunication Engineering Department, Adsul's Technical Campus, Ahilyanagar, India [5]

Abstract: *Onion storage is a major challenge for farmers due to temperature, humidity, and gas accumulation that lead to spoilage. This project presents an IoT-based smart agricultural storage system designed to monitor and control environmental conditions in onion storage facilities. The system uses an ESP32 microcontroller along with DHT22 temperature and humidity sensors and an MQ-135 gas sensor to detect harmful gases produced by rotting onions. When environmental parameters exceed safe limits, the system automatically activates ventilation fans through relay modules. Sensor data is transmitted to a cloud platform using Wi-Fi, allowing farmers to monitor storage conditions remotely through a mobile dashboard. The proposed system helps reduce post-harvest losses, improves storage efficiency, and provides an affordable solution for small-scale farmers. In this paper we have proposed an IoT based Onion storage monitoring and automation control system which controls the environment of onion's in the onion storage place. This system enables real-time climate monitoring, identifies early wastage, and alerts the farmer based on the analyzed data; which helps to reduce wastage of onion and helps to store onion up to eight months..*

Keywords: Smart Agriculture, IoT, Onion Storage, ESP32, DHT22, MQ-135, Automation, Post-Harvest Management

I. INTRODUCTION

The Internet of Things (IoT) is a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices. Internet of Things focuses on connection of different sensors to physical object and transmits information to internet. It has a significant role in the field of agriculture in terms of control and protection, providing real time information and communicating with the physical world. Onion storage methodology to reduce its degradation.[1] Focuses on studying various monitoring systems that have been designed and implemented in the field of agriculture. Internet of Things plays a important role in smart agriculture monitoring system. Smart farming is an emerging concept, because IoT sensors can provide information about their fields. The main feature is monitoring temperature and humidity in agricultural field.[2] Monitoring of the temperature and humidity in the agricultural field is the major feature. With a share of 10 percent in output and 16 percent of the global area, India is the secondlargest producer of onions after China. 4.30 million tonnes of bulbs are produced annually on 0.39 million hectares of land in India (FAO,1995). Production for the present year is predicted to be 4.7 million tonnes. It is one of the most significant vegetable crops in our nation and is consumed every day in practically every family. Over 43 million tonnes of onions are produced worldwide. China, the United States, the Soviet Union, the Netherlands, Spain, and Turkey are notable producers.[3] The states of Maharashtra, Gujarat, Uttar Pradesh, Orissa, Karnataka, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, and Bihar account for the majority of India's onion production. With 20% of the area and 25% of the production, Maharashtra is the leading producer.[4] Onion currently has a storage capacity of approximately 4.6 lakh tons. In comparison to the entirety of our production,

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

this is extremely inadequate. Even the majority of the available structures are conventional and unscientific.[5] However, the Expert Committee on Cold Storage and Onion Storage has predicted that in the next five years, approximately 1.5 lakh tons of capacity will be required on farms in production areas and 3.0 lakh tons will be required at APMCs (Agricultural Produce Market Committee) and other markets.[8][9]

Problem Statement:

Growers bleed money after harvest because decent storage costs too much. In a standard warehouse, humidity jumps or rot starts in the heart of the pile, and nobody knows. The outside looks fine while the inside turns to mush. By the time eyes spot the damage, half the load is trash. We need a cheap, quiet watchdog—something that feels the air, sniffs out decay before it spreads, fires up ventilation on its own, and screams at the owner immediately.

Onion rabi crops need preservation methods since they must be preserved for several months until the next harvest because they are harvested in the winter. As a perishable vegetable, onions can rot quickly and cause farmers to suffer large financial losses if they aren't properly preserved. Pests, insects, and wetness can harm onion rabi crops and cause them to produce less of the crops in terms of both quality and quantity. Therefore, to avoid these problems and increase the onions' shelf life, suitable preservation methods are required. For onion rabi crops, standard preservation methods include drying, curing, and storing in a cold, dry, and wellventilated space. Before being kept, onions are often dried in the sun for a few days. This aids in decrease the onions' moisture content to stop bacterial and fungal growth. Another crucial stage in preserving onions is curing. Curing is storing the onions in a warm, dry environment for many weeks so that the skin may build a protective covering. By doing this, moisture loss and food degradation during storage are reduced.

Fig. 1. Roaten Onion

Objective of Project:

The primary aim of this project is to design, develop, and implement an Internet of Things (IoT)-based onion storage monitoring system to revolutionize the post-harvest preservation of onions. The project's specific objectives are as follows:

• Real-Time Monitoring: Create a system that continuously monitors and collects data on temperature, humidity, and moisture levels within onion storage facilities. This real-time monitoring will provide an accurate and up-to-date picture of the storage conditions.

• Data Processing and Analysis: Implement data processing algorithms that analyze the collected data to identify trends and anomalies. This analysis will enable the system to provide actionable insights into the onion storage environment.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

• Alerts and Recommendations: Develop a user interface that allows farmers and other stakeholders to access real-time data, historical trends, and receive alerts and recommendations. These alerts will prompt timely interventions to address deviations from optimal storage conditions.

• Reduction of Onion Spoilage: The project aims to reduce onion spoilage and quality degradation by enabling proactive measures based on real-time insights. This reduction in spoilage will lead to cost savings for farmers and improved quality for consumers.

• Resource Efficiency: By reducing the need for manual monitoring and providing efficient insights into storage conditions, the project aims to save time and labor costs for farmers and storage facility operators.

• Enhanced Availability of High-Quality Onions: Ultimately, the project aims to ensure a consistent supply of high-quality onions to the market by improving post-harvest storage management. The IoT- based onion storage monitoring system will provide a technological solution to the longstanding challenges associated with onion storage. By achieving these objectives, the project aims to offer a practical and efficient tool for onion farmers, storage facility operators, and consumers to ensure the freshness and quality of stored onions, ultimately benefiting both the agricultural and culinary sectors.

II. LITERATURE SURVEY

 Onion Post-Harvest Challenges: Numerous studies emphasize the challenges associated with onion storage, including vulnerability to moisture, temperature fluctuations,and humidity levels. Research has highlighted the impact of these factors on onion quality and shelf life[1].

 Traditional Storage Methods: Literature also documents traditional storage practices, such as drying, curing, and ventilated storage rooms. These methods have been practiced for generations but are limited by their inability to provide real-time insights into the storage environment[2].

 IoT in Agriculture: A significant body of literature explores the applications of IoT in agriculture. IoT has been employed in monitoring soil conditions, crop growth, and pest control. However, there is limited research on its application in onion storage[3].

 Sensor Technologies: The literature reveals various sensor technologies used in agricultural applications. For onion storage, sensors measuring temperature, humidity, and moisture levels are crucial. These sensors can be integrated into IoT systems[4].develop them.

III. METHODOLOGY

The block diagram maps the data flow from the environmental sensors to the ESP32 microcontroller, which subsequently controls the ventilation relays and communicates with the Cloud Server for remote user access.

Onions when stored between 25oC-30oC and 65%RH-70%RH, their durability increases. To achieve this a DHT-11 sensor is used, which detects the temperature and humidity. In order to maintain the specified range, forced ventilation i.e, fans are used. Whenever the temperature and humidity exceed 30oC and 70%RH respectively, DHT 11 sensor sends message to microcontroller which then forwards the message to the relay to turn on the fans, vice versa action happens when temperature and humidity are below 25oC and 65%RH respectively. This is how temperature and humidity are maintained.MQ-4 gas sensor is used to detect the spoilage of onions in advance. Threshold value of 450ppm is preferred, so whenever the methane level in the air exceeds 450ppm, the sensor sends an alert to the phone through the microcontroller. This entire sensor system is kept near the onions which are being stored and monitors them continuously. An alert is created using software tools IFTTT and ThingSpeak. The threshold value is fixed in ThingSpeak and alert is created in IFTTT.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

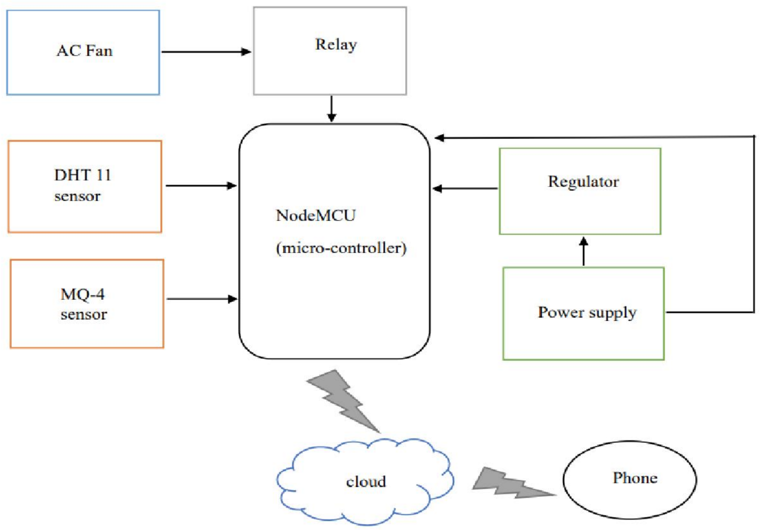

Fig. 2. Block Diagram of System

A. Components:

ESP32 – the shed brain: Dual-core, WiFi onboard, ADC for gas, GPIO for relay. Reads sensors, compares thresholds, clicks relay, pushes cloud. Rugged because agricultural—dust, heat, voltage spikes. Enclosed in box, ventilated, survives. Arduino IDE familiar, farmer's son can modify, community repair possible.

• DHT22 – the weather watcher: ±0.5°C, ±2% humidity, digital output, no calibration drift. One wire, one library, one reading. AM2311 more accurate, triple price—DHT22 sufficient, replaceable, understood. Critical bounds 25-30°C, 65-70% humidity; deviation triggers fan, restoration attempted.

• MQ-135 – the rotting nose: Heated metal oxide, resistance changes with gas. Ammonia, hydrogen sulfide, general VOCs—rotting onions releases all. Not specific, context clarifies: in onion shed, smell means spoilage. Calibrated by exposing to known rot, threshold set where human nose barely detects. Early warning, days before visible.

• 12V DC exhaust fans – the lungs: Cross-ventilation, damp hot air out, fresh in. Two fans opposed, flow directional, replacement rapid. 12V because solar compatible, battery backup possible, grid failure survivable. Noise acceptable, survival preferable.

• 2-channel relay module – the muscle: ESP32 3.3V logic, fans 12V power—relay bridges. Optocoupler isolated, safe, reliable. Two channels: one fan, two fans, or fan plus future load. Solid-state considered, mechanical chosen—cheaper, replaceable, click audible confirmation.

16x2 I2C LCD – the local window: Temperature, humidity, gas status—two lines sufficient. "T:28C H:68% G:OK" or "FAN ON ALERT". Worker glances, knows, and continues. I2C saves pins; backpack handles contrast. Visible in dim shed, readable at angle, sufficient.

• 12V SMPS – the life: Mains in, 12V out, stepped to 5V for logic, 3.3V for ESP32. Robust because agricultural voltage fluctuates, spikes dies. SMPS survives where linear smokes. Fan power abundant, sensor power clean, system stable.

B. Working:

Boot and calibration – the morning stretch: ESP32 wakes, WiFi hunts, connects. MQ-135 heats—sensor needs 20 seconds warm-up, readings stabilize. Pre-heating phase coded, delay respected. LCD flickers "System Ready", farmer knows vigilance begun.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 18, April 2026
Impact Factor: 8.2

• Continuous acquisition – the endless watch: DHT22 polled every 10 seconds—temperature, humidity, digital, reliable. MQ-135 analog read every scan—voltage mapped to ppm, trend watched, spike feared. Rot starts slow, accelerates fast; frequent sampling catches early.
• Threshold comparison – the judgment: Three lines, any crossed triggers action. Humidity 70%—fungal risk, damp dangerous. Temperature 30°C—sprouting imminent, quality drops. Gas spike—rotting begun, cascade threatens. Logic OR, not AND; single danger sufficient, combination worse.
• Automated actuation – the response: Relay clicks, fans spin, air moves. Humidity drops, temperature equalizes, gas dilutes. No farmer decision, no delay, no visit required. Fans run until threshold cleared, then rest. Override button exists—farmer can force, can silence, rarely does.
• IoT telemetry – the distant eye: Data packages—temperature, humidity, gas, fan status—HTTP POST to cloud. Dashboard graphs, phone buzzes, alert fires. "Humidity 78%, fans activated, 2:47AM". Farmer kilometers away, sleeping, now informed. Historical data reveals—monsoon worst, morning recovery, fan effectiveness proven. Learning accumulated, optimization possible, losses prevented not merely recorded.

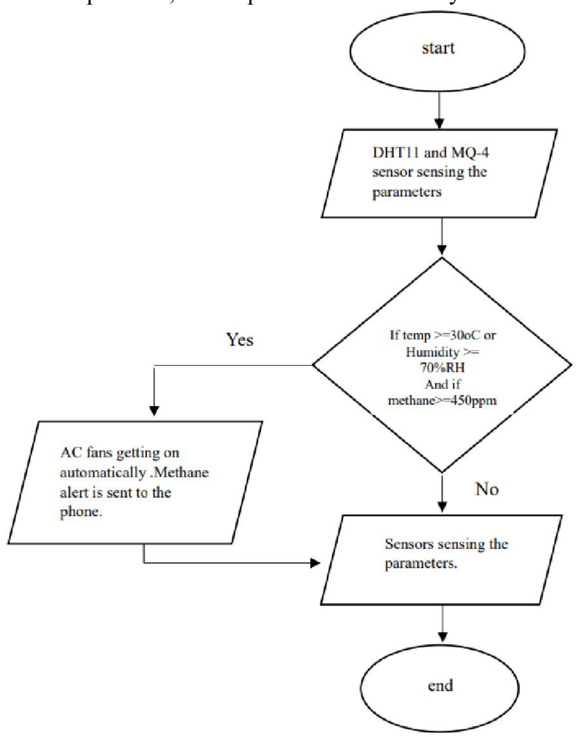

Fig. 3. Flow chart of System

IV. ADVANTAGES & APPLICATION

A. ADVANTAGES

• Spoilage stopped early: One bad onion poisons pile—gas spreads, moisture spreads, rot accelerates. MQ135 catches first whisper, fan dilutes, farmer removes culprit. Chain reaction broken, not merely documented.
• Cheap to build, cheap to run: Cold storage lakhs upfront, thousands monthly electricity. We cost ₹2,500, fans sip power, solar viable. Small farmer accessible, debt avoidable, adoption possible.
• No daily babysitting: Traditional sheds need morning visit, evening visit, weather watch. System automates—farmer sleeps, system breathes, alert only when trouble. Labor saved, attention freed, other fields tended.

Copyright to IJARSCT
www.ijarsct.co.in
DOI: 10.48175/568

• Data teaches: Historical graphs reveal—monsoon humidity spikes July, fans overworked, shed needs sealing. Next season, farmer prepares, losses drop. Experience digitized, wisdom accumulated, strategy optimized.

B. APPLICATIONS

• Onion, garlic: Built for this—dry, ventilated, gas-monitored. Root crops, bulb crops, similar needs. Thresholds tuned empirically, adjustable for variety.

• Potatoes: Code tweak—temperature limit lower, humidity tolerance higher. Same hardware, different numbers, adapted in minutes. Modular because simple.

• Grain silos: Moisture kills wheat, mold poisons corn, toxins persist. Humidity watch critical, gas detection secondary, principle identical. Scale up—more sensors, more fans, same brain.

V. CONCLUSION

A low-cost and easy-to-use method of preserving onions has been developed utilizing sensors. The system is programmed to continuously observe the onions and send a notification to the user when they reach the desired state. Depending on the amount of onions, the sensor system can be customized and set up. With the help of this sensor system, onions can be stored for as long as eight months. The IoT based onion storage monitoring and automation control system is an effective way to monitor and control onion storage. It is also a convenient way to monitor and control the storage of onions because it does not require manual intervention. The system can also help reduce the cost of onion storage by automating the storage process. In this system we can monitor a temperature by using temperature sensor i.e., LM35. We also monitor humidity, moisture and odour by using humidity sensor (HR202), moisture sensor and gas sensor i.e. (MQ-6) respectively.

A. FUTURE SCOPE

• Machine learning stuff: We got data now—tons of it. Hot days, wet weeks, which batches went bad when. Maybe computer finds pattern we miss. Like, "humidity spikes 3 days, onions toast by Friday." Farmer sells early, beats rot, gets better price. Cloud does heavy thinking, she'd just keeps sensing. Not there yet, but doable.

• Proper dehumidifier: Fans just shuffle wet air around. Coastal places? Useless. Need Peltier thing—cold plate, water drips off, actually dries air. Sucks power, costs more, but some places nothing else works. Kerala farmers already asking.

• Solar and that old GSM: Electricity cuts, sun doesn't. Slap panel on roof, battery inside, done. WiFi? Forget it—no tower for miles. But 2G signal somehow reaches. SIM800L module, ₹300, fires text message: "SHED 3 HUMID." Farmer gets it, jumps on bike, checks. Backup because onions too precious to lose to dead router.

ACKNOWLEDGMENT

It gives us great pleasure in presenting the paper on "IOT Driven Smart Agriculture Storage System for Onion Preservation". We would like to take this opportunity to thank our guide, Prof. Priti Sudhakar Gund Pujari, Professor, E&TC Department, Adsul's technical Campus, Ahlyanagar, for giving us all the help and guidance we needed. We are grateful to her for hers kind support, and valuable suggestions were very helpful.

REFERENCES

[1] P. P. Ray, "Internet of Things for Smart Agriculture: Technologies, Practices and Future Direction," Journal of Ambient Intelligence and Smart Environments, vol. 9, no. 4, pp. 395-420, 2017.

[2] A. Kamilaris and A. Pitsillides, "IoT in Agriculture: A Comprehensive Review of Technologies and Solutions for Post-Harvest Spoilage Monitoring," IEEE Communications Surveys & Tutorials, vol. 18, no. 1, pp. 270- 290, 2016.

[3] M. K. Singh and A. K. Gautam, "IoT Based Smart Crop Storage Monitoring System," Proceedings of the IEEE International Conference on Smart Technologies for Agriculture, pp. 110-115, 2021.

[4] S. K. Rajput and P. K. Sharma, "Automated Onion Storage and Microclimate Monitoring System using IoT," Proceedings of the IEEE International Conference on Smart Agriculture (ICSA), pp. 112-118, 2022.

[5] Espressif Systems, "ESP32 Series Datasheet," Version 3.7, 2023.

[6] Aosong Electronics, "Digital Temperature and Humidity Sensor DHT22/AM2302 Datasheet," 2020.

[7] Zhengzhou Winsen Electronics Technology Co., Ltd., "MQ-135 Gas Sensor Technical Data for VOC and Ammonia Detection," 2019.

[8] S. V. Kulkarni and V. K. Sharma, "IoT-based Smart Ventilated Structures for Onion Storage (Chawl)," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 8, no. 6, pp. 115-120, 2019.

[9] C. V. L. N. Murthy and M. V. R. Murthy, "Detection of Spoilage in Stored Onions using MQ-135 Gas Sensor and Microcontroller," Journal of Agricultural Engineering, vol. 58, no. 3, pp. 245-251, 2021.

[10] S. F. Hussain et al., "Development of an Efficient Ventilation Control System for Smart Agricultural Storage Facilities," International Journal of Electronics and Communication Engineering, vol. 9, no. 1, pp. 1-8, 2022.

[11] A. R. Al-Ali, I. A. Zualkernan, and M. Rashid, "A Smart IoT System for Agricultural Storage Management," IEEE Transactions on Consumer Electronics, vol. 63, no. 4, pp. 426-434, 2017.

[12] H. Navarro-Hellín et al., "A Wireless Sensors Architecture for Efficient Microclimate Management in Greenhouses and Storage," Agricultural Water Management, vol. 176, pp. 122-131, 2016.

[13] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions for Smart Farming," Future Generation Computer Systems, vol. 29, no. 7, pp. 1645-1660, 2013.