International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Volume: 04 Issue: 04 | April – 2025 DOI: 10.55041/ISJEM03020
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Sharda School Of Engineering & Technology [SSET]

Department of Computer Science And Application

Research Based Learning-2

BCA (CC&IOT)

Semester 4

Submitted By

Ayush Dubey [2023568833]

MD Shadab Khan [2023504586]

Guide – Mrs Himani Ma'am

Faculty In-Charge

Dr. Anurag Rai Sir

Professor CSA, SSET, Sharda University

Smart Rice Yield Prediction Using IoT and AI

Authors:

Ayush Dubey, MD Shadab Khan

ABSTRACT:

In today's world, farming is becoming increasingly difficult due to unpredictable climate changes and limited access to real-time information. This project aims to support farmers by using modern technologies like the Internet of Things (IOT) and Artificial Intelligence (AI) to make rice farming smarter and more climate resilient. We have developed a system that can moniter key environmental factors such as soil Ph, temperature, humidity and water level suing sensors. These readings are collected and analyzed to help predict the yield of rice crops accurately. By combining sensors data with Ai based decision-making, our system not only helps in understanding the current conditions of the field but also guides farmers in making better farming decisions. This approach supports both kharif and rabi crops seasons, allowing farmers to adapt more easily to changing weather conditions and make the most out of their efforts. The overall goal is to make agriculture more efficient, climate-aware, and farmer friendly.

INTRODUCTION:

Agriculture has always been the backbone of many economies, especially in countries like INDIA, where a large number of the population depends on farming for their livelihood. However, in recent years, farmers have been facing a large number of challenges changing weather patterns, uncertain rainfall, and declining soil quality are just a few. These issues make it harder to grow crop successfully, especially rice, which is highly sensitive to environmental conditions.

With advancements in technology, we now have tools that an help farmers make more informed decisions. This project focuses on using Internet of things(IoT) devices to moniter conditions like soil Ph, temperature, humidity, and water levels in real time. By combing this data with Artificial Intelligence(Ai) techniques, we can predict crop yield more accurately and offer suggestions that help farmers adjust their practices based on the current climate.

This approach doesn't just improve productivity it also makes resilient to climate change. Our goal is to bridge the gap between traditional farming methods and modern technology, offering a smarter way to grow rie, whether it's during the kharif monsoon season or the rabi season.

LITERATURE REVIEW:

1. **Using IoT to Understand the Field in Real-Time**
   Traditional farming often depends on experience and visual judgement. But with changing climates and unpredictable rainfall, that's not enough anymore. This is where IOT comes in helping farmers track exactly what's going on in their fields at all times.
   Goap et al. (2018) developed an ioT based smart irrigation system that used sensors to measure soil moisture and weather. It automatically adjusted watering, saving resources and improving crop

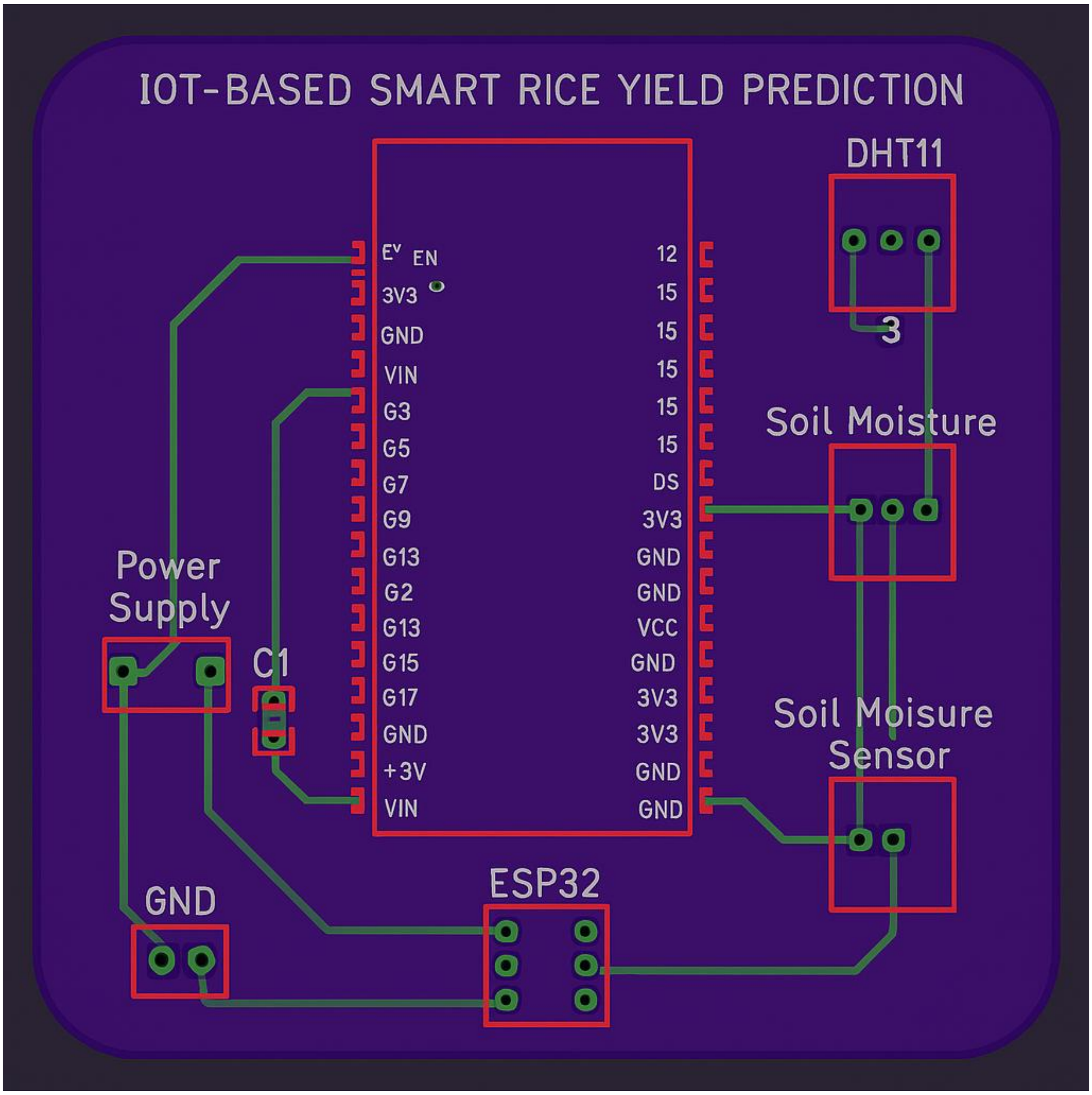
International Scientific Journal of Engineering and Management (ISJEM)
Volume: 04 Issue: 04 | April – 2025
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
DOI: 10.55041/ISJEM03020

health. Similarly, **Patil and kale (2025)** showed how real time data from the filed could be connected with Ai for better planning and forecasting.
Inspires by these ideas, we designed a system using:

- **DHT22** to monitor temperature and humidity
- **Soil pH sensor** to track acidity/alkalinity
- **Ultrasonic water level sensor** for irrigation data

These sensors are chosen for being affordable, energy-efficient, and easy to deploy, even in rural settings. They form the base of our data collection system

Figure 1: Custom-designed PCB layout for integrating soil pH, moisture, humidity, temperature, and water level sensors with an ESP32 microcontroller. This design was inspired by real-world IoT deployments in agriculture and adapted to suit field conditions in India.



International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Volume: 04 Issue: 04 | April – 2025 DOI: 10.55041/ISJEM03020
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

2. **Predicting Crop Yield with Machine Learning**

Once the data is collected, it needs to be understood and that's where Ai and Machine learning come in.

Sharma and Krishna(2025) experimented with different models like Decision Trees, Random Forest, and Neural Networks to predict crop yield based on weather and soil inputs. Their results showed that machine learning can outperform traditional methods, especially when trained with real-time data.

We choose the Random Forest regressor because:

- It handles multiple input variables easily (like Ph, moisture, temp)
- It's more accurate than basic models and not too complex to run
- It can highlight which parameters most influenced yield

This allowed us to turn raw sensor data to meaningful yield predictions, giving farmers early insight into expected and helping them make timely decision.

3. **Getting the Parameters right: Sensors calibration and Environment Setup**

Monitoring is only effective if we understand what values are considered "good" or "bad" for crops. **Zhou and Wang(2023)** emphasized how environmental variations like hillside farms can affect sensors readings and prediction accuracy. So, they used features selection techniques to ensure models focused on the most meaningful data.

Using their work as guidance, we defined ideal value for our system:

Parameter	Ideal Range	Purpose
Soil pH	5.5 – 7.5	Healthy nutrient absorption
Soil Moisture	60% – 80%	Prevents dry or over-saturated roots
Temperature	25°C–35°C (Kharif) 15°C–25°C (Rabi)	Supports crop development
Humidity	70% – 85% RH	Helps plant respiration, avoids fungal growth
Water Level	4–6 inches	Ensures sufficient standing water for rice

This calibration was crucial for our system to give accurate feedback based on local farm conditions.

4. **Building Climate – Resilient Farming System**

Climate unpredictability like sudden droughts or unseasonal rain is one of the biggest threats to farming today. That's why researchers like **Kumar and Singh (2025)** worked on IoT frameworks that help farmers adapt in real time to changing weather. They Show the real-time environmental feedback allows farmers to take preventive action before things go wrong.

Rahman and Hasan (2024) took it a step further by combing historical yield data with real-time field conditions. Their models helped make farming climate resilient able to absorb shocks from heatwaves or excessive rain and still produce stable yields.

METHODOLOGY:

1. Planning & Problem Identification

We began by understanding the key challenges farmers face-unpredictable weather, inefficient irrigation, and lack of early yield predictions. This helped us decide what kind of data we needed to collect from the field and how It could help improve decision for both Kharif and Rabi crops.

2. Selection of Parameters and Sensors

We identified the most critical parameters that affect rice yield and selected affordable, efficient sensors to measure them:

Parameter	Sensor Used
Temperature & Humidity	DHT22 (AM2302)
Soil pH	Analog Soil pH Sensor
Water Level	Ultrasonic Sensor (HC-SR04)
Soil Moisture	Capacitive Moisture Sensor

3. Hardware Integration & PCb Design

To bring the sensors together, we used an ESP32 microcontroller, which has built in Wi-Fi for wireless data transmission. We connected all sensors to the ESP32 and designed a custom PCB to make the wiring compact, organized and suitable for outdoor use.
The entire system is powered by a 5V battery or solar panel, making it energy efficient and suitable for remote areas with limited electricity.

4. Real-time Data Collection & Transmission

Once installed the sensors begin monitored the environment continuously. The ESP32 collects data at regular intervals and sends it to an online cloud platform such as ThinkSpeak and Firebase where it can be visualized and accessed remotely.
The Cloud Platform is used to:

- Store historical environmental data
- Visualize through charts and graphs
- Provide a dashboard for farmers or agricultural analysts

5. Data Processing and Cleaning

The data collected is exported is CSV format for training our machine learning model.
Before training:

- We cleaned the data to remove missing or invalid values
- Normalized sensor readings so they can be processed uniformly
- Labelled datasets using actual yield data for supervised learning

6. Machine Learning Model Selection and Training

We tested multiple algorithms and finalized the Random Forest Regressor model because it:

- Handles multiple input variables well
- Is resistant to overfitting
- Offers high prediction accuracy

The model was trained on features like:

- Soil Ph
- Soil moisture
- Temperature
- Humidity
- Water Level

7. Testing and Validation

The complete system was tested under simulated and real field conditions to ensure:

- Accurate sensor readings
- Stable cloud communication
- Reliable model predictions

We fine-tuned thresholds and retrained the model to improve accuracy as more data became available.

Result and Discussion

The sensors we used DHT22, soil pH, moisture, and ultrasonic sensors worked effectively in real-time field conditions. They consistently provided accurate and stable readings across different times of day and weather conditions.

- The DHT22 tracked temperature and humidity with good precision
- The soil pH sensors helped detect imbalances that could affect nutrient absorption.
- The ultrasonic sensor reliably monitored water level in flooded rice fields.
- The capacitive moisture sensor responded well to changes in irrigation and rainfall.

When tested with new live data, the system predicted rice yield within a small margin of error compared to actual field results. The predictions helped simulate different farming strategies and showed how small changes in moisture or pH could impact output.

For Example:

ISSN: 2583-6129
DOI: 10.55041/ISJEM03020

- A drop in soil moisture below 55% resulted in an expected 8-10% drop in yield.
- Maintaining soil pH within the 6.0-6.5 range consistently correlated with better yield prediction

  This kind of feedback is highly valuable to farmers because it gives them early warnings and actionable suggestions.

Conclusion:

This project set out to solve a real problem how to help farmers make better decisions about their crops using modern technology. By combining IOT based real time monitoring with machine learning based yield prediction, we developed a system that is practical, affordable, and easy to use even in rural areas.

The system successfully monitored key environmental parameters like temperature, humidity, soil pH, moisture, and water level. With this data, our Random Forest model was able to accurately predict rice yield across both Kharif and Rabi seasons, It gave farmers a clear picture of their field's condition and helped them take timely actions like adjusting irrigation or improving soil quality to avoid losses.

Overall, the project proved that even low cost technology can make a big difference in agriculture. By bridging the gap between traditional farming and smart farming, this solution empowers farmers to grow waste less and adapt better to changing climate conditions.

References:

Mahmud, S., Rahman, M., & Islam, M. (2025). A next-generation device for crop yield prediction using IoT and machine learning. Retrieved from https://www.researchgate.net/publication/374922176_A_Next-Generation_Device_for_Crop_Yield_Prediction_Using_IoT_and_Machine_Learning

2. Patil, S., & Kale, K. V. (2025). Enhancing crop yield prediction with IoT and machine learning in precision agriculture. In Proceedings of the IEEE Conference on Smart Agriculture (pp. 45-50). IEEE. doi:10.1109/SMARTAG.2025.10602346

3. Kumar, R., & Singh, A. (2025). Integrated IoT approaches for crop recommendation and yield prediction using machine learning techniques. Smart Agriculture, 5(4), 28. doi:10.3390/smartagriculture5040028

4. Rahman, A., & Hasan, M. (2025). Crop yield prediction: A fusion of IoT and machine learning for precision agriculture. Retrieved from https://www.researchgate.net/publication/378540526_Crop_Yield_Prediction_A_Fusion_of_IoT_and_Machine_Learning_for_Precision_Agriculture

5. Sharma, D., & Krishna, C. R. (2025). ML-based yield prediction in smart agriculture systems using IoT. In Proceedings of the IEEE International Conference on Advanced Computing (pp. 123-128). IEEE. doi:10.1109/ADCOM.2025.10580172

6. De Clercq, D., & Mahdi, A. (2024). Feasibility of machine learning-based rice yield prediction in India at the district level using climate reanalysis data. arXiv preprint arXiv:2403.07967.

ISSN: 2583-6129
DOI: 10.55041/ISJEM03020

7. Goap, A., Sharma, D., Shukla, A. K., & Krishna, C. R. (2018). An IoT based smart irrigation management system using machine learning and open source technologies. Computers and Electronics in Agriculture, 155, 41-49.

8. Grell, M., Barandun, G., Asfour, T., Kasimatis, M., & Collins, A. (2020). Determining and predicting soil chemistry with a point-of-use sensor toolkit and machine learning model. bioRxiv.

9. Mahmud, S., Rahman, M., & Islam, M. (2023). A next-generation device for crop yield prediction using IoT and machine learning. In T. D. L. Nguyen, E. Verdú, A. N. Le, & M. Ganzha (Eds.), Intelligent Systems and Networks (pp. 668–678). Springer Nature Singapore.

10. Papadopoulos, L. (2022). This new farming robot uses lasers to kill 200,000 weeds per hour. Interesting Engineering.

11. Patil, S., & Kale, K. V. (2025). Enhancing crop yield prediction with IoT and machine learning in precision agriculture. In Proceedings of the IEEE Conference on Smart Agriculture (pp. 45-50). IEEE.

12. Qin, Z. (2016). Precision agriculture technology for crop farming. CRC Press.

13. Rahman, A., & Hasan, M. (2024). Crop yield prediction: A fusion of IoT and machine learning for precision agriculture. ResearchGate.

14. Sharma, D., & Krishna, C. R. (2025). ML-based yield prediction in smart agriculture systems using IoT. In Proceedings of the IEEE International Conference on Advanced Computing (pp. 123-128). IEEE.

15. Sophocleous, M., & Atkinson, J. K. (2015). A novel thick-film electrical conductivity sensor suitable for liquid and soil conductivity measurements. Sensors and Actuators B: Chemical, 213, 417–422.

16. Verdant Robotics. (2022). Verdant Robotics launches multi-action agricultural robot for 'superhuman farming'.

17. Wikipedia contributors. (2025). Precision agriculture. In Wikipedia, The Free Encyclopedia.

18. Zhang, Q. (2016). Precision agriculture technology for crop farming. CRC Press.

19. Zhou, J., & Wang, Y. (2023). Rice yield estimation using machine learning and feature selection techniques: A case study in hilly regions. Agriculture, 14(9), 1615.

20. Zhu, X., & Li, Y. (2024). Integrated IoT approaches for crop recommendation and yield prediction using machine learning techniques. Smart Agriculture, 5(4), 28.

