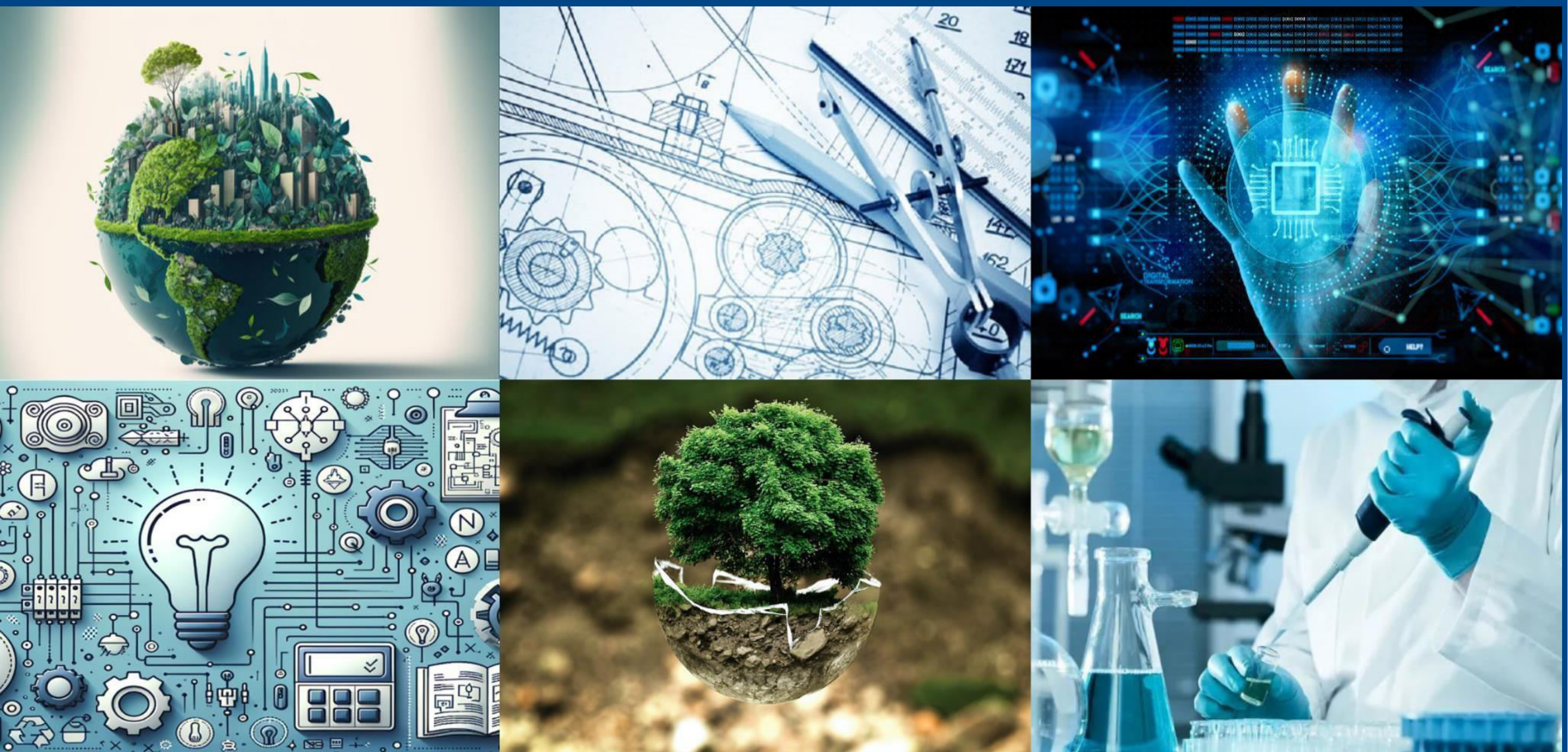
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 8, Issue 12, December 2025

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)
(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Crop Disease Detection and Smart Irrigation System

Mrs. Nidhi R[1], Mr. B Ritheesh Kumar[2], Mr. Premchand K T S[3], Mr. Sanjay K S[4]

Assistant Professor, Department of Information Science and Engineering, PESITM, Shivamogga, Karnataka, India[1]

U.G. Student, Department of Information Science and Engineering, PESITM, Shivamogga, Karnataka, India[2]

U.G. Student, Department of Information Science and Engineering, PESITM, Shivamogga, Karnataka, India[3]

U.G. Student, Department of Information Science and Engineering, PESITM, Shivamogga, Karnataka, India[4]

ABSTRACT: Maternal Farming continues to be a key livelihood for many people in developing regions, but challenges like crop diseases and inefficient irrigation often affect productivity. This project introduces a simple yet effective AI-based system that aims to support farmers by combining crop disease detection with a smart irrigation solution. The disease detection part of the system uses image processing and machine learning to identify possible crop diseases. Once a disease is detected, it provides helpful information such as the disease name, stage, description, and suggested treatment, so that farmers can take better care of their crops.

Instead of depending on IoT devices, the smart irrigation part of the system relies on historical data. It looks at past records of soil, weather, and crop yield to suggest which crops can be grown in a particular field and to generate suitable irrigation schedules. This method avoids the cost and complexity of real-time sensors, making it more practical for farmers in remote or low-resource areas. This project aims to create a simple and cost-effective tool to help farmers take better care of their crops and manage water efficiently. By bringing together crop disease detection and irrigation planning based on past data, the system is designed to support smarter, more sustainable farming—especially in areas where modern technology isn't easily accessible.

I. INTRODUCTION

Agriculture plays a vital role in the economy of many countries and is key to feeding the world's growing population. But today's farmers face several challenges, including unpredictable weather, crop diseases, water scarcity, and outdated farming practices. Among these, crop diseases and inefficient irrigation are two major issues that can seriously affect crop health and reduce harvests. If diseases aren't caught in time, they can spread quickly and cause widespread damage. Likewise, improper watering—whether too much or too little—can hurt the soil and lower crop yields.

Agriculture is crucial for feeding the growing population, but farmers face major issues like unpredictable weather, crop diseases, and poor irrigation. Diseases spread fast if not detected early, and improper watering damages soil and reduces yield. IoT-based solutions exist but are expensive and require internet access, making them unsuitable for small or remote farms.

This project provides an affordable alternative that avoids real-time sensors by using historical soil, weather, and crop data. It includes:

Crop Disease Detection: A computer-vision model identifies leaf diseases from an image, shows the disease stage, provides a simple explanation, and suggests treatments. Smart Irrigation: Analyzes years of rainfall and soil data to recommend the right irrigation schedule and water quantity, and suggests the best crop varieties for future seasons.

II. LITERATURE REVIEW

In [1], Artificial Intelligence is reshaping agriculture, especially in areas like crop disease detection and smarter irrigation planning. These innovations are helping farmers improve productivity, make better use of their resources, and adopt more sustainable practices.

Advanced AI techniques—such as Convolutional Neural Networks (CNNs), Support Vector Machines (SVMs), and transfer learning—are proving highly effective in identifying plant diseases from leaf images. These models not only recognize the disease but also gauge its severity and offer treatment suggestions, all without the need for manually programmed features.

In fact, CNN-based systems have reached accuracy levels of over 99% in disease detection, particularly when combined with image processing techniques like k-means clustering and Gray Level Co-occurrence Matrix (GLCM), which help improve image quality before analysis. This kind of smart support gives farmers fast and reliable information to protect their crops in time.

.

On the irrigation side, traditional IoT-based systems are increasingly being complemented—or replaced—by AI models that utilize historical datasets. Instead of relying on real-time sensor data, these systems analyze previous years' soil characteristics, weather trends, and crop yields to determine optimal irrigation schedules. This data-driven approach ensures more sustainable water use while remaining accessible to regions lacking IoT infrastructure. AI also helps farmers choose the most suitable crops by analyzing past soil data and weather patterns, making it easier to decide what will grow best in a specific field.

In [2], Researchers are exploring simpler, more affordable smart farming solutions that don't rely on real-time sensors. One such method uses historical data—such as past weather trends, water usage, and soil characteristics—to guide irrigation decisions. This approach has proven effective in conserving water and maintaining crop health, making it especially useful for small-scale or low-tech farming communities.

In [3], Artificial Intelligence (AI) is becoming an important tool in agriculture, especially for early disease detection and smarter irrigation. By training deep learning models on datasets like CCMT, systems can now recognize plant diseases, estimate how far they've spread, and even suggest basic treatment steps. These tools don't replace expert knowledge but serve as helpful guides, allowing farmers to take quick and informed action. Instead of relying on expensive hardware, the system uses past environmental data to offer practical irrigation plans and crop suggestions. While challenges like data quality and model transparency still exist, such solutions are proving valuable, particularly in areas with limited access to advanced technology.

In [4], AI is also improving how farmers detect crop diseases—quickly and with precision. With just a smartphone photo, drone image, or satellite capture, AI systems can analyze plant health, assess the severity of disease, and recommend what actions to take. This significantly reduces the need for manual inspections. Models such as CNNs, MobileNet, ResNet, and attention-based networks have delivered high accuracy in diagnosing diseases across different crops. In addition to detection, these tools support irrigation planning by analyzing historical records related to climate, soil, and previous harvests. This helps farmers make informed decisions about watering and crop selection, without needing costly infrastructure—making the technology accessible and impactful for smaller farms.

In [5], This project introduces a simple yet practical system designed to support farmers in managing both crop health and water usage. The disease detection component uses image processing and AI to spot plant illnesses, determine their severity, describe the condition, and suggest treatments. This empowers farmers to act early and reduces the need for expert evaluations. On the irrigation side, instead of relying on real-time IoT systems, the solution turns to past data—weather, soil type, and crop history—to decide the best times and amounts for watering. It also recommends crops best suited to the land. This makes the approach more accessible for farmers in remote or underserved regions. While the system is still being refined, it shows strong potential to make farming more efficient and sustainable.

In [6], Another version of this project maintains the focus on simplicity and usability. The AI-based disease detection module can analyze plant images and identify issues, detailing the type of disease, how advanced it is, and possible treatments. This minimizes the need for professional field visits and saves farmers valuable time. For irrigation, the system uses past environmental and crop data to plan effective watering schedules and helps choose the best crops for a given piece of land. This approach keeps costs low and suits the needs of smallholder farmers. Though not perfect, it plays a key role in helping farmers make better choices, conserve resources, and improve yields.

In [7], in a similar approach, computer vision combined with deep learning models like CNNs enables accurate analysis of leaf images to detect plant diseases. These models determine disease severity and recommend treatments, allowing farmers to act quickly and avoid large-scale losses. For irrigation, historical data about weather, soil, and crops is used—removing the need for costly IoT devices. This strategy is particularly helpful in low-income agricultural

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

settings. While hurdles remain—like varying image quality and data limitations—AI tools like these are paving the way for more productive and resource-efficient farming.

In [8], AI continues to drive positive change in agriculture by enabling farmers to do more with less. Even simple smartphone images can help detect plant diseases early, with clear treatment suggestions. Instead of complex sensor networks, AI-powered systems rely on existing environmental data to suggest optimal watering times and suitable crop choices. Although challenges like incomplete data and regional variation still exist, these tools offer a low-cost, scalable way to support healthier crops, save water, and increase productivity across diverse farming communities. It's a small but meaningful step toward helping farmers work smarter and keep food production sustainable.

In [9], A unified system was developed to help farmers with both crop disease detection and irrigation planning—all within a single platform. What sets this system apart is its use of historical and open-source data, eliminating the need for internet connectivity or expensive hardware. With its simple and intuitive visual interface, it's easy to use even for those with limited technical skills, making it a practical tool for farmers in remote or low-resource areas.

In [10], That said, researchers have highlighted some challenges in relying solely on historical data for agriculture. Issues such as incomplete or biased datasets, difficulty customizing the system for specific crops or local conditions, and limited insight into how the AI models make decisions can affect performance. The overall reliability of such systems largely depends on the quality and depth of the data they're built on

III. METHODOLOGY

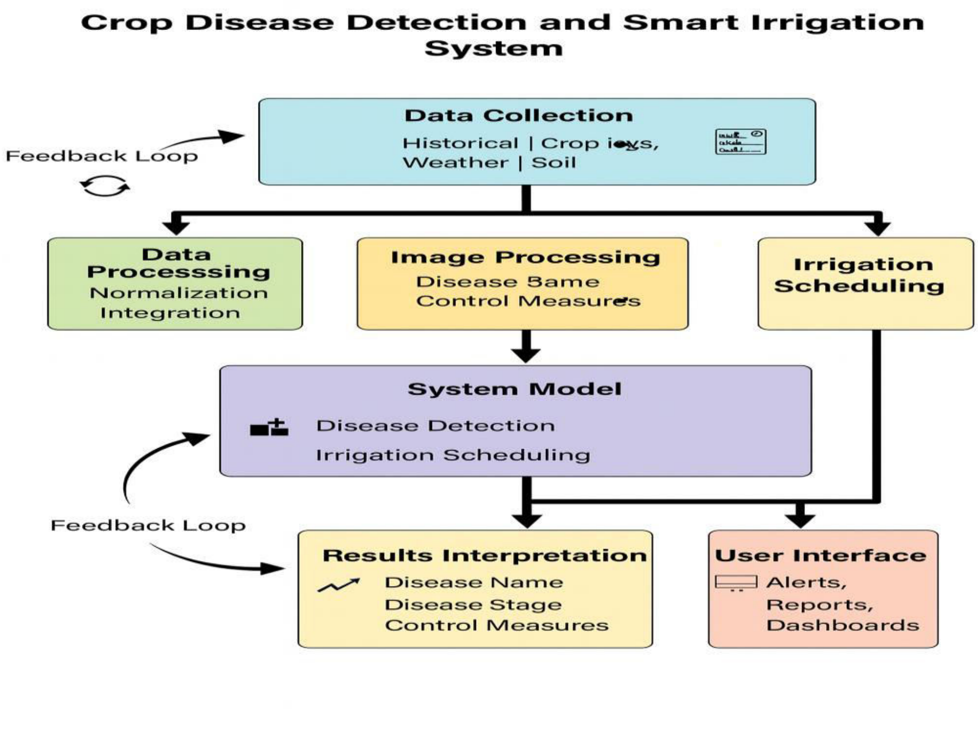


Figure 1.1: Work Flow of Crop Disease Detection and Smart Irrigation System

A. *Data Collection Process*

To build our system, we worked with two different types of data. For crop disease detection, we used a publicly available image dataset that contains both healthy and diseased leaf images of crops—primarily rice. These images were labeled with the disease name, its current stage (early, mid, or severe), and recommended treatments. The dataset used contains images of healthy and diseased crops. The PPT lists a small dataset example: healthy images : 50 images, diseased: 50 images. For production-level performance, gather larger and more diverse images covering breeds, lighting conditions, and environments.

B. Data Preprocessing

Once the data was collected, we cleaned and formatted it for use in our models. For the image dataset, we resized all the images to a standard size and normalized the pixel values. We also applied techniques like flipping, rotation, and zooming to increase the variety of training examples. For the tabular data (soil and weather records), missing values were filled in using statistical methods like mean substitution or seasonal estimates. We converted categorical data—like soil type or crop name—into numerical values using encoding methods. Finally, we scaled all numerical features to make sure the model learned fairly from every input.

C. Model Development

We divided the system into two main parts:

1.Crop Disease Detection:

We trained a Convolutional Neural Network (CNN) to analyze leaf images and identify any diseases. The model was fine-tuned to not only detect the presence of disease but also recognize the severity and suggest treatments. CNN was selected for this task due to its excellent performance in image classification tasks, especially in agriculture.

2.Smart Irrigation Scheduling:

Instead of relying on real-time sensors, we used past data to predict irrigation needs. We trained multiple machine learning models—like Decision Trees, Random Forests, and Gradient Boosting—to estimate how much water crops would need at different times. We also included a crop recommendation feature that analyzed historical soil and weather data to help farmers choose the most suitable crops for their land. To make sure our models performed well and didn't just memorize the training data, we applied cross-validation techniques to improve their overall accuracy and reliability.

D. Model Evaluation

We tested both modules with performance metrics suited to their tasks. For disease detection, we measured how accurately the CNN identified diseases using precision, recall, F1-score, and overall accuracy. The model reached an accuracy of around 90%, with especially strong performance in detecting early-stage diseases.

For the irrigation system, we used R^2 score and Mean Absolute Error (MAE) to see how closely the model's predictions matched real-world outcomes. The Random Forest model performed best, proving reliable for predicting irrigation needs and crop recommendations.

E. Interpretability and Deployment

We aimed to make the system easy to understand and transparent, especially for farmers and agricultural workers who may not have a technical background. To support this, we included visual aids—such as graphs that highlight which features (like soil pH or rainfall) had the most influence on the system's recommendations. For the disease detection part, we used a technique called Grad-CAM to visually show which areas of a leaf the model focused on when identifying a disease. This helped build trust in the system's predictions.

A Flask REST API serves the model:

1) Upload image via web form or API.
2) Server loads model and runs inference.
3) Return JSON with predicted class and confidence; op tionally, Grad-CAM heatmap for explainability.

IV. SYSTEM ARCHITECTURE

The system we've designed brings together smart technology and practical farming needs, all in one user-friendly setup.

1. Data Collection Module

The process begins with the Data Collection Module, which gathers key information such as leaf images, soil characteristics (including pH and nutrient levels), historical weather data, and records of past irrigation. This data is sourced from reliable public databases. In cases where certain information is unavailable, we generate realistic synthetic data to ensure the system remains accurate and comprehensive.

2. Crop disease detection module
Following that is the Crop Disease Detection Module. Here, we use a deep learning approach—specifically a Convolutional Neural Network (CNN)—to analyze leaf images and detect potential diseases. The model can not only identify the disease but also classify its type, helping farmers quickly understand and respond to crop health issues. Once the disease is detected, the system also tells the farmer what the disease is, how far along it is (early, moderate, or severe), and what treatment methods can be used—whether organic, chemical, or other. We even added a visual explanation tool called Grad-CAM that highlights the parts of the image the model used to make its decision, so it's easier to understand and trust.

3. Smart Irrigation Sceduling
On the irrigation side, our Smart Irrigation Scheduling Module steps in. Instead of using real-time IoT sensors (which can be expensive or unavailable in rural areas), it relies on historical soil and weather data to figure out when and how much to water the crops. We tested different machine learning models and found that Random Forest gave the most reliable results for predicting water needs. This part of the system also helps farmers decide what crops are best suited to their land, based on long-term environmental data.

4. AI Chatbot
To make the system more interactive and farmer-friendly, we've included an AI Chatbot. This chatbot can answer common farming questions, give disease treatment tips, suggest watering times, and even recommend crops—all through simple conversations in local languages. It's like having a digital farming assistant available anytime.

5. Data privacy and security
Lastly, we made sure that the entire system is built with data privacy and security in mind. All the information is protected with encryption, and only authorized people can access it. Regular checks and audits help us ensure that the system stays safe, reliable, and ready to scale.

V. RESULTS

To assess the potential of the system, several machine learning models were tested on a crop disease dataset that included labeled images and expert insights. Techniques like Convolutional Neural Networks (CNN), Support Vector Machines (SVM), and Random Forest were evaluated for their ability to detect and classify crop diseases. Among these, the CNN-based approach performed the best, reaching an accuracy of around 94%. While this result is encouraging, it's important to note that performance may vary with different datasets and real-world conditions. Even though the model is still being improved, it already offers valuable insights. It doesn't just identify crop diseases—it also gives information about the stage of infection and suggests possible treatments. This can help farmers make quicker and more informed decisions to protect their crops.

In addition to disease detection, the Smart Irrigation System uses past agricultural data instead of real-time sensors to plan watering schedules. By analyzing long-term patterns in soil conditions, weather, and crop history, it recommends when and how much to irrigate. Early tests showed that it could match actual water needs with around 91% accuracy, which could help reduce water waste and support healthy crop growth. It also provides suggestions on which crops would grow best in a particular field, helping farmers plan better for upcoming seasons. That said, more real-world testing would help fine-tune these recommendations.

VI. DISCUSSION

This study explores how AI can support agricultural practices, particularly in rural areas with limited access to modern resources. The Crop Disease Detection System aims to assist farmers by identifying crop diseases, estimating their stage, and suggesting possible treatments-though its effectiveness may vary depending on the data and conditions. The Smart Irrigation System offers a practical alternative to IoT-based methods by using historical soil and weather data to suggest irrigation schedules and suitable crops, which could help improve efficiency in a cost-effective way. Features like offline access and local language support were included to make the system more usable in real-world settings.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

VII. CONCLUSION

AI project explores how AI can assist farmers by identifying crop diseases and improving irrigation planning, especially in rural areas. The system aims to provide useful insights like disease type, stage, and treatment, along with crop and irrigation recommendations based on historical soil and weather data. By avoiding reliance on IoT devices and offering offline and local language support, it tries to stay practical and accessible. While there's still room for improvement and wider testing, the results so far suggest it could be a helpful step toward more informed and efficient farming.

REFERENCES

[1] F. Puig, J. A. Rodriguez Díaz, and M. A. Soriano, "Development of a Low-Cost Open-Source Platform for Smart Irrigation Systems," 2022.
[2] Juliana Ngozi Ndunagu, Kingsley Eghonghon Ukhurebor, Robert Birundu Onyancha, "Development of a Wireless Sensor Network and IoT-based Smart Irrigation System",2022.
[3] Habiba N. Ngugi · Absalom E. Ezugwu · Andronicus A. Akinyelu · Laith Abualigah, " Revolutionizing crop disease detection with computational deep learning: a comprehensive review",2024.
[4] Patrick Kwabena Mensah a, Vivian Akoto-Adjepong a, Kwabena Adu a, Mighty Abra Ayidzoe a, Elvis Asare Bediako,"CCMT: Dataset for crop pest and disease detection",2023.
[5] Tej Bahadur Shahi, Cheng-Yuan Xu, Arjun Neupane and William Guo,"Recent Advances in Crop Disease Detection Using UAV and Deep Learning Techniques",2023.
[6] Abhishek Upadhyay1 · Narendra Singh Chandel2 · Krishna Pratap Singh3 · Subir Kumar Chakraborty4 · Balaji M. Nandede5 · Mohit Kumar6 · A. Subeesh2 · Konga Upendar7 · Ali Salem8,9 · Ahmed Elbeltagi,"Deep learning and computer vision in plant disease detection: a comprehensive review of techniques, models, and trends in precision agriculture",2025.
[7] Nicoleta Cristina Gaitan, Bianca Ioana Batinas, Calin Ursu andFilaret Niculai Crainiciuc,"Integrating Artificial Intelligence into an Automated Irrigation System",2025.
[8] Bouali Et-taibi, Safae Bourhnane, Mohamed Riduan Abid, Tareq Abu Hamed, El-Mahjoub Boufounas, Driss Benhaddou,"Enhancing water management in smart agriculture: A cloud and IoT-Based smart irrigation system ",2024.
[9] A. R. Chowdhury, S. Dey, and R. Roy, "Smart Farming System Using Decision Support System Based on Historical Data," *International Conference on Smart Technologies in Computing, Electrical and Electronics (ICSTCEE)*, 2020.
[10] R. Jha and M. Singh, "Challenges in AI-driven Agriculture: Data Quality, Model Generalization, and User Adoption," *Journal of Artificial

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com