AI CROP SUGGESTION AND DISEASE PREDICTOR WITH FERTILIZER RECOMMENDATIONS

Dheeraj J S
Department of Information Science
Bengaluru, India
dheerajs.21.beis@acahrya.ac.in

Gunjan Prasad
Department of Information Science
Bengaluru, India
gunjans.21.beis@acahrya.ac.in

Ashwani Mishra
Department of Information Science
Bengaluru, India
ashwanis.21.beis@acahrya.ac.in

Ankit Kumar Yadav
Department of Information Science
Bengaluru, India
ankithh.21.beis@acahrya.ac.in

***Abstract*— The "AI Crop Suggestion and Disease Predictor with Fertilizer Recommendations" project aims to revolutionize traditional farming by incorporating artificial intelligence to improve efficiency, productivity, and sustainability. The system integrates three primary functionalities: crop suggestion, disease prediction, and fertilizer recommendations, creating a comprehensive solution for modern agricultural challenges.**

The project involves collecting and preprocessing datasets for soil analysis, plant diseases, and environmental factors. This ML models are trained to deliver accurate predictions and recommendations. A user-friendly interface allows farmers to input data, such as soil test results or plant images, and receive actionable outputs.

***Keywords*—** *AI, Machine Learning, Crop Suggestion, Disease Prediction, Fertilizer Recommendation, Sustainable Farming, Soil Analysis, Precision Agriculture.*

I. INTRODUCTION

Agriculture is vital to managing global food resources and supporting livelihoods, especially in rural communities. However, farmers face ongoing challenges such as crop diseases and improper planting, which can lead to reduced yields, financial losses, and environmental damage. Technologies such as artificial intelligence (AI), machine learning, and computer vision offer effective solutions to these problems by providing accurate diagnostic and treatment recommendations, enabling farmers to make informed decisions. The project focuses on developing intelligent systems that combine image processing technology and machine learning models to assist farmers in real time. The system uses convolutional neural networks (CNNs) to detect plant diseases from images with high accuracy and leverages environmental and soil information to provide recommendations for plant breeding. Designed to be easily accessible to users, this platform reduces the need for expensive expert consulting while also encouraging permaculture practices. The program, which provides AI-powered insights, increases food production and contributes to a sustainable and resilient agricultural sector.

II. LITERATURE SURVEY

It is important that the research articles are broad in scope because they address different criteria. The main purpose of the document review is to examine the history of the project in detail, to reveal the shortcomings of the current field, and to highlight the problems that still need to be solved. The issues discussed not only provide a background to the project, but also highlight the difficulties and uncertainties that led to the design and solution of the project.

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- *Automatic detection and classification of leaf diseases using deep learning: M. P. Krishna, R. P. Mahesh (2022):*

  In this paper, Krishna and Mahesh (2022) proposed an automatic detection system for leaf diseases based on machine learning and deep learning. The system uses an algorithm called a convolutional neural network (CNN) to analyze leaf images, allowing it to identify various diseases. The model automates the diagnostic process, reducing reliance on manual inspections, making it faster and more efficient. This method not only increases the accuracy of disease diagnosis, but also helps reduce crop losses by encouraging early intervention. This approach is close to the goal. Improve plant disease management with reliable and practical solutions that can be used in real agriculture for effective crop management and disease control.

- *Smart Agriculture: A Vision for Machine Learning Applications in Precision Farming*:

  J. Wu, H. Wang, Q. Zhu (2023) In this paper, Wu et al. (2023) explore machine learning techniques in precision agriculture, focusing on their potential to transform smart agriculture. Author. Discuss how these machine learning models can be applied to various agricultural applications such as crop monitoring, disease detection, and yield estimation. These technologies enable farmers to use resources

more efficiently and accurately, improving decision-making capabilities, enabling better management practices and optimization. This project pursues the goal of using AI to improve agriculture, providing a foundation for integrating technologies such as machine learning into agriculture to increase efficiency and sustainability.

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- *Plant Disease Detection Using Convolutional Neural Network:*

J. Liu, B. Liang, X. Wu (2017) Liu, Liang, and Wu (2017) discover the method for disease detection in plants based on a algorithm called convolutional neural networks (CNNs). The system processes plant images to identify various diseases, making it a best tool for early detections and intervention. By automating the classification process, the system reduces the manual effort required for disease detection, offering scalability and accuracy. This approach aligns with the broader goal of developing AI-based systems to support crop disease management, improving farmers' ability to make informed decisions and mitigate crop loss.

- *Deep Learning in Agriculture: Research*

A. Kamilaris, F. Prenafeta-Boldó (2018) Kamilaris and Prenafeta-Boldó (2018) conducted a comprehensive review of deep learning applications in agriculture. The paper introduces the concept of deep learning, such as CNNs and neural networks (RNNs), which have been applied to a variety of agricultural applications, including crop disease detection, pest monitoring, and yield prediction. The authors discuss the potential of deep learning. Increase agricultural productivity and sustainability by providing equitable solutions. This research contributes to increased knowledge in agriculture and aligns with efforts to improve disease control and crop management.

- *A Novel CNN-Based Disease Identification Method on Different Types of Crop Diseases:*

X. Zhang, J. Qiu, F. Wang (2020**)** Zhang, Qiu, and Wang (2020) introduce a best method for crop disease identification using a algorithm called convolutional neural networks (CNNs). Their approach enhances the accuracy of disease detection by classifying various types of crop diseases with high precision. The system leverages large datasets of plant images to train the CNN, making it effective for real agricultural fields. This article highlights the importance of depth. In particular, in the field of disease research, pursuing efforts to develop modern agricultural education and intelligence-driven plant health management solutions.

- *Application of machine learning in plant disease testing and fertilizer recommendation: Review:*

P. P. Brahmane, S. V. Khandait (2020) Brahmane and Khandait (2020) review the applications of machine learning in plant disease detection and fertilizer recommendation. This paper introduces various machine learning algorithms and approaches for disease prediction. They can recommend appropriate fertilizers by combining soil and environmental information. This approach improves crop health through intervention, increasing productivity and reducing resource waste. This work contributes to the development of intelligent systems that help farmers make informed decisions towards the goal of AI-based agriculture.

- *IoT and machine learning for crop disease prediction and optimization in precision agriculture:*

Singh, S., Jain, N., Kataria, S. and Kataria, P. (2020) Singh et al. (2020) Investigating the use of IoT and machine learning for crop disease prediction in precision agriculture. The paper discusses how IoT sensors can collect real-time data about crops and analyze this data using machine learning models to predict diseases and improve agricultural practices. This approach can help farmers make informed decisions and increase crop health and yield. The system improves agricultural processes by combining the Internet of Things (IoT) and Artificial Intelligence (AI), which directly correlates to efforts to increase agricultural productivity and sustainability.

- *Open source health image library to support mobile application development:*

D. P. Hughes, M. Salathé (2015) Hughes and Salathé (2015) provide an open source plant health image library to aid in the development of mobile disease detection tools. This image collection is a valuable resource for researchers and developers to develop intelligent plant disease detection systems.

III. PROPOSED SYSTEM

The proposed system harnesses artificial intelligence and machine learning to identify crop diseases and suggest suitable fertilizers. Using image analysis, it accurately detects fungal, bacterial, or viral infections in plants, offering real-time solutions. By incorporating soil and environmental data, the system tailors fertilizer recommendations to specific conditions, ensuring optimal growth while minimizing resource waste. This approach not only boosts productivity through early disease detection but also helps farmers save costs by reducing

reliance on expert consultations. Moreover, it promotes sustainable farming practices and equips farmers with valuable insights, enabling better decision-making and improved crop yields.

➢ *System Architecture Overview:*

The architecture is built on a data-driven platform that processes crop images and environmental data to deliver precise disease diagnosis and fertilizer recommendations. Key components include machine learning models for disease detection, an interface for inputting crop and soil data, and an algorithm that integrates these data points to provide tailored recommendations. This system is made in a way that it is user-interactive, and it ensures that farmers can use it easily with different levels of technical expertise.

➢ *Security Considerations:*

Ensuring data integrity and privacy is crucial for this system. It uses encryption methods to securely store and transmit data while regularly updating machine learning models to maintain accuracy. Strict access controls allow only authorized users to input sensitive information, reducing the risk of misuse and ensuring reliable protection..

➢ *Performance Evaluation:*

Performance is assessed through extensive testing to ensure the system operates efficiently under various conditions. Factors such as image processing speed, accuracy of disease detection, and the responsiveness of fertilizer recommendations are analyzed. Optimization strategies, including model enhancements and algorithm improvements, are explored to ensure the system can handle large-scale usage in real-world farming environments.

IV. RESULTS

Test Case No.	Type of Testing	Input	Expected Output	Obtained Result	Status of Test case	Remark
1	Unit Testing (Model)	Soil parameters: pH 6.5, N=50, P=30, K=40, temperature=25°C	Suggested crop: "Wheat"	"Wheat" suggested	Pass	NA
2	Unit Testing (Model)	Soil parameters: pH 4.5, N=20, P=10, K=15, temperature=30°C	Suggested crop: "Rice"	"Rice" suggested	Pass	NA
3	Integration Testing	Input empty soil parameters	Error message: "Invalid input"	Error message displayed	Pass	NA
4	Integration Testing	Input: null data for soil parameters	Error message: "Input required"	Error message displayed	Pass	NA
5	System Testing	Large dataset input (multiple soil and weather conditions)	Accurate crop recommendation for all inputs	Accurate recommendation generated	Pass	Handles large datasets efficiently
6	System Testing	unrealistic values (e.g., pH = -1, N = -50)	Error message: "Invalid soil parameters"	Error message displayed	Pass	NA

V. OBJECTIVE

➢ To Diagnose Crop Diseases Using Image Analysis:
This project introduces an AI-driven system designed to identify fungal, bacterial, and viral diseases in crops using advanced image analysis, helping farmers detect issues early and take timely action.

➢ To Provide Customized Fertilizer Suggestions:
The system incorporates soil and crop data to offer tailored fertilizer recommendations that optimize growth and improve yields.

➢ To Boost Agricultural Productivity:
By enabling early detection of crop problems, the project helps reduce resource wastage and enhances overall farm productivity.

➢ To Promote Environmentally Sustainable Farming:
The project fosters sustainable agricultural practices by utilizing precision farming tools that minimize environmental impact.

➢ To Create an Accessible and Affordable Platform:
The platform is designed to be user-friendly and cost-effective, making it easily accessible to farmers from various regions.

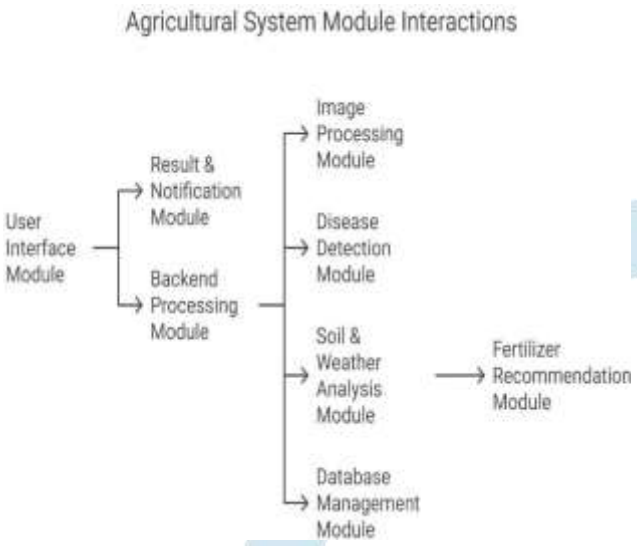

Figure 1: MODULE INTERACTIONS

VI . ACKNOWLEDGMENT

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VII . CONCLUSION

The project demonstrates how advanced technologies such as artificial intelligence (AI), machine learning (ML) and image processing can solve important problems in agriculture. By offering an AI-powered system for diagnosing crop diseases and recommending fertilizers, it provides farmers with a simple, efficient, and affordable tool to boost productivity and encourage sustainable farming. Combining computer vision for precise disease detection with data-driven fertilizer recommendations, the system empowers farmers to make better decisions in real time. It also reduces reliance on costly expert consultations, minimizes resource wastage, and supports environmental conservation. With the goal of improving agricultural yields, securing farmer livelihoods, and strengthening global food security, this project highlights the transformative role technology plays in building a sustainable and thriving future for agriculture.

VIII. REFERENCES

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