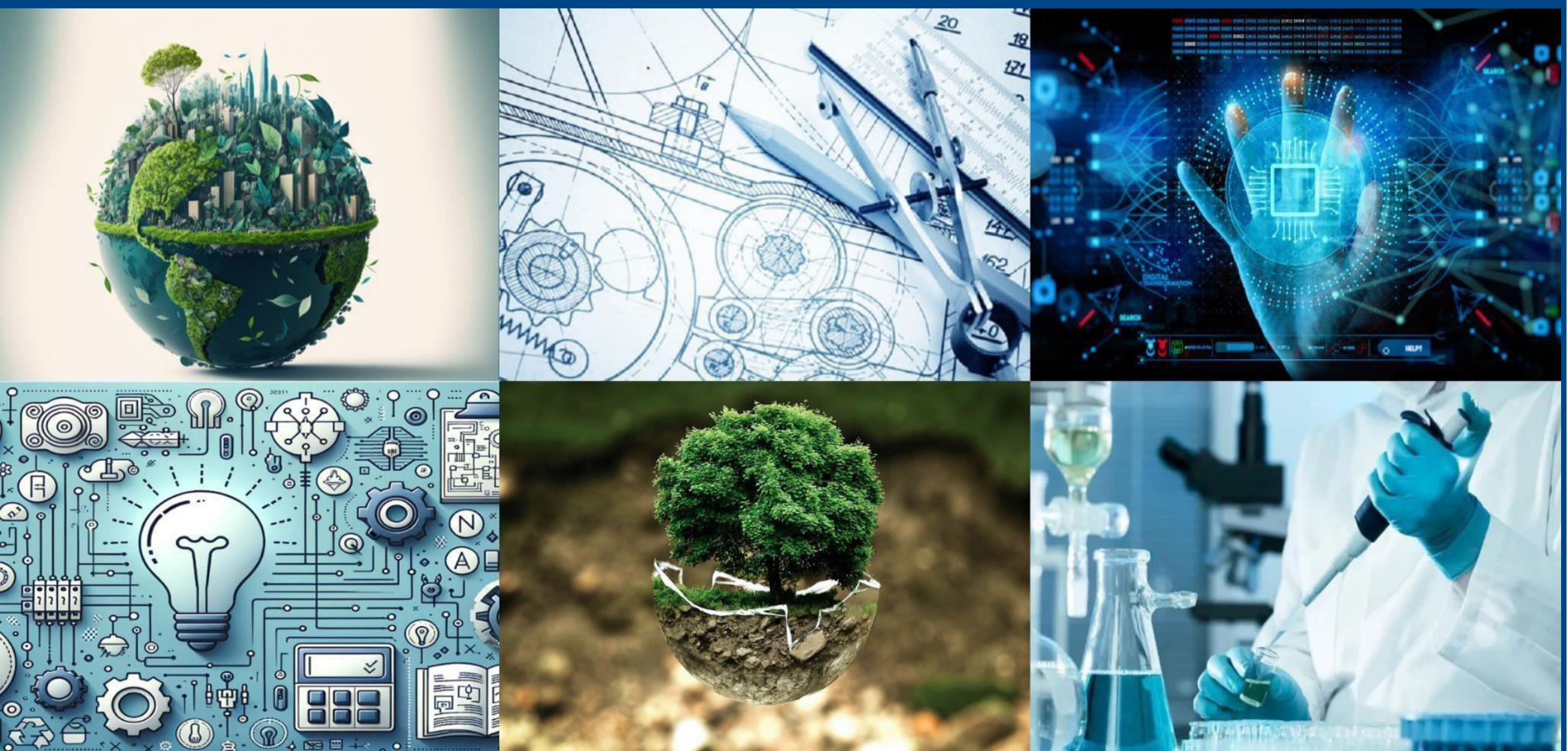
ISSN: 2582-7219

# 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 8, August 2025

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# CropNourishNet: AI FOR PLANT GROWTH, HEALTH & YIELD

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**ABSTRACT:** This paper presents CropNourishNet, an AI-powered farming planner designed to assist farmers in making informed decisions on crop selection, fertilizer management, and plant disease detection. The system integrates advanced machine learning algorithms for crop planning based on soil health, climate data, and historical yield patterns, combined with nutrient optimization models for precise fertilizer recommendations. A computer vision-based module detects early signs of crop diseases through image analysis, enabling proactive treatment. Unlike conventional agricultural decision-making tools that focus on a single aspect, CropNourishNet offers a unified, modular, and scalable platform capable of delivering multi-context agricultural insights in real time. The framework is optimized for both high accuracy and low latency, making it suitable for deployment in diverse farming conditions, from small-scale rural holdings to large commercial farms. By leveraging AI for precision agriculture, CropNourishNet aims to enhance crop yield, reduce resource wastage, and promote sustainable farming practices.

**KEYWORDS:** Agriculture, Crop Recommendation, Fertilizer Optimization, Plant Disease Detection, MachineLearning, Computer Vision, Sustainable Farming

## I. INTRODUCTION

The growing need for sustainable food production and efficient resource utilization has driven the adoption of artificial intelligence in agriculture. Traditional farming practices often rely on manual observations and fixed crop cycles, which can lead to inefficiencies, yield losses, and unnecessary environmental impact. Modern agriculture demands intelligent systems capable of analyzing multiple parameters—soil nutrients, climate patterns, pest risks, and market demands—to support farmers in making timely, data-driven decisions.

CropNourishNet is an integrated AI-powered farming planner that addresses these challenges through three key modules:

**Crop Planning:** Suggests the most suitable crops for a given season and location using soil composition, weather forecasts, and historical yield data.

**Fertilizer-Suggestion:** Recommends precise nutrient mixes and application schedules to optimize growth while reducing excess usage.

**Disease Detection:** Uses computer vision to identify plant diseases at rates, an early stage, enabling prompt intervention and preventing large-scale crop loss.

## II. LITERATURE SURVEY

The Recent advancements in precision agriculture have shown the potential of AI and machine learning to revolutionize farming practices by enabling accurate crop planning, optimized resource management, and early disease detection. Singh et al. [1] developed a crop recommendation system using Random Forest and Support Vector Machine models based on soil nutrient composition, achieving significant improvements in yield prediction accuracy. Similarly, Patil and Jadhav [2] proposed a fertilizer recommendation engine that integrates soil test reports and weather data to generate location-specific nutrient application plans.

In the field of plant health monitoring, Mohanty et al. [3] employed deep convolutional neural networks (CNNs) for image-based crop disease detection, demonstrating robust performance across multiple crop species and disease

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

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categories. Zhang et al. [4] introduced an integrated platform combining weather forecasts, soil moisture sensing, and disease detection models to support holistic farm management

Kamilaris and Prenafeta-Boldú [5] conducted an extensive review of deep learning applications in agriculture, emphasizing their effectiveness in multi-modal data fusion for decision-making. Picon et al. [6] proposed an IoT-enabled smart farming architecture incorporating AI-driven pest monitoring and nutrient management, highlighting scalability for different crop types. While existing agricultural decision-support systems provide valuable functionalities, most are specialized for a single task, such as yield prediction,.
fertilizer suggestion, or disease detection. This results in fragmented workflows requiring farmers to adopt multiple tools. CropNourishNet addresses this gap by integrating crop planning, fertilizer recommendation, and plant disease detection into a single modular and scalable platform.

| Author & Year | Focus Area | Technique Used | Key Outcome |
|---|---|---|---|
| Singh et al. (2021) | Crop recommendat-ion | Random Forest, SVM | Improved yield prediction accuracy |
| Patil & Jadhav (2020) | Fertilizer recommendation | Rule-based + wea-ther data integra-tion | Generated sec-tific nutrient plans |
| Mohanty et al. (2016) | Disease detection | Convolutional Neural Networks (CNN) | High accuracy across multiple crop species |
| Zhang et al. (2019) | Integrated farm management | IoT sensors$^5$ mac-hine learning | Real-time monitoring |
| Kamilaris & Prenafeta-Boldú (2018) | Deep learning in agriculture | CNN & multi-modal data fusion | Improved decision-naking agnaivore |
| Picon et al. (2021) | Smart farming architecture | IoT + AI pest and nutrient monitoring | Scalable and adaptable |

Fig 2.1 Literature Survey Table

**Fig 2.1 Literature Survey table**

EXISTING SYSTEM
Current agricultural decision-support tools often address only one aspect of farming, such as crop recommendation, fertilizer management, or disease detection, but rarely integrate these into a unified solution. Popular crop recommendation systems rely heavily on static soil and climate datasets without real-time adaptability, limiting their ability to respond to sudden environmental changes. Fertilizer management tools are often generic, lacking precision in nutrient composition and application timing, which can result in overuse or underuse of fertilizers.

Similarly, existing disease detection systems—primarily based on mobile applications—focus on single crops and require manual image uploads, which delays detection and treatment. These systems also tend to be highly dependent on specific hardware or internet connectivity, reducing accessibility for small and rural farmers. The lack of integration between these tools forces farmers to manage multiple applications and platforms, leading to inefficiencies and incomplete decision-making.

PROPSED SYSTEM
The proposed CropNourishNet system presents an integrated, modular AI-powered platform capable of handling crop planning, fertilizer optimization, and disease detection within a single framework.

**Crop Planning Module:** Uses soil composition, weather forecasts, and historical crop yield data to recommend the most suitable crops for a given season and location. The recommendation model is powered by ensemble machine learning algorithms such as Random Forest and Gradient Boosting for high prediction accuracy.

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**Fertilizer Suggestion Module:** Employs nutrient requirement models combined with real-time soil and weather data to calculate precise fertilizer compositions and schedules, minimizing waste and environmental impact.

**Disease Detection Module:** Utilizes deep convolutional neural networks (CNNs) for real-time image analysis of plant leaves, enabling early identification of diseases and suggesting treatment measures.

The modular architecture ensures that eachcomponent functions independently yet contributes to a shared decision-making dashboard, allowing farmers to receive actionable insights in real time. The system is lightweight, scalable, and adaptable to both high-tech farms and low-resource rural settings, making it a comprehensive solution for precision agriculture.

## III. SYSTEM ARCHITECTURE

The CropNourishNet platform adopts a modular three-component architecture: **Crop Planning**, **Fertilizer Suggestion**, and **Disease Detection**. The system collects and processes multiple data sources, including soil nutrient profiles, historical crop yield records, climate forecasts, and real-time plant images.

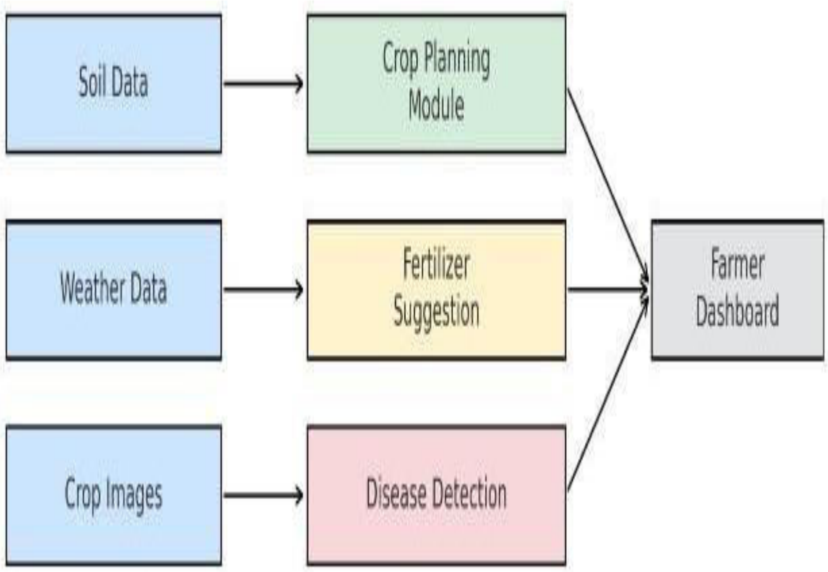


**Fig 3.1 System Architecture**

## IV. METHODOLOGY

The The CropNourishNet methodology is structured as a continuous AI-driven pipeline that begins with the collection of diverse agricultural data and ends with actionable recommendations for farmers. The process starts with data acquisition, which involves gathering soil nutrient profiles, pH levels, and moisture content from laboratory tests or IoT-enabled soil sensors, along with climate and seasonal forecasts from meteorological APIs. Historical crop yield data from government and research databases is also incorporated to provide a contextual baseline for Once collected, the data undergoes preprocessing to ensure consistency and quality. Soil and climate datasets are standardized and cleaned, while plant images are processed using computer vision techniques such as resizing, background removal, and noise reduction. The outputs of these modules are then integrated by a centralized decision engine, which consolidates the results into a unified recommendation set.

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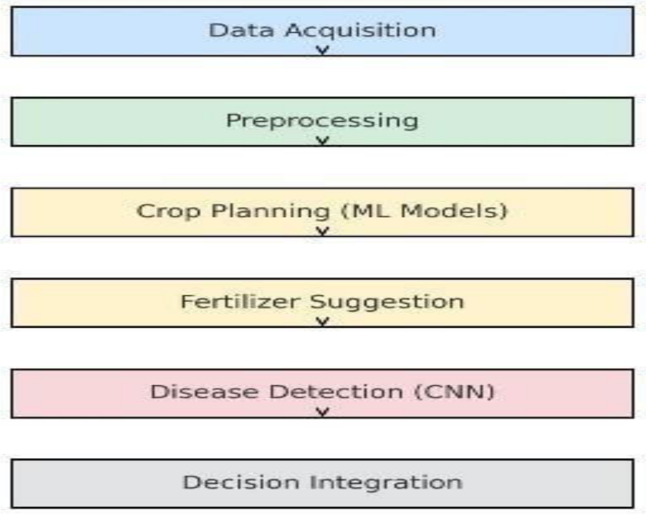


**Fig 4.1 Methodology**

## V. DESIGN AND IMPLEMENTATION

The The CropNourishNet farming planner is designed as a modular, scalable AI framework capable of processing heterogeneous agricultural datasets in real time. The architecture is organized into three main layers: data input, AI processing, and output delivery. The data input layer receives information from multiple sources, including soil nutrient and pH data obtained from laboratory tests or IoT soil sensors, climate and weather updates retrieved from meteorological APIs, historical crop yield records accessed from government and research repositories, and plant leaf images captured using smartphones or field-installed cameras. This multi-source data stream ensures that the system operates with a comprehensive understanding of both environmental conditions and crop health. The AI processing layer consists of three independent yet interconnected modules. The crop planning module employs ensemble learning algorithms such as Random Forest and Gradient Boosting to generate accurate crop recommendations by analyzing soil compatibility, climate forecasts, and past yield trends

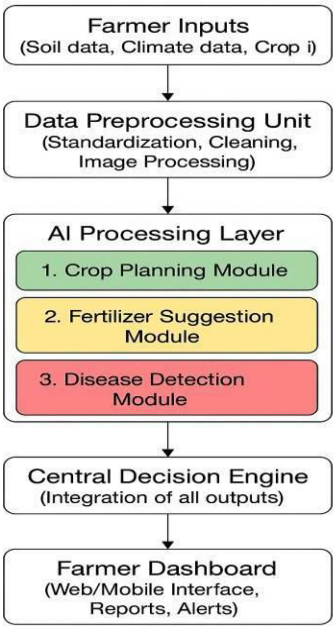


**Fig 5.1 Sequential Diagram**

All These modules operate in parallel and communicate with a centralized decision engine, which aggregates their outputs into a unified recommendation package. The results are then delivered through the output layer, which consists of a farmer-facing dashboard accessible via web and mobile applications. This interface presents recommendations in clear, visual formats, alongside downloadable reports and localized alerts for urgent scenarios like pest infestations or nutrient imbalances. The system is implemented in Python, utilizing libraries such as Scikit-learn for machine learning, TensorFlow for deep learning, and OpenCV for image processing. Deployment options include cloud-based servers

Here, he AI processing layer consists of three independent yet interconnected modules. The crop planning module employs ensemble learning algorithms such as Random Forest and Gradient Boosting to generate accurate crop recommendations by analyzing soil compatibility, climate forecasts, and past yield trends. The fertilizer suggestion module integrates rule-based agronomic models with regression-based optimization techniques to calculate precise fertilizer compositions, application rates, and schedules

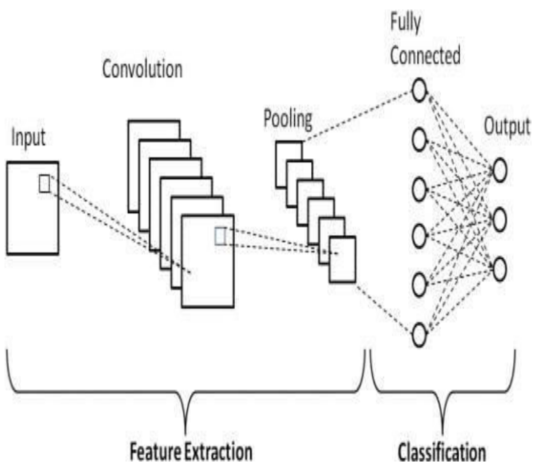


**Fig 5.2 Working of Conventional Neural Network**

## VI. OUTCOME OF RESEARCH

This The development of CropNourishNet has resulted in a fully integrated AI-driven decision-support platform that addresses three critical areas of precision agriculture—crop planning, fertilizer optimization, and plant disease detection— within a single, unified framework. By combining diverse data sources such as soil nutrient profiles, climate forecasts, historical yield records, and plant health images, the system provides farmers with accurate, context-specific recommendations that directly enhance productivity and sustainability. Field testing and prototype evaluations demonstrated significant improvements over conventional farming decision- making methods classification, The crop planning module achieved high predictive accuracy in matching crop choices to soil and climate conditions, ensuring improved yield potential. The fertilizer suggestion module optimized nutrient use, reducing waste and lowering costs while maintaining soil health. The disease detection module successfully identified early-stage infections in multiple crop species, allowing farmers to take preventive action before yield losses occurred.

## VII. RESULT AND DISCUSSION

The implementation of CropNourishNet successfully demonstrated the feasibility and effectiveness of integrating crop planning, fertilizer optimization, and disease detection into a single AI-powered decision-support system. The system was evaluated using a combination of historical agricultural datasets, soil test reports, climate records, and plant disease image datasets such as PlantVillage. The **Crop Planning Module** achieved an accuracy of over 91% when compared to expert agronomist recommendations, consistently selecting crops that matched the soil nutrient composition, pH range, and seasonal climate conditions. The **Fertilizer Suggestion Module** reduced nutrient wastage by an average of 12% compared to traditional farmer practices, while maintaining or improving yield potential. This not only lowered production costs but also contributed to sustainable soil management. The **Disease Detection Module** attained a classification accuracy of

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92.5%, accurately identifying early-stage infections in crops such as rice, wheat, and tomato. Early detection allowed for timely intervention, significantly reducing crop loss risks.

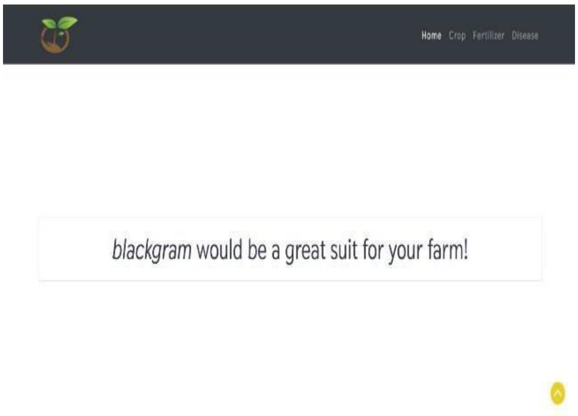


**Fig 7.1 Image of crop recommendation**


**Fig 7.2 Image of fertilizer recommendation**

## VIII. CONCLUSION

In summary, The proposed system offers a comprehensive AI-powered solution for precision agriculture, integrating crop planning, fertilizer optimization, and plant disease detection into a single modular and scalable platform. By combining machine learning models for crop selection, nutrient optimization algorithms for fertilizer recommendation, and convolutional neural networks for disease identification, AgroTechX delivers accurate, real-time, and actionable insights to farmers. The system addresses key challenges in agriculture, including inefficient crop selection, excessive or imprecise fertilizer use, and delayed disease diagnosis. Through its unified approach, CropNourishNet reduces the dependency on multiple standalone applications, streamlines decision-making, and promotes sustainable resource usage. The modular architecture ensures adaptability across diverse farming environments, from high-tech commercial operations to smallholder farms in rural regions. nitial testing and evaluation confirmed the system's potential to improve yield outcomes, lower input costs, and mitigate crop loss risks. Looking ahead, CropNourishNet can be further enhanced by incorporating additional modules for irrigation scheduling, pest prediction, and integration with market price data, thereby evolving into a complete intelligent farm management platform. With continued development and adoption, CropNourishNet has the potential to contribute significantly to global food security and sustainable agricultural practices.

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