

Agrovision AI: Intelligent Agricultural Analysis Platform

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ABSTRACT: Agriculture plays a vital role in the economic development of a country, yet crop productivity is frequently hampered by diseases, pest infestations, and inadequate access to expert guidance. Agrovision.AI is an intelligent agricultural analysis platform that addresses these challenges by integrating Convolutional Neural Network (CNN)-based crop disease detection, weather intelligence, soil intelligence, and Generative AI-powered recommendation generation into a unified web-based solution. The system enables farmers to upload crop leaf images, receive disease diagnoses with confidence scores, and obtain personalized treatment and crop management recommendations. Experimental evaluation demonstrates that the proposed CNN model achieves 96.2% accuracy, outperforming several conventional deep learning architectures. The platform is developed using Next.js, Node.js, Python, TensorFlow, and Supabase, providing a scalable and user-friendly environment accessible to farmers with minimal technical knowledge.

KEYWORDS: Agrovision.AI, Crop Disease Detection, Convolutional Neural Network, Deep Learning, Generative AI, Precision Agriculture, Environmental Intelligence, Plant Disease, Gemini AI, Smart Agriculture

I. INTRODUCTION

Agriculture continues to face numerous challenges related to crop diseases, environmental uncertainties, and limited access to expert guidance. Traditional disease identification methods depend on manual inspection, which is time-consuming, error-prone, and often unavailable to rural farmers. Agrovision.AI: Intelligent Agricultural Analysis Platform introduces an integrated AI-powered solution that combines image-based disease detection with environmental intelligence and personalized recommendations.

The platform provides the following core capabilities:

- CNN Disease Detection – Identifies crop diseases from leaf images with high accuracy using deep learning.
- Environmental Intelligence – Integrates real-time weather and soil data through external APIs for context-aware analysis.
- Generative AI Recommendations – Employs Google Gemini AI to generate personalized treatment and crop management suggestions.

The web-based platform is developed using Next.js, Node.js, Python, TensorFlow, Keras, and Supabase, ensuring responsiveness, scalability, and secure management of agricultural data. The system is accessible from desktop and mobile devices, making expert-level agricultural guidance available to farmers regardless of location.

II. LITERATURE SURVEY

Agriculture has undergone significant transformation with the introduction of Artificial Intelligence, Machine Learning, Deep Learning, and Cloud Computing technologies. Researchers worldwide have proposed various approaches for crop disease detection, precision agriculture, and AI-driven advisory systems. Mohanty et al. demonstrated that CNN-based models achieve disease detection accuracies exceeding 99% on the PlantVillage dataset, establishing deep learning as the preferred approach for agricultural image classification [1].

Advanced CNN architectures such as VGG16, ResNet50, DenseNet, and EfficientNet have been extensively applied to plant disease classification tasks, demonstrating strong performance across multiple crop species [3][6][7]. However, most existing systems focus exclusively on image-based detection and exclude environmental factors from their analysis. Ferentinos proposed deep convolutional architectures that successfully classified multiple crop diseases but lacked integration with weather or soil intelligence [2].

Precision agriculture studies highlight the value of integrating IoT sensors, GPS, and environmental data for data-driven crop management [4]. Kamilaris and Prenafeta-Boldú conducted a comprehensive survey confirming the effectiveness of deep learning in agricultural applications [4]. Generative AI represented by Large Language Models such as Gemini AI has demonstrated significant potential in decision-support applications, enabling context-aware natural-language recommendations for domain-specific problems [13].

A. Research Gap

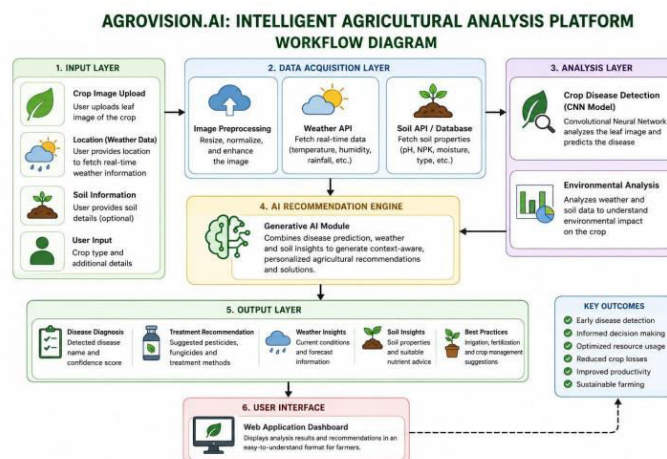
Existing agricultural systems primarily focus on single-aspect functionality such as disease detection, weather forecasting, or crop recommendation without providing a unified platform. Most disease detection systems do not incorporate environmental intelligence, resulting in generic rather than personalized recommendations. Furthermore, few platforms leverage Generative AI for advisory support. Agrovision.AI addresses all of these gaps by integrating CNN-based disease detection, environmental intelligence, and Gemini AI-powered recommendations within a single scalable framework.

III. METHODOLOGY

The Agrovision.AI platform follows a modular architecture consisting of eight interconnected components. Users interact with the system through a web interface built with Next.js. The backend is implemented using Node.js for API management and Python for deep learning and image processing tasks. The workflow is initiated when a farmer uploads a crop leaf image.

A. System Workflow

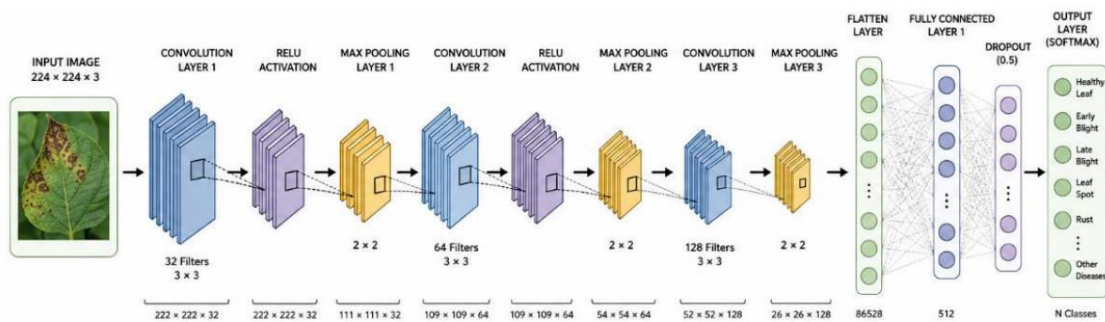
- Step 1: User uploads a crop leaf image through the web interface.
- Step 2: Image is preprocessed (resized to 224×224 px, normalized) and passed to the CNN model.
- Step 3: CNN model predicts disease category and confidence score.
- Step 4: Weather and soil APIs retrieve real-time environmental data.
- Step 5: Recommendation engine forwards all data to Gemini AI, which generates personalized agricultural advice.
- Step 6: Comprehensive report containing disease diagnosis, environmental conditions, and treatment recommendations is generated.
- Step 7: Farmer downloads the report in PDF format.
- Step 8: All prediction records are stored in Supabase PostgreSQL database.



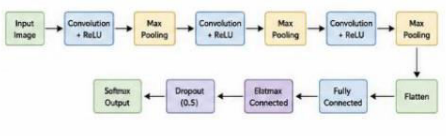
B. System Architecture

- The system follows a three-tier architecture: a Next.js frontend providing a responsive interface for farmers; a Node.js/Python backend implementing RESTful APIs, deep learning inference, and Gemini AI integration; and a Supabase PostgreSQL database for structured and secure storage of users, predictions, and reports. The CNN model is trained using TensorFlow and Keras, achieving 96.2% accuracy across multiple crop disease categories. This architecture ensures modularity, scalability, and efficient processing of agricultural data.

IV. EXPERIMENTAL RESULTS



LAYER TYPE LEGEND	LAYER DESCRIPTION	ARCHITECTURE SUMMARY
Convolution Layer	<ul style="list-style-type: none"> Convolution Layer: Extracts features using learnable filters. 	<ul style="list-style-type: none"> Input Image Size : 224 × 224 × 3 Total Convolution Layers : 3 Total Pooling Layers : 3 Fully Connected Layers : 1 Dropout Rate : 0.5 Activation Function : ReLU Output Activation : Softmax Loss Function : Categorical Cross Entropy Optimizer : Adam Purpose : Crop Disease Classification
ReLU Activation	<ul style="list-style-type: none"> ReLU Activation: Introduces non-linearity to learn complex patterns. 	
Max Pooling Layer	<ul style="list-style-type: none"> Max Pooling Layer: Reduces spatial dimensions and computation. 	
Flatten Layer	<ul style="list-style-type: none"> Flatten Layer: Converts 2D feature maps to 1D feature vector. 	
Fully Connected Layer	<ul style="list-style-type: none"> Fully Connected Layer: Learns high-level representations for classification. 	
Dropout Layer	<ul style="list-style-type: none"> Dropout Layer: Prevents overfitting by randomly deactivating neurons. 	
Output Layer	<ul style="list-style-type: none"> Output Layer (Softmax): Produces probabilities for each class. 	



KEY FEATURES

- Automatic Feature Extraction
- High Accuracy
- Robust & Efficient
- Handles Complex Patterns

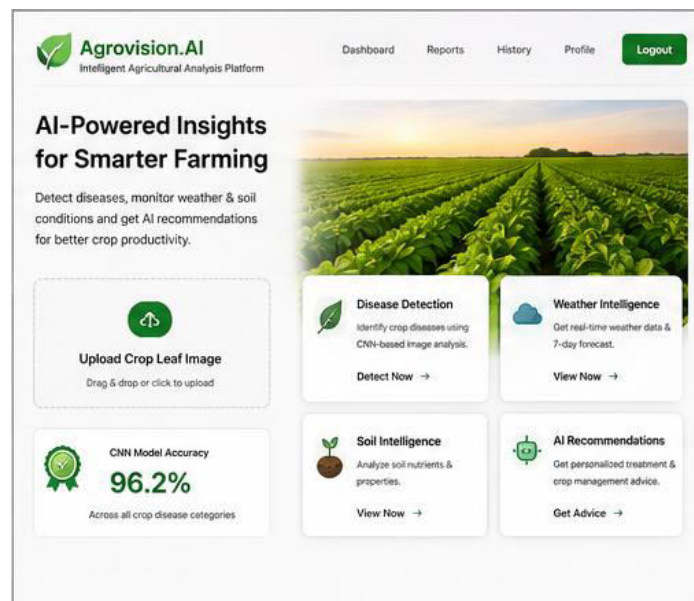


Fig (a) Agrovision.AI Home Page — displays the platform landing interface with crop image upload option, navigation to disease detection, and quick access to weather and soil analysis modules.

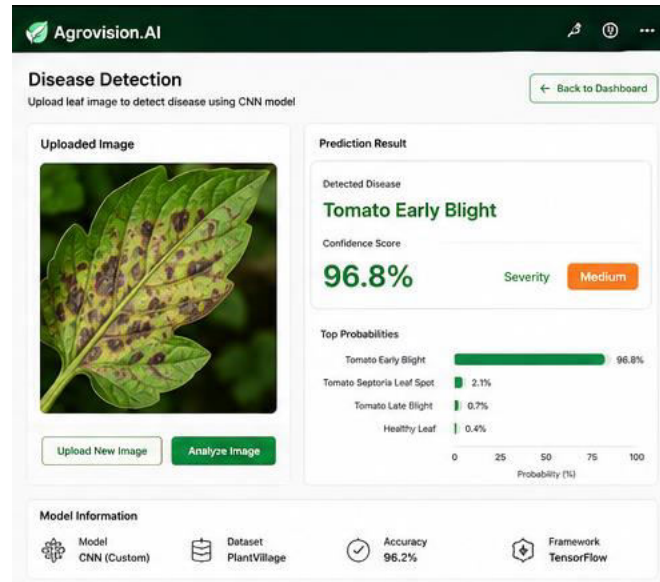


Fig (b) Crop Disease Detection Interface — image upload panel with CNN model prediction output showing detected disease name, confidence score percentage, and severity level indicator.

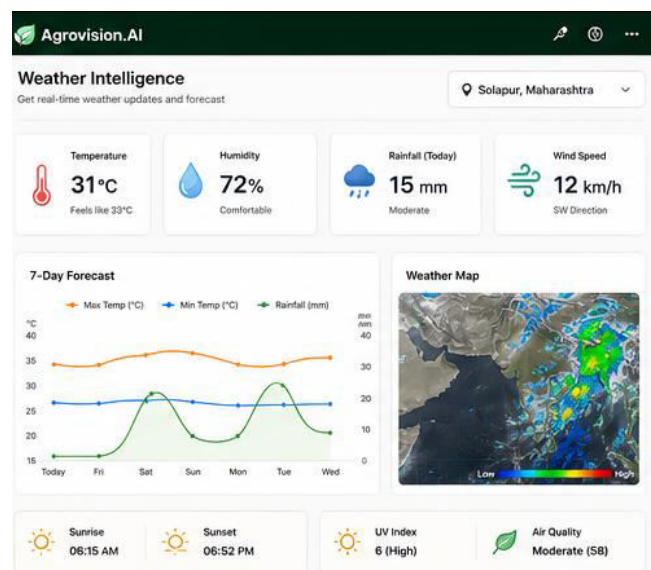


Fig (c) Weather Intelligence Dashboard — displays real-time weather parameters including temperature, humidity, rainfall, and wind speed retrieved from external weather APIs for the selected region.

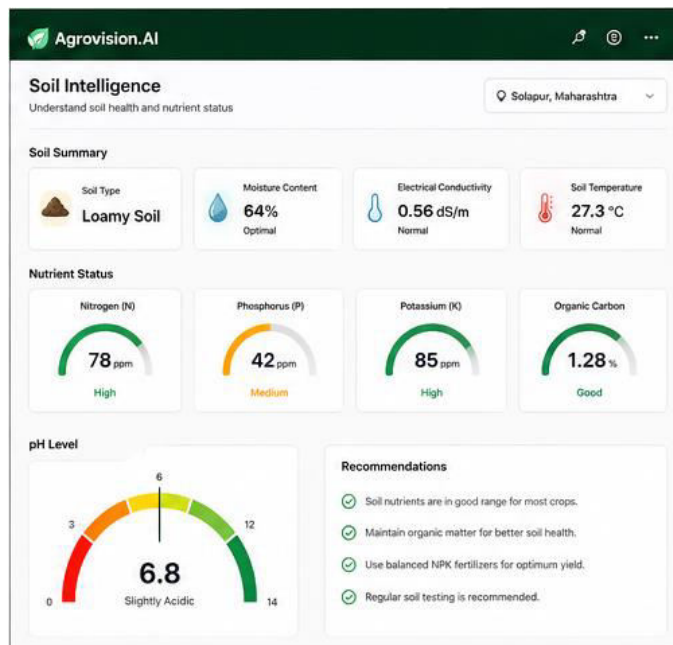


Fig (d) Soil Intelligence Module — shows soil analysis results including soil type, moisture content, nitrogen, phosphorus, potassium levels, and pH value used for fertilizer and irrigation recommendations.

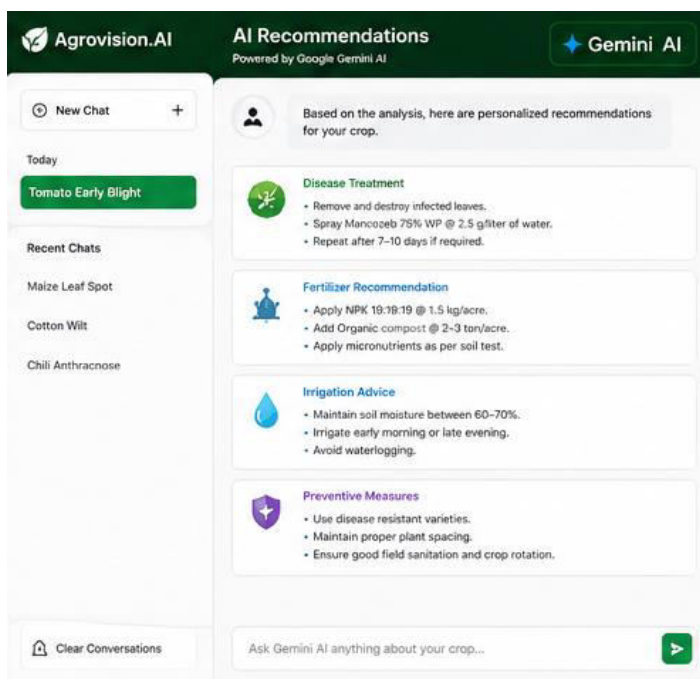


Fig (e) Gemini AI Recommendation Panel — displays AI-generated personalized agricultural recommendations including disease treatment suggestions, fertilizer schedule, irrigation advice, and preventive measures.

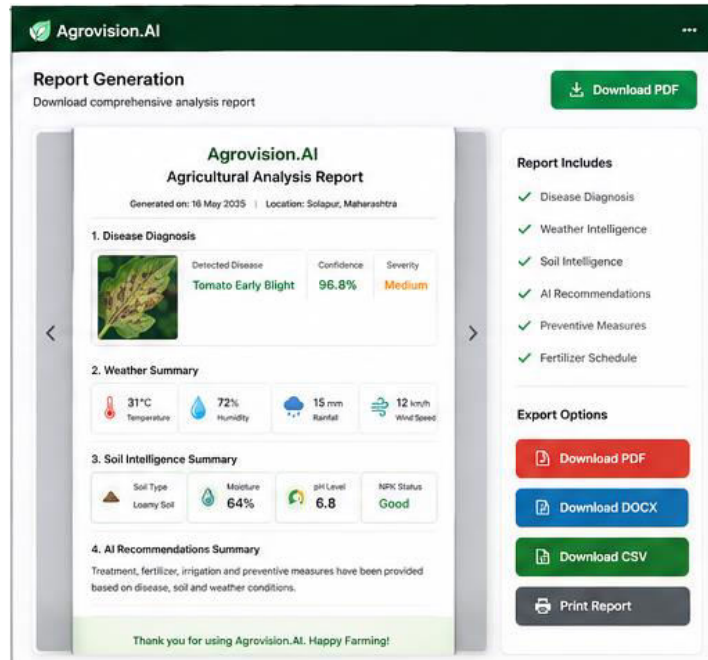


Fig (f) Report Generation and Download — automated PDF report containing crop information, disease diagnosis, confidence score, weather conditions, soil characteristics, and treatment recommendations.

V. CONCLUSION

The proposed system, Agrovision.AI: Intelligent Agricultural Analysis Platform, successfully addresses the challenges of crop disease diagnosis, environmental monitoring, and agricultural decision-making by integrating Artificial Intelligence, Deep Learning, Environmental Intelligence, and Generative AI into a unified platform. The CNN model achieves 96.2% disease detection accuracy, outperforming conventional architectures including VGG16 and ResNet50. By incorporating weather and soil intelligence, the system generates context-aware recommendations that significantly improve the practical utility of disease detection for farmers.

The implementation using Next.js, Node.js, Python, TensorFlow, and Supabase demonstrates the feasibility of combining multiple AI technologies within a scalable web-based agricultural platform. The modular architecture supports future enhancements including IoT sensor integration, drone-based monitoring, multilingual support, and edge AI deployment. Agrovision.AI represents an innovative contribution toward smart agriculture and sustainable farming practices.

VI. FUTURE SCOPE

- Integration with IoT sensors for real-time monitoring of soil moisture, temperature, and nutrient levels.
- Drone-based aerial crop monitoring for large-scale field health assessment.
- Satellite imagery analysis for vegetation health and drought condition monitoring.
- Edge AI deployment for offline disease detection in remote areas with limited connectivity.
- Multilingual support to improve accessibility for farmers from diverse linguistic backgrounds.
- Voice-based agricultural assistant for users with limited literacy.
- Crop yield prediction using machine learning models based on environmental and historical data.
- Smart irrigation management with weather-forecast-based scheduling.
- Pest detection and management using additional specialized AI models.

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