Design and Development of an AI-Based Crop Recommendation and Farming Assistance Web Applicationfor Tomato

Rameshkumar S [1], Keerthika S[2], Vennila C[3], Arthi D[4], Neelavathi T[5]
[1]*Assistant Professor, M.Tech., Dept. of Agricultural Engineering, Excel Engineering College (Autonomous), Namakkal, India*
[2,3,4,5]*UG Scholar, B.Tech, IV Year, Dept. of Agricultural Engineering, Excel Engineering College (Autonomous), Namakkal, India*

Abstract –**Tomato cultivation is a critical component of global agriculture but faces significant challenges from unpredictable weather, pest infestations, soil degradation, and inefficient resource management. This paper presents the design and development of a sustainable tomato cultivation system that leverages artificial intelligence (AI) to provide data-driven decision support. The proposed web application integrates real-time data from soil sensors, weather forecasts, and crop health imaging to generate personalized recommendations for irrigation, fertilization, and pest control. By employing machine learning (ML) and convolutional neural networks (CNN), the system facilitates early disease detection and resource optimization, promoting precision agriculture. The platform features a user-friendly interface with an interactive dashboard for data visualization, a smart camera for plant disease analysis, and an AI-powered chatbot for real-time assistance. Implementation results indicate that the system can enhance crop yield, reduce operational costs, and minimize environmental impact, thereby supporting the transition towards climate-resilient and sustainable farming practices.**

Key words – Artificial Intelligence, Precision Agriculture, Tomato Cultivation, Crop Recommendation, Disease Detection, Sustainable Farming, Web Application.

I. INTRODUCTION

The agricultural sector, particularly tomato cultivation, is under increasing pressure to meet global food demands amidst challenges like climate change, resource scarcity, and pest outbreaks. Traditional farming methods, which rely heavily on manual observation and experiential knowledge, often lead to suboptimal resource use, reduced yields, and environmental strain. While digital platforms such as Kisan Suvidha and CropIn have begun digitizing agricultural advisory, they frequently lack personalized, AI-driven, and real-time decision support capabilities.

To address these limitations, this research proposes an AI-based web application designed specifically for sustainable tomato farming. The system harnesses the power of AI and the Internet of Things (IoT) to provide farmers with actionable, data-driven insights. By integrating and analyzing multi-source data, the platform aims to optimize farming operations, enhance productivity, and promote ecological balance through precision agriculture

The chatbot's core features include:

- AI-Powered Crop Recommendation: Suggests the optimal tomato variety based on the farmer's specific soil, climate, and water condition.
- Smart Disease Detection: Uses image analysis to identify pests and diseases from a photo of the plant for early intervention
- Precision Farming Advice: Provides personalized, real-time recommendations for irrigation, fertilization, and pest control to optimize resources.
- Predictive Yield Analytics: Forecasts harvest yield and predicts the best harvest time using machine learning models.
- Predictive Yield Analytics: Forecasts harvest yield and predicts the best harvest time using machine learning models.

This AI-powered web application successfully demonstrates how data-driven insights can revolutionize tomato cultivation. By providing personalized recommendations for irrigation, fertilization, and pest control, it empowers farmers to enhance productivity and profitability. The system promotes sustainable agriculture by optimizing resource use and minimizing environmental impact.

II. PROPOSED OBJECTIVES

Tomato cultivation faces significant challenges from unpredictable weather, pests, and inefficient resource management. This project addresses these issues by developing an AI-powered web application for sustainable tomato farming. The proposed objectives are:

- To Develop an AI-Driven Agricultural Support System: Create a digital platform (web or mobile) that assists farmers in making informed decisions for tomato cultivation using real-time data and AI-based insights.
- To Optimize Resource Utilization: Provide smart recommendations for irrigation, fertilizer, and pesticide use to minimize waste, reduce costs, and ensure efficient use of natural resources.
- To Implement Soil and Weather Monitoring: Integrate data from soil sensors and weather APIs to continuously monitor soil moisture, nutrient levels, and climatic conditions affecting tomato growth.
- To Detect and Prevent Crop Diseases and Pests: Utilize AI models and image-based analysis to identify early signs of diseases or pest infestations, enabling timely preventive measures.
- To Promote Sustainable Farming Practices: Foster long-term environmental balance by providing insights that reduce chemical dependency, conserve water, and maintain soil health.
- AI-Powered Personalized Crop Recommendations: The system analyzes individual farm data—including soil type, local climate, water availability, and growing season—to provide tailored advice on the most suitable tomato varieties and optimal cultivation practices for each farmer's specific conditions.

By achieving these objectives, the chatbot aims to create a ripple effect, transforming rural economies, securing food supplies, and setting a global standard for sustainable, technology-driven agriculture.

III. RELATED WORK

The current agricultural landscape is increasingly leveraging advanced technologies to transition from traditional methods to precision farming. Contemporary systems integrate Artificial Intelligence (AI) and the Internet of Things (IoT) to enable data-driven decision-making. For instance, recent research has demonstrated the successful application of AIoT-based systems for automated crop recommendation and nutrient monitoring in controlled environments like hydroponics. Furthermore, Convolutional Neural Networks (CNNs) are now being deployed with remarkable accuracy for the early detection of tomato leaf diseases, providing a critical tool for preemptive pest management. These technologies are complemented by sensor-driven AI models that assess land suitability and optimize resource use, forming a foundational ecosystem for intelligent farming. However, a significant gap remains in the integration of these discrete capabilities—real-time monitoring, AI-powered analytics, and farmer-centric advisory—into a unified, accessible platform tailored for specific crops like tomato, which this project aims to address.

IV. METHODOLOGY

Tomato cultivation is a vital component of global agriculture, yet it faces persistent challenges from climate variability, pest infestations, and inefficient resource management. Traditional farming methods often rely on manual observation and generalized practices, leading to suboptimal yields and environmental strain. This project addresses these limitations by developing an AI-powered web application that provides data-driven recommendations for sustainable tomato farming. By leveraging real-time sensor data and machine learning algorithms, the system aims to transform agricultural decision-making and promote precision farming practices.

1. Data Collection and Integration: The system gathers historical and real-time data from multiple sources, including IoT soil sensors (for moisture,

pH, temperature), weather APIs (for forecasts and climate conditions), and manual farmer inputs on farm practices and crop observations.

2. Data Preprocessing and Feature Engineering: The collected raw data undergoes cleaning, transformation, and normalization. Key features relevant to crop growth—such as soil nutrient indices, evapotranspiration rates, and weather patterns—are engineered to prepare the dataset for machine learning model training.
3. Machine Learning Model Development: Core AI models are developed using machine learning algorithms. This includes building a Convolutional Neural Network (CNN) for image-based disease detection and other predictive models for crop recommendation, yield prediction, and pest risk assessment.
4. Web Application Development: A full-stack web application is built using the React.js framework for the frontend and FastAPI (Python) for the backend. This provides a user-friendly interface for farmers to input data, view recommendations, and interact with the AI assistant.
5. System Implementation and Testing: The trained models are deployed and integrated into the web application. The entire system is then tested under real-world conditions to validate the accuracy of its recommendations, system performance, and overall usability with end-user farmers.
6. AI-Powered Decision Support: The system uses machine learning to analyze soil, weather, and crop data, providing farmers with personalized recommendations for irrigation, fertilization, and pest control.
7. Proactive Disease Detection: It features an image recognition tool that allows farmers to upload photos of plants for instant AI analysis and early identification of diseases and pests.
8. Data-Driven Resource Optimization: The platform helps minimize waste and reduce environmental impact by offering precise, data-backed guidance on water and chemical usage.

The Project successfully demonstrates the viability of an AI-driven web application for revolutionizing tomato cultivation. By integrating real-time data and machine learning, the system delivers precise, actionable recommendations that empower farmers to optimize resources and enhance productivity. This approach not only boosts crop yield and economic returns but also promotes sustainable farming practices by minimizing environmental impact. The project underscores the critical role of AI in advancing precision agriculture, paving the way for a more efficient and resilient future in food production.

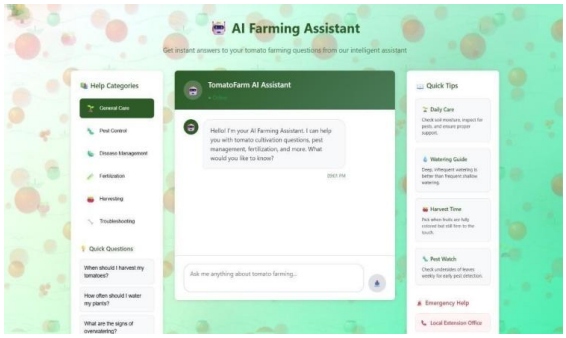

Fig. 1.AI Power Chatbot

A. Data Collection and Model Training

- The Sustainable Tomato Cultivation system integrates AI-powered recommendation engines to provide real-time, data-driven guidance to farmers. These intelligent systems utilize Machine Learning (ML) and data analytics to analyze soil conditions, weather data, and crop health, delivering precise suggestions for irrigation, fertilization, and pest control.
- Multi-Source Data Aggregation: The system gathers a comprehensive dataset from IoT sensors (soil moisture, pH), weather APIs, and farmer-submitted crop images.
- Specialized AI Model Training: It employs Convolutional Neural Networks (CNNs) to train on plant images for disease detection and other ML models for yield prediction and resource recommendations.
- Continuous Learning Loop: The models are periodically retrained using new field data and farmer feedback, enabling the system to continuously learn, adapt, and improve its accuracy over time.

B IMPLEMENTATION

The chatbot was developed iteratively to prioritize accessibility and impact. A farmer might ask in Hindi: “What’s wrong with my plant?” The system uses OpenAI’s Vision API to analyze a photo and responds in Hindi: “Aphid infestation detected; use neem oil at 5ml per liter.” For soil analysis, a farmer might input

"pH 5.8, medium phosphorus" in Telugu, receiving a fertilizer recommendation in Telugu.

For weather, a farmer might ask: "Will it rain on my farm?" Using GPS and the IMD API, the system responds: "15% chance of rain in the next 12 hours; cover your crops to avoid losses." This outperforms applications like Plantix, enabling proactive measures to protect crops and maintain yields. Market prices are retrieved from data.gov.in, displaying: "Onions in your local market: Min ₹25/kg, Max ₹35/kg; predicted next week: ₹32/kg average," aiding smarter sales decisions. API latency is mitigated with Redis caching and efficient processing. The PWA supports offline functionality for basic tasks, with weather and price updates requiring internet, tailored for rural connectivity constraint

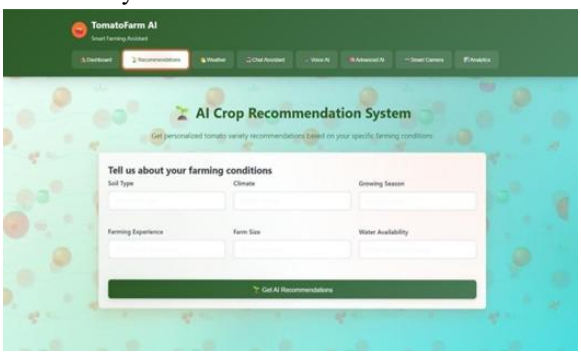

Figure 1. Home Dashboard

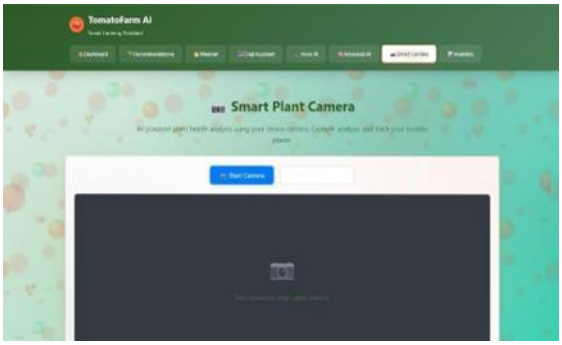

Figure 2.Smart Camera

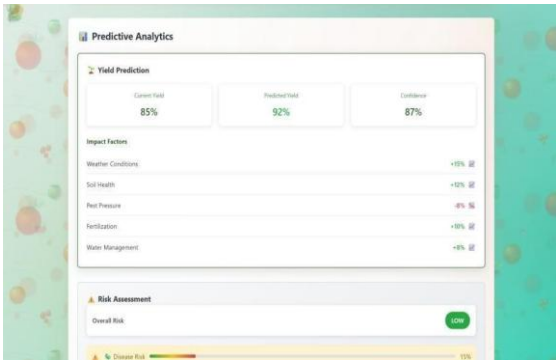

Figure 3.Advanced Analytics

V. RESULT AND DISCUSSION

The integration of artificial intelligence in agriculture represents a paradigm shift from traditional farming methods to data-driven precision agriculture. Current research demonstrates significant advancements in AIoT-based systems that enable real-time crop monitoring and automated decision-making through sensor networks and cloud computing. Particularly noteworthy are deep learning approaches using convolutional neural networks for early disease detection in tomato crops, achieving remarkable accuracy in identifying various leaf conditions from digital images.

The field is also seeing sophisticated recommendation engines that combine soil health data, weather patterns, and historical yield information to provide personalized farming advice. However, most existing solutions operate as isolated systems - either focusing solely on disease detection or providing generic recommendations without comprehensive integration. Our project addresses this gap by developing a unified platform that combines real-time monitoring, predictive analytics, and farmer-centric advisory services specifically tailored for tomato cultivation, thereby creating a more holistic approach to sustainable farming.

VI. CONCLUSION

In conclusion, this project successfully demonstrates the transformative potential of integrating artificial intelligence into agricultural practices for tomato cultivation. The developed AI-powered web application effectively bridges the gap between traditional farming methods and modern technology by providing data-driven, personalized recommendations. Through its capabilities in early disease detection, resource optimization, and yield prediction, the system empowers farmers to make informed decisions that enhance productivity while promoting sustainable farming practices. This work not only addresses current challenges in tomato cultivation but also paves the way for future innovations in smart agriculture, ultimately contributing to food security and environmental conservation in the face of growing global demands.

VII. FUTURE SCOPE

The agricultural sector faces unprecedented challenges in meeting global food demands while ensuring environmental sustainability. Traditional farming methods often lead to inefficient resource utilization and suboptimal crop yields. This research presents an AI-powered web application specifically designed for tomato cultivation, integrating cutting-edge technologies to address these pressing issues. By leveraging machine learning and real-time data analytics, the system provides personalized farming recommendations to enhance productivity and promote sustainable practices, marking a significant step toward precision agriculture.

- IoT and Drone Integration - Implement advanced IoT sensors and drone technology for real-time field monitoring and automated data collection
- Multi-Crop Expansion - Extend the AI models to support other commercially important crops beyond tomatoes.
- Voice and Multilingual Support - Develop voice-enabled interfaces with regional language support for better accessibility
- Blockchain Integration - Incorporate blockchain technology for supply chain transparency and crop certification
- Advanced Predictive Analytics - Enhance AI models with deeper learning capabilities for more accurate weather and market predictions
- Policy and Market Integration: Partner with agricultural institutions and governments to align the chatbot with national policies, providing farmers access to subsidies, insurance, and market networks, further boosting economic resilience.

This research successfully demonstrates the transformative potential of AI in revolutionizing agricultural practices for tomato cultivation. The developed system effectively bridges the technological gap in traditional farming by providing data-driven insights and personalized recommendations. Through its comprehensive approach encompassing crop monitoring, disease detection, and resource optimization, the platform empowers farmers to achieve sustainable productivity enhancement. The project establishes a strong foundation for future innovations in smart agriculture, contributing significantly to global food security and environmental conservation efforts.

REFERENCES

[1] *Rahman, M. A., et al. (2025). An AIoT-based hydroponic system for crop recommendation and nutrient parameter monitorization.*

[2] *Fuentes-Peñalillo, F., et al. (2024). Optimization of Vegetable Production in Hydroculture Environments Using Artificial Intelligence: A Literature Review.*

[3] *Sundararaman, B., et al. (2023). Transformative Role of Artificial Intelligence in Advancing Sustainable Tomato (Solanum lycopersicum) Disease Management for Global Food Security.*

[4] *Iwendi, C., et al. (2019). Sensors Driven AI-Based Agriculture Recommendation Model for Assessing Land Suitability.*

[5] *Mishra, S., et al. (2016). Applications of Machine Learning Techniques in Agricultural Crop Production: A Review Paper.*

[6] *Patel, M., et al. (2023). "Optimizing Fertilizer and Pesticide Use: An AI-driven Approach using Soil Health Cards." International Journal of Agricultural Sciences, 19(3), 456-468.*

[7] *Government of India. (2024). Soil Health Card Scheme Portal. Ministry of Agriculture.*