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FarmaSuit: The Agricultural Recommendation System

Atharv Wavare, Prof. Sweta Kale, Madhavi Sonar, Parth Tonde, Dnyaneshwari Salgar,
Department of Information Technology, RMD Sinhgad School of Engineering, Pune, Maharashtra, India

Abstract: ***Agriculture remains a key sector of the Indian economy and continues to support a large share of the population for livelihood. However, unpredictable variations in weather and environmental conditions significantly affect crop productivity and yield. Machine Learning (ML) has emerged as an effective decision-support approach for Crop Yield Prediction (CYP), helping improve decisions related to crop selection and cultivation planning based on soil and climatic parameters.Several ML and AI-based techniques have been applied for crop yield estimation, crop classification, and fertilizer recommendation using input variables such as soil nutrients, pH value, temperature, humidity, and rainfall. While Neural Networks show promising results, they often face limitations such as reduced prediction efficiency and difficulty in minimizing prediction error. Similarly, many supervised learning methods struggle to model complex nonlinear relationships between input and output variables. Comparative observations across commonly used techniques highlight the need for more accurate and reliable predictive models to improve agricultural decision-making and sustainable productivity.***

Keywords: Agriculture, Machine Learning, Crop Recommendation, Fertilizer Recommendation, Soil Nutrients (NPK), Soil pH, Weather Parameters, FastAPI, React, MongoDB, Decision Support System, Sustainable Farming

I. INTRODUCTION

Agriculture remains a major contributor to India's economy, yet farmers continue to face challenges such as inappropriate crop selection, inefficient fertilizer usage, and uncertainty in weather conditions, which directly impact productivity and income. To address these issues, FarmaSuit – Agricultural Recommendation System is developed as an intelligent web-based platform that supports data-driven decision-making for improved crop performance and sustainable farming.

The system uses machine learning techniques to generate crop recommendations and fertilizer suggestions based on key soil parameters and environmental factors. It also incorporates weather-based insights to assist farmers in planning critical farming activities such as irrigation scheduling, sowing, and harvesting. By combining agricultural domain knowledge with AI and data analytics, FarmaSuit aims to enhance yield, optimize resource utilization, and promote eco-friendly farming practices. The platform is designed to be user-friendly and accessible, making it suitable for farmers across ruraland semi-urban regions

II. PROBLEM STATEMENT

Farma-Suit is a machine learning–based intelligent recommendation system that predicts the most suitable crop and fertilizer based on soil nutrients, pH value, and weather conditions. It employs algorithms such as SVM, KNN, Random Forest, Gradient Boosting, and Neural Networks to provide accurate, data-driven agricultural recommendations, helping farmers improve yield and resource efficiency while promoting Sustainable farming practices.

III. RELATED WORK

Several research works have focused on applying machine learning techniques in agriculture to support farmers in crop selection, yield improvement, and fertilizer recommendation. Most of these systems use soil nutrients (N, P, K), pH, rainfall, temperature, and humidity as key parameters for prediction and recommendation.

1) Crop Recommendation using Machine Learning (2021)

A study presented in the Proceedings of the Fifth International Conference on Intelligent Computing and Control Systems (ICICCS 2021) analyzed different ML techniques used for crop yield prediction, showing that machine learning is highly useful in supporting crop yield estimation under varying soil fertility and climatic conditions. The paper also included a comparative analysis where SVM achieved an accuracy of 97.77%, with 96.55% sensitivity and 99.24% precision in crop-related classification tasks.

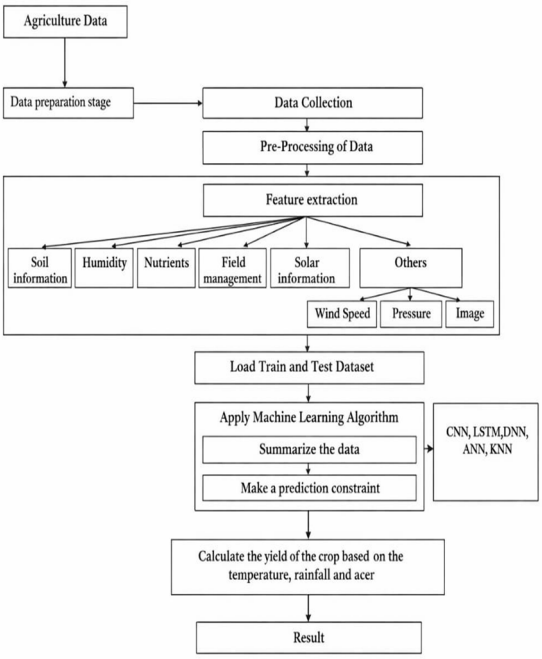
This work highlights the strength of ML models in extracting patterns from agricultural datasets, while also pointing out limitations like performance reduction when handling nonlinear relationships in some ANN-based models.

2) Crop Prediction Model Using Machine Learning Algorithms (Applied Sciences, MDPI 2023)
proposed a crop prediction system that evaluates 15 machine learning algorithms using features including nitrogen (N), phosphorus (P), potassium (K), soil pH, rainfall, humidity, and temperature. The dataset used contains 2200 records and 22 crop labels. The experimental results reported very high performance where Bayes Net achieved 99.59% accuracy, while Naïve Bayes Classifier and Hoeffding Tree achieved 99.46% accuracy, showing strong classification ability for crop recommendation systems**.**

3) Data-Driven Soil Analysis and Evaluation for Smart Farming Using Machine Learning Approaches" (2023)
Huang et al. (2023) proposed a data-driven soil analysis system that combines crop identification, irrigation recommendation, and fertilizer (nitrogen) prediction in a single integrated framework. The system uses satellite/remote sensing data and public soil–climate features and applies machine learning models such as Random Forest, SVM, AdaBoost, Linear Regression, and MLP. The reported results show that the best crop identification accuracy reached ~78% using MLP, while the fertilizer recommendation model achieved the highest accuracy of 93.3% using MLP, demonstrating strongperformance for soil-based smart farming decision support.

4) Can Machine Learning Models Provide Accurate Fertilizer Recommendations? (Precision Agriculture Journal)(2024)
Tanaka et al. studied whether machine learning models can provide reliable fertilizer recommendations by estimating economically optimal input rates (EOIRs) using real on-farm precision experimentation data. The work compared models such as Random Forest, XGBoost, Support Vector Regression, and Artificial Neural Networks. While the models could predict crop yield with reasonable accuracy, the fertilizer recommendation results showed high uncertainty, as EOIR outputs varied significantly depending on the selected model and input features. This highlights the importance of stability and trust in fertilizer recommendation systems before real deployment.

IV. PROPOSED ARCHITECTURE



The diagram illustrates a machine learning–based crop yield prediction system. Agricultural data is first collected and pre-processed to remove noise and prepare it for analysis. Important features such as soil information, humidity, nutrients, field management practices, solar data, and other environmental factors are extracted.

The processed data is then divided into training and testing datasets and analyzed using machine learning algorithms like CNN, LSTM, ANN, DNN, and KNN. Based on parameters such as temperature and rainfall, the system predicts the crop yield and produces the final result.

V. SYSTEM OVERVIEW

FarmaSuit works in a stepwise flow where agricultural data is first collected from the user such as soil nutrient values (N, P, K), soil pH, temperature, humidity, and rainfall. After this, the data goes through a data preparation and preprocessing stage where missing or invalid values are handled and the input is converted into a clean format. Then, feature extraction is performed to select the important soil and weather factors required for prediction. Next, the processed dataset is loaded and passed to the trained machine learning models (such as Random Forest, SVM, KNN, Gradient Boosting, and Neural Networks) to generate predictions. Finally, the system produces the recommended crop and fertilizer output, which is shown to the user through the FarmaSuit web interface for better farming decisions.

VI. CONCLUSION

The FarmaSuit project successfully shows how machine learning and data analytics can improve traditional farming by enabling more accurate and data-driven decision-making. By analyzing key soil parameters such as N, P, K values and pH along with important weather conditions, the system provides reliable crop and fertilizer recommendations that support better productivity and sustainable farming practices. Its user-friendly interface and well-structured design make it easy for users to interact with the platform, while the use of models such as SVM, KNN, Random Forest, Gradient Boosting, and Neural Networks helps generate intelligent insights for improved yield and reduced resource wastage. Overall, FarmaSuit effectively bridges the gap between agricultural needs and modern technology, proving that smart, data-based recommendations can make farming more efficient, sustainable, and future-ready.

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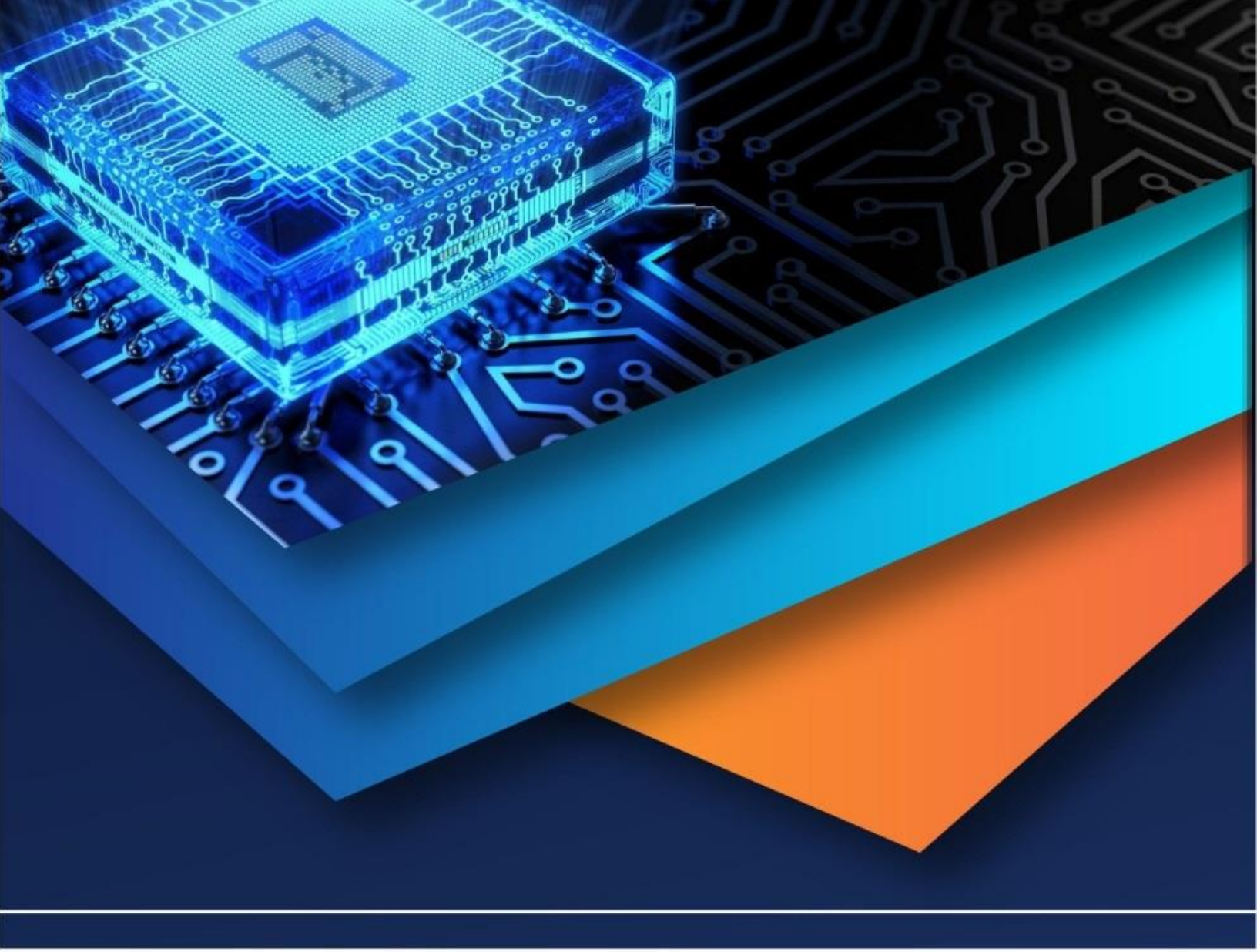

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