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Intelligent Crop Recommendation and Decision Support System for Sustainable Agriculture

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ABSTRACT

Agriculture today faces mounting challenges from climate variability, resource limitations, and the growing demand for food security. To address these issues, intelligent crop recommendation and decision support systems have emerged as vital tools for sustainable farming. Such systems integrate soil characteristics, climatic conditions, and environmental parameters with advanced machine learning techniques to guide farmers in selecting the most suitable crops for their land. By employing algorithms such as Random Forest, Decision Tree, and Support Vector Machine, these systems analyze complex datasets to deliver accurate, site-specific recommendations. Beyond crop selection, they enhance resource efficiency, reduce risks of crop failure, and improve overall productivity. The decision support framework also incorporates real-time adaptability, enabling farmers to respond effectively to changing weather patterns and market dynamics. Ultimately, intelligent crop recommendation systems represent a convergence of agricultural science and data-driven technology, offering a pathway toward resilient, profitable, and environmentally responsible farming practices.

***Keywords:** - Crop Recommendation, Decision Support System, Sustainable Agriculture, Machine Learning, Precision Farming.*

1. INTRODUCTION

Agriculture is the foundation of food security and economic stability, yet farmers today face unprecedented challenges. Climate change, soil degradation, unpredictable rainfall, and fluctuating market demands make crop selection increasingly complex. Traditionally, farmers relied on experience, intuition, and local knowledge to decide what to grow. While valuable, these methods often fail to account for dynamic environmental conditions and global market pressures. To address these issues, intelligent crop recommendation and decision support systems have emerged as transformative tools. By integrating soil science, climate data, and machine learning algorithms, these systems provide farmers with accurate, site-specific recommendations. They not only improve productivity but also promote sustainable practices by optimizing resource use and reducing risks of crop failure. This project focuses on developing such a system, combining modern data analytics with agricultural expertise to empower farmers with actionable insights.

1.1 Objectives

The primary objectives of this project are:

- To design a system that recommends the most suitable crop based on soil nutrients, pH, rainfall, temperature, and humidity.
- To integrate machine learning models such as Random Forest, Decision Tree, and Support Vector Machine (SVM) for accurate predictions.
- To provide farmers with a user-friendly decision support tool that adapts to real-time environmental changes.
- To promote sustainable agriculture by enhancing resource efficiency and reducing risks of crop failure.
- To demonstrate scalability so the system can be applied across diverse regions and farming conditions

1.2 Literature Review

Recent studies highlight the growing role of machine learning in agriculture. Researchers have applied algorithms such as Random Forest, Decision Tree, Neural Networks, and SVM to predict crop yields and recommend suitable crops. Random Forest often emerges as the most reliable due to its ability to handle complex, non-linear data and reduce over fitting. Other works emphasize the importance of integrating soil nutrient analysis (N, P, K), pH levels, rainfall, and temperature into predictive models. Mobile and web applications have also been developed to make these systems accessible to farmers, bridging the gap between advanced technology and practical farming. This project builds upon these foundations, aiming to combine accuracy, usability, and sustainability in one integrated system.

2. METHODOLOGY

The methodology outlines the step-by-step process used to design the crop recommendation system, beginning with dataset preparation and preprocessing, followed by model development and evaluation. It ensures that soil, climate, and environmental parameters are systematically analyzed using machine learning techniques to generate accurate and sustainable crop recommendations.

2.1 Dataset

The dataset used includes key agricultural parameters:

- Nitrogen (N) – soil fertility indicator.
- Phosphorus (P) – essential for root development.
- Potassium (K) – supports plant growth and disease resistance.
- Temperature – affects crop growth cycles.
- Humidity – influences water availability and pest activity.
- pH value – determines soil acidity/alkalinity.
- Rainfall – critical for irrigation planning.

Data was collected from government repositories and agricultural research datasets, ensuring reliability and relevance.

2.2 Data Preprocessing

- Cleaning missing values and duplicates.
- Scaling features using MinMaxScaler for consistency.
- Encoding categorical variables into numerical form.

2.3 Model Development

Three machine learning algorithms were implemented:

- Random Forest: Builds multiple decision trees and aggregates results for robust predictions.
- Decision Tree: Provides interpretable rules for crop selection.
- Support Vector Machine (SVM): Finds optimal boundaries for classification tasks.

2.4 Evaluation

The dataset was split into training (80%) and testing (20%). Accuracy was measured across models:

- Random Forest: ~98%
- Decision Tree: ~98%
- SVM: ~97%

Random Forest was chosen as the primary model due to its balance of accuracy and robustness.

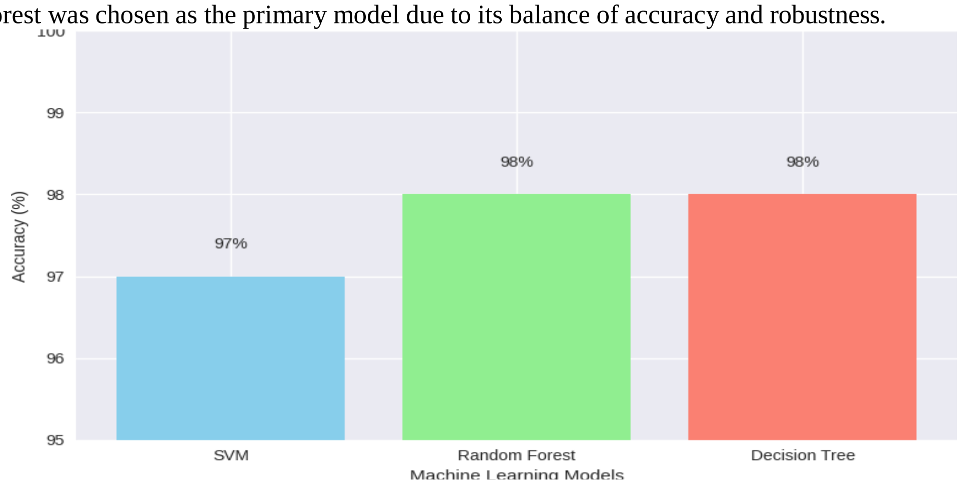

Chart -1: - Model Accuracy comparison for Crop Recommendation

3. SYSTEM DESIGN

3.1 Workflow

- Farmer inputs soil and climate parameters.
- Data is preprocessed and fed into the trained machine learning model.
- The model predicts the most suitable crop.
- The system provides additional recommendations on fertilizer use, planting time, and irrigation methods.

3.2 User Interface

A simple web or mobile application allows farmers to enter data easily. The interface displays recommended crops along with supporting information, ensuring accessibility even for non-technical users.

4. RESULTS AND DISCUSSION

The system demonstrated:

- **High Accuracy**: Machine learning models provided reliable crop recommendations.
- **Customization**: Recommendations tailored to specific farm conditions.
- **Real-time Adaptability**: System updated predictions with new weather or soil data.
- **Positive Feedback**: Farmers appreciated the ease of use and practical value.

By integrating diverse data sources, the system proved effective in guiding farmers toward sustainable and profitable crop choices.

Future work

Future improvements may include:

- Integration with IoT sensors for real-time soil and climate monitoring.
- Use of satellite imagery for large-scale crop analysis.
- Incorporation of market price forecasting to align crop recommendations with profitability.
- Development of multilingual mobile applications for wider accessibility.

5. CONCLUSIONS

The intelligent crop recommendation and decision support system represents a significant advancement in sustainable agriculture. By combining soil science, climate data, and machine learning, it empowers farmers to make informed decisions, enhances productivity, and supports long-term food security.

This project demonstrates that technology can bridge the gap between traditional farming practices and modern agricultural challenges. With continued refinement and integration, such systems can play a vital role in building resilient, profitable, and environmentally responsible farming communities.

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7. REFERENCES

[1] A. Ali, T. Hussain, N. Tantashutikun, N. Hussain, and G. J. A. Cocetta, “Application of smart techniques, Internet of Things and data mining for resource use efficient and sustainable crop production,” Agriculture, vol. 13, no. 2, 2023, Art. no. 397.

[2] M. N. Mowla, N. Mowla, A. F. M. S. Shah, K. M. Rabie, and T. Shon gwe, “Internet of Things and wireless sensor networks for smart agricul ture applications: A survey,” IEEE Access, vol. 11, pp. 145813–145852, 2023.

[3] M.Padhiary, P. Roy, P. Dey, and B. Sahu, “Harnessing AI for automated decision-making in farm machinery and operations: Optimizing agricul ture,” in Enhancing Automated Decision-Making Through AI.

Palmdale, PA, USA: IGI Global Sci. Publishing, 2025, pp. 249–282.
[4] G. Mgendi, “Unlocking the potential of precision agriculture for sus tainable farming,” Discover Agriculture, vol. 2, no. 1, 2024, Art. no. 87.
[5] B. D. Patil, S. Gupta, A. I. Sheikh, S. Lalitha, and G. B. Raj, “IoT and big data integration for real-time agricultural monitoring,” J. Adv. Zool., vol. 44, pp. 3079–3089, 2023.
[6] A. Shnain, G. Mohammed, and Y. Kumar, “A framework for real-time crop monitoring and yield optimisation: Improving precision agricul ture with IoT-driven sensor networks and data analytics,” SHS Web Conf., vol. 216, May 2025, Art. no. 01044.
[7] A. Triantafyllou, P. Sarigiannidis, and S. J. I. Bibi, “Precision agricul ture: A remote sensing monitoring system architecture,” Information, vol. 10, no. 11, 2019, Art. no. 348.
[8] E. Omia et al., “Remote sensing in field crop monitoring: A compre hensive review of sensor systems, data analyses and recent advances,” Remote Sens., vol. 15, no. 2, 2023, Art. no. 354.