**Smart Crop and Fertilizer Recommendation System using Machine Learning**

# Abstract

With the growing need for intelligent agriculture, optimizing crop yield and resource usage is crucial. This paper proposes a machine learning-based system that recommends the most suitable crop and fertilizer based on soil nutrients and weather parameters. The system uses classification models trained on real agricultural datasets. It enhances decision-making for farmers by suggesting appropriate fertilizers after predicting the ideal crop. The model is deployed through a user-friendly web interface using Streamlit, making it accessible and practical for real-world use.

# Keywords

Crop Recommendation, Fertilizer Prediction, Machine Learning, Agriculture, Decision Tree, Streamlit, Smart Farming

# 1. Introduction

India’s agriculture sector faces several challenges, such as improper crop selection, incorrect fertilizer usage, and decreasing soil fertility. Technological interventions like machine learning can support farmers in making data-driven decisions. This project proposes a system that recommends both crops and fertilizers based on soil composition (N, P, K), temperature, humidity, moisture, and crop type.

# 2. Problem Statement

Farmers often rely on intuition or traditional methods for selecting crops and fertilizers, which leads to low productivity and soil degradation. There is a need for a system that uses historical agricultural data to make precise recommendations, improving crop yield while maintaining soil health.

# 3. Objectives

- To predict the most suitable crop using soil and environmental parameters.

- To recommend the best fertilizer based on the predicted crop and nutrient composition.

- To develop a user-friendly interface for real-time usage.

# 4. Methodology

4.1 Dataset Used

- Crop Recommendation Dataset (N, P, K, Temperature, Humidity, pH, Rainfall)  
- Fertilizer Dataset (Soil Type, Crop Type, N, P, K, Moisture, Temperature, Humidity)

4.2 Preprocessing

- Label Encoding for categorical columns (Crop Type, Soil Type)  
- Feature scaling using StandardScaler

4.3 Machine Learning Models

- Crop Prediction Model: Decision Tree Classifier (Accuracy: ~97%)  
- Fertilizer Prediction Model: Decision Tree Classifier

4.4 Tools & Technologies Used

- Python, Pandas, NumPy  
- Scikit-learn  
- Streamlit  
- GitHub for code management

# 5. Results

The crop recommendation model achieves high accuracy with good generalization. The fertilizer model accurately maps fertilizer types to crop and soil conditions. The Streamlit web application provides real-time interaction and ease of use.

# 6. Features Implemented

- Crop prediction based on N, P, K, temperature, humidity, pH, rainfall

- Fertilizer prediction using moisture, N, P, K, crop type, soil type

- GUI with sliders and dropdowns for better accessibility

- Error handling and user-friendly display

# 7. Conclusion & Future Scope

This system simplifies agricultural decision-making by providing scientific, data-driven recommendations. In the future, the system can be improved by integrating real-time data using IoT devices and satellite data for dynamic recommendations. Multilingual support and voice inputs could make it more inclusive for rural farmers.

# 8. Improvisations Done

While the initial codebase was basic, several enhancements were made:  
- Streamlined input preprocessing with proper label encoding  
- Error-handling added in Streamlit interface  
- Proper feature alignment for model prediction  
- Complete integration of crop-to-fertilizer recommendation pipeline  
- Visual flowchart and clean UI improvements

# 9. GitHub Repository

Source Code: <https://github.com/oyedivyansh/AIML-Crop_fertlzr/blob/main/app.py>

# 10. App Link

Link: https://aiml-cropfertlzr.streamlit.app/