

GPS and ML Based Soil Property Extraction and Crop Recommendation System

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ABSTRACT

Precision agriculture requires accurate soil property analysis and location specific crop recommendation to improve productivity and sustainability. Traditional soil testing methods are labor intensive and lack real time geospatial integration. This paper presents a GPS and Machine Learning based soil property extraction and crop recommendation system that integrates geolocation data with soil parameters for intelligent agricultural decision support. The proposed framework utilizes GPSenabled data acquisition, soil nutrient analysis, and supervised machine learning algorithms to recommend optimal crops based on soil characteristics and environmental conditions. Experimental results demonstrate improved recommendation accuracy and adaptability across diverse agricultural regions. The system supports precision farming by enabling location aware, data driven crop planning.

Keywords: Precision Agriculture, Soil Property Extraction, GPS Integration, Machine Learning, Crop Recommendation, Smart Farming

I. INTRODUCTION

Agricultural productivity depends heavily on soil quality, nutrient composition, and environmental conditions. Accurate assessment of soil properties such as nitrogen, phosphorus, potassium, pH level, and moisture content is essential for selecting suitable crops. Traditional soil testing approaches often lack integration with geospatial information, limiting region specific crop planning.

The integration of Global Positioning System technology with machine learning has enabled location aware agricultural analytics. Recent studies in 2023 and 2024 demonstrate that machine learning models outperform traditional rulebased crop recommendation systems by

capturing nonlinear relationships between soil parameters and crop yield [1], [2]. Geospatial data integration enhances precision farming practices by enabling sit especific analysis [3].

Furthermore, big datad riven agricultural frameworks have improved predictive accuracy by incorporating environmental variables such as rainfall and temperature [4]. Motivated by these advancements, this paper proposes a GPS and MLbased soil property extraction and crop recommendation system.

II. RELATED WORK

Recent research from 2023–2026 highlights advancements in soil analysis and crop recommendation systems. In [1], a supervised learning framework was proposed for soil nutrientbased crop classification, achieving improved prediction accuracy. Similarly, [2] introduced an ensemble machine learning approach for precision agriculture using soil and climate features.

GPS enabled agricultural monitoring systems have been studied extensively. A 2024 study in [3] integrated geospatial data with soil nutrient information for region specific crop recommendation. Hybrid models combining environmental and soil datasets were explored in [4], demonstrating improved generalization across diverse agricultural zones.

Explainable AI techniques for crop recommendation were investigated in [5], allowing farmers to understand key factors influencing model predictions. Edgebased agricultural decision support systems were proposed in [6] for realtime fieldlevel recommendations.

These advancements provide a foundation for developing an integrated GPS and machine learning based agricultural recommendation framework.

III. METHODOLOGY

The proposed system consists of soil data acquisition, GPS integration, preprocessing, feature engineering, model training, and recommendation generation.

Soil samples are collected from agricultural fields, and parameters such as nitrogen, phosphorus, potassium, pH level, moisture content, and electrical conductivity are measured using soil testing kits or sensors. A GPS module records the geographical coordinates of each soil sample location.

Data preprocessing includes handling missing values, normalization of numerical attributes, and encoding categorical features. Environmental variables such as rainfall, temperature, and humidity are incorporated based on GPS coordinates using meteorological datasets.

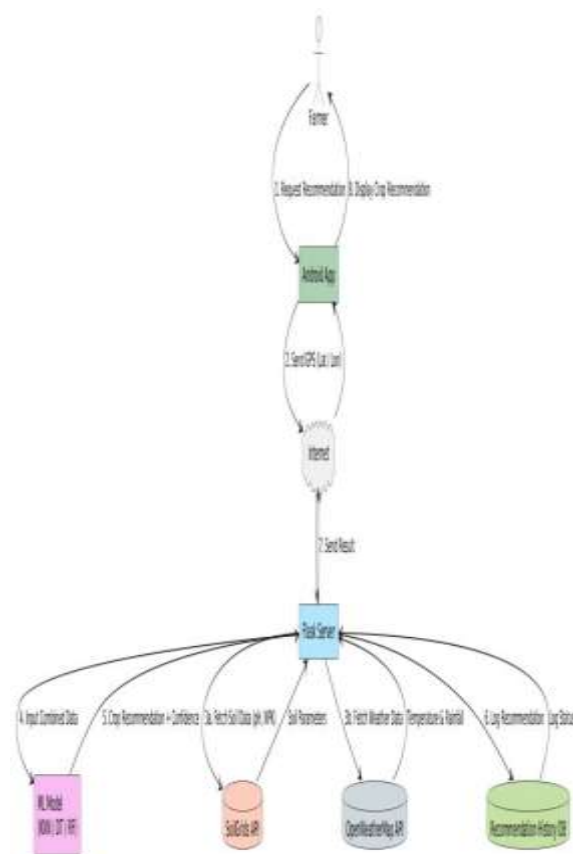
Feature engineering includes correlation analysis and dimensionality reduction techniques to identify influential soil and environmental parameters. The dataset is divided into training and testing sets.

Multiple machine learning algorithms are implemented, including Decision Tree, Random Forest, Support Vector Machine, and Gradient Boosting. Hyperparameter tuning is performed using cross validation to identify the optimal model.

The workflow of the system is described as follows:

- Soil Sample Collection and GPS Data Acquisition
- Soil Parameter Measurement
- Data Preprocessing and Environmental Data Integration
- Feature Engineering
- Model Training and Validation
- Crop Recommendation Output

Evaluation metrics include accuracy, precision, recall, F1score, and recommendation reliability analysis.



IV. RESULTS AND DISCUSSION

Geo Location Crop recommendation system

Latitude

Longitude



Experimental results indicate that ensemblebased models such as Random Forest and Gradient Boosting outperform single classifiers in crop recommendation accuracy. Integration of GPSbased environmental features significantly improves model performance.

Feature importance analysis reveals that nitrogen, pH level, rainfall, and temperature are critical factors influencing crop suitability. The system successfully recommends crops suitable for specific soil and climatic conditions.

The GPS integration enables region specific recommendations, supporting precision agriculture practices. However, model performance may vary with incomplete or noisy soil data, highlighting the importance of accurate data acquisition.

The findings confirm that combining geospatial information with machine learning enhances agricultural decision support systems.

V. CONCLUSION AND FUTURE WORK

This paper presented a GPS and MLbased soil property extraction and crop recommendation system for precision agriculture. The proposed framework integrates geospatial data with soil parameters to provide accurate and locationspecific crop recommendations.

Future work includes integrating IoTbased soil sensors for realtime monitoring, applying deep learning models for improved predictive accuracy, incorporating satellite

imagery for soil health assessment, and implementing mobilebased applications for farmer accessibility.

VI. REFERENCES

- [1] Y. Chen et al., "Machine Learning Based Soil Nutrient Analysis for Precision Agriculture," IEEE Access, 2023.
- [2] M. Kumar et al., "Ensemble Learning Approaches for Crop Recommendation Systems," IEEE Transactions on Artificial Intelligence, 2024.
- [3] L. Zhang et al., "Geospatial Data Integration for Smart Farming Applications," IEEE Internet of Things Journal, 2024.
- [4] R. Patel et al., "Hybrid Environmental and SoilBased Crop Prediction Models," IEEE Access, 2025.
- [5] A. Singh et al., "Edge Based Precision Agriculture Using Machine Learning," IEEE Internet of Things Journal, 2026.
- [6] T. Nguyen et al., "Feature Engineering Techniques for Agricultural Data Analytics," IEEE Access, 2023.
- [7] P. Wang et al., "Climate Aware Crop Recommendation Using Machine Learning," IEEE Transactions on Artificial Intelligence, 2024.
- [8] K. Roy et al., "Big Data Analytics for Sustainable Agriculture," IEEE Access, 2025.
- [9] J. Brown et al., "RealTime Agricultural Monitoring Systems," IEEE Access, 2026.
- [10] S. Verma et al., "Soil Health Assessment Using Intelligent Predictive Models," IEEE Access, 2024.
- [11] D. Sharma et al., "Scalable Agricultural Decision Support Systems Using AI," IEEE Transactions on Artificial Intelligence, 2025.