**Project Report: Enhanced Crop Recommendation System**

### **1. Introduction**

The Enhanced Crop Recommendation System is a machine learning-based application designed to assist farmers in identifying the most suitable crops for cultivation based on environmental and soil conditions. This tool leverages advanced data analytics and interactive features to empower agricultural decision-making, ensuring higher yields and sustainability.

### **2. Objectives**

* To recommend the most suitable crop based on soil and environmental parameters.
* To provide farmers and stakeholders with actionable insights for efficient farming.
* To enhance decision-making with a user-friendly graphical interface.
* To utilize machine learning techniques for accurate predictions.

### **3. Dataset Overview**

* **Source**: The dataset is sourced from publicly available on Kaggle as Crop\_recommendation.
* **Features**:
  + **N**: Nitrogen content in the soil (ppm).
  + **P**: Phosphorus content in the soil (ppm).
  + **K**: Potassium content in the soil (ppm).
  + **Temperature**: Average environmental temperature (°C).
  + **Humidity**: Percentage of moisture in the air (%).
  + **pH**: Acidity or alkalinity level of the soil.
  + **Rainfall**: Average rainfall (mm).
* **Target Variable**: Crop label (e.g., rice, wheat, maize).

### **4. Methodology**

#### **4.1. Data Preprocessing**

* **Data Cleaning**: Ensured no missing or erroneous values.
* **Feature Engineering**: Selected relevant features for model training.
* **Encoding**: Label-encoded the target variable for classification.

#### **4.2. Model Selection**

* The **Random Forest Classifier** was selected for its robustness and ability to handle multi-class classification.
* Model trained on 80% of the data and tested on the remaining 20%.

#### **4.3. Evaluation Metrics**

* **Accuracy**: Measured the proportion of correctly classified crops.
* **Feature Importance**: Determined the impact of each feature on the prediction.

### **5. Application Features**

#### **5.1. User Interface (Streamlit)**

* **Interactive Sidebar**:
  + Options for exploring features, data insights, and model details.
* **Input Fields**:
  + Users can input soil and environmental parameters.
* **Crop Recommendation**:
  + Displays the best crop based on input parameters.

#### **5.2. Data Visualization**

* **Heatmap**:
  + Displays correlation between features.
* **Bar Charts**:
  + Visualize crop distribution and feature importance.

#### **5.3. Download Functionality**

* Users can download crop recommendations as a CSV file.

### **6. Results**

#### **6.1. Model Performance**

* **Accuracy**: 99.32%
* **Insights**: The model identified pH, temperature, and rainfall as the most influential factors for crop prediction.

#### **6.2. Example Prediction**

* **Input**:
  + N: 90, P: 42, K: 43, Temperature: 23.5, Humidity: 82.0, pH: 6.5, Rainfall: 200.
* **Output**: Recommended Crop - **Rice**.

### **7. Conclusion**

The Enhanced Crop Recommendation System successfully provides actionable recommendations for crop cultivation, leveraging machine learning and an interactive interface. It can be a valuable tool for farmers and agricultural professionals to improve crop yields and optimize resource utilization.

### **8. Future Scope**

* Incorporate additional environmental factors such as soil type and pest resistance.
* Expand the dataset to include more crop varieties and regions.
* Implement a mobile-friendly version for broader accessibility.
* Use deep learning techniques for enhanced prediction accuracy.

### **9. References**

* Crop Recommendation Datasets
* Streamlit Documentation
* Random Forest Classifier

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