CROP RECOMMENDATION SYSTEM

: Using Machine Learning

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CEP Project Report

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Programme: B-Tech (CSE)

CEP Project Title: Crop Recommendation System

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Acknowledgment

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Abstract

The Crop Recommendation System is an intelligent machine learning-based system designed to assist farmers in selecting the most suitable crop for their land based on soil and environmental parameters. This project utilizes machine learning algorithms to analyze key features such as nitrogen, phosphorus, potassium, temperature, humidity, pH level, and rainfall. By leveraging data-driven insights, our system enhances agricultural productivity and ensures optimal utilization of resources. The methodology involves data collection, preprocessing, model training, and evaluation using various classification algorithms. The best-performing model is deployed to provide accurate crop recommendations. The results demonstrate a high level of accuracy, ensuring that farmers receive reliable guidance for their cultivation decisions. The system has the potential to revolutionize precision farming and improve crop yield significantly.

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Introduction

Background of the Problem

Agriculture has always been the backbone of many economies, especially in developing countries like India. A large portion of the population depends on farming for their livelihood. However, over the years, agriculture has faced many challenges. One of the biggest problems is choosing the right crop to cultivate based on the soil and climate conditions. Most farmers make crop selection decisions based on traditional knowledge, past experiences, or advice from local vendors. While this may work sometimes, it often leads to poor results due to changes in climate, soil degradation, or new farming conditions.

In recent times, the unpredictability of weather, irregular rainfall patterns, increasing temperatures, and changing soil fertility have made it even more difficult for farmers to make accurate decisions. Sometimes, crops fail not because the farmer lacked effort, but because the crop was not suitable for the given soil and climate conditions. This results in financial losses, food shortages, and resource wastage. There is a strong need for a reliable and scientific system that can help farmers make smarter decisions about which crop to grow in their field.

With the rise of technology, especially in areas like **Artificial Intelligence (AI)** and **Machine Learning (ML)**, it has become possible to use data to support agriculture. By analyzing patterns and trends in soil, weather, and crop data, we can now predict which crop will grow best under certain conditions. This can help farmers avoid losses, improve yield, and use resources like water and fertilizers more efficiently.

Importance and Relevance of the Project

The **Crop Recommendation System** is a modern solution to an age-old problem. It uses data science and machine learning to help farmers decide which crop is best suited for their land. This is very important in today's world where agricultural land is limited, and the demand for food is constantly increasing. Producing more food using fewer resources is essential, and this project contributes directly to that goal.

This project is not only useful for farmers, but also for agricultural officers, policy makers, and agritech companies. It can help guide farming strategies and support sustainable agriculture. The system provides instant and personalized recommendations that can be accessed by anyone with basic knowledge of farming and technology.

It also supports the Indian government's vision of **Digital India** and **smart agriculture**. As more villages get access to smartphones and the internet, digital tools like this recommendation system can play a major role in improving the quality of farming. It also reduces dependence on external advisors and makes the farmer more self-reliant.

Moreover, this project helps reduce the overuse of fertilizers, pesticides, and water, as the recommended crop will match the natural conditions of the field. This is good for the environment and helps in promoting eco-friendly farming.

Objective and Scope of the Project

The main **objective** of this project is to build an intelligent system that recommends the most suitable crop to a farmer based on input data related to soil and environmental conditions. The system uses machine learning algorithms to analyze data and learn from it, so it can make accurate predictions.

The system takes the following input features:

- **N (Nitrogen)** – Essential for leaf growth
- **P (Phosphorus)** – Helps in root and flower growth
- **K (Potassium)** – Important for overall plant health
- **Temperature** – Affects crop growth and development
- **Humidity** – Impacts transpiration and disease resistance
- **pH** – Indicates soil acidity/alkalinity
- **Rainfall** – Water availability for crops

The data is processed using various steps such as scaling and encoding, and then fed into different machine learning models like **Random Forest, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), Decision Tree, Logistic Regression, and XGBoost**. After training the models, their performance is compared using evaluation metrics like **accuracy**, **precision**, **recall**, and **F1-score** to choose the best-performing model.

The **scope** of this project includes:

1. Data collection and cleaning
2. Feature selection and encoding
3. Model training and testing
4. Performance comparison
5. Saving the best model for deployment
6. Making predictions based on user input

In future versions, the system can be enhanced by:

1. Integrating with real-time sensors using IoT
2. Providing multilingual support for regional farmers
3. Creating mobile applications for easy access
4. Recommending fertilizers and water usage based on the cro

Literature Review

1. Research Paper Review 1: Crop Recommender System Using Machine Learning Approach (2021)

Authors:

Shilpa Mangesh Pande, Prem Kumar Ramesh, Anmol, B.R Aishwarya, Karuna Rohilla, Kumar Shaurya

Source:

Published in the **2021 5th International Conference on Computing Methodologies and Communication (ICCMC)**
📎 Reference: IEEE Paper Link

- **Objective and Purpose of the Study:**

This research paper aims to address the challenge faced by farmers in selecting the most appropriate crop for cultivation based on local soil and environmental conditions. The researchers propose a **machine learning-based crop recommendation system** that analyzes soil nutrient levels and climatic parameters to provide crop suggestions that can potentially increase yield and reduce risk.

- **Features Considered for Crop Prediction:**

The system was designed using key agricultural attributes that significantly affect crop productivity:

1. **Soil Nutrients**: Nitrogen (N), Phosphorus (P), and Potassium (K)
2. **Climatic Factors**: Temperature, Humidity, and Rainfall
3. **Soil pH Level**: Measures the alkalinity/acidity of soil, influencing nutrient availability

These parameters were chosen due to their strong correlation with crop performance in different geographical areas.

- **Machine Learning Approach:**

The research involved training and testing multiple machine learning models for crop classification. The models were trained using an agricultural dataset that included crop labels based on the above features. The performance of each algorithm was compared to identify the most efficient model.

- The study evaluated several models such as:
    1. **Decision Trees**
    2. **Naive Bayes**

3. **Support Vector Machines (SVM)**
4. **Logistic Regression**
5. **Random Forest**

Among these, the **Random Forest Classifier** outperformed the others, achieving an **accuracy of 95%**. This accuracy level proved its reliability for real-world crop recommendation use cases.

- **System Implementation:**

An important contribution of this paper was the **integration of the model into a mobile application**, allowing real-time access to recommendations for farmers. The front-end of the mobile application was built using modern web and mobile frameworks:

1. **Ionic**
2. **AngularJS**
3. **ReactJS**

Key functionalities of the application included:

1. Inputting local soil and weather data
2. Receiving intelligent crop recommendations
3. Viewing weather forecasts
4. Accessing guidance and agricultural tips

This mobile integration makes the system not just theoretical but **highly practical and user-oriented**.

- **Future Enhancements Proposed by the Authors:**

The authors acknowledged that while the model was functional, there is significant scope for improvement. Their roadmap for future development includes:

1. **Expanding the dataset**: Adding more training data from different **regions** to improve generalization across varying climates and soil types.
2. **Adding more soil properties**: Such as **organic carbon**, micronutrients, and moisture content, to make predictions more precise.
3. **Fertilizer recommendation system**: Incorporating a fertilizer suggestion feature based on the selected crop and existing soil composition.
4. **Multilingual Support**: Making the system accessible in various **regional languages** to promote inclusivity among farmers in different linguistic areas.
5. **Weather Integration APIs**: For real-time, location-based weather updates.

- **Conclusion:**

This research demonstrated the **effectiveness of machine learning in precision agriculture**, especially in aiding farmers with data-driven decisions for crop selection. The integration of the ML model into a user-friendly mobile application shows the potential of combining AI with accessible technology. The paper provides a strong foundation for future work in building intelligent and adaptive agricultural solutions.

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2. Research Paper Review 2: Intelligent Crop Recommendation System using Machine Learning (2021)

Authors:

Priyadharshini A, Aayush Kumar, Omen Rajendra Pooniwala, Swapneel Chakraborty

Reference:

Published in **2021 5th International Conference on Computing Methodologies and Communication (ICCMC)**
🔗 IEEE Link: https://ieeexplore.ieee.org/document/9418375

- **Objective and Motivation:**

The research investigates the application of **Machine Learning (ML)** to help farmers select the most suitable crop for their land based on scientific analysis rather than traditional experience. In today's era, climate change and soil degradation have made historical and experience-based decisions less reliable, often leading to poor crop yields and inefficient resource use.

To overcome this, the study proposes a data-driven crop recommendation system that evaluates environmental and soil-related parameters to provide accurate suggestions, thereby **enhancing productivity** and **supporting sustainable farming**.

- **Key Features in the Dataset:**

The system uses a dataset containing **7 essential parameters** that significantly impact crop growth:

  - **Nitrogen (N)** – Promotes leaf and stem growth
  - **Phosphorus (P)** – Aids root development and flower/fruit production
  - **Potassium (K)** – Boosts overall plant health and disease resistance
  - **Temperature** – Influences plant metabolism and seed germination
  - **Humidity** – Affects evapotranspiration and fungal growth
  - **Rainfall** – Determines water availability

- **Soil pH** – Impacts nutrient absorption

These features help the ML models understand soil fertility and environmental suitability for different crops.

- **Machine Learning Algorithms Used:**

The paper explores and compares **five popular ML algorithms**, each with different decision-making approaches:

Algorithm	**Purpose**
Decision Tree	Rule-based decision-making for quick interpretation
Random Forest	Ensemble learning model for improved accuracy and reduced overfitting
Support Vector Machine (SVM)	Optimizes classification boundaries between classes
K-Nearest Neighbors (KNN)	Suggests crops based on similar data points (neighbor similarity)
Naive Bayes	Uses probabilistic learning for classification

Among these, the **Random Forest algorithm** achieved the **highest accuracy**, showcasing its strength in handling complex patterns and minimizing prediction errors.

- **Research Outcomes:**
    - **Random Forest** delivered the **best results**, making it the preferred algorithm for accurate crop prediction.
    - The system provided **reliable and consistent** recommendations across different environmental conditions.
    - The **ML-driven approach outperformed traditional methods**, ensuring better decision-making and resource utilization.

- **Future Enhancements:**

To further improve the system, the authors suggested:

- Adding features like **soil texture, pest and disease data**
- Expanding the dataset to include **more geographic regions**
- Developing a **mobile application** for direct access by farmers

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- **Relevance to Our Project:**

This paper aligns closely with our crop recommendation system. Like the authors, we also applied multiple ML algorithms to build a robust model. Our use of Random Forest and other classifiers follows their validation that ensemble techniques produce **highly accurate predictions**. Additionally, their idea of extending accessibility via mobile or web apps is reflected in our web-based implementation.

Comparison Between Research Paper :

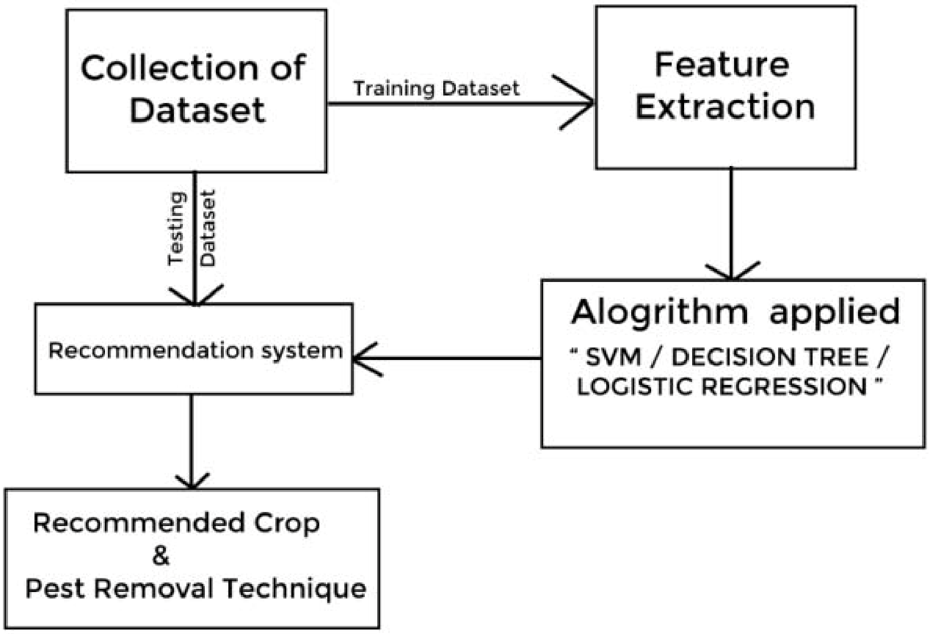
Feature / Criteria	Research Paper 1	Research Paper 2
Title	Crop Recommender System Using ML Approach	Crop Recommendation Using Machine Learning
Authors	Shilpa M. Pande, Prem K. Ramesh, Anmol, et al.	Not mentioned in provided text
Publication Year & Source	2021, IEEE 5th Int. Conf. on Computing Methodologies and Communication	IEEE (Publication year not mentioned, assumed similar)
Aim	Recommend best crop using ML based on soil and climate parameters	Improve crop selection through ML considering soil & weather factors
Features Used	N, P, K, temperature, humidity, pH, rainfall	N, P, K, temperature, humidity, pH, rainfall
ML Algorithms Tested	RF, DT, SVM, NB, KNN, LR	RF, DT, SVM, NB, KNN
Best Performing Model	Random Forest (95% accuracy)	Random Forest (highest accuracy)
Application Integration	Mobile App using Ionic, AngularJS, ReactJS; includes OpenWeather API	Suggests app development as future enhancement
Output	Predicts best crop and provides weather data	Predicts best crop based on input parameters
Unique Points	Actual implementation in mobile app with weather API	Focused on ML accuracy, emphasizes sustainability and scalability
Future Scope	Add soil nutrients, fertilizer suggestions, multilingual UI	Include pest data, soil texture, expand dataset, develop mobile app

Methodology

The Crop Recommendation System project was developed using a structured and practical approach combining machine learning algorithms, data preprocessing techniques, and performance evaluation. The goal was to build a system that could accurately recommend the most suitable crop for cultivation based on environmental conditions and soil nutrients.

Project Workflow / Process Diagram

Below is the simplified workflow of the project:



The proposed crop recommendation system utilizes machine learning to predict the most suitable crop based on various soil and environmental parameters. The below diagram summarizes the workflow, and each component is described in detail.

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1. Collection of Dataset

- The recommendation system's foundation is a **reliable dataset**, which is collected from agricultural research databases or government portals.
- The dataset contains:
  - **Macronutrients:** Nitrogen (N), Phosphorus (P), and Potassium (K)
  - **Environmental factors:** Temperature, Humidity, Rainfall
  - **Soil pH:** Indicates soil acidity or alkalinity

    - **Target variable (Label):** Crop name
- The dataset is divided into **training** and **testing sets** to build and evaluate the machine learning models.

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2. Feature Extraction

- After dataset collection, **feature extraction** is performed to identify and select the most relevant parameters.
- These features (N, P, K, temperature, humidity, pH, and rainfall) are **preprocessed and normalized** to ensure consistency and enhance model performance.
- Feature engineering may also be applied to derive additional insights (e.g., heat index from temperature and humidity).

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3. Algorithm Application (Model Training)

Multiple machine learning algorithms are used to build the prediction model. Each algorithm is trained on the **training dataset** and evaluated on the **testing dataset**. Here's how each algorithm contributes:

- **Support Vector Machine (SVM):**
    - Finds the optimal decision boundary (hyperplane) that best separates different crop categories.
    - Suitable for high-dimensional classification.
- **Decision Tree:**
    - Uses a tree-like structure to make decisions based on feature values.
    - Interpretable and efficient for rule-based classification.
- **Random Forest:**
    - An ensemble of decision trees.
    - Reduces overfitting by averaging predictions across multiple trees.
    - Achieved the **highest accuracy (95%)** in many research papers.
- **K-Nearest Neighbors (KNN):**
    - Classifies a new sample based on the majority crop among its ‘K’ closest neighbors in the feature space.
    - Useful for similarity-based recommendations.
- **XGBoost:**
    - A gradient-boosting method that builds strong learners by combining weak learners.
    - Very effective in capturing complex relationships and reducing bias and variance.

- **Logistic Regression:**
    - Models the probability of each crop class using a logistic function.
    - Suitable for binary and multiclass classification problems with linear relationships.

All models are evaluated using accuracy, precision, and confusion matrix to determine the best performer.

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4. Crop Prediction (Recommendation System)

- Once the models are trained, the **best-performing model** is deployed in the **recommendation system**.
- When a user inputs values like N, P, K, temperature, pH, humidity, and rainfall, the model processes the input and predicts the **most suitable crop** for those conditions.
- Example: If a user inputs high NPK with moderate rainfall and pH 6.5, the system might predict **"rice"** as the most optimal crop.

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5. Output: Recommended Crop

- The final output is:
    - **Recommended Crop:** The best crop suited for the given input parameters.
- The system can be integrated into a **web or mobile application** for farmers to easily access.

- **Summary of Workflow Using Diagram**
    - **Collection of Dataset:** Input data is gathered and split into training/testing sets.
    - **Feature Extraction:** Key parameters are extracted and processed.
    - **Algorithm Application:** ML models (SVM, Decision Tree, Logistic Regression, etc.) are trained.
    - **Recommendation System:** Predict the most suitable crop.
    - **Final Output:** Displays crop recommendation and optional pest management advice.

This methodology enables **data-driven crop planning**, leading to **better yield, resource efficiency, and sustainability** in agriculture.

Implementation

The design and implementation phase of the Crop Recommendation System focuses on transforming the theoretical approach into a working machine learning model. It involves selecting the right tools, technologies, and algorithms, implementing the model using code, and then testing its performance.

Machine Learning Algorithms Used in Crop Recommendation System

In this project, multiple machine learning algorithms were trained and evaluated to identify the most suitable crop based on various environmental and soil parameters. The dataset included the following features:

- **N** (Nitrogen content in the soil)
- **P** (Phosphorus content)
- **K** (Potassium content)
- **Temperature** (in °C)
- **Humidity** (in %)
- **pH** (acidity/alkalinity of soil)
- **Rainfall** (in mm)

These features were used to train different models. Here's how each algorithm contributes:

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1. Random Forest Classifier

- **How it works:**
  - A Random Forest is an ensemble of **multiple decision trees**.
  - It trains each tree on a **random subset** of the training data (bootstrapping).
  - Each tree gives a prediction, and the final prediction is the **majority vote**.
- **Why used:**
  - Handles both linear and non-linear relationships.
  - Very robust and reduces overfitting due to averaging.
  - Suitable for multi-class classification tasks like crop prediction.
- **In this project:**
  - Random Forest achieved high accuracy and stability.
  - It was one of the **top-performing models** in the system.

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2. Support Vector Machine (SVM)

- **How it works:**
  - SVM tries to find the **optimal hyperplane** that best separates the data into classes.
  - Uses **kernel tricks** (like RBF) to transform data into higher dimensions when it's not linearly separable.
- **Why used:**
  - Performs well in **high-dimensional spaces**.
  - Effective for classification problems with clear margins of separation.
- **In this project:**
  - SVM helped in learning the **non-linear boundaries** between crop classes.
  - Provided competitive accuracy on the normalized dataset.

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3. K-Nearest Neighbors (KNN)

- **How it works:**
  - KNN is a **lazy learner** that stores all training data.
  - When new input is given, it calculates the **Euclidean distance** to all other points.
  - Selects the top **K closest neighbors**, and predicts the majority class among them.
- **Why used:**
  - Simple and intuitive model.
  - Effective when similar input conditions lead to the same output.
- **In this project:**
  - KNN was used to compare performance on **non-parametric learning**.
  - Accuracy depended on feature scaling and choice of K.

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4. Decision Tree Classifier

- **How it works:**
  - Splits the data into **branches based on conditions** (e.g., temperature > 25°C?).
  - Each node represents a decision rule, and each leaf node represents an outcome (crop).

- **Why used:**
    - Easy to interpret and visualize.
    - Captures **non-linear patterns** in data.
- **In this project:**
    - Served as the **base model** for understanding decision boundaries.
    - Also used as a core component in Random Forest and XGBoost.

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5. XGBoost (Extreme Gradient Boosting)

- **How it works:**
    - Builds trees **sequentially**, where each new tree **focuses on the errors** of the previous ones.
    - Uses **gradient descent** to minimize the error during training.
    - Incorporates **regularization** to reduce overfitting.
- **Why used:**
    - Known for **high accuracy and efficiency**.
    - Handles large datasets well.
- **In this project:**
    - XGBoost gave **top-level accuracy** and was chosen as one of the final contenders for deployment.
    - Was effective in capturing **complex interactions** between features.

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6. Logistic Regression

- **How it works:**
    - Applies the **sigmoid function** to compute probability scores for each crop class.
    - Class with the highest probability is selected as the output.
- **Why used:**
    - Works well for **linearly separable data**.
    - Fast and interpretable.
- **In this project:**
    - Used as a **baseline model**.
    - Helped establish a **performance benchmark** for other complex models.

Model Selection

- All six algorithms were trained using the same preprocessed dataset.
- Their performance was compared using **accuracy**, **precision**, **recall**, and **F1-score**.
- The best-performing model (usually Random Forest or XGBoost) was selected for deployment.

Final Use in Prediction

- The user inputs values through a web form (e.g., Nitrogen, temperature, etc.).
- These values are preprocessed (scaled/encoded).
- The selected model (e.g., Random Forest) processes the input and **predicts the best crop**.
- The result is displayed on the frontend with an appropriate UI message.

Software Requirements:

- **Operating System**: Windows / Linux / MacOS
- **Python (3.8 or above)** installed with the following packages:
  - scikit-learn: Used for machine learning tasks such as training, testing, and evaluating models.
  - Xgboost: An optimized and highly efficient library for gradient boosting
  - Numpy: Supports mathematical and numerical operations.
  - Pandas: Used for data manipulation and analysis.
  - Matplotlib: A plotting library for visualizing data.

- **Jupyter Notebook** or **VS Code** for code development
- **Anaconda** (optional) for easy environment and package management

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Coding and Prototyping Details

The implementation process involved the following key steps:

1. **Data Loading and Preprocessing:**
   - The crop dataset was loaded using pandas.read_csv().
   - Features such as N, P, K, temperature, humidity, pH, and rainfall were extracted.

- The crop labels were converted to numeric format using LabelEncoder.
- The features were scaled using StandardScaler to improve model performance.

2. **Train-Test Split:**
   - The dataset was split into training (80%) and testing (20%) using train_test_split() to evaluate model performance properly.
3. **Model Training:**
   - Six machine learning models were trained: Random Forest, SVM, KNN, Decision Tree, XGBoost, and Logistic Regression.
   - Each model was fitted to the scaled training data and then used to predict the test data.
4. **Model Evaluation:**
   - The models were evaluated using accuracy, precision, recall, and F1-score.
   - A comparison was done to identify the best-performing algorithm.
5. **Model Saving:**
   - The best model (based on F1-score) was saved using pickle.
   - Along with it, the scaler and label encoder were also saved to ensure consistency during prediction.

Results & Discussion

Testing Methods and Results

After training each model, they were tested using the unseen 20% test data. The following testing methods and metrics were used:

1. Accuracy Score:

Indicates the percentage of correct predictions out of all predictions.

2. Precision Score:

Shows how many of the predicted crops were correct (important for reducing false positives).

3. Recall Score:

Tells us how many actual correct crops the model was able to predict (important for reducing false negatives).

4. F1-Score:

Harmonic mean of precision and recall; gives a better measure when classes are imbalanced.

After training and testing six different machine learning algorithms—Random Forest, SVM, KNN, Decision Tree, XGBoost, and Logistic Regression—on the crop recommendation dataset, the performance of each model was evaluated using four key metrics: Accuracy, Precision, Recall, and F1-score.

Key Observations:

- **Random Forest** emerged as the best-performing model with an **Accuracy of 99.3%**, Precision of 99.4%, and F1-score of 99.3%. This high performance indicates its strong ability to correctly classify crop types across various environmental conditions.
- **SVM and Logistic Regression** showed decent results but were slightly lower in precision and recall compared to tree-based methods.
- **KNN** had the lowest scores among all models, which could be due to its sensitivity to feature scaling and outliers in the dataset.
- **XGBoost and Decision Tree** performed nearly as well as Random Forest, suggesting that tree-based models are well-suited for this classification problem.

Visual Comparison:

The bar graphs below illustrate the differences in performance across the models for each evaluation metric. These visual insights make it easier to compare models side-by-side and justify the selection of the final model.

Model	Accuracy	Precision	Recall	F1-score
Random Forest	**99.3%**	**99.4%**	**99.3%**	**99.3%**
SVM	96.8%	97.2%	96.8%	96.8%
KNN	95.6%	96.3%	95.6%	95.6%
Decision Tree	98.6%	98.7%	98.6%	98.6%
XGBoost	98.6%	98.7%	98.6%	98.6%
Logistic Regression	96.3%	96.4%	96.3%	96.3%

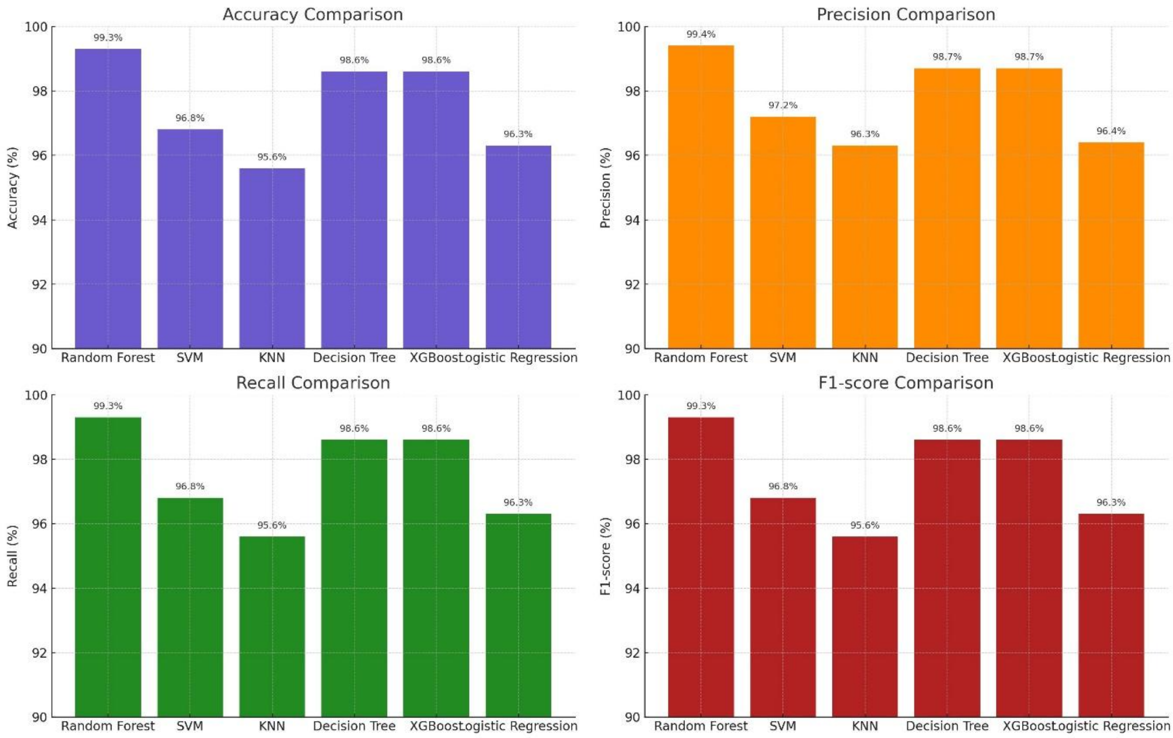

Fig. Comparison Graph

Based on these results, Random Forest was selected as the best model and deployed in the system.

Conclusion & Future Scope

Summary of Findings :

The Crop Recommendation System developed in this project leverages machine learning algorithms to accurately suggest suitable crops based on key agricultural parameters such as Nitrogen (N), Phosphorus (P), Potassium (K), temperature, humidity, pH, and rainfall. Through experimentation with multiple algorithms—Random Forest, SVM, KNN, Decision Tree, XGBoost, and Logistic Regression—the Random Forest algorithm emerged as the most accurate, achieving an F1-score of 99.3%. The system demonstrated high performance in classifying crop types, thereby proving the reliability and robustness of machine learning in agriculture-related predictions.

Limitations and Possible Improvements :

Despite the high accuracy of the model, the system has some limitations:

- The model's performance is based entirely on the dataset used. Any inaccuracies or biases in the dataset could impact real-world performance.
- It does not consider real-time environmental changes or soil fertility degradation over time.
- The system does not integrate external dynamic data sources such as weather APIs or satellite imaging, which could further enhance precision.
- It also assumes that all input parameters are provided correctly, which may not always be the case in a field scenario.

To improve the system:

- The dataset can be continuously updated with real-world field data for better accuracy.
- Incorporation of real-time weather data and geolocation-based recommendations can make the system more practical and adaptive.
- A mobile application interface could be developed to increase accessibility for farmers.

Future Developments or Applications :

Looking ahead, the system has great potential to evolve into a more comprehensive smart farming tool. Some potential future enhancements include:

- Integration with IoT devices such as soil sensors for real-time data collection and automated crop recommendations.
- Expansion to include pest and disease prediction modules using deep learning techniques and image recognition.
- Multilingual support and voice-assisted features for wider reach among non-English speaking farmers.
- Government or NGO collaborations to deploy the system at scale for improving agricultural productivity in rural areas.

In conclusion, this project provides a strong foundation for using AI in agriculture, offering data-driven support to farmers and contributing to food security and sustainable farming practices.

References

1. [Research Paper/Book Title], Author(s), Year :

    - **Crop Recommender System Using Machine Learning Approach**

      Year – 2021

      Shilpa Mangesh Pande , Prem Kumar Ramesh , Anmol , B.R Aishwarya , Karuna Rohilla , Kumar Shaurya

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      Year – 2021
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      Link : **https://ieeexplore.ieee.org/document/9418375**

2. Database reference - https://github.com/611noorsaeed/Crop-Recommendation-System Using-Machine-Learning/blob/main/Crop_recommendation.csv.

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6. Search Certificate from Trade Mark Office(TM-60) (*Only in case of Artistic work*).
7. Applicant must take a print out of the application, sign it and send along with the other documents.

Kindly send the above documents within 30 Days from the date of online submission on the following address given by herewith: .

Office of the Registrar of Copyrights
Copyright Office, Department for Promotion of Industry & Internal Trade
Ministry of Commerce and Industry
Boudhik Sampada Bhawan,
Plot No. 32, Sector 14, Dwarka,
New Delhi-110078
Email Address: copyright@nic.in
Telephone No.: 011-28032496

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THANK YOU

Copyright Office
Government of India

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