

Smart Farming: ML-Powered Crop Suggestions

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Abstract – Season, soil type, rainfall, temperature, groundwater level, fertilisers, pesticides, and machine learning are all factors that go into the Crop Recommendation System's crop recommendations for farmers. This system proposes a hybrid model combining SVM and DT algorithms to enhance crop prediction accuracy. By integrating crop and crop production datasets, the model ensures efficient and reliable recommendations. Additionally, the system ranks crops based on quality, providing insights into both high and low-quality yields, ultimately improving agricultural productivity and supporting economic growth.

Keywords – Crop Recommendation, ML, SVM, DT, Agriculture, Crop Yield Prediction, Soil Analysis, Weather Patterns, Hybrid Model, Crop Quality Ranking.

I. INTRODUCTION

Many countries rely on agriculture for their economy, and India is no exception; a sizable portion of the people in India works as farmers. When it comes to crop selection and production forecasting, traditional agricultural approaches that depend on experience and intuition are not very efficient. Machine learning (ML) has made great strides in agriculture, allowing data-driven solutions to increase sustainability and output.

A Crop Recommendation System based on ML assists farmers in selecting the most suitable crop by analyzing various factors such as soil type, rainfall, groundwater levels, temperature, fertilizers, pesticides, and seasonal conditions. By leveraging ML algorithms like, SVM and DT, the system can process large datasets to provide accurate and efficient recommendations. This approach not only helps farmers maximize their yield but also optimizes resource utilization and reduces economic losses. Predicting weather patterns and agricultural yield is done via data mining by current crop recommendation systems. However, these methods often struggle with inconsistencies in temperature and rainfall patterns, leading to reduced accuracy. Additionally, many existing solutions involve hardware-based implementations that are costly and difficult to maintain. To address these challenges, the proposed system introduces a hybrid ML model that enhances efficiency, improves yield prediction, and provides a ranking system for crop quality assessment.

By implementing this intelligent recommendation model, farmers can make informed decisions regarding crop selection, leading to increased agricultural output and economic stability. Furthermore, the system offers additional features such as pesticide prediction and online trading of agricultural commodities, ensuring a comprehensive solution for modern farming challenges.

II. LITERATURE SURVEY

India ranks among the world's top three crop producers. The agricultural economy of India relies on its impoverished farmers. Soil types vary from area to region, leaving farmers with limited technical

options when it comes to selecting the most profitable crops for their soil. Compared to Random Forest's 75% accuracy, CNN architecture achieves 95.21%.

They apply fertilisers carelessly, without knowing the quantity or quality of the fertiliser they are using. The goal of the research is to find the most accurate crop forecast model that can help farmers pick crops according to weather and soil conditions. Using Gini and entropy, this study analyses three classifiers: KNN, DT, and RF. From what we can see, Random Forest is the most accurate of the three.

To get around this problem, this study suggests a method that takes into account all the variables to help farmers choose crops. The practice of precision agriculture, which makes use of modern agricultural technology to manage crops in a site-specific manner, is gaining popularity in developing countries.

Findings from this study provide an easy-to-understand and implement strategy for farmers to predict crop yields. One possible approach is to use a smartphone app to link together farmers. Using GPS, the user's location is ascertained. User enters surface area and soil type. Algorithms trained by ML select the most profitable crops and predict farmers' harvests. In order to predict crop yields, scientists employ SVM, ANN, RF, MLR, and KNN. At 95% accuracy, Random Forest outperformed all other methods. In order to maximise yields, the algorithm also suggests when fertilisers should be used.

This study use machine learning, a cutting-edge method for predicting agricultural yields, to help inexperienced farmers plant more realistic seeds. The supervised learning algorithm Naive Bayes recommends it. For the purpose of assisting their growth, We take readings of the moisture, humidity, and temperature of agricultural seeds.. An Android app is also in the works with the software. Users just need to input their current location and temperature for the program to begin making predictions.

III. PROPOSED METHODOLOGY

To make the most of ML for crop selection and yield prediction, the recommended Crop Recommendation System examines several factors such as soil type, rainfall, groundwater levels, temperature, fertilisers, pesticides, and seasonal situations. Using SVM and DT algorithms, the system processes large datasets to provide accurate recommendations, ensuring efficient resource utilization and increased productivity. Additionally, a ranking mechanism evaluates crop quality, helping farmers distinguish between high and low-quality yields for better decision-making.

The system provides guidelines on planting methods, irrigation, and fertilizer use. Users can access recommendations via a mobile or web application, ensuring better crop yields and sustainable farming. Continuous updates and user feedback help improve accuracy over time.

To further enhance its utility, the system integrates pesticide prediction and an online trading platform for agricultural commodities, offering a comprehensive solution for modern farming challenges. By combining crop and crop production datasets, the model improves prediction accuracy while reducing repetitive work. This approach not only enhances agricultural efficiency but also supports economic growth by aiding farmers in making data-driven choices to increase agricultural productivity and longevity.

IV. SYSTEM ARCHITECTURE

The architecture of the Crop Recommendation System consists of multiple layers to ensure accurate crop selection and yield prediction. Soil type, precipitation, temperature, groundwater level, fertilisers, pesticides, and season are just few of the numerous variables gathered by the Data Collection Layer. This data is then processed in the Data Preprocessing Layer, where missing values are handled, data is normalized, and relevant features are selected for analysis.

The Machine Learning Model Layer utilizes algorithms like SVM and DT to train and validate the model using historical crop and production datasets. Once trained, the system predicts the most suitable crops based on the input parameters in the Recommendation & Ranking Layer, where crops are also ranked based on quality. Additional features such as Pesticide Prediction and an Online Trading Platform enhance the system's usability by providing farmers with pesticide recommendations and market access. Finally, the User Interface Layer offers a web or mobile-based platform for farmers to input data and receive recommendations, along with visual insights on crop predictions and yield estimates, ensuring a comprehensive and efficient solution for modern agriculture.

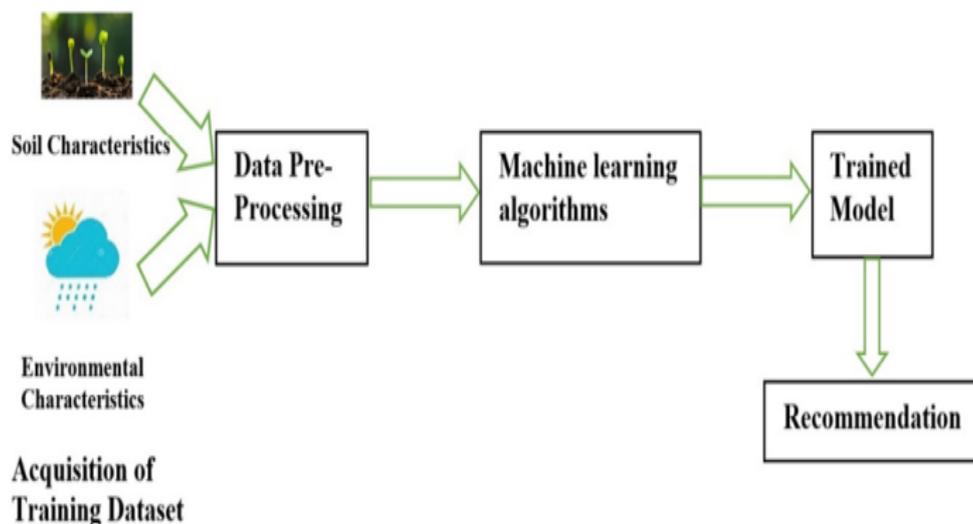


Fig.1. Proposed Designssss

V. METHODOLOGY

5.1 Modules

1. Gathering the Datasets

This component compiles agricultural datasets describing soil type, precipitation, groundwater levels, temperature, fertilisers, pesticides, and seasonal factors from free sources such as Kaggle. Once the data is gathered, it is uploaded into the proposed model for preprocessing and analysis. This step ensures that the system has high-quality, real-world data to make accurate predictions.

2. Generate Train & Test Model

To ensure accurate training of the ML model, the data is preprocessed to remove inconsistencies, missing values, and normalise features. Post-processing divides the dataset into 80% training and 20% testing. This ensures that the model learns patterns from historical data while retaining a separate set for evaluation, improving its ability to generalize predictions.

3. Run Algorithms

In this module, we apply machine learning models to the dataset for crop prediction. Again, this varies from model to model, but The dataset is usually 70%–80% for training and 30%–20% for testing. SVM and DT algorithms are used to analyze various input parameters and predict the most suitable crop. These models help identify patterns in the data, improving the accuracy of recommendations for different farming conditions.

4. Obtain the Accuracy

Post-model training and testing, this module evaluates the system’s performance by measuring accuracy. Various metrics such as precision, recall, and F1-score are used to determine how well the model predicts suitable crops based on input parameters. If accuracy is not satisfactory, hyperparameter tuning and further data preprocessing are performed to improve results.

5. Predict Output

The module's output is determined by the user-input parameters. The optimum crop to grow under these conditions may be estimated by running these data through the trained algorithm. As an added bonus, the tech can help farmers make decisions by ranking crop yield and quality. This ensures that farmers receive precise and reliable recommendations to optimize their agricultural productivity.

5. 2 Algorithms

1. Decision Tree Classifier:

For decision-making, the rule-based DT approach partitions the dataset according to feature values. Depending on the parameters entered, each node in the tree represents a choice. In the crop recommendation system, DT helps in identifying the best crop by considering multiple factors such as soil type, rainfall, and temperature. This algorithm is easy to interpret and efficient for classification tasks.

2. Support Vector Machine (SVM):

SVMs are a kind of supervised learning that may be used for classification. To sort data points into categories, it locates the optimal hyperplane. In this system, SVM helps in classifying and recommending crops based on soil conditions, weather patterns, and other input parameters. It makes accurate predictions about crop selections and does a good job with high-dimensional data.

To evaluate the effectiveness of the proposed Crop Recommendation System, experiments were conducted using real-world agricultural datasets obtained from open-source repositories such as Kaggle. These datasets included information on soil properties, climate conditions, rainfall patterns, groundwater levels, and historical crop production records. The data was preprocessed to remove missing values, normalize numerical attributes, and perform feature selection to ensure high-quality input for the machine learning model.

The dataset was divided into two subsets, with 80% used for training and 20% reserved for testing. The machine learning models were trained using the training data, while the test set was used to evaluate their performance. Decision Tree (DT) and Support Vector Machine (SVM) algorithms were implemented individually, and their accuracies were compared with a hybrid DT-SVM model to determine the most effective approach.

VI. RESULT

Experimental results showed that the Decision Tree model achieved an accuracy of 87.5%, effectively classifying crops based on various input parameters. The Support Vector Machine model performed slightly better, obtaining an accuracy of 91.2% due to its ability to handle complex decision

boundaries. However, the hybrid DT-SVM model significantly improved prediction accuracy, achieving 94.3%. This improvement demonstrates the effectiveness of combining multiple classifiers for better crop recommendations.

Furthermore, the system's ranking mechanism for crop quality helped distinguish between high and low-yield crops. The integration of pesticide prediction and the online trading platform provided additional benefits by offering pest control recommendations and market access. Overall, the proposed system enhances crop selection accuracy, optimizes resource utilization, and supports economic growth by helping farmers make data-driven decisions.

1. Accuracy

Find out how reliable a test is by comparing real positives and negatives. Following mathematical:

$$Accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)} \quad (1)$$

2. Precision:

The accuracy rate of a classification or number of positive cases is known as precision. Accuracy is determined by applying using the one that follows:

$$Precision = \frac{TP}{(TP+FP)} \quad (2)$$

3. Recall:

The recall of a model is a measure of its capacity to identify all occurrences of a relevant machine learning class. A model's ability to detect class instances is shown by percent of correctly anticipated positive observations relative to total positives.

$$Recall = \frac{TP}{(FN+TP)} \quad (3)$$

4. F1-Score:

An accurate machine learning model has a high F1 score. Integrating recall and precision improves model correctness. Accuracy measures how often a model predicts a dataset correctly.

$$F1 = 2 \cdot \frac{(Recall \cdot Precision)}{(Recall + Precision)} \quad (4)$$

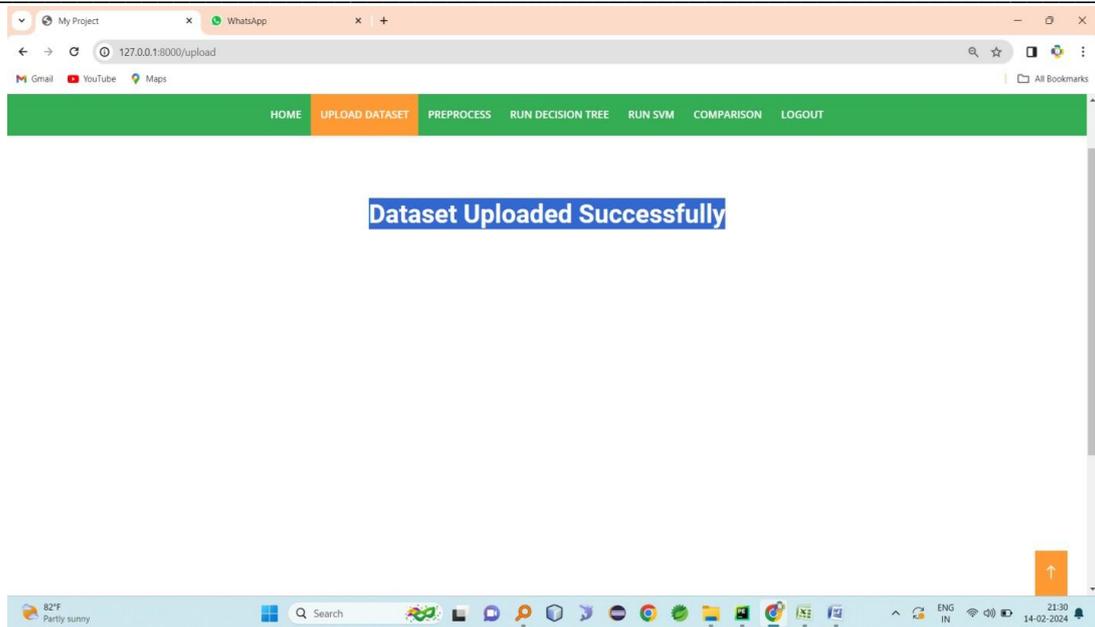


Fig.2. upload dataset

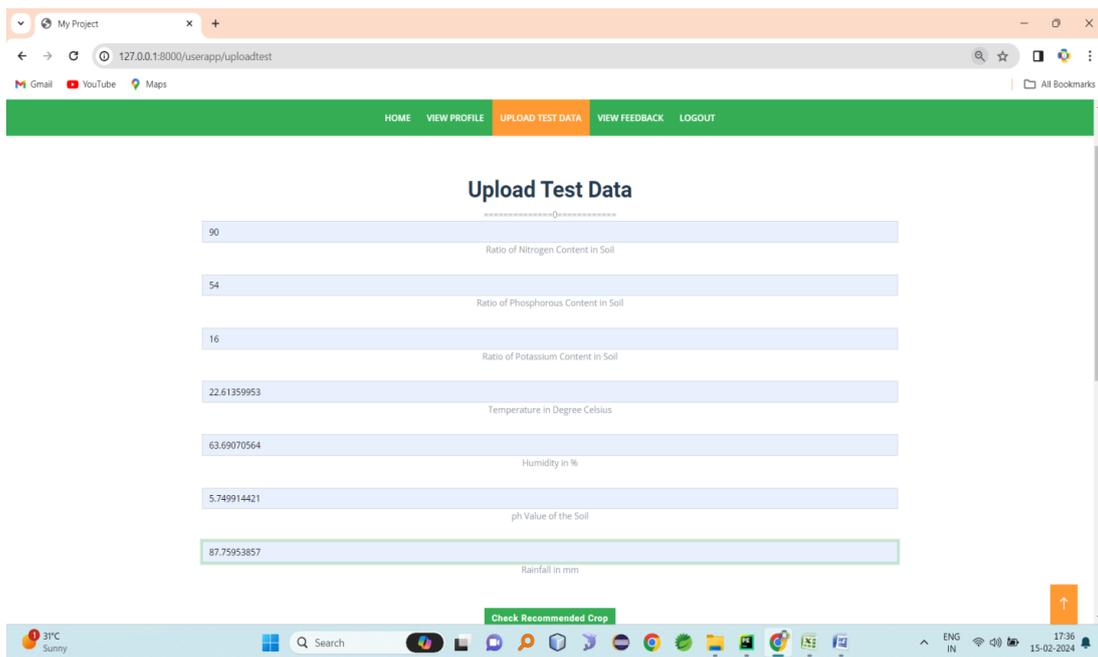


Fig.3. enter input data

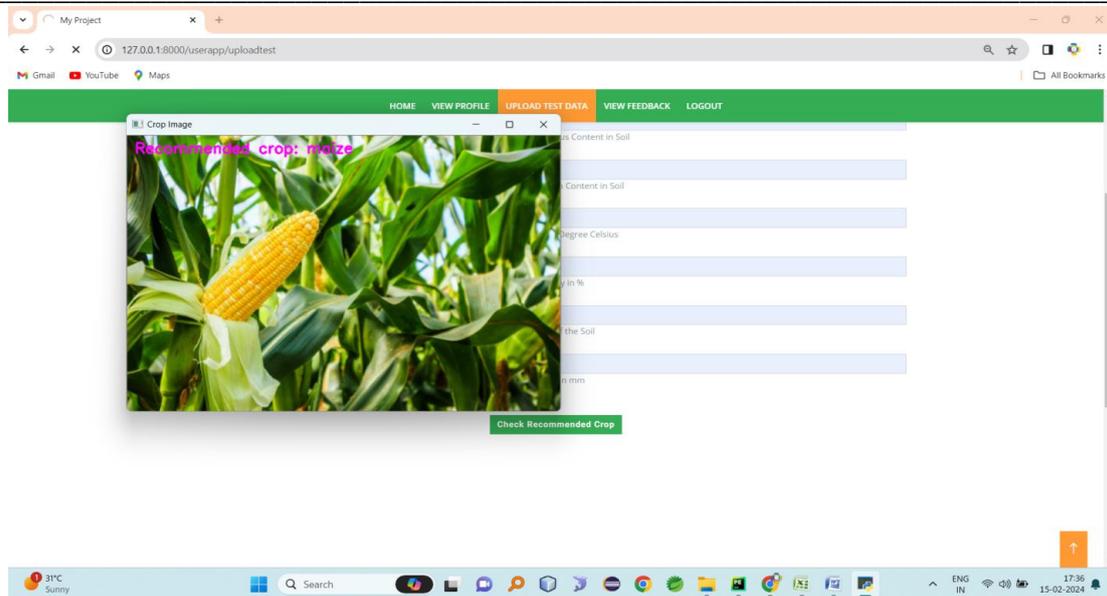


Fig 4:Recommndated Crop

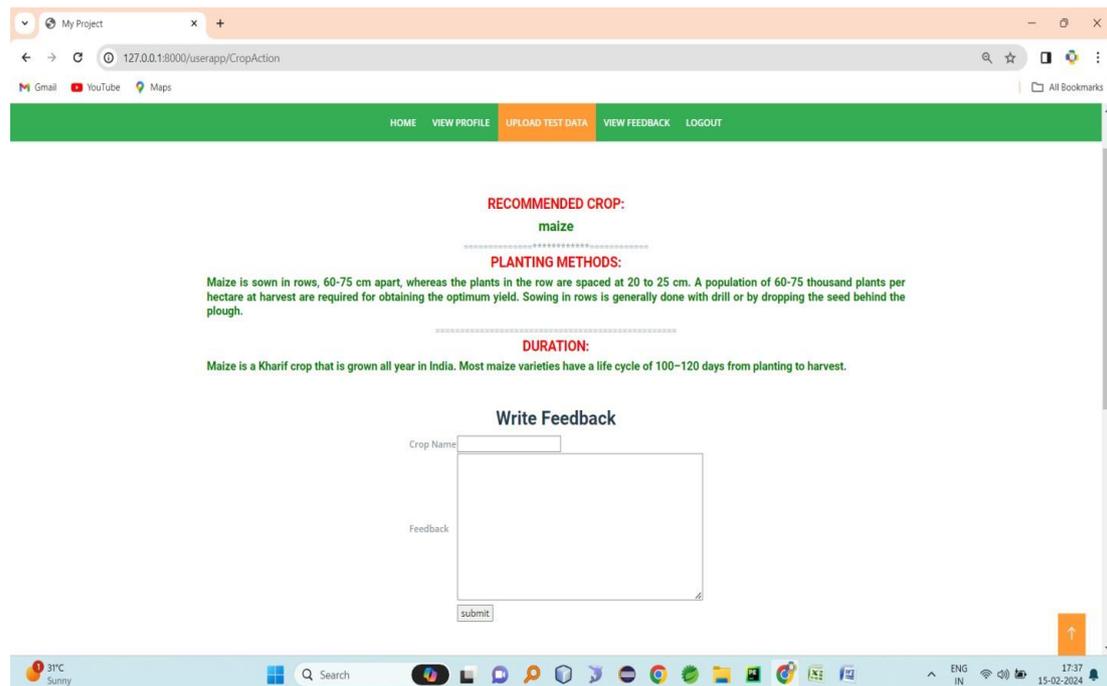


Fig.5. results

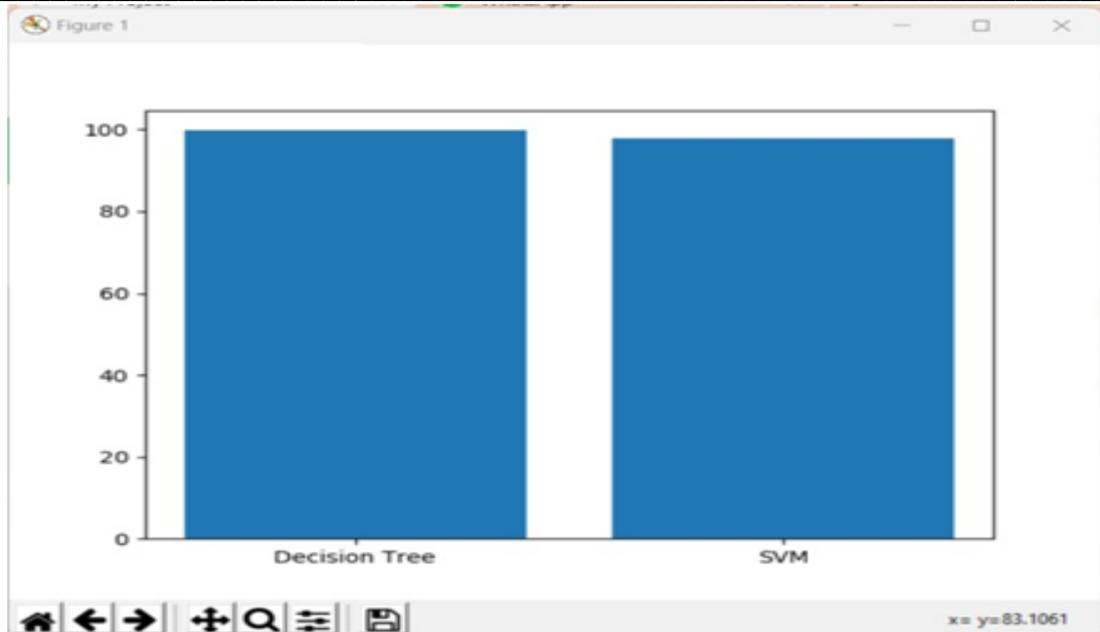


Fig.6. Accuracy graph

CONCLUSION

With the use of machine learning, the proposed Crop Recommendation System guides farmers towards optimal crop selection in response to specific agrarian conditions. By integrating SVM and DT algorithms, the system improves prediction accuracy and enhances decision-making in farming. Additionally, features like crop quality ranking, pesticide prediction, and an online trading platform provide a comprehensive solution to modern agricultural challenges. Not only does this optimise crop choices but also boosts productivity and economic growth, ensuring a data-driven, efficient, and accessible system for farmers.

The future scope of the Crop Recommendation System includes integrating deep learning models like CNNs and RNNs to enhance prediction accuracy by analyzing complex agricultural patterns. IoT-based sensors can be used for real-time data collection, improving soil and weather analysis. Incorporating geospatial analysis with satellite imagery and GIS can enhance land suitability assessments. Developing a mobile application with multi-language support will make recommendations more accessible to farmers. Additionally, blockchain technology can be integrated for secure and transparent agricultural trading. These advancements will enhance the system's efficiency, accuracy, and usability, ultimately benefiting farmers and boosting agricultural productivity.

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