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CROP AND FERTILIZER RECOMMENDATION SYSTEM

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ABSTRACT

The Crop and Fertilizer Recommendation System is a Python-based Machine Learning project aimed at recommending optimal crops to farmers based on various soil properties and environmental factors. The goal is to leverage data-driven insights to suggest the most suitable crops using the right fertilizer types, thereby enhancing agricultural productivity and promoting sustainable farming. In this project, we will develop a predictive model that can analyze soil nutrients (such as Nitrogen, Phosphorus, Potassium levels), climatic conditions (including temperature and humidity), and rainfall patterns, along with the type of fertilizer to recommend the most appropriate crop for cultivation. The goal is to predict the crop category and the appropriate fertilizer class, such as Wheat, Rice, Maize, etc., based on soil type. This aligns with the definition of a classification problem, where the target variable is categorical.

1. INTRODUCTION

Agriculture remains the backbone of many developing economies, where maximizing crop yield is essential for food security and farmer income. However, challenges such as poor soil management, incorrect crop selection, and improper fertilizer usage often lead to reduced productivity and environmental degradation. To address these issues, modern technology is being integrated into agriculture through intelligent systems that provide data-driven solutions.

Existing System:

In India we have 58% of farmers and they only earn 19.9% of the country's GDP. We have different websites for farmers which gives them information about which crop would give them high yield and profits.We also have websites which detect the diseases of the crop cultivated. Various websites give farmers the information regarding the fertilizers they need to use in order to have good yield and profits.

Proposed System:

To overcome the disadvantages of the existing system we had created an integrated platform for the farmers called AgriPredict.AgriPredict website utilizes machine learning and data analytics that provides a one-stop platform for farmers in rural India, to suit their information demands. There are 3 major features in this project namely; Crop recommendation based on nutrients present in soil and weather in that area, Fertilizer recommendation based on nutrients in soil and crop, Disease prediction based on a picture**.**

2-RELATED WORK

Title: "Machine Learning Approaches for Crop Recommendation and Yield Prediction" Reference: IEEE Access, 2023

Authors: Patel, R., Sharma, S., & Verma, A.

Summary:

This study evaluates different ML models (Random Forest, SVM, and Neural Networks) for crop recommendation based on soil parameters (N-P-K levels, pH, moisture) and weather data. The authors found that Random Forest outperformed other models with an accuracy of 92% in recommending suitable crops. The system also integrates historical yield data to improve predictions.

Key Features:

Uses soil sensor data and weather APIs.

real-time recommendations via a mobile app.

Focuses on minimizing input costs while maximizing yield.

3-REQUIREMENT ANALYSIS

Functional Requirements:

A Crop and Fertilizer Recommendation System utilizes machine learning to analyze soil, weather, and historical crop data to provide optimal recommendations. Below are the key functional requirements categorized based on system functionality.

- User registration and authentication
- Accept soil parameters (pH, moisture, NPK levels)
- Predict the best crop based on soil and weather data
- Suggest optimal fertilizers based on soil deficiencies

Non-Functional Requirements:

The system should be scalable, secure ,and efficient ,with a user-friendly interface ensuring smooth performance

- Performance
- Security
- Scalability
- Usability
- Reliability & Availability
- Logging &Monitoring

Software Requirements:

1. Operating Systems : Windows 10
2. Coding Language :

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Python , Web technologies

3. IDE : VS Code
4. Libraries : utils, pickle, torch, PIL……
5. Interface : Flask

Hardware Requirements:

Processor : Intel Core i5 or higher.
RAM : 8GB.
Storage : At least 120GB HDD or SSD

4-DESIGN

System Architecture:

The Crop and Fertilizer Recommendations System is designed to support farmers by providing intelligent, data-driven recommendations through an integrated architecture. The system begins with the User Interface, where farmers can input data, set their preferences, view personalized recommendations, and update their requests. This input is complemented by various Data Sources such as soil data, weather data, and crop data, which are essential for accurate analysis. All the collected data is sent to the Analysis Engine, which processes the information using advanced recommendation algorithms to generate suitable suggestions for crop selection and fertilizer application. The processed data and outputs are stored securely in a Database, ensuring easy access for future use and reporting. Finally, the Report Generation module creates detailed and user-friendly reports based on the analysis results, offering farmers actionable insights that can enhance their agricultural productivity and decision-making.

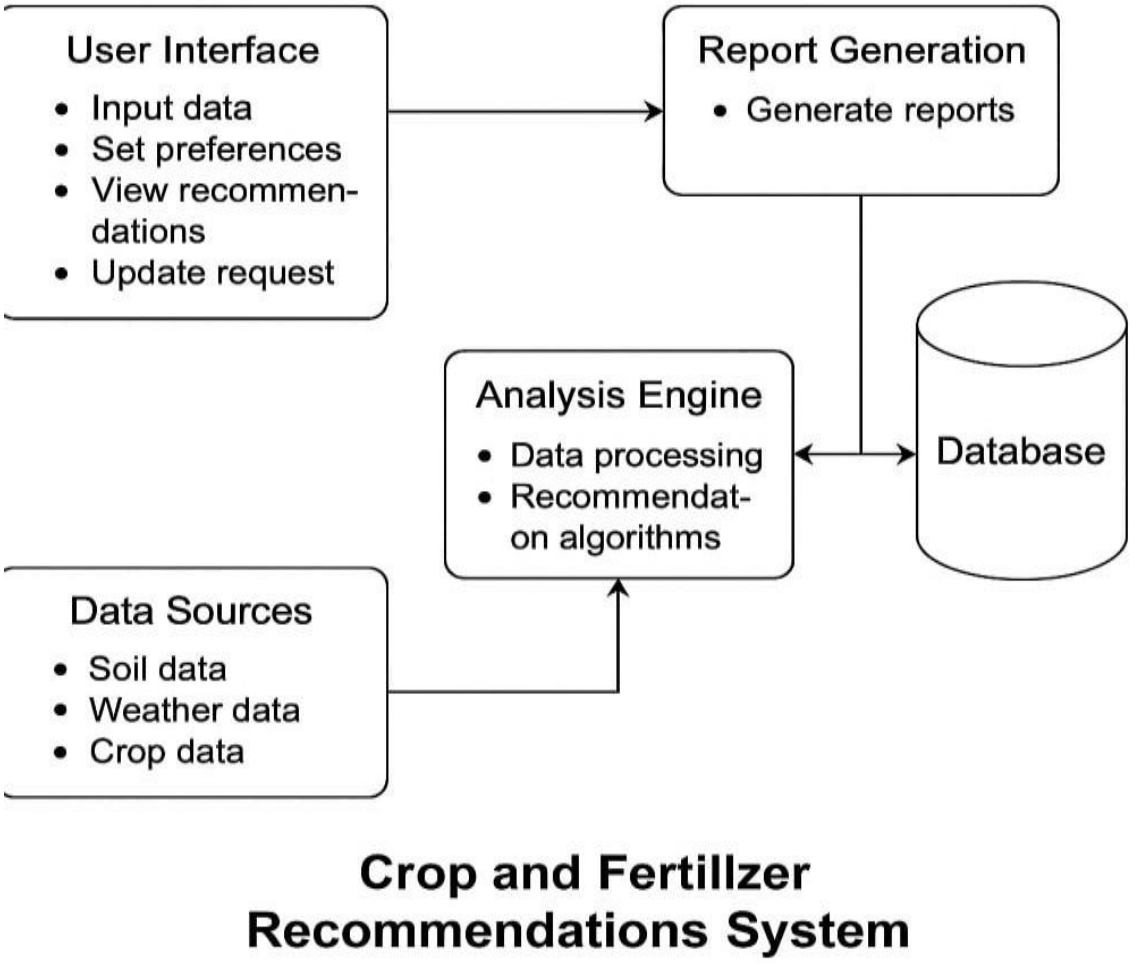

Fig. 4.1.1 System Architecture

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Technical Architecture:
The technical architecture of the Crop and Fertilizer Recommendations System is designed to serve various stakeholders such as farmers, agronomists, researchers, and government officials. These users interact with the system through a web browser, acting as an HTTP client. When a user submits a request, it is sent as an HTTP request to the backend system. The core of the system includes a recommendation logic layer, which processes the user's request by applying a machine learning model. This model is trained on a variety of agricultural data sets, which it retrieves to analyze and generate accurate recommendations. Once the analysis is complete, the system sends back the results as an HTTP response to the user's browser. This seamless flow of data enables users to receive timely and precise crop and fertilizer recommendations based on scientific analysis and historical data patterns.

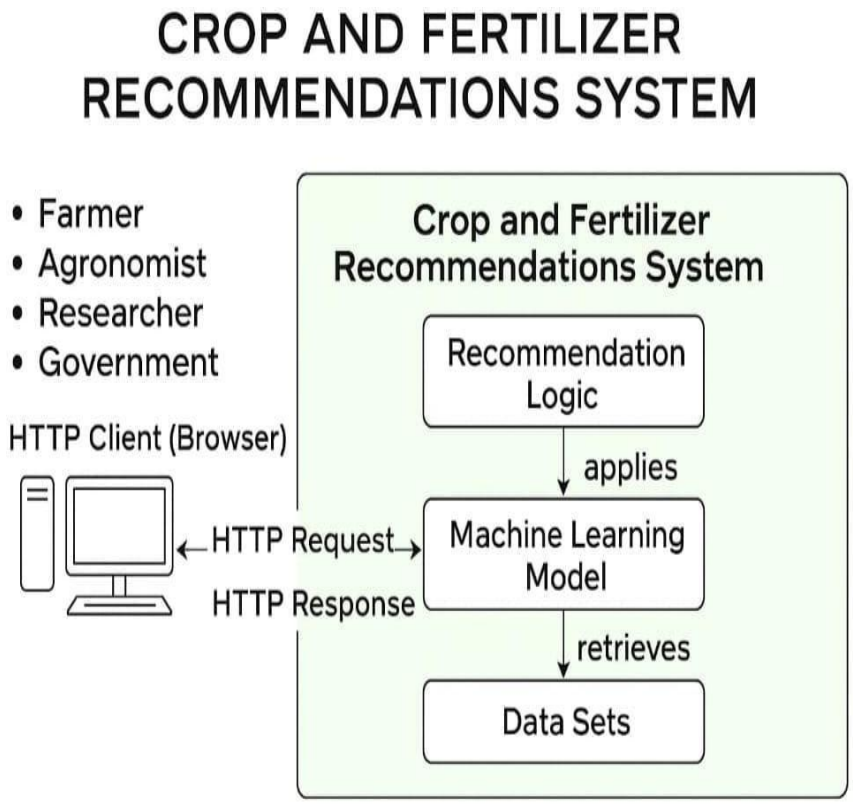

Fig. 4.1.2 Technical Architecture

FLOW CHART
The process begins when the user opens the application and selects the option for crop and fertilizer recommendation. The system then prompts the user to input various essential agricultural parameters, including the nitrogen (N), phosphorus (P), and potassium (K) values, followed by micronutrient values, pH level, rainfall data (in mm), humidity, and temperature. Once all the required input fields are completed, the user proceeds by clicking on the button to get recommendations. The system then processes the data using its recommendation engine and machine learning model to generate accurate suggestions. These suggestions are displayed in a new window for the user to view. This flow ensures a smooth and structured interaction for farmers and users seeking data-driven agricultural insights.

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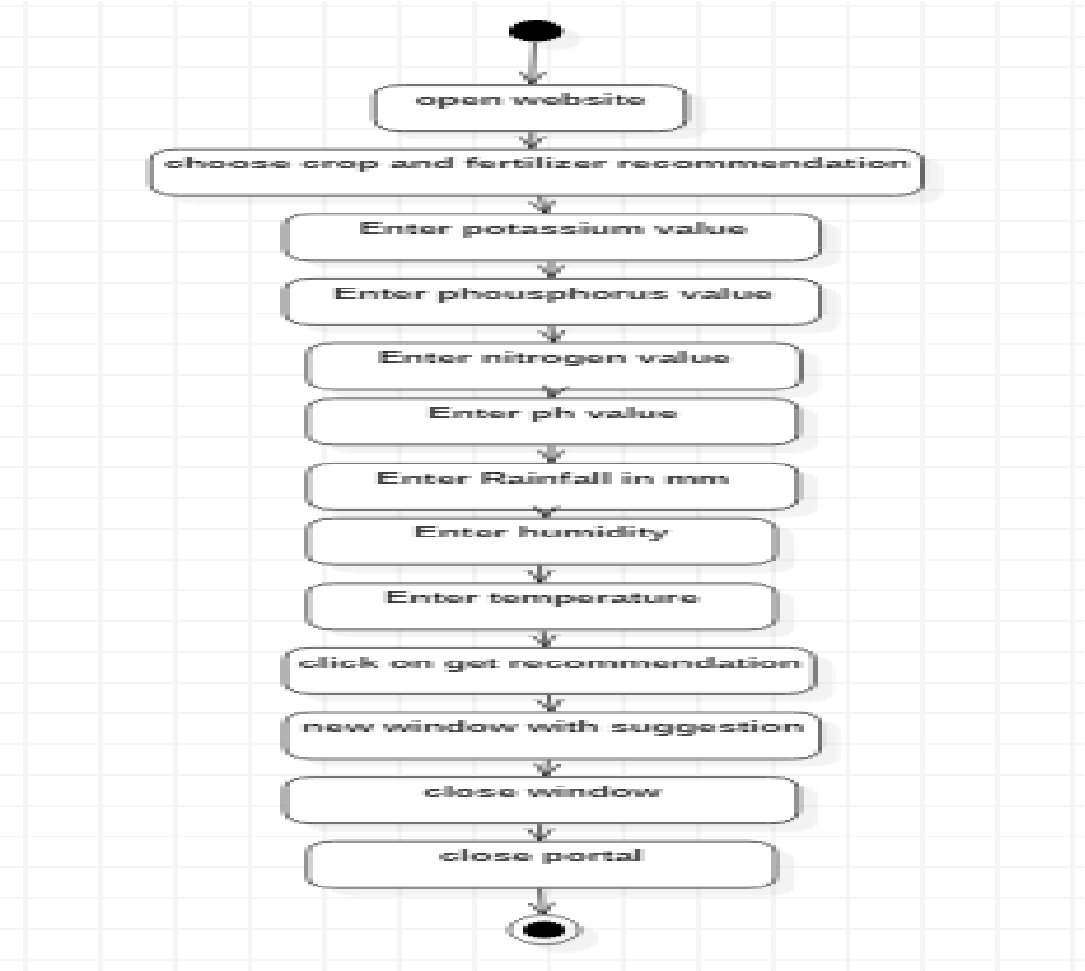

Fig. 4.2.1 flow chart

5-IMPLEMENTATION

The implementation of the **Crop and Fertilizer Recommendation System** involves integrating a trained machine learning model with a backend server and connecting it to a user- friendly frontend interface built using HTML, CSS, and JavaScript.

The backend is developed using **Python** and the **Flask** (or Django) framework. A machine learning model, trained using the **Random Forest Classifier**, is used for predicting the most suitable crop based on inputs like **Nitrogen (N)**, **Phosphorus (P)**, **Potassium (K)**, **pH**, **temperature**, **humidity**, and **rainfall**. The model is trained offline using Scikit-learn and saved in a serialized format using **Pickle (.pkl)** for later use in production.

The fertilizer recommendation logic is rule-based. It compares the actual nutrient values with the ideal nutrient levels required for the predicted crop. Based on the difference, the backend returns the type of fertilizer required, such as **Urea** for nitrogen deficiency or **Muriate of Potash** for potassium deficiency.

The **frontend** is designed using **HTML and CSS** for layout and styling, and **JavaScript** is used to handle user interactions and dynamic form handling. The frontend presents a clean and simple interface where users can enter soil and environmental parameters.

When the user submits the form, **JavaScript** sends the input data to the backend using an **HTTP POST request (usually via Fetch API or AJAX)**. The Flask backend receives this data, passes it through the machine learning model and fertilizer logic, and returns the results (recommended crop and fertilizer) as a JSON response.

This response is then handled by JavaScript, which updates the webpage dynamically without needing a page reload—providing a smooth user experience.

Finally, the complete application (including the backend server, trained model, and frontend files) is tested thoroughly and deployed on a platform such as **Render**, **Heroku**, or a local host for demonstrations. This allows real users—such as farmers or agricultural.

6-SCREENSHOTS

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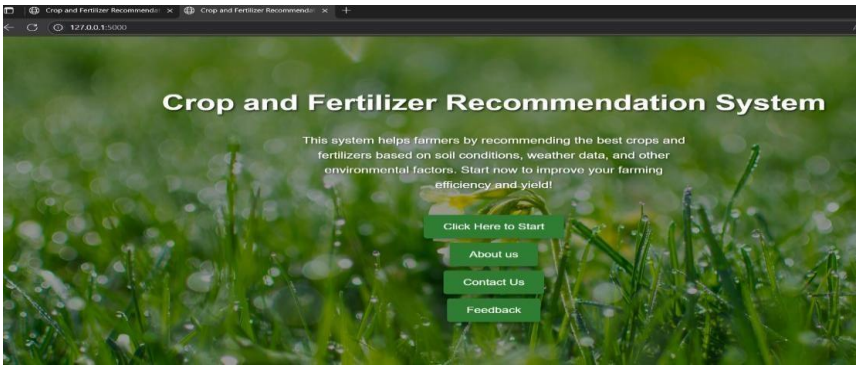
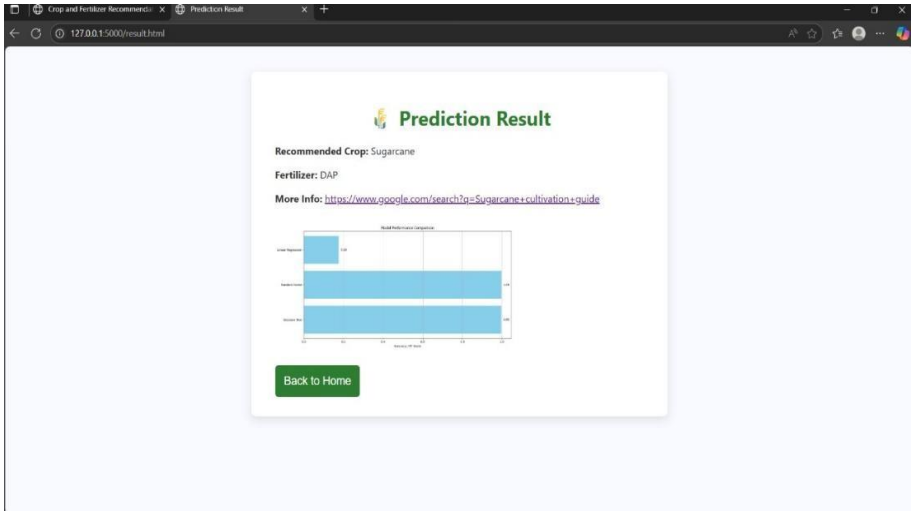


Screenshot 6.1 Home page of Crop And Fertilizer Recommendation System

Screenshot 6.2 Crop And Fertilizer Recommendation Page



Screenshot 6.3 Crop And Fertilizer Recommended Page

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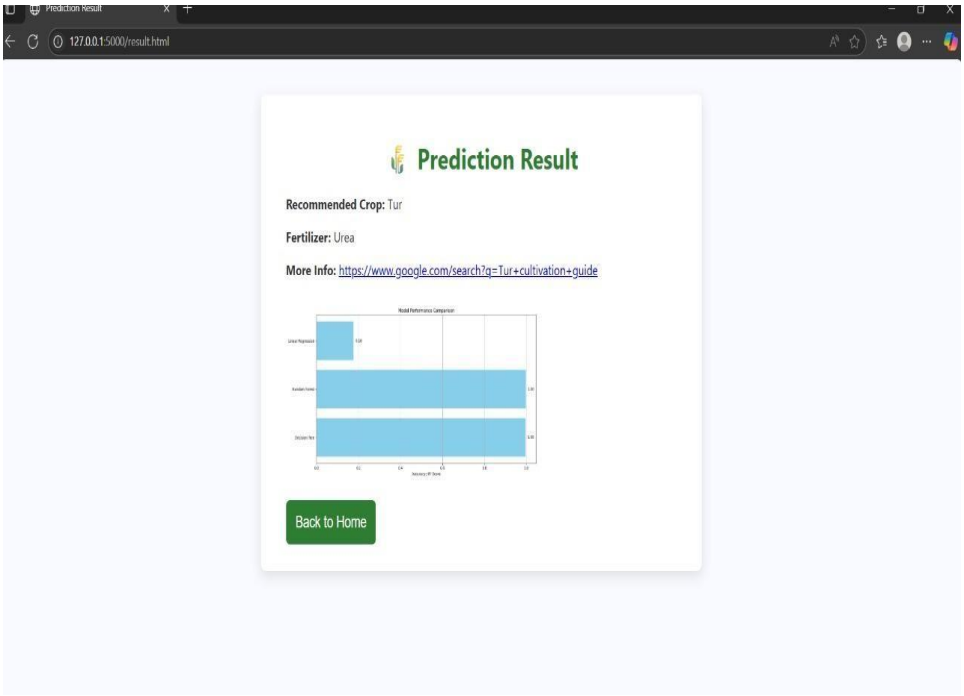
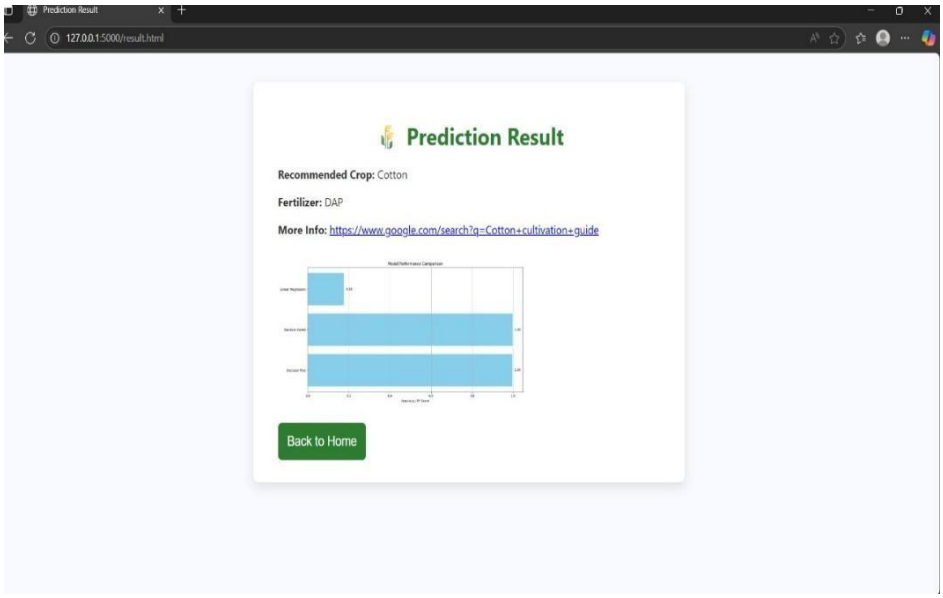


Screenshot 6.3.1 Crop And Fertilizer Recommended Page



Screenshot 6.3.2 Crop And Fertilizer Recommended Page

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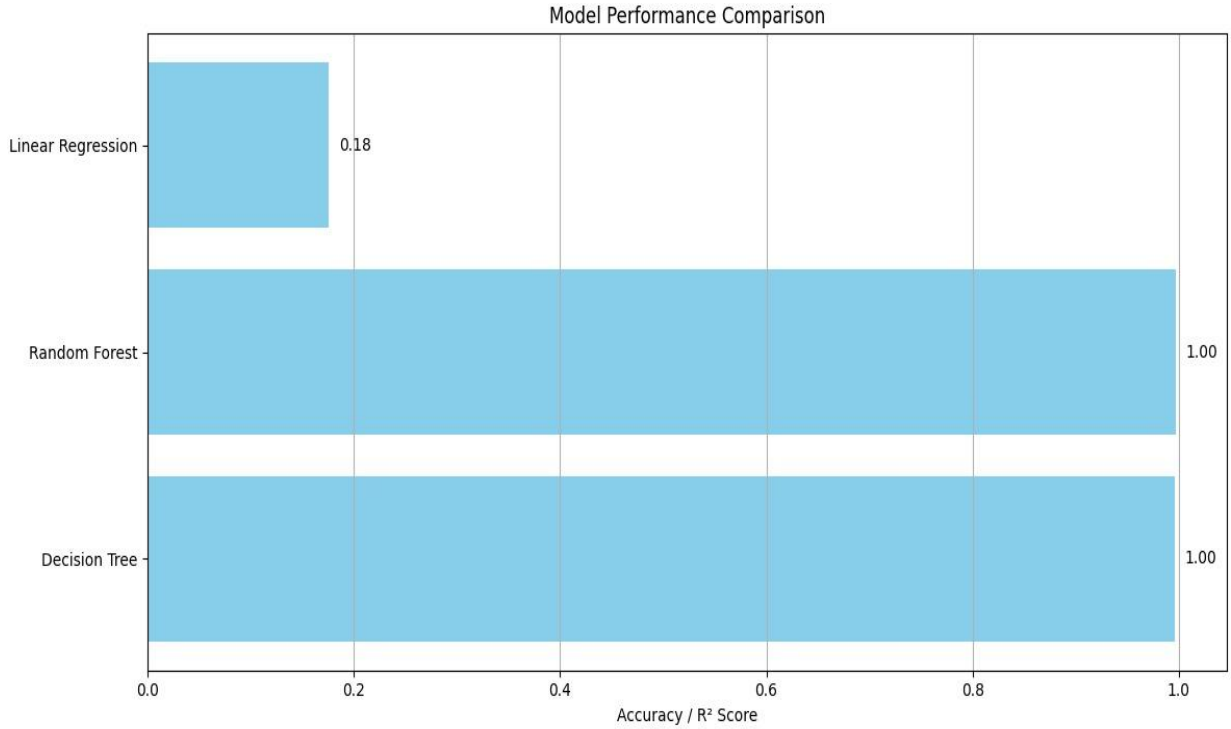

Screenshot 6.3.3 Accuracy Graph

7-CONCLUSION

This project successfully developed a crop and fertilizer recommendation system using machine learning, deployed as a user-friendly website. By analyzing soil and environmental parameters, the system provides accurate crop suggestions and suitable fertilizer recommendations. The web-based platform ensures easy access for farmers and agricultural stakeholders, promoting smarter, data-driven farming practices. Overall, the system supports improved crop yield, efficient resource use, and sustainable agriculture.

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