Crop Management Using Machine Learning Techniques

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Abstract:

India is an agricultural nation where crop productivity plays a major role in the country's economy. Thus, it is possible to argue that agriculture will serve as the foundation for every business in our nation. The country's economy is growing mostly due to the agriculture sector. Changes in the climate and other environmental factors are becoming a serious danger to agriculture. The application of machine learning (ML) is a crucial strategy for finding workable and efficient answers to this issue. Crop yield prediction is the process of forecasting crop production using historical data, such as weather, soil, and previous crop output. This focuses on utilizing the Random Forest algorithm to forecast the crop's production based on the available data. The forecast will assist farmers in forecasting yield.

Keywords: Random Forest, Machine learning, Crop yield, Historical data.

1. Introduction

1.1 Motivation

The core of any economy is agriculture. In a nation like India, where the population growth has led to a constant increase in food consumption, agricultural advancements are necessary to satisfy the demands. Since ancient times, India's primary and most prominent culture has been agriculture. Because they cultivated their own food, the ancient people were able to meet their own requirements. The sector of agriculture is gradually deteriorating since new, creative technology and approaches have been developed. Because of these numerous inventions, people's attention has been drawn to creating hybrid, artificial goods that might lead to an unhealthy lifestyle. People in today's world are unaware of the importance of cultivating crops at the proper time.

1.1 Objective and Problem Statement

Predicting crop yields is a significant issue in agriculture. The main determinants of agricultural productivity are crops and weather (rain, temperature, etc.). Making judgments about agricultural risk management and forecasting the future requires accurate knowledge of crop production history. Crop recommendations enable farmers to make money. The goal of this research is to tackle the problem by combining prediction and suggestion.This project proposed certain high yield crops for such conditions and attempted to forecast agricultural production based on many factors like crop, pH, rainfall, etc. An online application that estimates agricultural production and suggests a few high-yielding crops would be the project's output. The farmers will be able to choose which crop to cultivate with the assistance of the machine learning algorithms' predictions.

2. Literature Survey

2.1 Crop Yield Prediction using Machine Learning Algorithms [1]

The paper uses machine learning techniques to predict crop yield and accuracy, including logistic regression, Naïve Bayes, and Random Forest. It helps farmers make informed decisions about which crops to cultivate in their fields. However, the research has limitations, such as using few parameters for measuring crop yield and lacking a recommendation system. Further enhancements could enhance the accuracy.

2.2 An interaction regression model for crop yield prediction [2]

The prediction model uses multiple linear regression to attribute crop yield to weather, soil, and management interactions. It combines linear regression's explainability, machine learning's prediction accuracy, and agronomic insights. However, it lacks a recommendation system and can be improved by using different training methods.

3. Proposed Model:

The recommended approach is a web-based application that forecasts crop production and suggests a few high-yielding varieties. Numerous factors, including temperature, area, nitrogen, season, rainfall, and so on, affect crop yield. Random Forest Regressor is utilized for prediction in this project. According to peter[3] it will achieve the most accurate forecast.
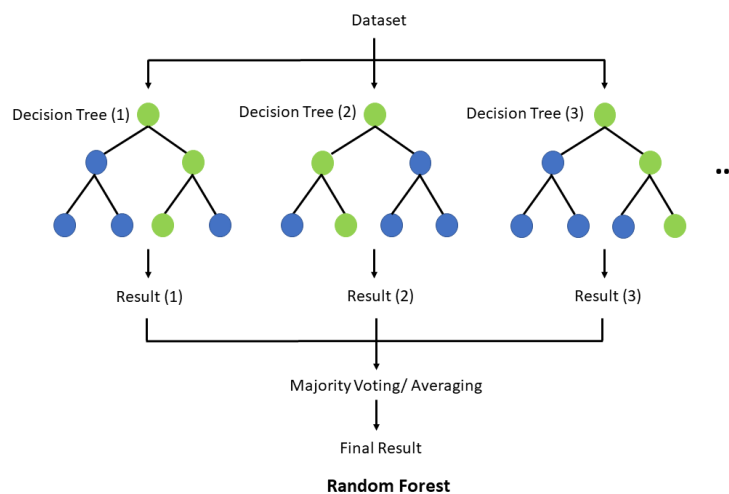

Figure 1 : Illustration of how random forest algorithm works

4. Performance measure:

Root Mean Square Error: This is a common method for calculating a model's prediction error for quantitative data. This suggests, heuristically, that RMSE can be conceptualized as a distance of some type separating the vector of observed values from the vector of anticipated values.

$$\sqrt{[\,\Sigma(Pi - Oi)2 \,/\, n\,]}$$

**Equation 1 :** RMSE equation

5. DataSet:

The data set that is taken from Kaggle[4] contains the attributes like temperature, area, season, rainfall, nitrogen etc. The data is preprocessed and cleaned before training. Columns are ['Area', 'Production',

'Rainfall', 'Season', 'Temperature', 'Crop', 'pH', 'Nitrogen(kg/ha)']
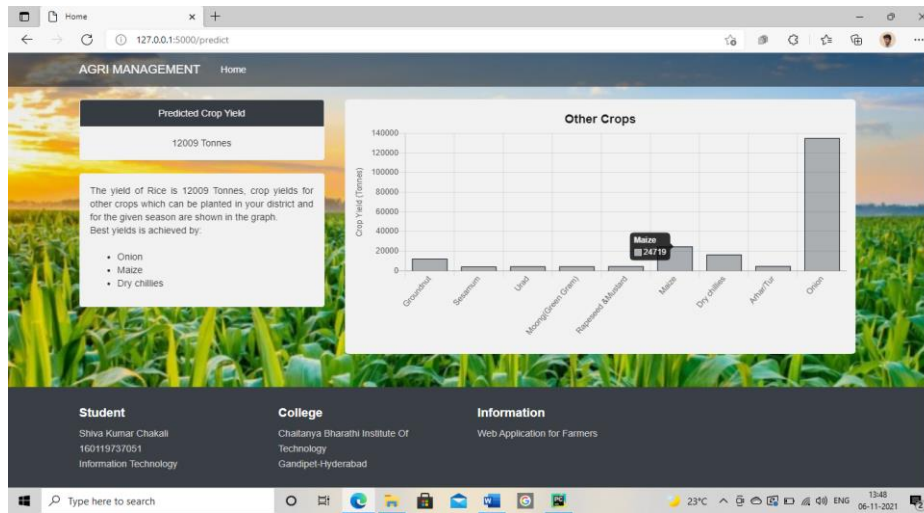
5. Result:

The main activities in the application were detail_entry and results_fetch. The user fills the fields in the home page to move onto the results activity. The retrieved data passed to the machine learning model and crop production is predicted. The machine learning model has an accuracy of 94% on training and 78% on testing data.
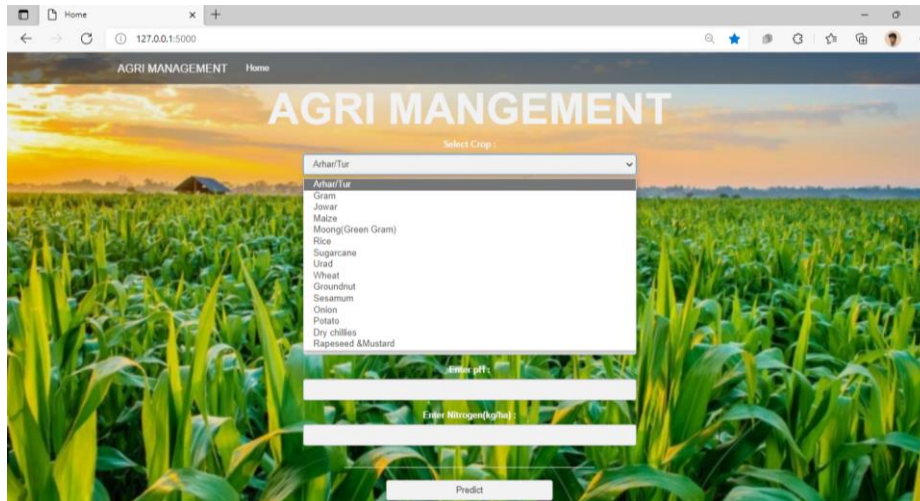
Figure 2 : Dropdown menu - There are two dropdown menus to select Crop and Season from a list of available options.
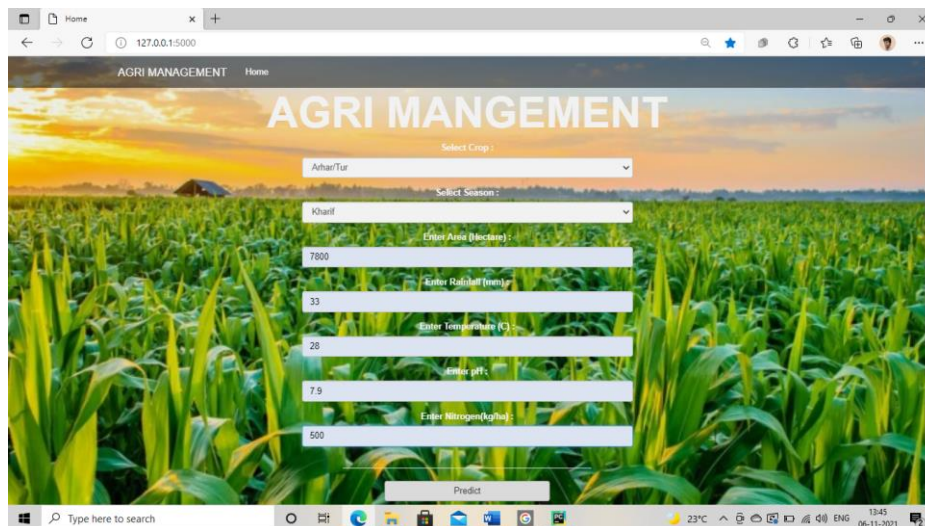
Figure 3 : Button 'Predict' - Home page with navigation bar at the top and input boxes and drop down menus are provided to give inputs. So that user can give inputs to predict results.

Figure 4 : Result tab - The result tab contains yield in tones and recommends high yielding crops based on the graph drawn.

6. Conclusion and Future Scope:

The project uses machine learning techniques to predict crop yield using a Random Forest Regressor. It also implements a crop recommendation system based on past data collection. This helps farmers make informed decisions about which crops to cultivate, enhancing efficiency and productivity. The project aims to improve the Indian economy by maximizing crop production yield rates. Thanks to Akash[5] and StackOverflow[6] for the learning and debugging part. The system can also be integrated to increase soil fertility, potentially enhancing its effectiveness across India.

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