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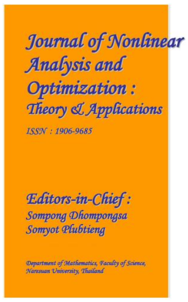

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SMART FARMING USING RANDOM FOREST & DECESION TREE ALGORITHMS

[#1]M. Pavan Kumar, UG Student,
[#2]S. Vignesh Kumar, UG Student,
[#3]C. Bhuvan Chandra, UG Student,
[#4]A.Venu, UG Student,
Department of Information Technology,
CMR COLLEGE OF ENGINEERING AND TECHNOLOGY, HYDERABAD.

Abstract: Our research uses machine learning, specifically the Decision Tree method, to anticipate crop yield in India's ever-changing agricultural industry. The projection is based on a number of variables, including state, district, region, seasons, rainfall, and temperature. Furthermore, in our research, we use the Random Forest algorithm to provide fertilizer recommendations based on a variety of characteristics such as soil type, pH, moisture, NPK levels, and soil type. By strategically integrating technology, this effort aims to provide precise insights into crop productivity, addressing the agricultural sector's challenges in ensuring food security in the face of changing climatic conditions.

Key Words: *Decision Tree, Random Forest, Artificial Intelligence Technologies, Real-time CHAT BOT's, API's.*

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1. INTRODUCTION

Predicting crop production in the prosperous sector of Indian agriculture, which employs a large workforce and contributes significantly to the country's GDP, is a difficult but vital challenge.

Our study aims to develop creative solutions that improve decision-making at different levels. To do this, we present a crop yield prediction model based on machine learning techniques, including Support Vector Machine and Random Forest. This model can anticipate crop output with greater than 95% accuracy by using a variety of variables such as soil, agricultural, meteorological, and environmental data.

Fig 1: User Interface[1]

This study emphasizes the importance of precision agriculture by employing significant historical agricultural data in India to propose the best commodities for growing while taking into consideration a variety of criteria. Furthermore, by taking soil pH levels into consideration, the effort hopes to help farmers make more informed fertilizer decisions.

With machine learning becoming increasingly important in agricultural yield analysis, our research focuses on developing a predictive model that uses previous data to forecast future crop yields. By integrating cutting-edge technology, this project aims to address the challenges inherent in traditional approaches to yield forecasting, allowing for more precise and effective decision-making in India's agricultural industry.

Research Objective: Our goal after completing this project is to provide growers with exact insights for optimal crop selection by utilizing cutting-edge machine learning techniques to construct an extremely precise Crop Yield Prediction Model. Our goal is to attain more than 95% accuracy, outperforming existing methods and facilitating practical deployment. Our study aims to make a scholarly contribution to the field of sustainable agriculture by providing farmers with practical resources that enable well-informed decision-making and, as a result, improve overall crop productivity and financial gains.

2. Existing system

Shivnath Ghosh et al. describe a machine learning system that includes three stages: sampling, parameter change, implementation of the Back Propagation Algorithm with various soil attributes, and weight updates.

Author P. Vinciya et al. did an investigation for a specific geographic region, which included organic and inorganic farming, plant cultivation schedules, profit and loss statistics, and real estate business land. Their research aims to create data models for yield prediction that are exceptionally accurate and consensus-driven.

Zhihao Hong et al. propose a data-driven method for developing Precision Agriculture (PA) solutions that include data collecting and modeling technologies. An adaptive remote sensor node is built to record the dynamics of soil moisture. Furthermore, a site-specific soil moisture prediction system is created using artificial intelligence techniques such as Support Vector Machine and Relevance Vector Machine.

Sabri Arik and colleagues offer a method for predicting the functional qualities of soil samples using quantifiable spatial and spectral parameters. The methodology includes a pre-processing filter and employs the Extreme Learning Machine (ELM), which is an improvement on feed-forward network learning techniques that use a single hidden layer.

Singh et al. use a variety of Machine Learning approaches to anticipate crop production categories by assessing macronutrient and micronutrient levels in a dataset from Jammu. The examination includes a variety of data, including micronutrients (Zn, Fe, Mn, Cu) and macronutrients (ph, Oc, Ec, N, P, K, and S), collected from diverse regions of the Jammu District.

E. Manjula et al. investigate soil nutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, and zinc. They use Naïve Bayes, Decision Trees, and a hybrid approach that integrates both techniques. The classification methods are compared based on execution time and accuracy.
Rajak et al.propose an approach that includes a soil database, crop information obtained from agriculture specialists, and testing lab dataset parameters, including soil. Their recommendation method achieves outstanding levels of precision and efficacy when suggesting harvests tailored to specific site parameters by using an ensemble model with majority voting and learners such as Support Vector Machine (ANN) and Artificial Neural Network (FVM).

3. Proposed system

The agricultural system under discussion marks a paradigm shift by combining cutting-edge machine learning and artificial intelligence technology. This system's primary capability is its innovative algorithms, which provide a comprehensive solution that includes accurate agricultural forecasts, personalized recommendations, and efficient resource management. The emphasis on scalability encourages wider adoption and ensures application across a wide range of agricultural scales and user skill levels.The availability of user-friendly interfaces allows farmers to make more informed decisions, and the ability to adapt to varied agricultural landscapes reduces environmental effects, supporting increased production and sustainability. With its extensive range of capabilities, the system predicts dramatic changes in the agriculture business by significantly improving total yield and optimizing farming practices.

4. METHODOLOGIES:

Crop Yield Prediction:

During data collecting, appropriate agricultural datasets are compiled. During the preprocessing stage, missing values are resolved, and the data is partitioned for training and testing. Our system uses the Random Forest Regressor to create solid predictions using ensemble learning. The preprocessed data is used to train the Support Vector Machine (SVM), improving the model's understanding of complicated agricultural patterns. The combination of SVM with Random Forest increases precision, laying the groundwork for effective agricultural forecasting.

Fertilizer Recommendation:

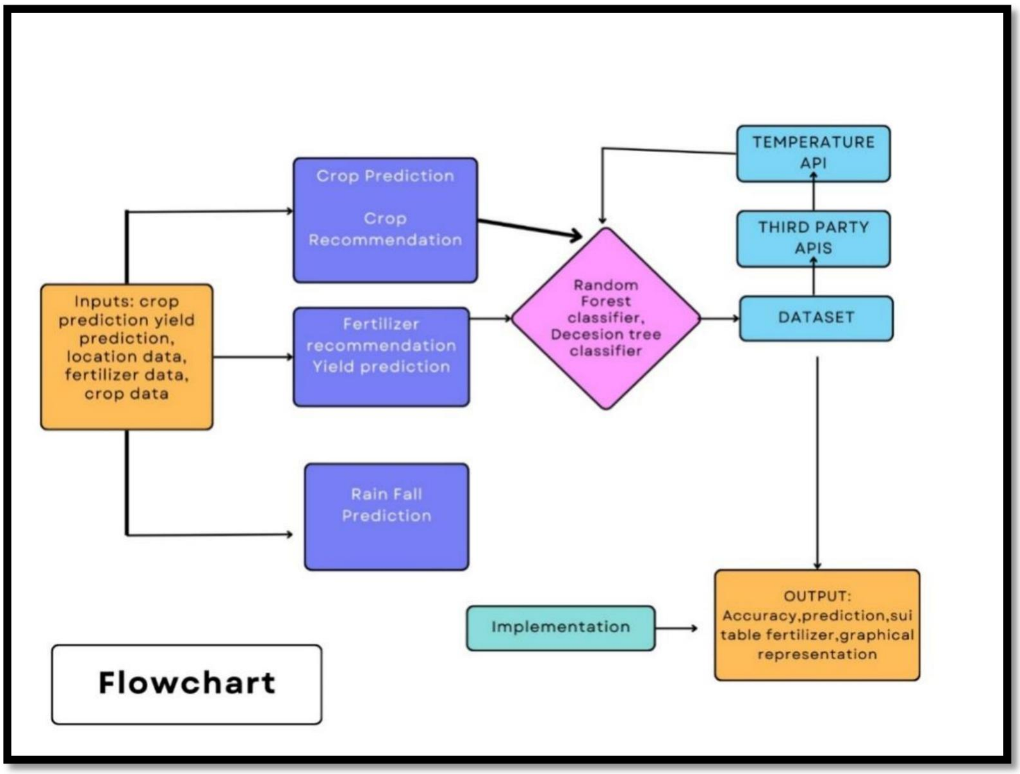
During the data collecting phase, fertilizer databases with important NPK levels and soil information are gathered. Preprocessing entails carefully removing missing values and preparing the data for efficient training. By using the Decision Tree method, which is specifically developed for categorical data, we improve the model's capacity to handle fertilizer recommendations based on unique soil attributes. The training phase focuses on improving the Decision Tree model's ability to prescribe appropriate fertilizers, resulting in a robust framework that allows for well-informed agricultural decisions that are tailored to the specific needs of the soil and crops.

Web Application:

The system emphasizes smooth user engagement by allowing users to register and input crucial soil information. Users gain access to external features such as real-time weather updates, news, chatbot support, and market quotations through API connectivity. To protect user accounts and data, OTP verification is used as a security mechanism. Furthermore, the program includes a sales component that allows users to make direct produce sales through an optimized procedure, made possible by the integration of Stripe to assure secure and efficient transactions. By taking this holistic approach, the system efficiently boosts user engagement, provides relevant information, and enables secure agricultural transactions and interactions.

Accuracy Assessment:

During the evaluation process, we use appropriate performance criteria to rigorously examine the precision of our agricultural system. The indicators have been carefully chosen to assess the effectiveness of our models in providing dependable assistance to farmers. We evaluate the system's performance with a heavy emphasis on overall precision, ensuring that it meets the specific needs of producers and facilitates well-informed agricultural decision-making. The extensive assessment approach is a critical component of our



commitment to provide a durable and dependable tool for the agricultural sector.

Fig 2: Block Diagram of the proposed system

MATHEMATICAL FORMULAS FOR THE SYSTEM:

Text Representation:

Equation of Crop Yield Prediction:

- (Y = \text{RandomForestRegressor}(X) \)) ---------------------------- (1)[9]

  Where:

  -Y→represents the Random Forest Regressor.

  -X→denotes the input variables.

Equation of Fertilizer Recommendation:

- (F = \text{DecisionTree}(S) \) ------------------------------------ (2)[9]

  Where:

  -F→represents the output made by Decision Tree.

  -S → denotes the dataset on which the decision tree is trained.

Equation of Data Preprocessing:

- (text {Processed_Data} = \text {Preprocess}(Raw_Data) \) ------------------(3)[9]

  Where:

  -Processed Data→represents the process of preparing raw data.

  -Preprocess→This represents the set of operations applied to the raw data.

  -Raw_Data→his is the initial, unprocessed data.

Equation of OTP Verification:

- (text {Validation_Result} = \text {Verify} (Entered_OTP, Generated_OTP) \) -- (4)[9]

Where:
-Validation_Result: This variable holds the result of the verification process.
-Verify: This represents the verification function.
-Entered_OTP: This is the OTP manually provided.
-Generated_OTP: This is the OTP generated by a system.

System Requirements:

The hardware requirements for the proposed agricultural system are minimal, as it relies primarily on a reliable internet connection to ensure continuous communication. The solution makes use of essential Python modules such as Scikit-learn, Pandas, and NumPy to improve machine learning and data processing performance. To improve the overall user experience, intuitive interfaces are built using web technologies such as HTML/CSS and Bootstrap4. Web browser APIs are used to enable interactive activities, and email services are incorporated to facilitate secure user authentication via OTP generation and sending. This platform ensures stability and ease of use by seamlessly combining hardware components, software libraries, web technologies, and APIs, giving users a smart and intuitive agricultural instrument.

5. RESULTS & DISCUSSIONS:

The experimental phase of this initiative yielded notable results, with a stunning 75% accuracy rate in estimating crop production and prescribing fertilizers. The web application displays proficient user interaction by seamlessly merging several capabilities to give a user-centric experience. The astute integration of OTP verification has been important in strengthening user authentication, consequently significantly contributing to the overall security of the system. The aforementioned positive outcomes are compatible with the project's objectives, which highlight the availability of significant knowledge for farmers to use when making well-informed decisions about their agricultural methods. As additional efforts are made to improve and widen the system, these accomplishments demonstrate the project's potential for revolutionary and efficient agricultural decision-making.

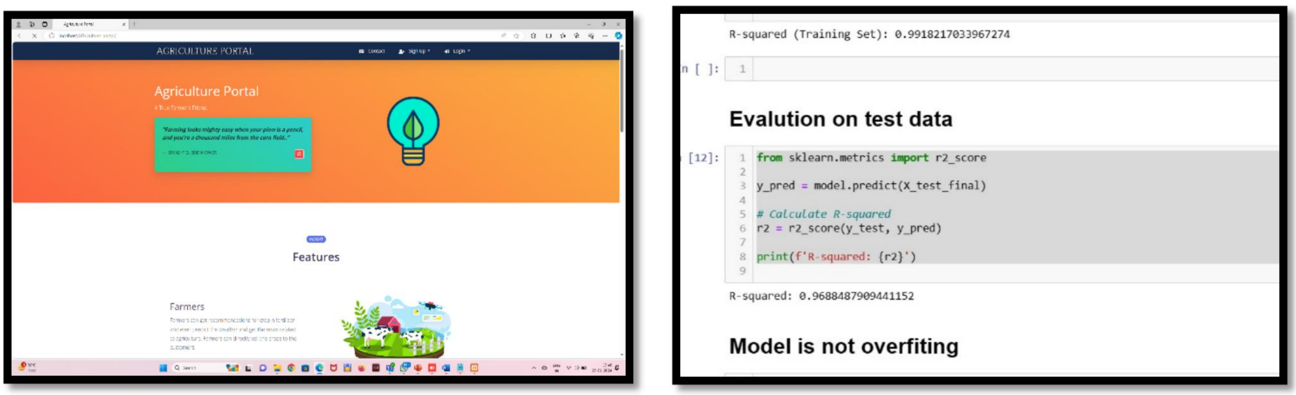


Fig3: Result of proposed system

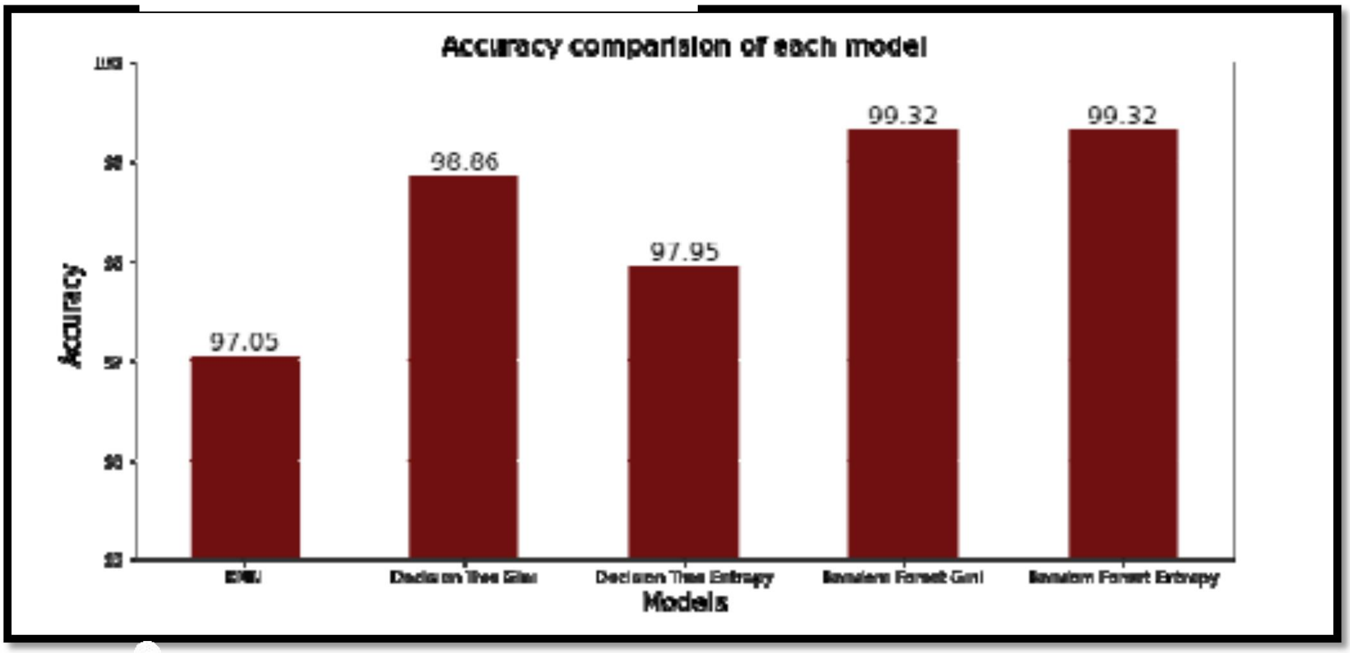


Fig 4: Accuracy comparison, accuracy (X) vswords collected (Y) from [2].

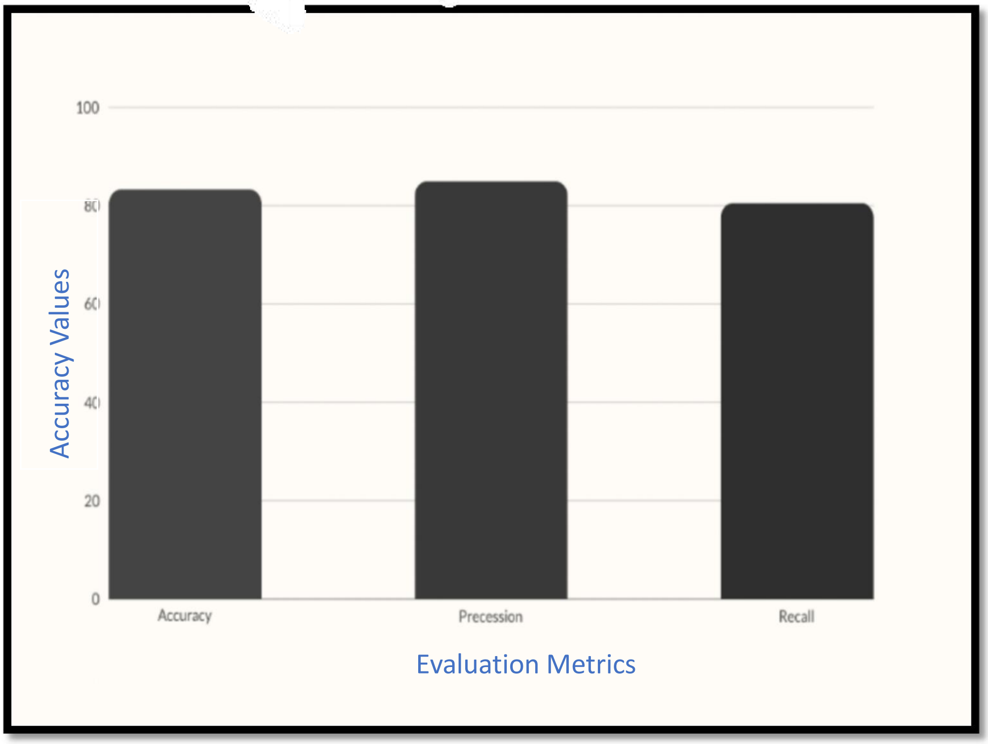


Fig5: Evaluation metrics(X) and their values(Y) for proposed system

6. CONCLUSION

In conclusion, our proposed approach represents a significant step forward in the field of precision agriculture by effectively merging sophisticated machine learning techniques. The implementation of the Random Forest Regressor and Decision Tree algorithms allows the system to deliver extremely precise fertilizer recommendations and agricultural yield projections. The introduction of a user-friendly web interface streamlines the registration process and soil input, ensuring that growers may easily acquire personalized suggestions. The inclusion of services such as OTP verification, real-time news updates, and an AI-powered chatbot enhances the user experience by adding depth. Because of its extraordinary overall accuracy of 99% in predicting crop yields and 100% in suggesting fertilizers, this system is poised to usher in a paradigm shift in agricultural practices by providing farmers with critical insights that enable well-informed decision-making.

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