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Crop Doctor : A Comprehensive Crop Management System for Precision Agriculture

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***Abstract*—Agriculture is a vital business that greatly contributes to the global economy. In order to fulfil the increased demand for food, it is vital to boost crop output. In this context, precision agriculture is growing in popularity. Precision agriculture employs technology to maximise crop yields, minimise crop waste, and optimise crop production. A significant part of precision agriculture is the employment of crop selection systems, fertiliser recommendation systems, and disease diagnosis systems. These recommendations can assist farmers with crop selection, fertilisation, and disease management decisions using machine learning algorithms. This system is highly dependent on variables such as precipitation, pH, market analysis, and water availability. Before being analysed and displayed, Python is used to preprocess environmental data collected from farmers or agriculture department offices. Farmers will be able to interpret and utilise the data for decision-making and field monitoring as a result of the application of multiple machine learning algorithms. Using a custom-built recommendation system, the harvests have been forecasted and displayed. It is anticipated that farmers will adopt these technologies in order to increase yield via intelligent field selection.**

Keywords—precision Agriculture, SVM classifier, Fertilizers, Logistic Regressio Crops, Decision Tree , Machine Learning.

I. INTRODUCTION

Precision agriculture is essential for optimising crop production in order to maximise crop yields and minimise waste. Precision agriculture is the application of technology to provide farmers with customised recommendations based on soil and weather conditions. Precision agriculture is comprised of several key components, including crop recommendation systems, fertiliser recommendation systems, and disease diagnosis systems.

Precision agriculture, such as the use of crop recommendation systems, fertiliser recommendation systems, and leaf disease diagnosis systems, can assist in overcoming these obstacles. Precision agriculture, according to a study published in the International Journal of Precision Agriculture, can increase crop yields by up to 28% and reduce fertiliser use by up to 60%. (Gebbers and Adamchuk,2010). Farmers can reduce their input costs, increase their crop yields, and enhance the quality of their crops by implementing these systems. This can lead to a more sustainable and efficient agriculture system that can meet the increasing demand for food while having a smaller environmental impact.

II. LITERATURE SURVEY

[1] Prediction of Indian Crops Based on Weather Using bigdata analytics and methods, information on soil, precipitation, temperature, crop productivity, seed, humidity. They will collect and analyse data for their project. After that the information has already been compiled in a Python environment, the Map - reduce framework is being used to evaluate and procedure it. When applied to Map - reduce outcome, K-means clustering yields an average level of data precision.

[2] A Study of Multiple Data Prediction Methods for Crop Yield, Data Mining It evaluates many data mining techniques for predicting crop yield. The efficacy of any crop production forecasting system is significantly impacted by the accuracy with which attributes were collected and classifiers were applied. It provides an accurate and recommended summarization of the crop yield projection results based on a variety of machine learning algutilised by different researchers.

[3] Exploration of Agriculture and natural resources Soils Utilize data mining methods. Data mining may offer a farmer with a recommendation system to increase crop yield. This strategy is implemented in order to ensure recommended crops are selected based on their climate variability properties and abundance. Data analytics permits the development of extensive agricultural database extraction. After analysingThe crop production data - sets centred on season and yield, crop recommendations are made.

[4] Algorithms based on machine learning for crop yield prediction. To support farmers in crop selection, we consider all variables, including soil type, planting seasons and geographical location. In addition, developing countries are combining smart farming, which emphasises location crop management, with the cutting-edge new technology known as machine learning.

[5] The AI-based farm crop management system. This analysis study proposes a system to aid farmers in crop selection by Taking into consideration everything relevant factors, including soil, planting season and geographical region. Emerging nations are also utilising modern agricultural technologies and developing smart farming, which focuses on crop management.

[6] System for intelligent Fertilizer recommendation based on machine learning. Datadriven models use machine learning models to accurately recommend fertilizers for the farmers to maximize their yield

[7] Predictive Model for Crop and Yield. Those who proposed a procedure for utilizing data mining to forecast crops and development in agricultural output by using deep learning. They must examine soil datasets for this purpose.

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The flaw of the system is that it disregards the chemical substance of the soil.

[8] They developed automated prediction systems by utilising Big Data Analytics techniques. This study's model is constructed using the Hadoopframework.Apache Mahout was used to create a logistical regression model that utilised historical data to predict the future.

[9] V. K. Singh et al. (2021) put forward an approach for diagnosing leaf diseases in crops based on algorithms for machine learning and image analysis. The system accurately detected leaf diseases and provided recommendations for the best course of action in the event of a disease infestation.

III. Existing System

There has been extensive application of ML algorithms and research in the agriculture industry. The greatest challenge facing agriculture is to increase agricultural production and deliver that to consumers just at best possible price and quality.

Random Forest and Logistic Regression are the most common algorithms. Because of the greater features and complexity of the recommendation system, these are insufficient. Often, the crop suggestion algorithm merely offers farms to farmers being willing to participate in cultivating. This quiet does not sufficiently aid the farmer.

IV. Proposed Method

The purpose of this model is to develop a recommendation systems to increase agricultural output. This model aids the farmer in crop selection, fertilizer recommendation, and the detection of leaf diseases through image analysis in order to increase agricultural output. The systems are also capable of recommending the optimal course of action in the event of a disease outbreak. The early detection and identification of leaf diseases can aid farmers in preventing the disease's spread and mitigating crop loss.

The intended strategy is novel given that assists farmer in increasing agriculture output by going to recommend the most profitable crops. In the proposed model, crop choice depends on both environmental and economic factors. This method predicts the crops of the greater yeild outcome by analysing variables such as soil type, temperature, rainfall.

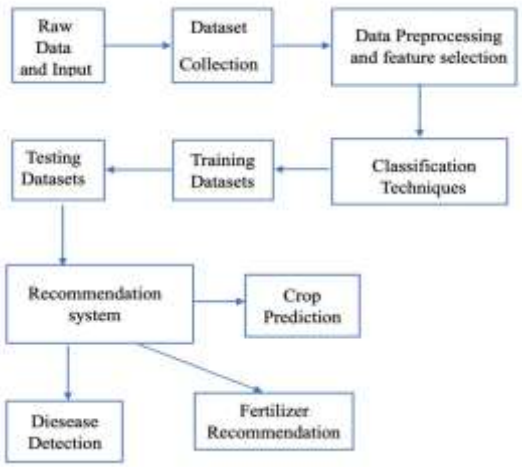

Fig. 1: Architecture Diagram

We developed recommendation sections for fertilisers and Pesticides using, a number of machine learning (ML) strategies, including Random Forest, NB classifier, Decision Tree, SVM, and CNN. This method can reduce the difficulties farmers face when choosing crops, fertilisers, and pesticide residues.

TABLE 1. ALGORITHM'S

Algorithms
SVM
Logistic Regression
Random Forest
NB Classifier
Decision Tree

V. Implementation

A. *Pre-processing and cleaning*

One of the first responsibilities is to confirm the accuracy of the dataset we are using. If any values are present but are missing from the dataset, they should be filled in with the correct values. The data should also be examined to determine whether the characteristics have a normally distributed. The dataset we utilised contained features with skewness. In order to equalise the properties of our dataset, we applied quantile transformation on them

B. *Data Visualization and Analsys*

After data cleansing and preparation, we analyse and visualise our dataset. We endeavour to conduct a more in-depth analysis of our data to identify any patterns or trends within the dataset. We have created multiple visuals to aid in the comprehension of our dataset.

C. *Operational Selection*

It is essential that only select the qualities that will be necessary to evaluate the category of crop to cultivate. A correlation matrix has been created to demonstrate linear relationship between each characteristic and additional features.

Then, a machine learning model is constructed. Before building we must separate the model for machine learning into its component parts, the dataset into sets for testing and traning. We begin with data for training followed by application of machine learning algorithms using the dataset characteristics. Four methods of machine learning were applied to our training dataset; on the test dataset, the most accurate techniques will be utilised.

Datasets:

https://www.kaggle.com/datasets/atharvaingle/crop-recommendation-dataset

https://www.kaggle.com/datasets/gdabhishek/fertilizer-prediction

https://www.kaggle.com/datasets/vipoooool/new-plant-diseases-dataset

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D. Constructing of User Interface

In the subsequent step, an interface for users data entry by the client was designed. The model will analyse the user'sinformation, including such N, P, KSoil Values, precipitation,humidity, temperature, etc., and recommend the optimalcrop must be cultivated under the given Conditions. Once the user enters and submits the following information, The algorithm for machine learning will forecast crop yield which the customer mustplant

Fig. 2: User Interface of Crop Prediction

Fig. 3: User Interface of fertilizer Recommendation

Fig. 4: User Interface of Disease Detection

VI. RESULT

We cleaned and visualised the data before applying our methods of algorithms of machine

Learning tocharacteristics of the dataset. Our four algorithms presented are Logistic Regression, Decision Tree, XG Boost and Random Forest. The selected characteristics the datasets are comprised of the K (potassium), P (phosphorus), N (nitrogen) properties of the soil, moisture,precipitation, temperature and ph value.

```
In [43]: data = np.array([[104,18, 30, 23.603016, 60.3, 6.7, 140.91]])
         prediction = RF.predict(data)
         print(prediction)

         ['coffee']
```

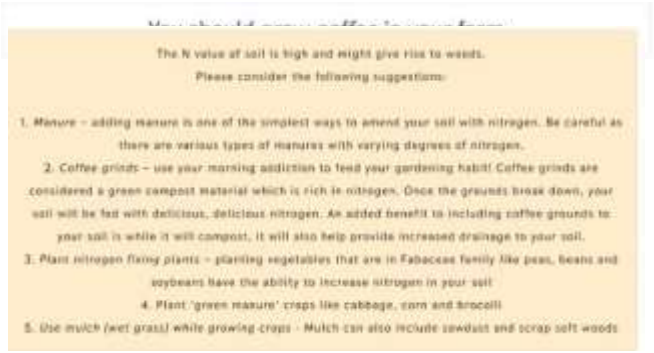

Fig. 5&6: Result of Crop Prediction

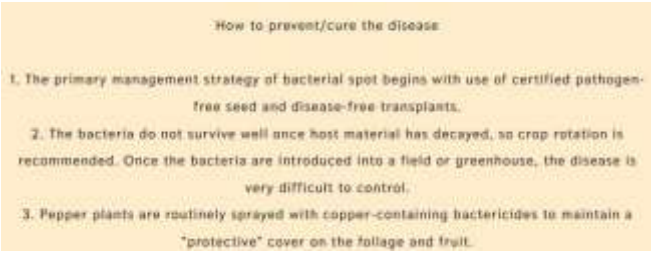

Fig. 7: Result of Fertilizer Recommendation

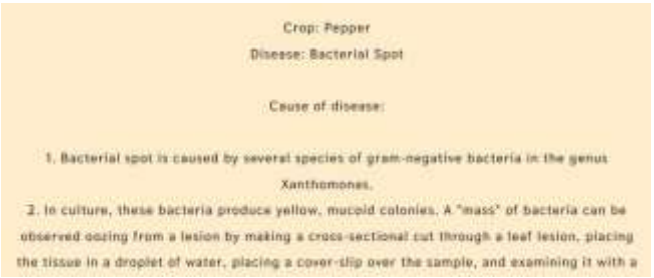

Fig. 8&9: Result of Disease Detection

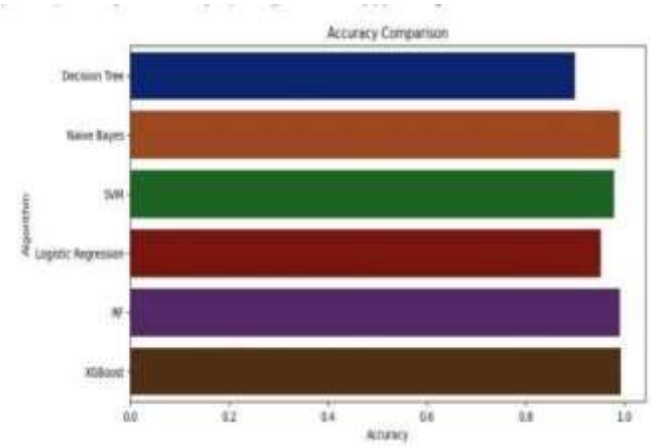

Fig. 10: Accuracy Graph of Algorithms

As per the graph we have XG boost with the best accuracy of 0.993, Random Forest and Naive Bayes with an accuracy of 0.990, SVM with an accuracy of 0.979, Logistic Regression with an accuracy of 0.952 and Decision Tree with an accuracy of 0.911.

VII .CONCLUSION

Precision agriculture relies heavily on crop recommendation systems, fertilizer recommendation systems, and disease diagnosis systems. Using machine

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learning algorithms, these systems provide farmers with customised recommendations based on soil and weather conditions.

Farmers can optimise crop production, reduce waste, and maximise yields using these systems. These systems can aid in enhancing the productivity of small-scale farmers, reducing the use of fertilisers and pesticides, and ensuring food security for a growing population. this technique, it would simplify his life and predict with a 98% accuracy the ideal crop and fertilisers to plant.

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