

An Integrated System for Crop & Fertilizer Recommendation

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Abstract—India is a country of farmers, and the sector employs millions of people worldwide and forms the core of the Indian economy. Because they don't know anything about the conditions of the soil, farmers just keep cultivating the same crops with haphazard amounts of fertilizer. In the end, this causes the soil and its top layer to become acidic. If farmers know how to develop things that fit their own living environments, they can attain larger yields. Precision agriculture is being used in this research to create a crop suggestion system that will assist farmers in raising crop yields. Therefore, in order to solve these issues, we used machine learning techniques such as Random Forest and Decision Tree to create a crop recommendation system. The goal of this research is to assist farmers by recommending the best crop to produce based on soil conditions, weather, and other factors such as temperature, humidity, rainfall, and levels of phosphorus, potassium, and nitrogen in the soil. Therefore, farmers can learn about the many crops they need to produce through our project in order to maximize their production, which will enhance their profit and reduce soil pollution.

Index Terms— Crop recommendation system, Machine learning algorithms, Random Forest, Decision Tree, Location based crop selection, Soil parameters.

I. INTRODUCTION

Since Crops are the driving force behind India's overall development, agriculture is the most significant industry in the country. The primary sector of the Indian economy is agriculture. For the great majority of Indian farmers, it serves as their main source of income. With 1.42 billion people living in India, 60.3% of the country's land is used for agriculture in order to feed this large population[1]. Approximately 58% of the population is employed in agriculture, which contributes roughly 17% of the GDP. While the population was growing daily, farmers' holding sizes were contracting. Since the soil is the foundation of agriculture and has been farmed for thousands of years, its health has been diminished, which reduces agricultural output [2]. However, as farmers' ignorance causes the soil to deteriorate over time, embracing new agricultural technologies is crucial.

Farmers can lessen these difficulties and choose crops that will optimize yields while boosting production by employing machine learning-based crop suggestions [3]. Both the farmers and the public will benefit from this, as the former may boost output and profit while the latter can purchase crops at lower costs. Prior to the invention of modern farming methods, farmers would just plant crops based on the needs of the populace, without properly understanding the conditions of their soil, and they would apply fertilizers indiscriminately, which would cause soil acidity and reduce output by damaging the soil's upper layer [4]. We develop a crop recommendation system using machine learning (ML) techniques such as Random Forest, SVM Classifier,

Decision Tree, etc. to solve this issue. A range of data, including soil, weather, and market data, can be analyzed using crop recommendation systems. Machine learning models can be trained using this data to determine which crops have the best chance of succeeding in a certain area. Systems that recommend crops can also tell farmers about the best ways to grow particular crops[5]. It will examine the soil and meteorological conditions and suggest the best crops to plant. Farmers are asked to gather information for the model, including rainfall, potassium, phosphorus, and nitrogen contents. Items that are required and will be utilized. After that, every input—including SVM, Decision Tree, and Random Forest—is applied to the model in order to find patterns in the data and forecast the harvest based on those patterns[6].

Crop Recommendation System : Taking into account their soil type, climate, and other variables like NPK, a crop recommendation system can assist farmers in selecting the best crop to plant.

Fertilizer Suggestion System: In order to utilize the fertilizer recommendation system, farmers must input information about their soil and crop. Afterwards, based on this information, the system would suggest which fertilizers to use and in what quantities.

II. OBJECTIVE

- A. To create an intelligent system that can offer appropriate crops and matching fertilizer recommendations based on user input and real-time environmental data.
- B. Provide a system that can adjust dynamically to changing weather, such as changes in humidity, temperature, and rainfall, so that suggestions are still applicable and useful in the moment to increase the effectiveness of crop selection in order to minimize losses and enhance production to lower the risk of crop failure and financial losses as a result of making bad crop choices.
- C. Higher crop yields
- D. Lower expenses
- E. Higher crop quality

III. LITERATURE REVIEW

A machine learning-based crop prediction model is used. This model uses input from a variety of sources, including soil conditions, meteorological parameters, and historical crop data. With this information, the model is able to predict which crops should be grown in the future, assisting users and farmers in making the best crop choice given the current conditions. The model is trained using historical crop data as well as pertinent variables including soil conditions and water parameters. All of the training and testing data are derived from our dataset, which allows us to assess the model's accuracy[1].

The goal of the research in the Biswanath area of Assam was to develop a crop recommendation system based on the physical characteristics of the soil. 180 soil samples covering a latitude and longitude range of 26°35' to 27°00' and 92°50' to 93°50' were gathered and subjected to a variety of physical property analyses. High variability (CV > 35%) was observed in key indices, including bulk density, particle density, soil texture, and hydraulic conductivity. While measures like bulk density, particle density, total porosity, field capacity, mean weight diameter, micro aggregate, macro aggregate, and volume expansion demonstrated minimal variability (CV < 15%), available water showed moderate variability (CV 15–35%). These findings were incorporated by the research into a machine learning model to create an approachable crop recommendation system for nearby farmers[2].

In this work, near-perfect accuracy machine-learning algorithms for crop recommendation are presented. The technology makes precise predictions about the most suitable crops by utilizing a number of characteristics, such as soil composition and climate data. The system could change the way that crop recommendations are made. It boosts productivity, sustainability, and overall profitability for farmers of all sizes [3].

Millions of people worldwide rely on agriculture as their primary source of income, and it is the foundation of the Indian economy. Industry 4.0's Learning Technology Option provides recommendations and other solutions through the use of AI and machine learning algorithms. The study's data was downloaded and annotated via Kaggle. N, P, K, temperature, humidity, pH, precipitation, and other characteristics make up its total of 08 features and 07 parameters. The authors also employ optimization approaches to raise the efficiency of smart factories [4].

The goal of this research is to maximize crop productivity in nations where agriculture plays a significant role in the economy. Using machine learning methods, the researchers implement precision agriculture and create a crop recommendation system. Based on certain characteristics of the soil, such as pH level, potassium,

phosphorus, and nitrogen, the system recommends crops. The study hopes to have a big impact on the agriculture industry by highlighting freely accessible soil data, especially in South Africa[5].

Based on input parameters like soil pH, temperature, rainfall, and levels of nitrogen (N), phosphorus (P), and potassium (K), this study suggests the crop that would be most appropriate. Using a variety of supervised machine learning techniques, this project forecasts the accuracy of the production of eleven different crops in India, including rice, maize, chickpeas, kidney beans, pigeon peas, moth beans, mung beans, lentil, pomegranate, banana, mango, grapes, watermelon, muskmelon, apple, orange, papaya, coconut, cotton, jute, and coffee crops. It also suggests the most appropriate crop. The machine above learning system utilized various techniques, including Decision Trees, Naive Bayes(NB), Logistic Regression, Random Forest (RF), and K closest neighbor[6].

In rural India, agriculture and its allied industries are without a doubt the main sources of income. Furthermore, agriculture has a significant influence on the GDP of the nation. Crop yield per hectare, however, falls short of global norms. This is among the leading reasons for suicide among India's marginal farmers. The finest recommendation method was suggested by this study. Based on factors like temperature, soil, moisture, and nutrients from the fields—including pH, rainfall, and nitrogen, phosphorus, and potassium (NPK)—the suggested system suggested crops to farmers. Based on all aspects, machine learning algorithms allow for the best possible product selection[7].

Although agriculture plays a major role in GDP and is essential to human life, there is still room for development, especially in crop recommendation. Productivity is increased by accurate crop prediction, particularly when dealing with the effects of climate change. Agronomists find it challenging to manually choose crops based on soil and environmental factors. To tackle the problem, this chapter suggests a recommendation system that makes use of deep learning and machine learning methods to help farmers choose the right crop varieties. The objective is to increase crop yield by taking use of different factors such soil properties, climate, and geographic position[8].

Climate has a major influence on agricultural productivity, therefore choosing crops at the right time is essential for best outcomes. In order to create a recommendation system for farmers, this study presents a categorization model that takes into account agro-climatic factors including temperature, relative humidity, soil type, pH, and crop length. Using machine learning methods, data augmentation, and study of optimizers and activation functions in artificial neural networks, the unique approach predicts crops in 33 districts of Tamil Nadu based on crop patterns[9].

The importance of agriculture to humankind makes the creation of a crop recommendation system necessary. The focus of this project is on crop selection according to meteorological factors and soil characteristics (nitrogen, phosphorus, and potassium). Structured datasets are processed by machine learning algorithms using techniques like classification. By dividing the dataset into training and testing data, different models' accuracy is evaluated, and the algorithm that performs best overall is chosen based on the highest accuracy[10].

IV. DATA FLOW DIAGRAM

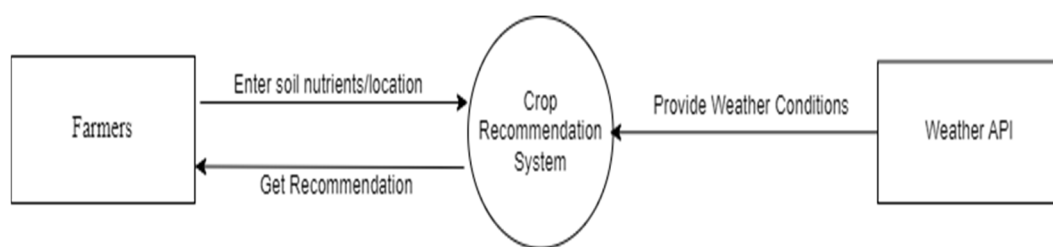


Fig.1 level 0 dfd

Above figure shows level 0 DFD where the system will gather the nutritional data of soil and geographical location from the farmers and fetches weather condition data from a weather API, and then recommend crop based on this data.

V. METHODOLOGY

A. User Interface

This is the interface that the user uses to communicate with the system, give it input, and get crop recommendations.

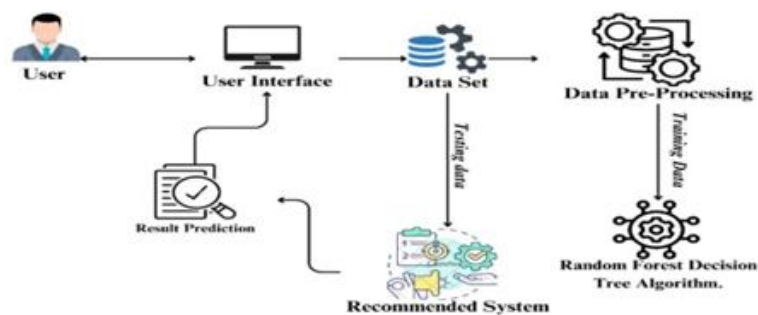


Fig.2 Methodology

B. Data Collection

Gathering information about various crops is the first step. Numerous sources, including government organizations, agricultural databases, and farmers themselves, can provide this information. Among the particular data points that could be gathered are:

Climate data: This comprises particulars like humidity, precipitation, and temperature.

Soil data: This comprises details on the kind of soil, pH, and amount of nutrients present.

C. Data Pre-processing

To prepare it for machine learning, the data must be cleansed and prepared after it has been gathered. This could entail scaling the data, eliminating outliers, and transforming categorical variables into numerical ones.

D. Model Training

Next, using the pre-processed data, a machine learning model is trained. The model's objective is to discover the connections between the various elements that affect crop yield and growth. Several widely-used machine learning techniques that are suitable for crop recommendation are as follows:

Random Forest, SVM, Decision Tree

E. Model Evaluation

To determine the model's performance after training, it must be tested on a hold-out test set. This makes it more likely that the model will accurately generalize to fresh data.

F. Model Deployment

The model can be put into production after it has been assessed and determined to be functioning well. This entails providing users with access to the model so they can receive crop recommendations.

VI. FLOWCHART

The flowchart is shown in the figure 3 on next page.

VII. RESULT

The research project proposes an integrated approach for precision agriculture by employing advanced technologies for crop recommendation, fertilizer optimization, and disease detection. For crop recommendation, the system utilizes soil parameters such as nitrogen, potassium, phosphorus levels, alongside environmental factors like temperature, pH, and rainfall, to suggest the most suitable crops for cultivation. Fertilizer recommendation is tailored to the specific needs of the chosen crop, factoring in the soil's nitrogen, potassium, and phosphorus content. Additionally, the project introduces a novel disease detection mechanism through image processing.

As shown in the fig 4. is a combination line graph of nitrogen, phosphorous and potassium values. This graph indicates the amount of (N, P, K) for the different crops. Blue line represents the value of nitrogen, orange line represents phosphorous and the green represents potassium.

In Fig.5 It is imperative that we restrict our options to those that will truly help choose the kind of crop to be grown. To do this, we developed a correlation matrix that visually represents the linear relationship between any two features. It makes more sense to use all of the attributes rather than just a few to choose which crop to produce because they are associated with each other.

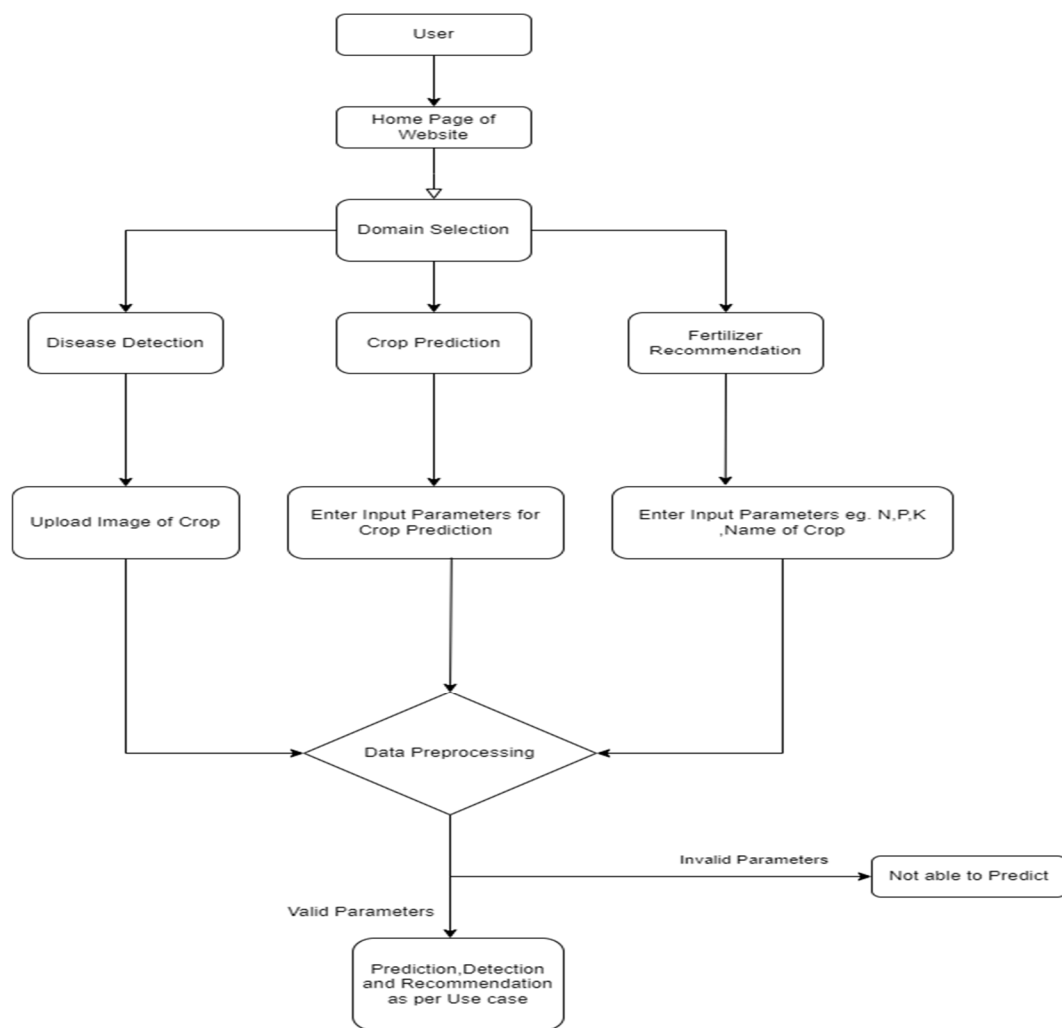


Fig.3 Flowchart

```
[31]: selected_columns = ["N", "P", "K"]
new_df = merge_fert[selected_columns]
plt.plot(new_df)
```

```
[31]: [ <matplotlib.lines.Line2D at 0x19a139f56d0>,
      <matplotlib.lines.Line2D at 0x19a139f5730>,
      <matplotlib.lines.Line2D at 0x19a139f5760>]
```

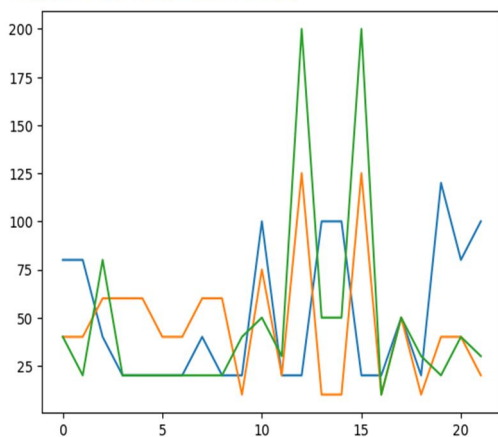


Fig.4 Comparison of NPK requirement for crops

```
In [11]: sns.heatmap(df.corr(),annot=True)
```

```
Out[11]: <AxesSubplot:>
```

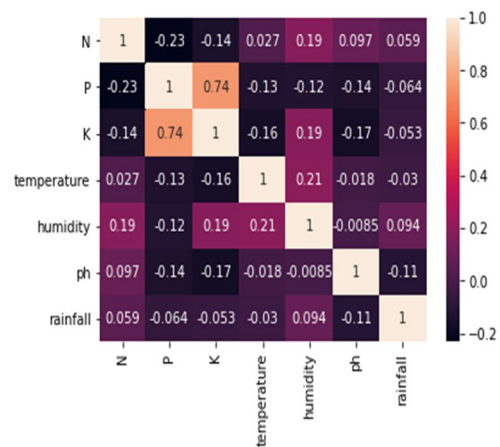


Fig.5 Correlaton matrix between different parameters

Fig.6 Crop prediction Page

Fig.7 Fertilizer Recommendation Output

Fig.6 is that page where user needs to input the values of soil nutrients (N, P, K) and also some meteorological information along with his geographical location and then submit the information and then the system provides best suitable crop to him.

In fig.7 shows the output for the fertilizer recommendation component of the website. After getting the nutritional component of the soil and the crop which he wants to grow as an input by the farmer then the project would suggest that which fertilizer present in excessive or less amount and also suggest some ways to manage that fertilizer which can increase the fertility in the soil.

Fig.8 Disease Detection Output

VIII. FUTURE SCOPE

1. We can gather information to enhance the crop recommendation system by putting sensors on the land.
2. To make the system easy for farmers to use, we can develop it in multiple languages for them.
3. Integrate with the system that notifies farmers about crop production, including the amount of crop that will be produced, based on the area of their farm.

IX. CONCLUSION

Farmers of today deal with a variety of issues and lack accurate knowledge on the planting and cultivation of crops. Farmers can better understand which crops to grow by following this guideline. Additionally, overuse of fertilizers by farmers can result in acidity of the soil and pollution from the environment. Using this technique, farmers can also recommend fertilizers based on the nutrients in their soil. Many machine learning algorithms are trained using unknown samples from the training dataset in order to identify the crop that is most suited for growing on a given plot of land based on the soil properties (i.e., ratio of nitrogen, phosphorus, and potassium), weather, temperature, soil PH, rainfall, etc.

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