# SOIL FERTILITY PREDICTION AND CROP RECOMMENDATION USING ML ALGORITHM

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**Abstract -** India's economy is heavily dependent on rising agricultural yields and agroindustry goods. In this paper, we explore various machine learning techniques utilized in crop yield estimation and provide the detailed analysis of accuracy of the techniques. Machine learning techniques learn from data set related to the environment on which the estimations and estimation are to be made. The outcome of the learning process is used by farmers for corrective measures for yield optimization. The Random Forest [RF] model provide suggestions for enhancing soil fertility and to recommend fertilizer depending on the soil's nutrient composition.
**Keywords:** Machine Learning, Soil fertility prediction, Crop Recommendation.

## 1 INTRODUCTION

Agriculture has long been acknowledged as the main supplier of goods to fulfil people fundamental needs. It is also recognized as a main employment and a significant industrial sector in India. Farmers should stick to traditional ways of observation that produce healthy crops without the use of pesticides on either their farmed area or animals in order to sustain healthy variety. To increase security and reduce the supply of food, the weather is rapidly changing today in opposition to the natural resources. In the interval, the agriculture sector's GDP has been progressively falling. It makes sense for Indian farmers to express a specific interest in efficient and precise farming. There are several techniques to increase the crop in India.

As a result, farmers have trouble using climate data to predict the weather and crops. The development of machine learning in recent years has had a significant impact on every industry, including agriculture. In this case, the crop prediction method involves combining the prior data. All industries, including agriculture, have seen substantial advancements in machine learning in recent years. In this instance, crop prediction entails fusing past and present data for a certain month to show the reliability of meteorological data. The principle behind machine learning, which may be a subset of AI, is that computers will use data analysis to make judgments with little to no human input. [8] It could also be a way for assessing data to automate the proposed model. This suggested system evaluates the application of supervised machine learning methods.

## 2 LITERATURE REVIEW

Kumar et al[18] have worked on using historical data and considering factors such the climate, humidity, ph., rainfall, and crop name, supervised machine learning can be used to estimate crop production in the agricultural industry. This strategy will cover the widest range of crops in all of India's districts. One can anticipate the best crop based on the field's weather by using the suggested approach. The decision tree and random forest algorithms effectively predict crops. Using the random forest approach, the most accurate value was obtained. More accurate findings increased the agricultural yield's profit.

Doshi et al [20] have developed an application named Machine Learning Algorithms for an Intelligent Crop Recommendation System. Along with the five primary crops (jowar, bajra, maize, rice, and wheat), the recommended approach is also suitable with fifteen minor crops (barley, cotton, groundnut, gram, jute, other pulses, potato, ragi, tur, rapeseed and mustard, sesame, soybean, sugarcane, sunflower, and tobacco). By using neural network algorithm to crop appropriate predictor system, this suggested system obtained 91.00% accuracy and 71% accuracy utilizing rainfall predictor model. Kulkarni et al [21] have been carried out a study on Crop Recommendation System to Increase Crop Productivity. This suggested system employed Linear SVM, Random Forest, and Naive Bayes as its machine learning techniques. The proposed crop groups, Kharif and Rabi, were broken up into using this crop selection technique using the provided soil data. The accuracy result obtained after using the proposed approach was 99.91%. Rajak et al[4]

have been carried out a research on crop recommendation system using Machine Learning Technique", to enhance agricultural productivity. Utilizing a soil database, this suggested technology is utilized to pinpoint a certain crop. In order to quickly and precisely choose a crop for a site-specific parameter, this technique used a number of machine learning classifiers, including the classifiers supported by the support vector machine (SVM), ANN, Random Forest, and Nave Bayes. Suresh et al[17] have worked on "Digital Farming: An Effective Machine Learning-Based Crop Yield Recommendation System. This proposed method is used to identify a certain crop using the provided data. To boost output and accuracy, support vector machines were deployed (SVM).

## 3 EVOLUTION OF MACHINE LEANRING IN AGRICULTURE

Artificial Intelligent Systems have replaced many traditional methods of agricultural management as a result of the digitization of agriculture. While creating knowledge-based agricultural systems, machine learning may be able to aid with a number of issues. Machine learning algorithms based on artificial neural networks are among the most efficient ones (ANN).


**Figure 1 ML in the field of Agriculture.**

Farmers will soon be able to identify weed infestations, for example, thanks to machine learning [7]. A successful agricultural operation depends on making complex decisions that take into account the interactions of several factors, including crop requirements, soil properties, climate change, and others [5].

## 4 METHODOLOGY

Fig. 2 shows that the overall methodology of the project .By this we come to know about the procedure. It signifies that how the project will work from the root to end step.

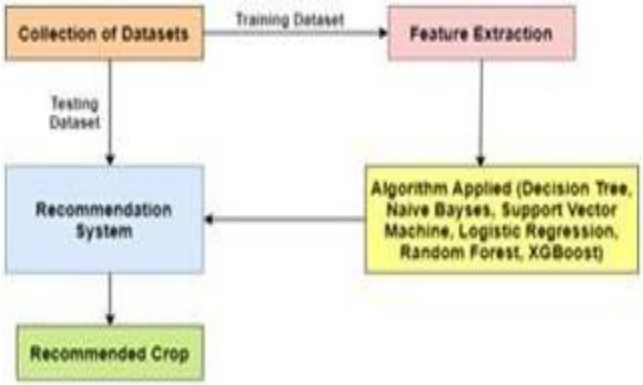


**Figure 2 Block Diagram of Overall Methodology.**

### Decision Tree:

By learning decision rules from prior data, [2] the main goal of employing a decision tree is to create a training prototype that can be used to predict the class or value of a target variable (training data).

**Naïve Bayes:**
An order computation for binary and multi-class arranging problems is Naive Bayes. When the data sources have a high level of dimensionality, it is advantageous that is based on the Bayes theory, the naive Bayes classifier.

$$P(A \mid B) = P(B \mid A) \qquad P(A)/P(B)$$

Here,
Posterior probability - P(A|B). Likelihood probability - P(B|A). prior probability - P(A) marginal probability - P(B)

**Support Vector Machine (SVM):**
It is used to address problems with classification and regression (SVM). A model or technique for supervised machine learning. The next step in categorizing is to find the hyper-plane that best separates the two classes.

**Logistic Regression (LR):**
In its simplest form, the logistic regression model simulates a binary dependent variable using a logistic function, there are many more complex variations available.

**Random Forest (RF):**
An ML algorithm is Random Forest. During the training phase, many decision trees are built, and the outcomes are then divided into outputs for classification and regression based on the number of classes.

**XGBoost:**
For viability, computation speed, and model performance, extrema Gradient Boosting (XG Boost), a flexible and enhanced variant of the gradient boosting technique, was developed. It is well known that XGBoost outperforms other machine learning techniques in terms of performance.

## 5 DATASET DESCRIPTION

The sample data set is as follows. Based on eight parameters, the statistics in Table I are utilized to forecast to recommend best crop by taking input of soil data. N, P, K, Temperature, Humidity, PH, Rainfall in millimetre are these 7 elements, and last parameter is class label. Using this data

| N | P | K | TEMPERATURE | HUMIDITY | PH | RAINFALL | LABEL |
|---|---|---|---|---|---|---|---|
| 90 | 42 | 43 | 20.8 | 82.00 | 6.5 | 202.9 | rice |
| 85 | 58 | 41 | 21.7 | 80.31 | 7.0 | 226.6 | rice |
| 60 | 55 | 44 | 23.0 | 82.32 | 7.8 | 263.9 | rice |
| 74 | 35 | 40 | 26.4 | 80.15 | 6.9 | 242.8 | rice |
| 78 | 42 | 42 | 20.1 | 81.60 | 7.6 | 262.7 | rice |

**Table 1 Sample Dataset of Crop Data**

We can build a machine learning model, train it, and get production estimates. It also allows anticipating how much Fertilizer should be applied to achieve the desired output. Eight variables make up the dataset, however only seven are used to forecast the output variable. The variable's details are as follows [1]:

**N (Nitrogen):** the soil's nitrogen content. Nitrogen is necessary for plant development (structure), food metabolism, and the formation of chlorophyll. Without enough nitrogen, the plant cannot produce enough food or increase its height (usually yellow).

**P (Phosphorus):** The soil's phosphorus content. A plant uses phosphorus primarily to transfer and store the energy produced during photosynthesis, which is then used for growth and reproduction. P is cycled through the soil in a variety of ways.

**K (Potassium):** soil's potassium concentration. A crucial ingredient for the development of plants is potassium.

**Temperature:** degree count for the temperature. High temperatures have a range of effects on plant growth.

**Humidity:** percentage relative humidity. Extreme humidity can encourage the growth of bacteria and diseases like root or crown rot that damage plants and ruin crops.

**PH:** The pH of the soil is number six. At pH levels between 5.5 and 7.0, plant nutrients leave the soil much more slowly than they do at pH values below 5.5. At pH values below 5.0, aluminium may dissolve in certain mineral soil.
**Rainfall:** Millimetres of precipitation. Plants need the soil's moisture to replace the water lost through transpiration.
**Label:** This output variable has values for 22 distinct crops, including "Apple," "Banana," "Black Gram," "Chickpea," "Coconut," "Coffee," "Jute," "Grape," "Lettuce," "Kidney Beans," "Mung bean," "Muskmelon," "Orange," "Papaya," and "Pigeon Pea.".

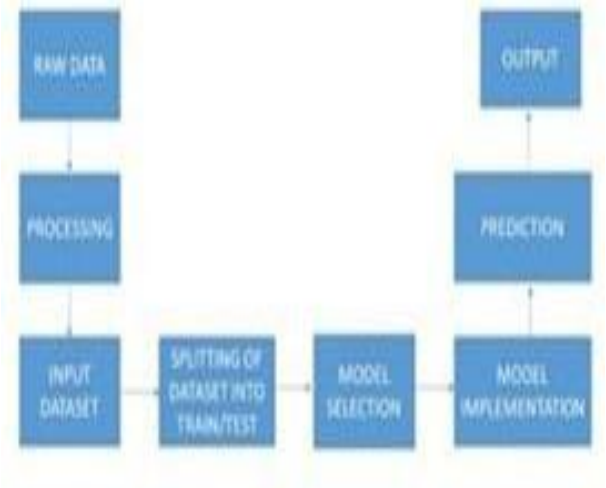


**Figure 3 Phases of Working Model**

The above fig 3 shows that how the model will work in an sequential manner. The following are the five phases of working process.

1) Gathering of Datasets
2) Noise removal during pre-processing 3)Feature extraction
3) Utilized various machine learning algorithms
4) An outline of suggestions
5) Crop suggestions

The major goal is to increase the range of crops that can be cultivated throughout the season [9].

## 6 RESULT AND DISSCUSSION

The major objective, as shown in the figure, is to help farmers make an educated decision before planting by advising them on the best crops to cultivate based on a range of criteria [12]. The data is prepared for implementation in the Google Colab platform after collection by being changed to generate a ratio of 70% for training and 30% for testing, which is carried out using a train test library [11].


**Figure 4 Home page**

Here the home page of the project


**Figure 5 About Page**

The above fig shows the about the project .it contain basic information regarding agriculture

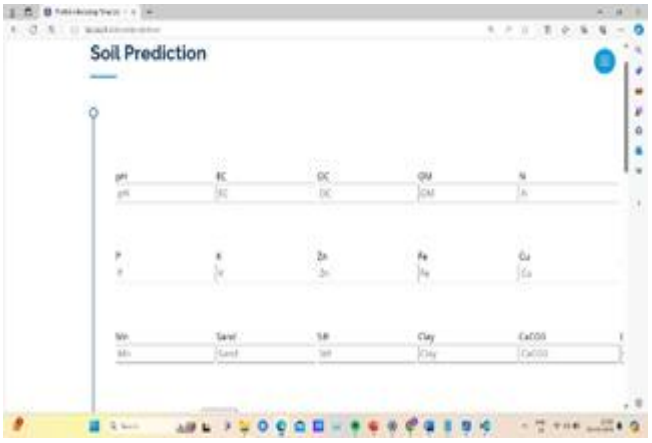


**Figure 6 Soil prediction**

The above fig shows the soil prediction in this we are giving the input in the form of numerical values and it will predict that over soil is fertile or not by considering some of the major factor factors such as PH, K, Mn, Fe etc

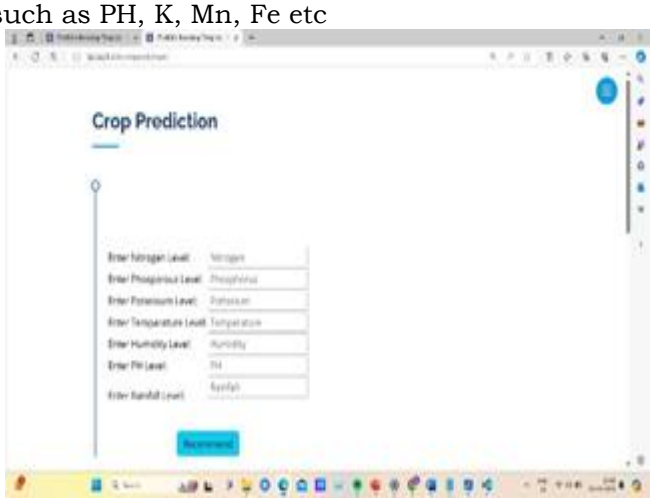


**Figure 7 Crop Prediction**

The above fig show the crop prediction by taking the input values of the PH, Humidity, Temperature, rainfall etc.

## 7 PERFORMANCE EVALUATION

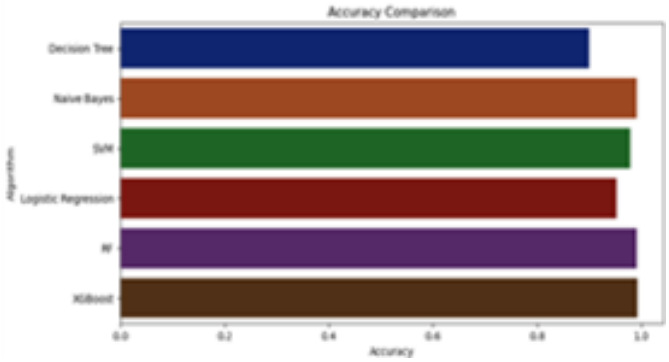


**Figure 8 Accuracy results comparison among the algorithm used to recommend crop.**

The following represents the accuracy results in percentage RF = 0.9909090909091
Naive Bayes = 0.9909090909091 Decision Tree = 0.9
SVM = 0.979545454545454545
Logistic Regression = 0.9522772727273 XGBoost =0.99318181818182.

## 8 CONCLUSION

This system is used to predict the soil Fertility and crop recommendation the solution will benefit farmers to maximize productivity in agriculture, reduce soil degradation in cultivated fields, and reduce fertilizer use in crop production by recommending the right crop by considering various attributes. However, ongoing research and development are crucial to refining models, ensuring accuracy, and addressing evolving challenges in the agricultural domain. The successful implementation of these technologies can lead to increased yields, reduced environmental impact, and overall advancements in precision agriculture

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