IJAER/ March-April 2024/Volume-13/Issue-2 ISSN: 2278-9677
International Journal of Arts & Education Research
(Peer-Reviewed, Open Access, Fully Refereed International Journal) Impact Factor:7.06

Machine Learning techniques for Crop Prediction and Leaf Disease Detection

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Abstract—

Agriculture as an occupation is backbone for many countries which have been supporting farmers. For decades, farmers have used specific pattern for farming but the changing climate is encouraging the farmers to rethink the pattern established by their forefathers. With progress in computer field and machine learning new techniques are emerging for farming. With same in view the system is proposed for leaf disease detection with prediction of crop which can be planted in specific type of soil and crop yield prediction help of machine learning algorithm. The system supports two different architectures for detection of leaf disease and prediction of crop. Machine learning techniques quantifies the crop yield prediction depending on factors such as weather, soil type and humidity. The image processing is used for leaf disease detection and remedies suggestion for removal of same. The application is established after careful analysis for both machine learning techniques and image processing algorithms which gives the results for disease detected leaves of tomato, grapes,etc. Based on the outcome of this research model we were able to predict different type of crops through the humidity, temperature and moisture content of soil. Through the comparative analysis on the parameters of accuracy Naïve base, RF, XGBoost models provides 99% , SVM provides 98%, Logistic Regression provides 96.5% and decision tree provides 95.5% accuracy.

Keywords— agriculture, leafdisease detection, crop prediction, crop yield prediction, machine learning, image processing.

INTRODUCTION

For centuries agriculture has been the main source to provide food and raw materials to many people across globe. The production and outcome from it is changing since the climatic change around the world. The production is declining and not meeting the need of growing population. The farmers are facing problem with declining crop production as well the income they earn from it. The farmers are not able to deal with changing environment , disturbed rainfall and the crop are diseased to give low yield. They lack knowledge for the good production of crop. The ignorance towards new techniques and disapproval for adaptation for same causes more problem.

Thus, emerging field of technology help for this crisis faced by farmers. They provide information to the farmers for good farming so that they can produce good and more yeild. With machine learning techniques the weather conditions can be predicted. The image processing techniques help in image perspective. The following objective is to provide a system that provides farmers with the necessary information in the selection process. In today's society, information technology is used in many areas around the world. Data mining is the part of data that we can use to solve the above agricultural problems. Analyze crop patterns with the help of historical data and plot them with statistical data. Monitor crop yields and find ways to increase yields. A profitable product is recommended for all types of soil. Help farmers choose crops. Provide information on appropriate fertilizer and irrigation methods for the selected crops. The main idea of data is to extract only important data from big data. More precisely, it is the process of extracting useful information from many documents.

The paper represents a system where crop is predicted depending on soil, weather conditions, temperature. The crop yield is predicted to ensure market requirement and the leaf images of plant are used to predict the disease and remedial suggestion to farmer to remove the same.

The paper is structured to present the implementation of leaf disease detection alongside an analysis of previously employed systems. Section I provides a detailed introduction, while Section II presents an overview of systems commonly utilized by farmers. Section III outlines the architecture for both crop prediction and leaf disease detection, accompanied by a discussion of the methodology. Section IV presents the results and analysis of the implementation.

Ease of Use

A. Crop Recommendation System for Precision Agriculture

In agriculture, data mining is used to analyze various biotic and abiotic factors. Indian agriculture plays an important role in the economy and employment. A common problem among farmers in India is their inability to choose the right crop according to the needs of the soil. As a result, their production faced serious problems. The farmer's problem is solved with precision agriculture. Precision farming is a modern agricultural technology that uses scientific data collected from soil properties, soil type, plant information and recommends suitable crops that the farmer does not have. This reduces product selection errors and increases profitability. In this paper, this problem is solved by proposing a common model that uses majority voting method using random trees, CHAID, K-nearest neighbors and Naive Bayes as learners to reach consensus on the accuracy and efficiency of crops for a given location.[4]

B. Design of fertilization recommendation knowledge base and application

The recommended method for planting involves using formulas to calculate the amount of various nutrients needed during the growing season, selecting the appropriate fertilizer, and scheduling fertilization time. The key to whether it can be widely used lies in whether the structure or parameters of the system can be easily adapted to local agricultural practices. To help solve these problems, it is necessary to have knowledge about the infrastructure and its applications. This article first uses the object-oriented approach to decompose the model to meet the requirements of C++ programming. Organizations are divided into three groups: non-owners and employees, and are used to transform materials used in composting into software system products.

The proposed application utilizes the ResNet50 transfer learning model as its core to differentiate between healthy and infected leaves and categorize the specific disease type. Its aim is to assist farmers in conserving resources and mitigating economic losses by early detection of plant diseases and administering suitable treatments[11].

The prototype[12] has been operational for three months and has demonstrated strong performance, enduring diverse weather conditions without rusting. The proposed plant disease prediction framework has achieved an impressive accuracy rate of 99.24%. Seven distinct classifiers were evaluated, revealing that the support vector machine (SVM) classifier attained the highest classification accuracy of 94.65%. The models were trained and tested on a dataset comprising 619 images[13].

The region growing method [14] is employed to address cluttered background challenges by interactively selecting growing seeds in real-field settings. Precision is utilized to calculate the performance measure, resulting in an average segmentation accuracy of 94%.

We select a set of measurement-based features representing the blobs, which are further filtered based on their impact on the model's performance through a wrapper-based feature selection algorithm, crafted with a hybrid metaheuristic approach. These selected features serve as inputs for an artificial neural network (ANN). Our methodology is contrasted with an alternative approach employing well-known CNN models[15].

The information that needs to run the model is then divided into four types according to its role and represented according to various rules stored in relational data. Finally, the decision-making engine is designed to use them. It is actually a special computer used to control the local environment and display the rules in the form of some ideas and make suggestions.[1]

Sr.no	Title	Year	Technology	Limitation
1	Crop Yield Prediction Using Deep Reinforcement Learning Model for Sustainable Agrarician Application	2022	Reinforncement Learning	Crop Damage is not Detected
2	System for agriculture recommendation using data mining	2021	The system will extracting databases for crop selection when farmer required .	IoT platform is used but prediction with machine learning for crop yield is not done.

C. A Study On Various Data Mining Techniques For Crop Yield Prediction

India is a country where agriculture and agriculture-related industries are the main source of income for its people. Agriculture is the main economy of the country. It is also a country where major disasters such as rain or floods destroy crops. This situation caused farmers to suffer huge economic losses and caused farmers to commit suicide. Pre-harvest crop forecasting, farmers' and government agencies' decision on storage, marketing, price support, minimum transportation quantity, import/export, etc. It can help you make appropriate plans such as: Predicting crop yield is primarily based on soil quality, pH, EC, N, P, K, etc. It requires examining large amounts of data regarding many variables such as. Since crop forecasting involves large amounts of data, this forecast becomes an ideal candidate for data mining. We extract information from large amounts of data through data mining. This article presents research on various data mining methods for predicting crop yield. The success of any product prediction depends on how many features are extracted and how well the distribution is used. This article presents results from various algorithms used for crop prediction by different authors, as well as their accuracy and agreement.[5]

D. Web based Recommendation System for Farmers

Since India is an agricultural country, it still practices traditional agricultural methods. Current recommendations for farmers are a one-to-one interaction between farmers and experts, and different experts have different recommendations. With data mining techniques, suggestions can be made to farmers using previous farming practices and business models can be combined with these, resulting in good results for the approver. The article describes the use of data mining to provide farmers with recommendations on crop yield, crop management, and fertilizer identification. Farmers can use the system online and on Android-based mobile devices. [3]

Sr.no	Title	Year	Technology	Limitation
3	Iot based smart agriculture system for grapes .	2020	The data acquired from sensors gives the con-dition at field like temperature, moisture in soil, leaf wetness and humidity .	Iot platform is used but prediction with machine learning for crop yield is not done.
4	Smart crop and fertilizer prediction system	2019	N, P, K prediction from humidity, electric conductivity (EC), ph and temperature.	Features such as soil type is not included. Crop damage is not detected.

*E. **A novel framework for potato leaf disease detection using an efficient deep learning model***

The presented algorithm introduces a groundbreaking approach, marking the first of its kind, aimed at effectively detecting and categorizing four diseases found in potato leaves. Evaluation of the algorithm's performance in tests resulted in an impressive accuracy rate of 97.2%. Numerous experiments have been conducted to validate that our proposed method exhibits greater consistency and accuracy in the detection and classification of potato diseases compared to existing standards..

I. METHODOLOGY

The system is designed to predict the crop to be planted in soil and crop yield depending on npk value of soil and weather, humidity of the specific place. Fig1 is architecture diagram for crop prediction and crop yield prediction. The machine learning concept of relearning is used for crop prediction.

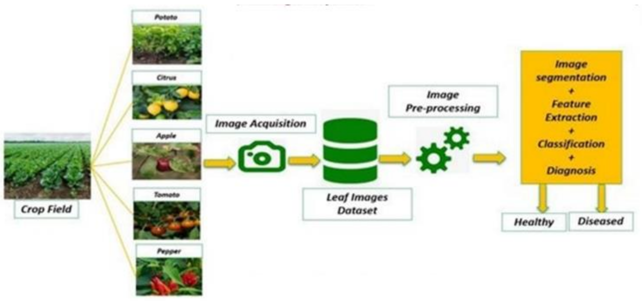


Fig 1: Overall System

The past data is used for training the model. The query data is input and preprocessed. When classification is applied for data with help of SVM, the crop is predicted while when regression is used on preprocessed data the yield is predicted.

The system first determined the crop and then the image processing approach is used to detect the disease for plant through image of leaf.

A. ***System Architecture***

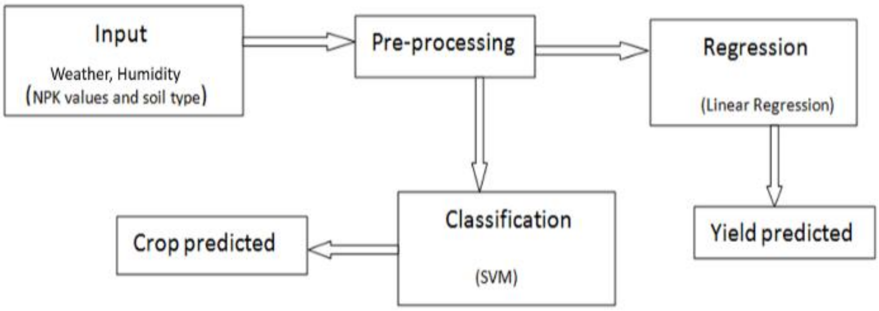


Fig 1: For Crop Prediction

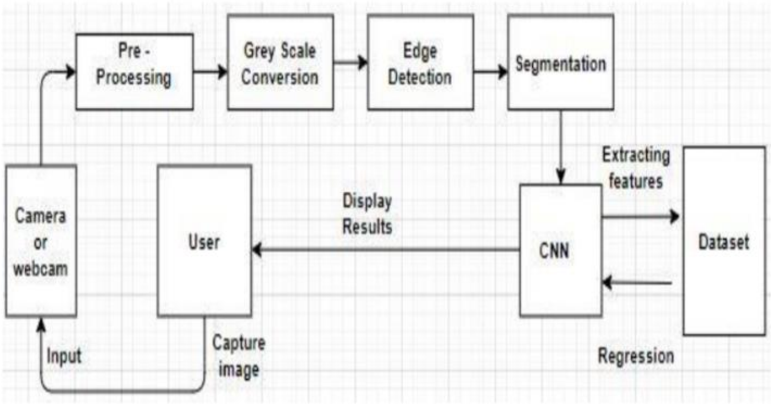


Fig 2 : For Leaf Disease Detection

B. Working

1) Crop Prediction:

The primary elements of the system are depicted in Figure 1:

• Pre-processing: The dataset undergoes pre-processing techniques aimed at converting raw data into a practical and effective format.

• Regression: Utilizing regression as the modeling approach.

• Yield Prediction: Training the model with data to predict crop yields.

• Classification: Employing SVM for classification purposes.

• Crop Prediction: Utilizing the model to predict the type of crop.

2) Leaf Disease Detection:

The key components of the system, as illustrated in Figure 2, include:

• Image Capture: Capturing the image.

• Pre-processing: Employing pre-processing techniques on the dataset to convert raw data into a more useful and efficient format.

• Greyscale Conversion: Converting the image to grayscale.

• Edge Detection: Detecting edges within the image.

• Segmentation: Segmenting or classifying the image.

• Disease Detection: Detecting diseases within the segmented image.

C. Algorithm :

1) Support Vector Machine:

SVM, a machine learning technique, is utilized to separate data by maximizing the margin between categories. This algorithm aids in the classification of textual feedback based on data obtained.

Input: Dataset D, Token Semantics, Feedbacks;

Output: Application Classification

Step 1: For each feedback ID in dataset D:

Step 2: Extract on-demand features and store them in vector x for the feedback ID.

Step 3: Append features obtained from feedback ID to vector x.

Step 4: End loop.

Step 5: For each feedback in vector x:

Step 6: Retrieve the first feature and store it as 'b', and store the rest of the features as 'w'.

Step 7: Calculate h(w, b)(x) = g(z), where z = (w^T x + b).

Step 8: If $z \leq 0$,

Step 9: Assign g(z) = 1.

Step 10: Else, assign g(z) = -1.

Step 11: End if.

2) CNN:

Step 1: The system is supplied with a dataset comprising images paired with reference captions.

Step 2: Utilizing a convolutional neural network, the system serves as an encoder to extract image features 'f' pixel by pixel.

Step 3: Matrix factorization is applied to the extracted pixels, resulting in an m x n matrix.

Step 4: Max pooling is conducted on this matrix, wherein the maximum value is selected and reinstated within the matrix.

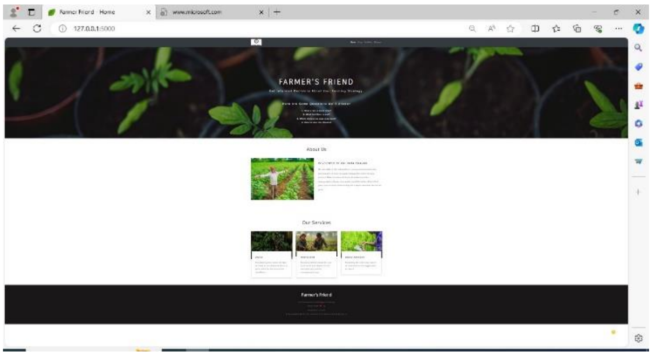
Step 5: Normalization is executed to convert any negative values to zero.

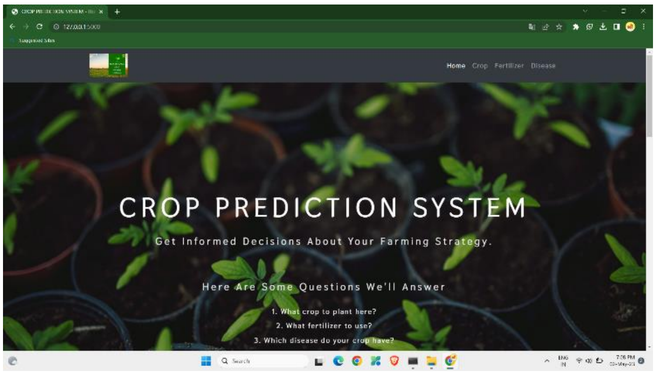
Step 6: Rectified Linear Units (ReLU) are employed to set negative values to zero, effectively converting them to zero.

Step 7: The hidden layers receive input values from the visible layers and subsequently assign weights after calculating the maximum probability.

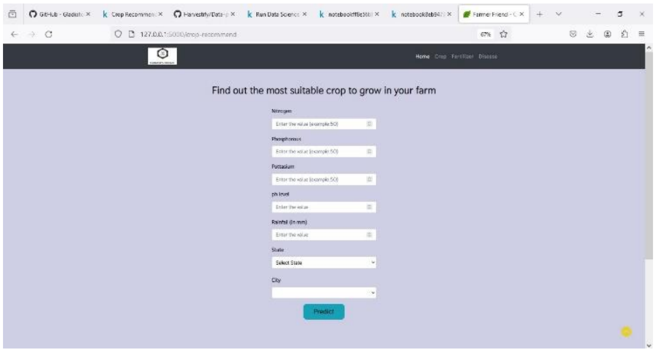
II. EXPERIMENTAL RESULTS

A. System application

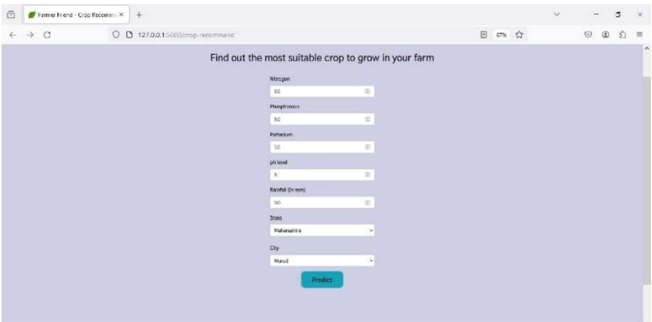


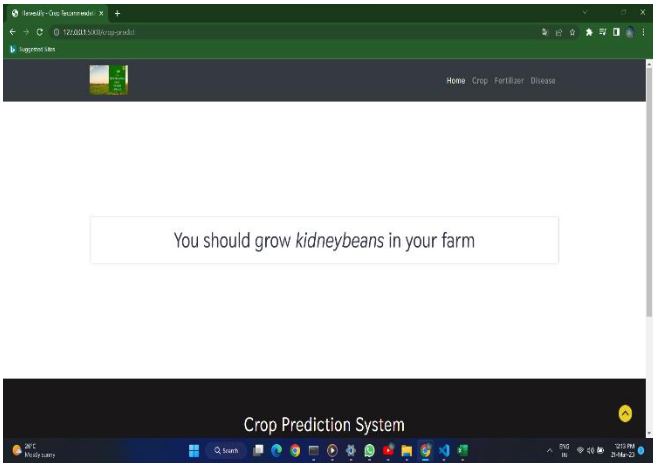


1) Crop prediction:

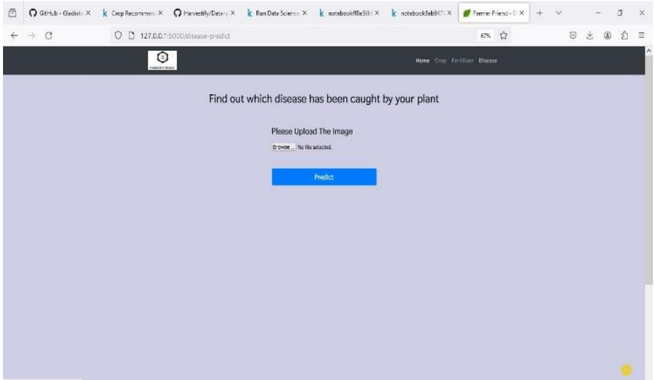


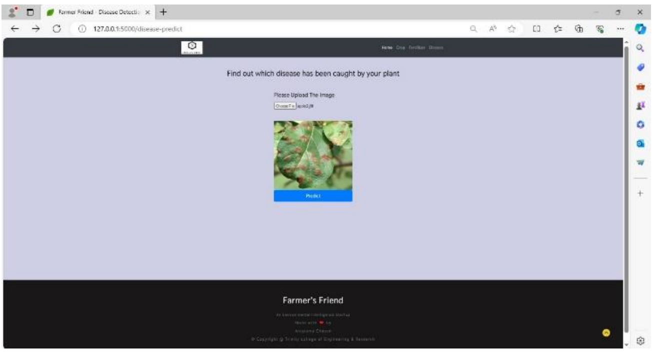
2) Crop Yield:

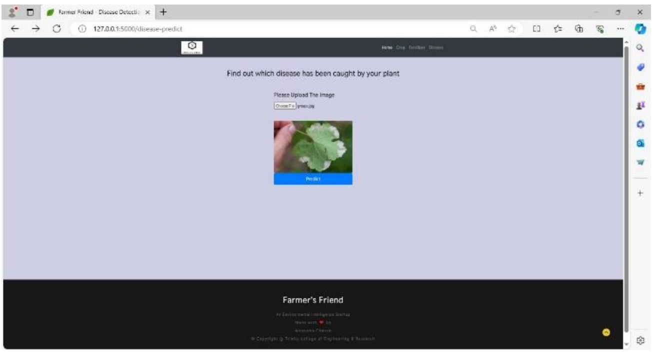




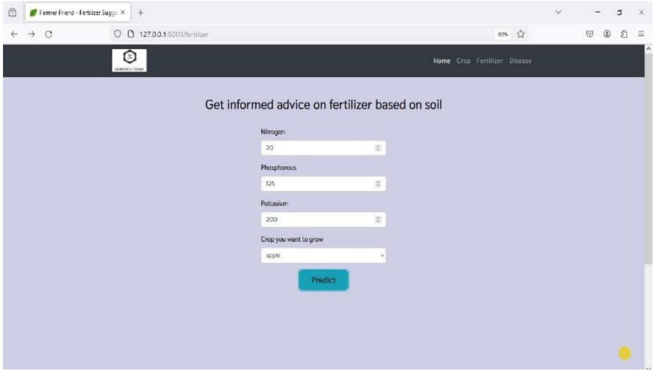
3) Disease Detection:

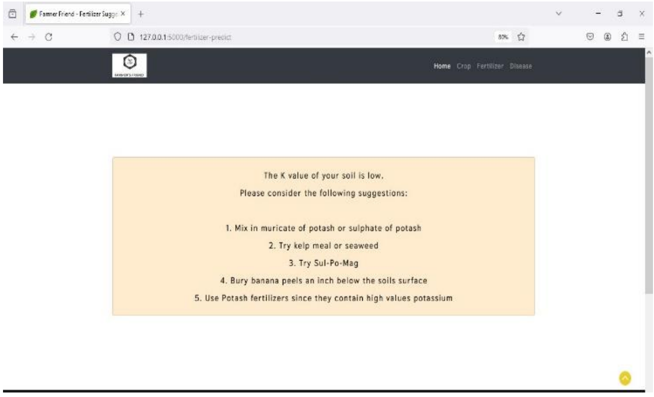




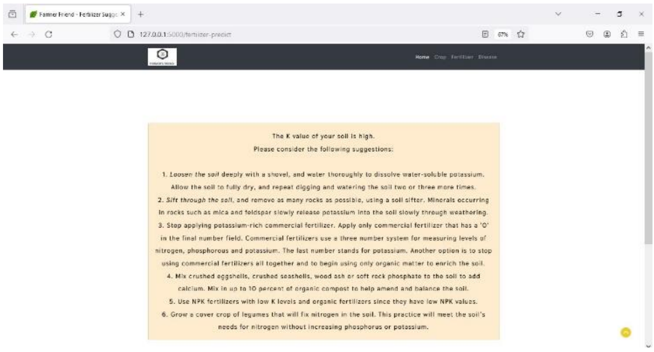


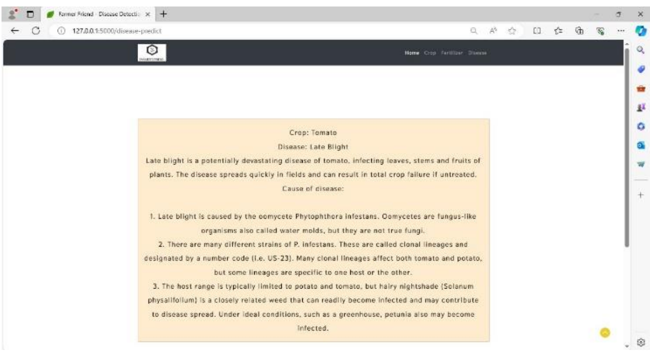
4) Fertilizer:

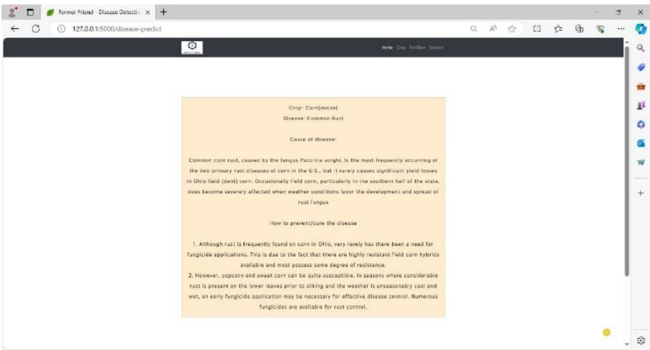

Home
Crop
Fertilizer
Disease
Get informed advice on fertilizer based on soil
Nitrogen
20
Phosphorous
125
Potassium
200
Crop you want to grow
apple
Predict


Home
Crop
Fertilizer
Disease
The K value of your soil is low.
Please consider the following suggestions:
1. Mix in muricate of potash or sulphate of potash
2. Try kelp meal or seaweed
3. Try Sul-Po-Mag
4. Bury banana peels an inch below the soils surface
5. Use Potash fertilizers since they contain high values potassium

B) Analysis:

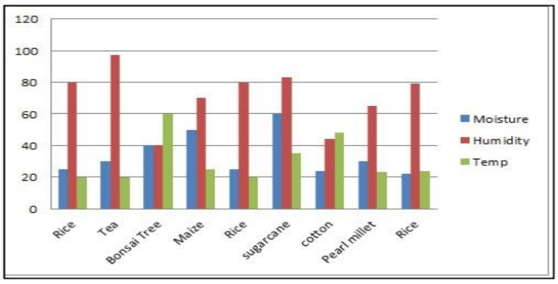

127.0.0.1:5000/fertilizer-predict
Home
Crop
Fertilizer
Disease
The K value of your soil is high.
Please consider the following suggestions:
1. Loosen the soil deeply with a shovel, and water thoroughly to dissolve water-soluble potassium. Allow the soil to fully dry, and repeat digging and watering the soil two or three more times.
2. Sift through the soil, and remove as many rocks as possible, using a soil sifter. Minerals occurring in rocks such as mica and feldspar slowly release potassium into the soil slowly through weathering.
3. Stop applying potassium-rich commercial fertilizer. Apply only commercial fertilizer that has a '0' in the final number field. Commercial fertilizers use a three number system for measuring levels of nitrogen, phosphorous and potassium. The last number stands for potassium. Another option is to stop using commercial fertilizers all together and to begin using only organic matter to enrich the soil.
4. Mix crushed eggshells, crushed seashells, wood ash or soft rock phosphate to the soil to add calcium. Mix in up to 10 percent of organic compost to help amend and balance the soil.
5. Use NPK fertilizers with low K levels and organic fertilizers since they have low NPK values.
6. Grow a cover crop of legumes that will fix nitrogen in the soil. This practice will meet the soil's needs for nitrogen without increasing phosphorus or potassium.


Home
Crop
Fertilizer
Disease
Crop: Tomato
Disease: Late Blight
Late blight is a potentially devastating disease of tomato, infecting leaves, stems and fruits of plants. The disease spreads quickly in fields and can result in total crop failure if untreated.
Cause of disease:
1. Late blight is caused by the oomycete Phytophthora infestans. Oomycetes are fungus-like organisms also called water molds, but they are not true fungi.
2. There are many different strains of P. infestans. These are called clonal lineages and designated by a number code (i.e. US-23). Many clonal lineages affect both tomato and potato, but some lineages are specific to one host or the other.
3. The host range is typically limited to potato and tomato, but hairy nightshade (Solanum physalifolium) is a closely related weed that can readily become infected and may contribute to disease spread. Under ideal conditions, such as a greenhouse, petunia also may become infected.

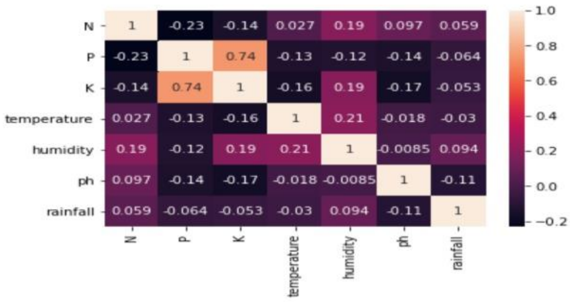


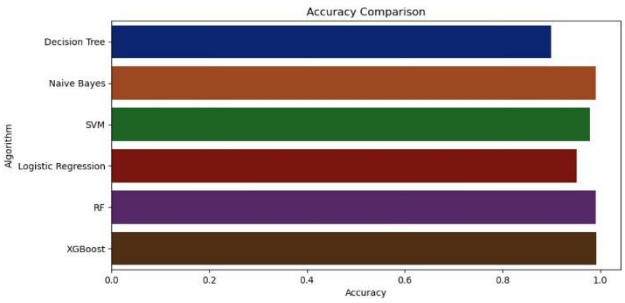
C) Graphs

Through the models we have presented various graphs that predict the various crops through content of soil .



We have also predicted the accuracy of different machine learning algorithms.





CONCLUSION

Crop forecast and crop yield forecast will ensure crop yield. The system will be trained on standard profile values for NPK and the type of soil required for successful cultivation. The system will be tested on real data with NPK values and soil types. SVM is used to estimate decision tree product yield. Rice yield prediction using linear regression machine learning algorithm. To verify the accuracy of the data, we tested the method for predicting the crops to be planted and the yield from the next crop. We compare the training data with the test data to choose the next crop to grow. Imaging is used to detect leaf diseases.

The system can be enhanced by creating an android app which will be of ease of use for farmers where they can know about the crop yield, as leaf disease, prevention for same as well market value for the product.

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