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Machine Learning based Prediction and Recommendation System for Detection of Pests and Cultivation of Crops

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***Abstract*: Serious infliction is induced to the growth of the crop by the pests resulting in a severe decline of the stock. The fundamental approach to making suitable prevention standards is the speedy and precise prediction of pest damage. The observation process, statistical plan, and mathematical representation are the traditional pest prediction arrangements. In farm areas, the endowment of primary pest forecasting locations, but these techniques have some restrictions because of their own faults, such as an experimental prediction of individual parts is clear, the correctness of the association coefficient utilized is moderate.**

By applying Machine Learning technology, we can precisely distinguish the appearance of pests and disease in the fields. In current years, some researchers have established the BP artificial neural network (Back Propagation Artificial Neural Network) Compared with the conventional approach of Back Propagation Neural Network which enhances the prediction efficiency and comfort of use, but there are two severe drawbacks: gradual convergence rate and simple to fall into the minimum point. Acknowledging the results of multivariable, time-varying, and unknown factors on insect pests, it is necessary to stabilize a pest model with powerful prediction performance, accuracy, and precision. First, based on the Back Propagation neural network, the existent climate is used.

***Keywords*: Image processing, Machine learning, Neural networks, Pest prediction.**

1. Introduction

Over the decades our country has been developed drastically, now we are in this state that we have more advancement in terms of Technology. With the increasing need for development in Agriculture, "The Modernization of Agriculture", we introduce a Recommender System which can efficiently recommend and predict pest attacked on crops. The prediction model is authenticated by utilizing the traditional data of insect pests, and then the genetic algorithm is adopted to search for the unique features of community optimization. The pest appearance can be guessed immediately and carefully by optimizing the weights and thresholds of the arrangement. As they say it, Prevention is better than cure, our project aids framers to accurately predict pest as well recommend crop suitable to their specifications.

It causes economic loss to farmers as weather changes pests and insects develop on the crops and destroy the yield. Farmers can inspect manually but these can take time and accuracy concern is present, so there arises a need to modernize the traditional agriculture system and with the help of the prediction system, we can minimize these problems. With the facility of recommendation system, it will be best to plant crops suitable to the climate conditions, land specifications, and other environmental factors.

The motivation of the project is, we want to digitalize our daily life and our country. In many countries, this prediction and recommender system is already available and is quite popular. And we want to apply this system in our country, as a part of achieving and stepping towards modernization of Agricultural techniques.

2. Literature Survey

Several suggestions are given for foretelling the farming crop results which are provided in this segment. [1] have produced a Classification model for predicting the cotton crop disease and also recognizing the constituents determining the pest population density which will further support the farmer apply pest control procedures on time to decrease crop loss. [2] used a fuzzy decision tree model for delivering coffee plant rust warning where the author has created the six datasets according to two distinguished infection rates, where this prototype can be utilized to trigger warnings and alert when calculated recurrent disease infection rates reach one of the two thresholds. The author has also explained the compression of all decision tree algorithms and pointed out that the fuzzy decision tree model produces better precision of power and predictability. [3] has addressed Data-Driven Approach for accumulating soil moisture where the author elaborates a framework to foretell the soil moisture using SVM plus RVM that is a relevant vector machine where they used historic field-collected sensor data where the author achieved moderate error rates and the highest similarity between predicted values and actual values. [4] Forecast the harvest of crops applying machine learning model classifiers, where the model is first trained by the author on the

interrelationship between the former environment patterns and crop management standards, then the models are correlated to test their efficiency on unknown climatic variables. [5] analyzed four continuous agriculture periods to explain the relation between crop-weather-pest/diseases utilizing wireless sensor and field level inspection data on groundnuts crop where the author applied Association Rule mining and multivariate regression mining.

There is a radical change in Agri-Tech. Not most of the farmers are utilizing the most advanced tech devices in their fields. We regularly see IoT-related farming in several journals, but none of them are suitably used in Indian farms. There is an immense gap between technology and farmers in India. Many start-ups have emerged to bridge this gap between technology and farmers. Now, even many MNCs are financing in Agri-Tech in India. Food requirement is exponentially growing because of the increase in population. People talking about tractors and heavy machinery in the farm's era is now superseded by smart technology such as the Internet of Things, Artificial Intelligence, and Machine Learning. Smart sensors are substituted by complex machinery in farms. We often hear that pests and diseases strike crops and therefore food progressively diminishes because of these attacks. By 2050, the earth's population is anticipated to rise by 9.7 billion. Therefore, a sharp graph of the growth in food requests is noticeable.

3. System Development

In Metropolitan areas of many countries prefer the use of technology in agriculture. Finding out manually requires a deep sense of knowledge, and accuracy rate is the primary concern. Hence there is a need for assistive technology, which would ease the task for agricultural producers. The System developed would allow users to detect the pest on their crop within a minimum amount of time and effort. The user needs to upload a photo of their infected crop and the system will predict the pest or disease-infected their crop. This would help them identify and implement a suitable technique to overcome the condition of the crop.

A. Proposed Approach

The proposed system comprises phases. Each of the phases is explained below:

- Development of Prediction and Recommendation System
- Training and Testing the model
- Feature Extraction from Images
- Classify Image
- Getting to the detail of Infected Pest or Disease
- A questionnaire-based on Recommendation System

The complete system comprises these 6 phases, the user can directly access and make use of the recommendation and the prediction system without authentication, hence no hassle of login. Whereas the admin needs to get authentication via admin login and password. Admin can upload more datasets for training and for testing and can also add a questionnaire for the recommendation system. The admin also has the provision to all the functionality of the system developed.

B. System Design

The purpose of the system architecture illustrates the formation, management, and more aspects of the system and analysis. The aim of the design is to design a module of the system which is utilized to develop the system. In the recommended system, Initially, once the user uploads a picture into the application, the user can recognize the pest and disease that happened to their crop.

C. System Architecture

The design intends to create a module of the system which is practiced to design the system. The user can upload an image and get the prediction and recommendation of the crop.

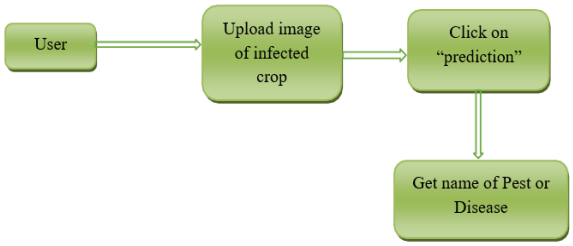

Fig. 1. User dashboard for prediction system

User Dashboard for Prediction System:

1. Initially, on the homepage, he can view sections such as Prediction and Recommendation.
2. In the Prediction Section, the user can see icons like Upload images for Testing and Prediction.
3. Click on Upload image for Testing and then click on Prediction icon
4. A pop-up window will appear showing results matching the uploaded image.
5. Click on View Results, details will appear on the screen.

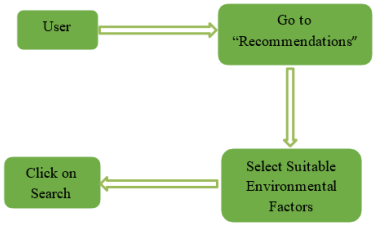

Fig. 2. User dashboard for recommendation system

User Dashboard for Recommendation System:

1. Initially, on the homepage, he can view sections such as Prediction and Recommendation.
2. In the Recommendation Section, the user can see the icon Solve Questionnaire.
3. Click the icon and select the appropriate fields.
4. Once all the fields are selected, click on view results. The

recommendation will appear at the bottom of the window.

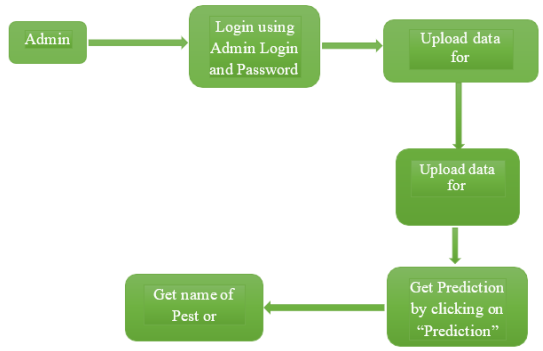

Fig. 3. Admin dashboard for prediction system

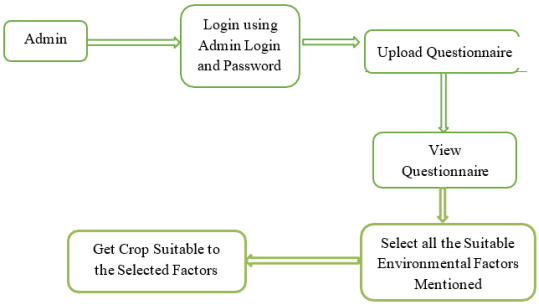

Fig. 4. Admin dashboard for recommendation system

Admin Dashboard for Prediction and Recommendation System:

1. Initially, on the homepage, he can view sections such as Prediction, Recommendation, and Admin Login.
2. Admin can log in using admin login and password.
3. They can upload more dataset for training and testing as well as add a questionnaire to the system.
4. Admin also has the access to the functionalities of the system, i.e., prediction and recommendations.

4. Methodology

This paper presents spatial information mining techniques particularly decision tree algorithm applying to agriculture arrive reviewing. The clue is to pool spatial information mining/decision tree strategies with master framework strategies and apply them to shape savvy agriculture arrive reviewing data framework.

Data mining is the practice of monitoring and amplifying purposeful information from the data. Data mining explores its applicability in diverse fields like banking, retail, medicine, farming, etc. In agriculture, it is used for analyzing the numerous biotic and abiotic constituents. Horticulture in India represents a significant role in the market and employment. The common dilemma breathing among the Indian farmers is they don't select the right crop based on their soil specifications. Due to this, they suffer a grave hindrance to fertility. This difficulty of the producers has been notified about through precision agriculture. Precision agriculture is a modernized farming practice that utilizes research data of soil properties, soil varieties, crop yield data gathering and introduces the farmers to the best crop based on their site-specific parameters. This diminishes the wrong judgment on a crop and enhanced fertility.

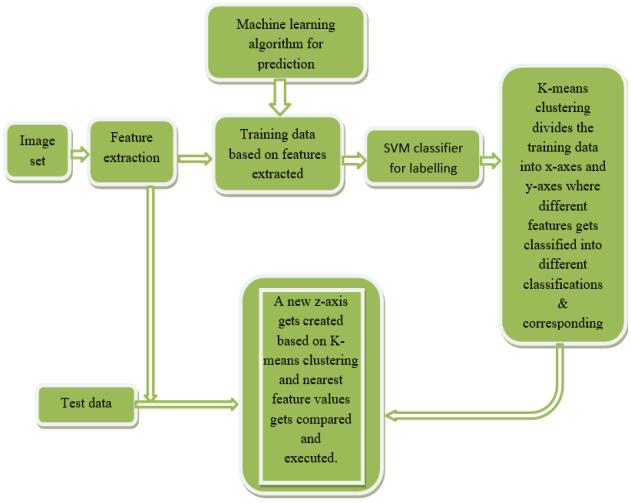

Fig. 5. Image of overall system working

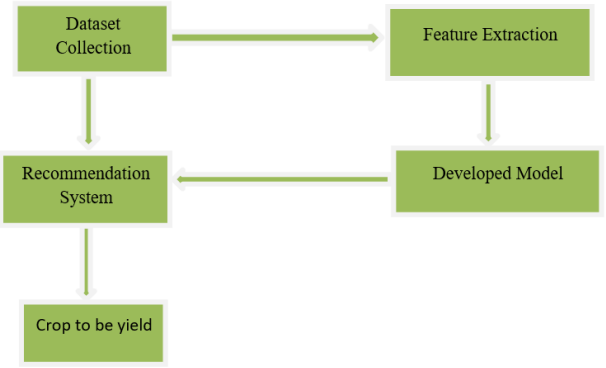

Fig. 6. The methodology of the recommended system

5. Techniques Used

This section gives a summary of the research on the significance of data mining methods for producing decisions in agriculture. These values for several data mining methods comprising of support vector machines, artificial neural networks, and Bayesian networks. The examination has outlined various able techniques that have been used to understand the connections of several environments and other constituents on crop yielding. This study suggests that additional studies are required to recognize how these techniques can be used with twisted datasets for product yield forecast combining annual and spatial constituents by adopting GIS technologies.

A. *Artificial Neural Network in Agriculture*

A prototype can be built applying the connections of associated variables. These figuratively interpret the associated processing neurons or joints of the human brain that are used. To create model prediction, a big number of input and output patterns are utilized to advance the formula to determine the connection. With limited knowledge of the practical connection, nonlinear connections, which are overlooked by different forecast techniques, can be defined.

B. *Bayesian Networks in Agriculture*

BN is a procedure for significant assumptions and information utilizing possibilities, especially important for arrangements that are remarkably complicated in their formation and working communications. It practices the probabilistic elements of an arrangement, as opposing to deterministic comparisons to explain the relationships amongst variables.

C. *Support Vector Machine in Agriculture*

SVM's are the entirety of the most modern supervised machine learning practices. Several types of research have been published on the application of SVMs in an agricultural context. The application proclaimed for SVM was the modeling of metropolitan land-use transformation. This study concluded the association between rural-urban land-use reform and different determinants.

SVM was also employed to produce insights within yield response patterns linked with climate situations by implementing the arrangements contribution review for agricultural yield prediction investigated various potential differences of the weather situations relating to support vector machines.

D. *Association Rule Mining in Agriculture*

The purpose of Association Rule Mining has been reported for numerous incidents in farming for explaining hidden patterns and associations among diverse climate and crop production.

6. Data Flow Diagrams

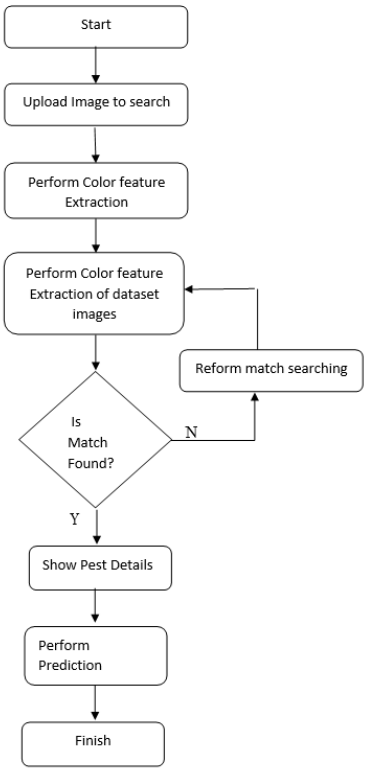

Fig. 7. Determination with color feature extraction

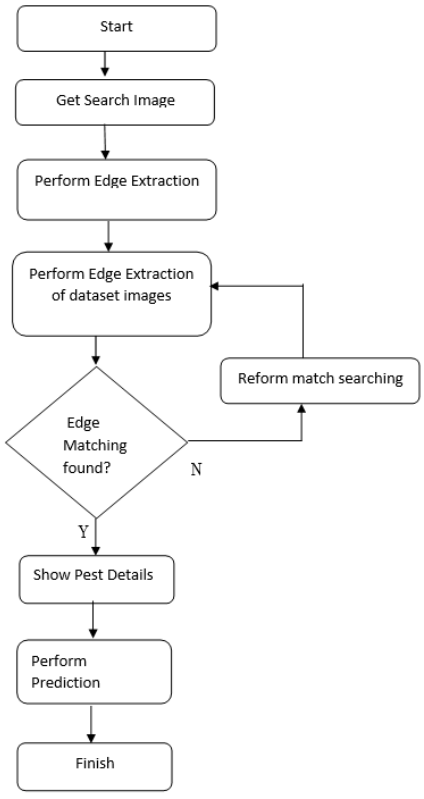

Fig. 8. Determination with edge comparison

7. Implementation and Result

A. *Admin Section*

This is the first screen that you see when you run the application. Here the admin can log in by using user-id and password.

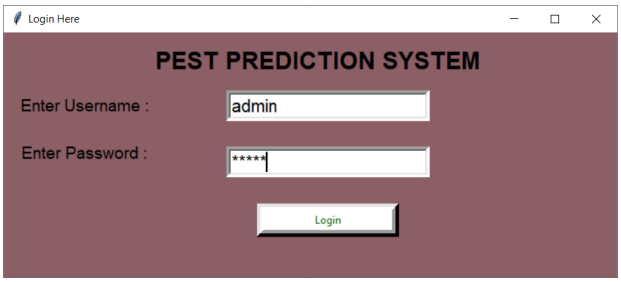

Fig. 9. Admin login

This is the first screen after you log in. On the home page, there are seven buttons through which the admin can train the system by uploading the image and the disease name. Here, the admin can also test whether the disease is predicted, correct, or not. The admin can also upload the dataset in excel format as well as add appropriate factors for the recommendation of crops. Lastly, there's a logout button for the admin to log out of the system.

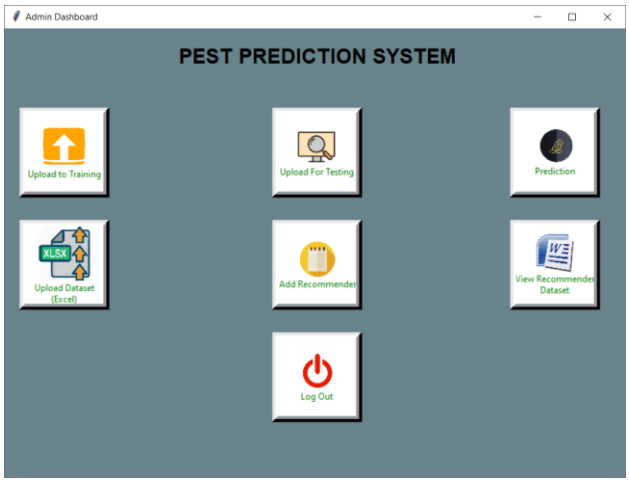

Fig. 10. Admin dashboard

Here the admin can upload the pest image along with the disease name and its solution.

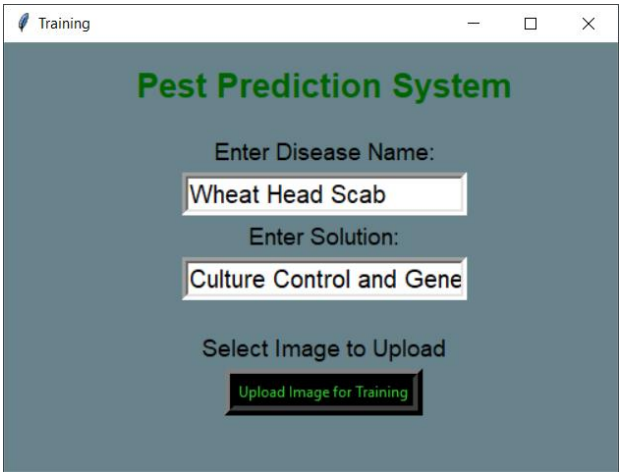

Fig. 11. Uploading training data

This is how images for training data looks like.

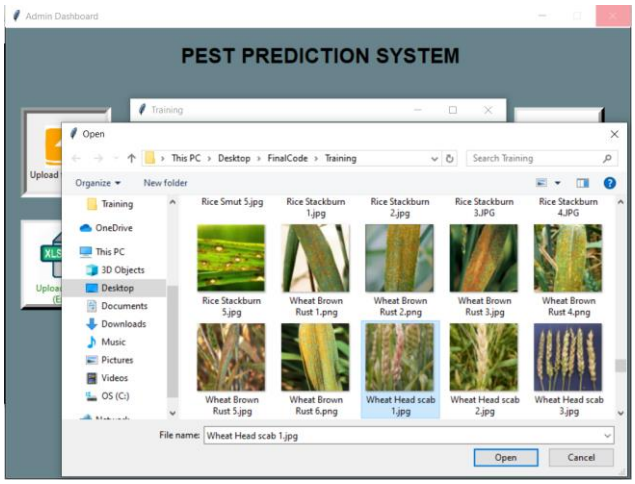

Fig. 12. Images for training

Here the admin can select the image for testing.

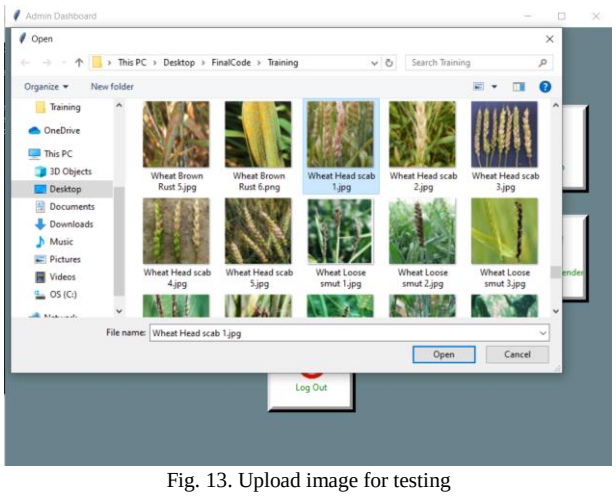

Fig. 13. Upload image for testing

After uploading the image for testing, the admin can predict

the disease by clicking on the prediction button. Here the application will show the matching ratio of images with the training dataset.

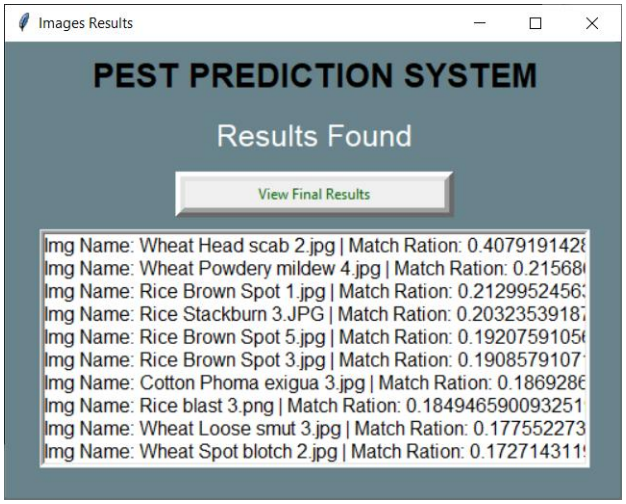

Fig. 14. Prediction

After clicking the view final results button, the admin can see the window with the predicted disease and the solution for the same.

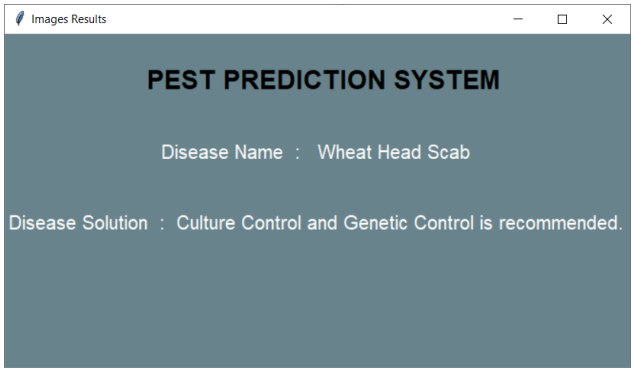

Fig. 15. Output prediction of disease

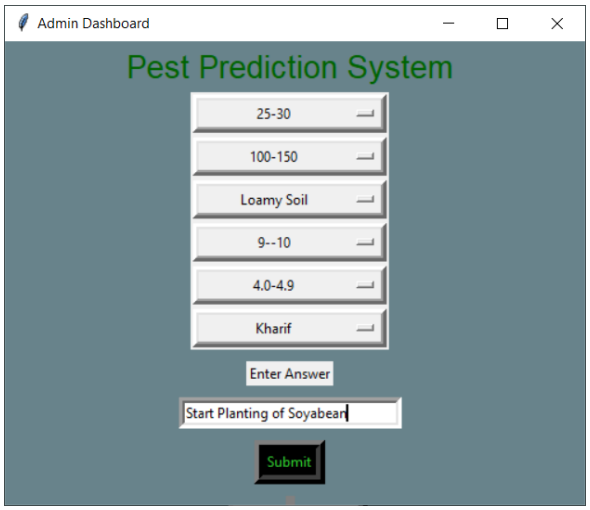

Fig. 16. Add recommender

The admin can add various factors like sunlight, rainfall, soil type, pH value. humidity and type of season along with the recommended answer.

B. User Section

This is the first screen that appears when the user opens the application. On the home page, the user can see two sections. The first being the Prediction and the second being Recommendation. Also, there are steps mentioned for using the application at the bottom of the homepage. There is an additional button for the admin to log in on the homepage.

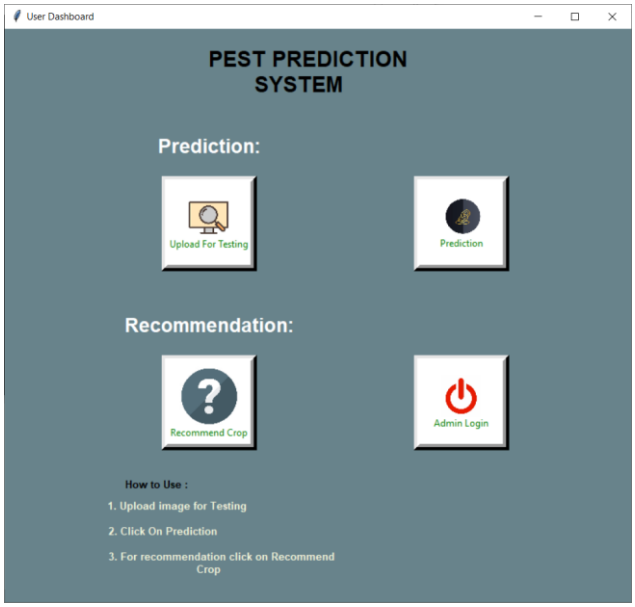

Fig. 17. User dashboard

Here the user can upload the crop image in the prediction segment.

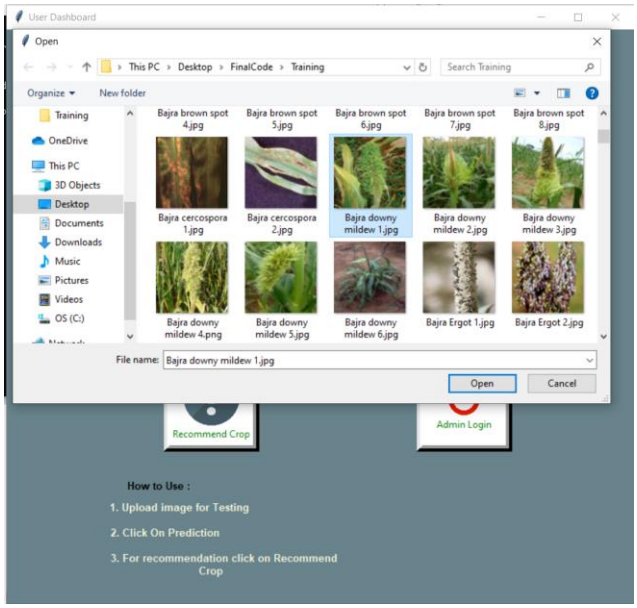

Fig. 18. Uploading image for testing

After clicking on the prediction button, the user can see the disease name and its solution.

Fig. 19. Prediction

The user can put values to various factors like sunlight, rainfall, soil type, pH value, humidity, and type of season and search for the recommended crop.

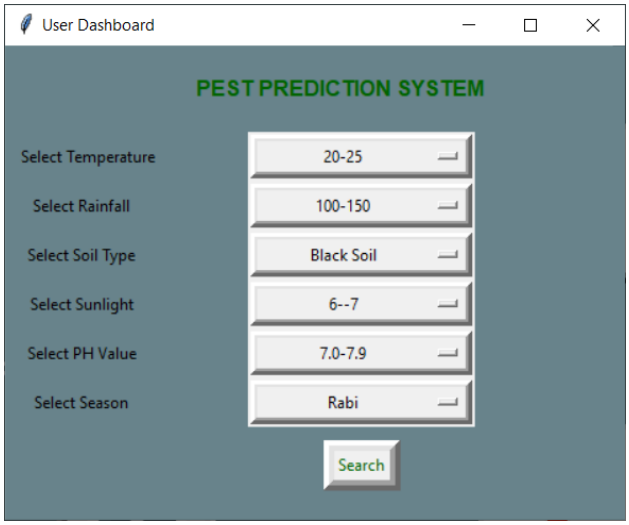

Fig. 20. Recommendation of Crop

After putting all the information and then clicking the search button, the user can see the recommended crop on the popup window.

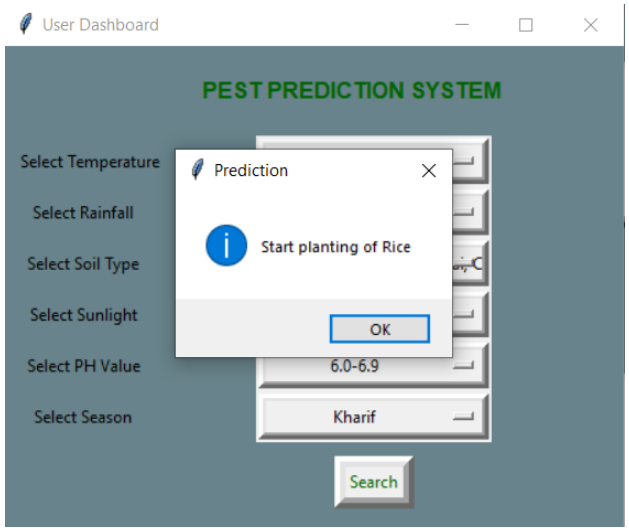

Fig. 21. Recommendation result

8. Challenges

Huge challenges are being faced by modernized agriculture. Now, the agricultural sector has evolved into a highly competing and globalized industry, where farmers and other actors have to consider regional climatic and geographic aspects as well as global environmental and political conditions to guarantee the economic continuation and sustainable production. Fostering an expanding world population requires a continual expansion in food production, but arable land remains a reserved resource. Increased demands for bioenergy or modifications in eating habits have put more pressure on horticultural production, while settlement and transport occupy more and more land. Speculated and notable differences in global climate, changing rainfall patterns, global warming, droughts, or the climbing frequency and duration of extreme weather situations jeopardize traditional production areas and carry extra risks and difficulties for global crop yields.

To cope with these obstacles, Agriculture requires a constant and sustainable increment in productivity and effectiveness on all levels of farm yield, while resources like water, energy, fertilizers, etc. should be used rightly and efficiently to preserve and support the environment including the soil condition of the arable land. The complexity of the challenge is elevated by further short-term events that remain difficult to predict, such as pandemics, economic crises, or price volatility toward agricultural raw materials and commodities.

9. Conclusion

This application focused on how Raw Data in the field and past data set are used to foretell the pattern in plant diseases by implementing the Naive Bayes algorithm. Climate plays an important role in the development or production of various troubles. Pests cause major harm in damaging the crops or by transporting the bacteria or virus to the crops, because of which there is a fall in the production of crops at the time of harvest. This produces huge damage to the farmer's community. Each season, pests spoil the crops.

To overcome this obstacle, a weather-based forewarning pest prediction model is proposed. The recommended model uses the Multiple Regression model plus Generalized Linear model procedures.

10. Future Scope

We are thinking to modify the project from a prototype to a comprehensive end to the end-user product. This can be achieved using the TensorFlow library within Python IDE with high processors. The finished product would be perfectly predicting disease/pest attacks simultaneously with recognizing them. A larger set of data would be provided for the training network.

The entire algorithm would be created using the TensorFlow library for better processing. OpenCV is utilized for Image analytics similar to Image Processing Toolbox in MATLAB.

Accordingly, the farmer has to just take a snap of the leaf, upload it to the cloud where the back-end processing will do analysis, and provide remedial measures for restricting and excluding external hosts.

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