Crop and Nutrient Recommendation System using Machine Learning for Precision Agriculture

Shabari Shedthi B[1], Vidyasagar Shetty*[2], Anusha[1], Rakshitha R Shetty[1], Anisha Shetty[1], B.A Divyashree Alva[1]
[1]*Nitte (Deemed to be University), NMAM Institute of Technology (NMAMIT), Department of Computer Science and Engineering, Nitte, India*
[2]*Nitte (Deemed to be University), NMAM Institute of Technology (NMAMIT), Department of Mechanical Engineering, Nitte, India*

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Abstract- *India is the land of agriculture, which is the backbone of the country. The most common issue among young Indian farmers is selecting the appropriate crop based on soil requirements. Due to this, they face a serious setback in productivity. The proposed work aims to assist farmers by analysing the soil's numerous properties and making crop recommendations based on the findings using a machine learning method. The system uses the machine learning techniques to build the crop suggestion system. The system maps the input given by the user with the crop data that is already stored in the database to predict the crop that is most appropriate for the user's soil and environment. In addition, if the user inputs the crop that he desires to grow along with the nutrient content of the soil, then the system returns information about the excess or deficient nutrient content that is present in this soil with respect to the crop the farmer desires to grow. Based on the results obtained, the farmer can make the right decision on which crop to grow based on the soil requirements.*

Keywords—Crop suggestion, Machine Learning, Nutrient suggestion, Machine Learning

I. INTRODUCTION

The agriculture industry is currently undergoing a revolution fueled by new technologies, which appears to be highly promising because it will allow this key sector to go to the next level of farm productivity and profitability. Precision agriculture is one such method that significantly improves the farming industry. Almost the majority of the Indians traditional occupation is agriculture and most

Indians are directly or indirectly dependent on agriculture [1]. It is one of the key elements that determines a nation's economy. Additionally, the government offers various benefits to farmers, including loan interest waivers and fertilizer subsidies. But today, crop loss is having a negative impact on farmers. The fact that farmers lack basic literacy regarding crops, fertilizers, and yield is one of the most significant factors. These factors have also led to greater crop losses, which have gradually reduced employment opportunities in the agricultural sector.

Crop prediction is the toughest task in the agricultural domain. A farmer or agriculturist often chooses the least favourable crop without considering market or weather risks, resulting in crop loss and, in some cases, bankruptcy. To reduce this type of loss, they can opt for a new technological solution for smart precision agriculture. We have developed a farmer-friendly Android application that will predict which would be the best crop for their farming land and also provide information about nutrients that are required for the growth of the crop. So as a solution, this project aims to develop an Android application in which machine learning (ML) algorithms are used to bridge the digital connections among rural farmers and technology in an easy to access and community-oriented design. ML is one of the important techniques used in agriculture. Machine learning techniques can be used to improve the productivity and quality of crops in the agricultural sector. By applying ML techniques, usually the following procedures are followed i.e., collecting the data, preprocessing the data, and training and testing phases to build the model.

II. LITERATURE SURVEY

This section gives a detailed literature summary related to different kinds of research that has been conducted to build the crop and nutrient recommendation system algorithm.

Kevin et al. [1] suggest a crop prediction system in which soil properties such as - "nitrogen", "phosphorus", "potassium" and "pH value" etc., are given as input to the model. Vaishali Pandith et al. [2] investigated the use of KNN, NB, multinomial logistic regression, and ANN, random forest. They achieved accuracy rates of 88.67%, 72.33%, 80.24%, 76.86%, and 94.12%. The parameters of the dataset are: EC (electrical conductivity), pH (pH value of soil), OC (organic carbon), N (nitrogen), P (phosphorus), K (potassium), Cu (copper), S (sulphur), Fe (iron), Mn (manganese) and Zn (zinc) representing soil nutrients.

Saranya et al. developed a model that classifies the soil in terms of macronutrients and micronutrients [3]. Next, it predicts the right crop for the particular soil type. The proposed model uses two datasets, soil and crop databases. The soil database comprises the geographical and chemical characteristics of soil. In this paper, they have used several ML algorithms like KNN,

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logistic regression, bagged tree and support vector machine. Based on the experimental results, the SVM was found to have achieved a maximum prediction of 96%. This developed model provides good accuracy, and the limitation is that they used a larger dataset for the proposed system.

Rahman et al. developed a model that predicts the soil types along with the land type and then suggests suitable crops [4]. The proposed system involves two datasets, namely the crop dataset and the soil dataset. Machine learning algorithms used are KNN, bagged tree, and SVM algorithms. It is observed that SVM has yielded an average accuracy of 94.5%. The merits are high efficiency and increased accuracy. But the proposed model uses a larger dataset to train the model.

Ashwini Rao et al. described the grading and classification of soil series using various scientific features [5]. Image data from a variety of soils is taken into account. The SVM algorithm is used for the purpose of classification. In this paper, techniques used for soil classification and image processing are applied. Here, soil features such as texture, color, and types of soil are considered. In this paper, soil classification and crop classification based on soil are done through one system.

Zeel Doshiet et al. [6] created a crop recommendation system based on temperature, rainfall, location, and soil condition using "Decision Tree (DT), Neural Network (NN), Random Forest, and KNN algorithm" and obtained good precision. In papers [7–10], works on building a crop recommendation system using soil type and other parameters are presented.

Mariappan et al[11] a model was put forth that gathers data on the soil and crop factors and maps them to a list of potential crops. pH, N, P, and K values for soils in several Chennai cities are considered and applied to the KNN algorithm and have 89% accuracy. K. R. Akshatha et al. [12] Considered attributes include things like "depth, texture, pH, soil color, permeability, drainage, water holding and erosion". In the system that is proposed, an ensemble technique is used that works based on majority voting. Mulge [14] used the IOT concept with a decision tree algorithm to build a smart farming system. Keerthan Kumar [15] used a machine learning algorithm for soil fertility prediction. is done based on site-specific parameters like pH, organic carbon, etc. They applied many machine learning algorithms for crop recommendation and observed that Random Forest has the highest accuracy score.

Everingham et.al.[16] proposed a sugar cane crop prediction based on information about climate , yield from fast two years and biomass index value. They found it would be very useful to the farmers. Priya et.al.[17] used a random forest classifier to calculate the yield of the crop based on temperature, rainfall and acre parameters. In this paper it was mentioned that random forests and random forest models were quite successful at predicting sugarcane yields very early in the season. Moraye et.al. [18] used a random forest algorithm for crop prediction. Based on district, season and crop, crop yield is predicted and got 87% of the accuracy.

Sharavani V et al. created a model that predicts soil types and recommends suitable crops [19]. Here, the proposed model includes two datasets, namely the crop dataset and the soil dataset. The dataset considered had 383 samples with 11 classes. The soil dataset includes the chemical characteristics of soil. In this paper, they have used different ML algorithms like the ensemble classifier, SVM, random forest, naive bayes, and majority voting. The maximum accuracy of 94.95% is obtained from the SVM algorithm. The proposed system has the major advantage of processing real-time soil data. In future scope, it is mentioned that current work can be extended to include a fertiliser recommendation system.

From the above literature, it can be observed that much work has been done on crop recommendation systems based on various soil parameters. Because not all crops are suitable for all regions, temperature and humidity value region-wise data are also considered in this work with soil parameters. With crop recommendation is a nutrition recommendation system also included. This helps new farmers, as it provides crop and nutrient recommendation systems with informative videos and materials.

III. PROPOSED METHODOLOGY

In the proposed system, soil and crop parameters are used to find the most suitable crops for a region. This provides easy accessibility to the users, so that they don’t face any issues. The application’s user interface (UI) is available both in English and Kannada, which is a regional language. Thus, this feature is an additional benefit that makes the app more convenient for farmers.

The crop dataset includes data samples of crops and their associated properties. Crops like paddy, coconut, arecanut, rubber and cashew are majorly grown in the Udupi and Dakshina Kannada districts are considered here. pH, nitrogen (N), phosphorus (P), and potassium (K), temperature and humidity are the crop characteristics that are used to characterise the crop. The data samples were obtained from the authorised horticulture department of Karnataka, Udupi district. The system employs an interface to collect user input. Depending on the module they chose, the input

type may change.

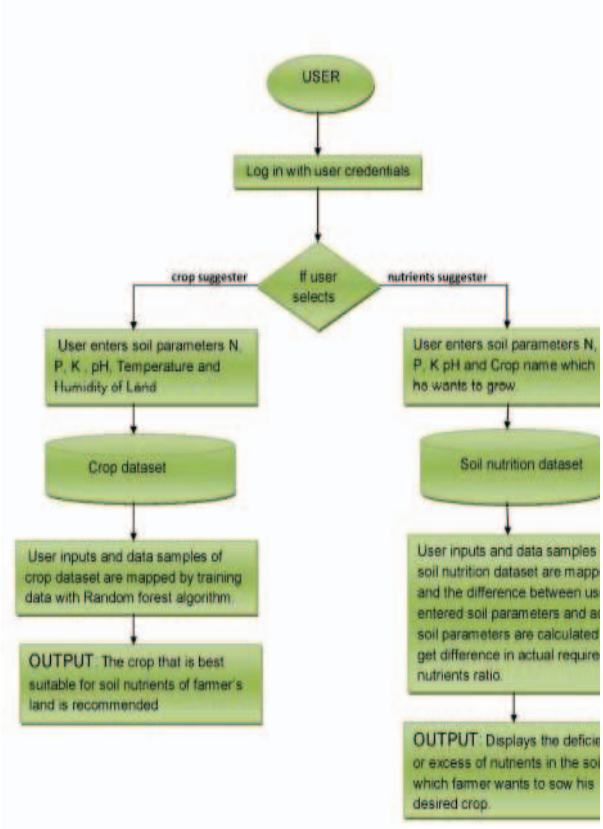

Figure 1: System design

As its name suggests, Random Forest is a separator that uses numerous decision trees on different subsets of a given database in order to increase the accuracy of its assumptions. The random forest uses forecasts from each decision tree along with numerous predictable votes to anticipate the outcome rather than relying solely on one decision tree. Our Android application incorporates two modules, the crop suggester that suggests crops and another module that determines if the required quantity of nutrients is available in the soil for the growth of a crop. The crop suggester performs detailed analysis of the inputs entered by the farmer with the help of a machine learning algorithm and recommends an appropriate crop for the soil nutrient values entered by the farmer. And the second module, nutrient suggester," provides information about the soil nutrients that are deficient or excessive for a particular crop. System design is shown in figure 1.

The "Random Forest" works in two stages i.e., first to create a random forest by combining the N tree, and secondly predictions for each tree made in the first phase.

The following steps can be used to

Creation of the Random Forest:

Select "n" data points from the original dataset (bootstrapping).
Construct a decision tree for each of the "n" number of new datasets created independently.
Randomly select "k" features from the bootstrapped dataset to train each tree.
Among "k" features, calculate the decision node "d" using the best split point.
Repeat the previous steps and build an individual decision tree
Prediction from the Random Forest:
Take a new data point and run it through each decision tree.
Calculate the prediction from each tree using the majority voting technique.
Consider the highest-voted prediction as the final prediction of the Random Forest algorithm.

Random Forest is used to build the model and has 98% accuracy, whereas SVM has a 75% accuracy rate. Random forest has more accuracy, and we found that it is more suitable for predicting the crop. Application is built through Android studio and Firebase is used to store the data. Android Studio is the official integrated development environment for Android application development. After the user enters all the input data, the flask server sends the http request for the particular action. All the user clicks are fetched from the android app to the flask server. Flask is an API of Python that allows us to build web applications and this can be used for the backend while developing an Android Application.

To create an Android application that allows farmers to choose the most suitable crop for their farming land. In order to achieve this, farmers must input their N, P, K and pH values along with their city, through which the temperature and humidity of that region get extracted with the help of an open weather map API. These parameters are processed through a machine learning model, and the most suitable crop will be recommended based on their soil and environmental factors. And if the farmer has already decided to cultivate or sow a particular crop, then our system will be able to help the farmer find the deficient or excess nutrient proportion that is present in their farming land with respect to the crop that he wishes to grow. In addition, to support new individuals who are interested in farming but who have no proper knowledge about farming, our application provides them with information such as a package of a practice, agricultural schemes, contact details of an agriculture department, soil laboratories nearby, and crop videos. This additional information would give them some knowledge about the farming practices.

The main purpose of this work is to help farmers make the right decisions before starting farming in their field. Our project mainly aims at making the right crop prediction based on farming soil and environmental conditions. For this purpose, we have developed an Android application where we implemented a machine learning algorithm to recommend crops and give suggestions about the nutrients that are more or less in the soil of the farmer's land where he wants to grow crops of his interest. Thus, it helps the farmer make the right decision about which crop to grow in their field or take the necessary steps to balance the nutrient contents in their soil that are required for the growth of crops. The UI design of the application is also available in the regional language Kannada, which is an added advantage to our application.

IV. RESULTS

The proposed system predicts the most productive crops that can be cultivated in such ideal soil conditions by taking into account the soil's N, P, K, and pH levels. which produce more yield and suggest suitable nutrients if their quantity is low for the required crop. The model is built using Random Forest, which has a 98% accuracy rate, whereas SVM has a 75% accuracy rate. Random forest has more accuracy, and we found that it is more suitable for predicting the crop.

The system's recommendation of the possible crop aids the farmer in deciding which crop needs to be planted in their region. Thus, this technique assists the farmer in selecting the crop that will be the most profitable as well as in identifying new crops that can be grown but have not been up until that point. Hence, farming can be done smartly.
The dashboard of the app with additional features and provides the user with two options, i.e. Crop suggester and Nutrient suggester, which is shown in figure 2.

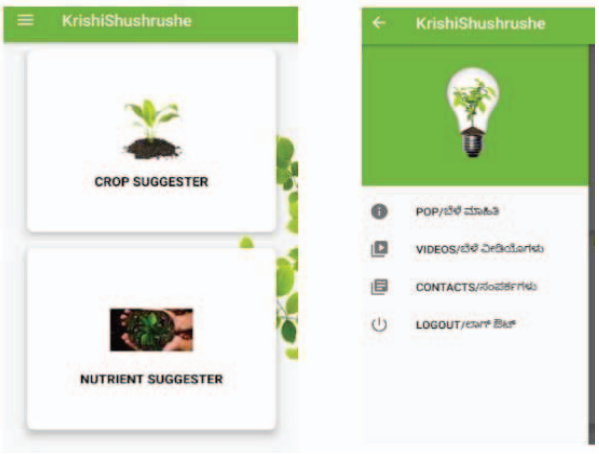

Figure 2: Proposed system dashboard

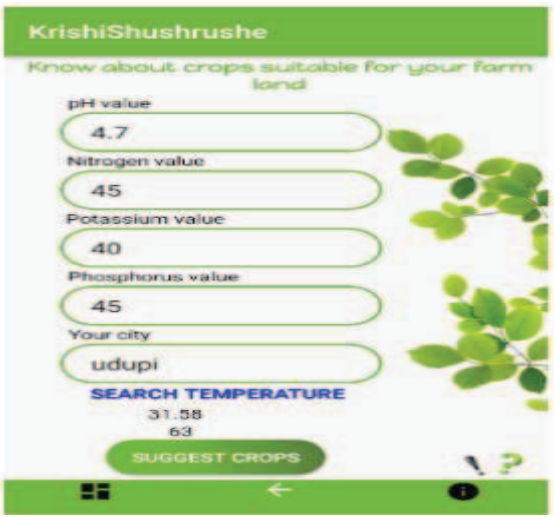

Figure.3: Crop suggester module user input.

Figure 3 shows the input page, which takes soil parameters, region, temperature and humidity value. Figure 4 shows the output of the module.

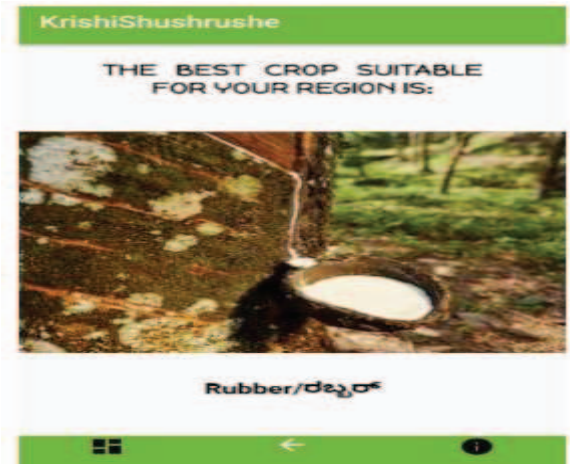

Figure 4: Crop suggester module output

In this work, nutrient recommendations are also provided with crop recommendations, i.e., shown in figures 5 and 6, which assist farmers in determining their soil's nutrient requirements based on the crop they want to grow and NPK values in kg/ha.

Figure 5: Nutrients recommendation module input

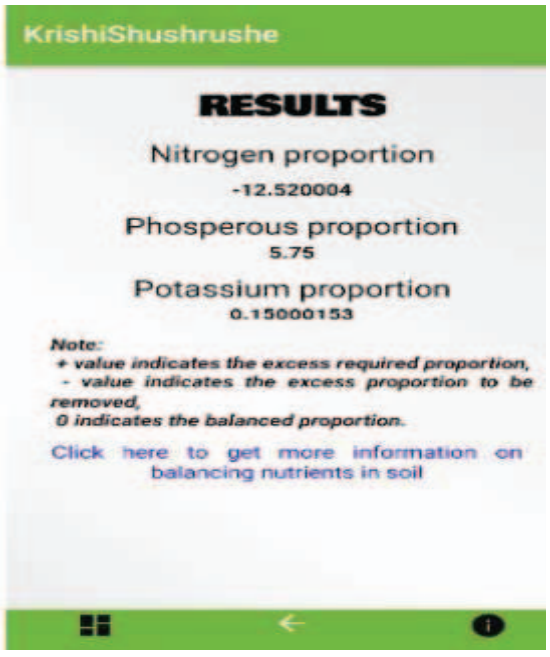

Figure 6: Nutrient recommendation outcome

Language flexibility helps the farmers understand the information in a better way. Because regional languages help farmers to know things in a convenient way.

Figure 7: Crop suggest input page in Kannada

Figure. 8: Crop suggest result in Kannada.

A Kannada version of the crop suggestion and nutrition recommendation system is also provided. i.e., shown in figures 7 and 8.

V. CONCLUSION AND FUTURE SCOPE

The proposed system is one of the most effective approaches that takes the values of the soil's N, P, K, and pH into account and chooses the best crops that can be cultivated in those appropriate soil conditions. The possible crop suggested by the system guides the farmer in deciding which crop needs to be cultivated on their field. This approach therefore assists the farmer in selecting the crop that will bring in the greatest profit and also in identifying new crops that can be grown but been cultivated till that time by the farmer by knowing what amount of nutrients is required for their growth. Of course, there are certain kinks to be worked out but we believe in the future, we can overcome it.

The system that we have currently developed has multiple features that benefit the user while interacting with the mobile application. Further we want to focus more on implementing the Android application using IOT, so that one can obtain the soil's real-time values. The sensors can be deployed on a farm to gather data about the present soil conditions, which will improve the accuracy and precision of the results. As a result, farming can be done smartly and efficiently.

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