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An Efficient And Intelligent Decision Making For Eco-Fertilization

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Abstract: Fertilizer use is typically under the limited control of farmers. For the farmers to achieve higher yields and reduce fertilizer loss, competent guidance is required for the best use of these fertilizers. Additionally, there is a connection between rainfall volume and nutrient loss for various fertilizer applications after each rainfall event. Rainfall that is moderate and falls at the right moment can help nutrients penetrate the soil's rooting zone and dissolve dry fertilizer. However, too much rain can increase the possibility of runoff and the pace at which nutrients like nitrogen (N) which is quintessential, phosphorus (P), and potassium (K) which are crucial, manganese (Mn), and boron (B) that are present in the soil. In this project it presents nutrient recommendations using an updated iteration of the random forest algorithm which is based on time-series data to forecast the required quantity of nutrients for various crops by examining rainfall patterns and crop fertility. The method suggested in this project, comes in handy for improving soil fertility by providing nutrients recommendations for optimum conditions for crop growth and reducing leaching and runoff potential.

***Index Terms* - Eco-Fertilization, NPK Estimation, weather report**

I. Introduction

A sector which is playing very important part of national economic growth is agriculture. Agriculture contributes 17-18% to India's GDP and ranks second worldwide in farm outputs. Plants need fertilizers and fertilizers replace the nutrients which crops take from the top layer of the soil. The absence of fertilizers can cause a drastic reduction in the volume of crop output. But fertilization requires precise action. Rainfall patterns and the amount of nutrients needed for a certain crop must be considered when using fertilizers. Machine learning is the current technology that can solve this problem by using available data for crop fertility and rainfall. Farmers can greatly benefit from the support of robust information about crops. This project uses a machine learning algorithm such as random forest algorithm with k-fold cross-validation technique which takes two inputs from the user that are crop and location. After applying the algorithm, it predicts the amount of nutrients required along with the best time to use fertilizers. The website is built using Flask Python (web framework) to provide access on all platforms and can be shared among users.

II. Literature Review

In Paper [1] the author expresses about purifying soil health content and development of new evaluation standards for soil health and quality by mixing different soil health indicators into indices in agroecosystems which can be further used for guiding crop management decisions.

In Paper [2] different researchers have stated numerous forms of data mining techniques that is necessary for the crop yield prediction. This prediction methodology by sensing various parameters of soil and environment will predict the suitable crop.

From the study of Paper [3] almost all kinds of crops yield in India can be predicted. This paper states by using simple boundaries like state, district, season, area and the yield of the crop in which year he or she wants to grow can be predicted by the users.

From the study of paper [4] the objectives are (i) the nutrient requirements and climatic or soil chemical properties and the relationship between them are evaluated and (ii) to support for the maximum regional nutrient management in northern and southern china estimating the N, P and K requirements.

In Paper [5] the author stated that in cropping systems due to increased rainfall may worsen the leaching losses of reactive N, and that no-till farming technique may moderate against these losses. Fluctuation in type of soil, soil structure, the climate for plant growth, and agronomical practices over larger geographical scales may affect the way that cropping systems answer to rainfall intensification.

In Paper [6] it describes that for the farmers to get more yield and prevent wastage of crops proper guidance is necessary for the optimal usage of fertilizers. This prediction decreases toxicity and deficiency in plants to certain extent and to get proper yield without much wastage

III. Proposed Model

In this study, a predictive model for the nutrients required for crops was obtained using random forest. Random forest regression with the technique called k-fold cross validation represents this model with acceptable accuracy for the prediction is then obtained. A total of seven features have been used to evaluate the algorithm. As shown in Fig 2, the algorithm requires input from the user (such as location and crop). The location is fed to the Weather API which will return certain characteristics (e.g. temperature, humidity, rainfall) and if there is a possibility of heavy rainfall, a precautionary message is displayed to the user, otherwise, the proposed algorithm is followed.

A. *Random Forest Algorithm*

Random forest (RF) is a collection of multiple decision trees that have variable hyper-parameters and are trained using varying subsets of data. In our project, we are going to take crop and location as input, and based on it, we will predict the value of N, P, and K. First, we will divide our dataset into the training and the test datasets, where training dataset is 80% of the original data and the rest 20% is test data. Then we will create three different random forests of size 50 (decision tree) for each N, P, and K and outputs the mean of the classes as the prediction of all the trees.

TABLE I
Random Forest Algorithm Table

BEGIN:
Step 1: The dataset of size n=2200 is divided into training and test dataset (where the raining set is 80% and the test set is 20% that is training set=1,760 and the test set=240).
Step 2: Apply random forest regression to each N, P and K (Nitrogen, Phosphorus & Potassium) value with n estimators=50 (n estimators is the number of decision trees).
Step 3: Train the N label, P Label and K Label with the training dataset and dependent variable (Where the dependent variable is N for N Label, P for P Label and K for K Label).
Step 4: Each N Label, P Label and K Label generates a 50 decision tree as an output based on the training dataset.
END

We have tested for different n_estimator values, but the upmost accuracy achieved for *N_Label* is 0.87 for two decimal digit precision. As shown in below figure Fig 1

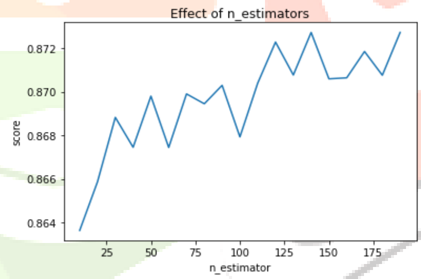

Fig 1: Effect of n_estimator

B. *Cross-Validation*

In order to evaluate machine learning algorithm on a small set of data, cross-validation is a re - sampling technique. The algorithm's sole parameter, k, indicates how many groups should be formed from a given data sample. As a result, the technique is frequently referred to as k-fold cross-validation. When a precise value for k is given, it can be substituted for k in the model's regard, such as k=4 for cross-validation that is performed four times. In applied machine learning, cross-validation is mostly used to gauge how well a machine learning model performs on untrained data. That is, to use a small sample to assess how the model will generally perform when used to generate predictions on data that was not utilized during the model's training.

It is a well-liked technique since it is easy to comprehend and typically yields a less biased or overly optimistic assessment of the model ability than other techniques, including a straightforward train/test split.

Following is the general process:

1. Randomly shuffle the dataset.
2. Create k groups from the dataset.
3. For every distinct group:
   a. The group should be used as a holdout or test data set.
   b. As a training dataset contains, use the remaining groupings.
   c. Adapt a model to the training set, then evaluate it against the test set.
   d. Keep the evaluation result, but discard the model.
4. Using a sample of quality assessment ratings, summaries the model's skill.

C. *Input Features*

- Crop: rice, cotton, mango, orange, lentil, etc.
- Temperature: temperature measured in Celsius
- Humidity: measured relatively in percentages

- Rainfall: rainfall in mm

D. Output Features

- Label N: proportion of Nitrogen content in the soil
- Label P: proportion of Phosphorous content in the soil
- Label K: proportion of Potassium content in the soil

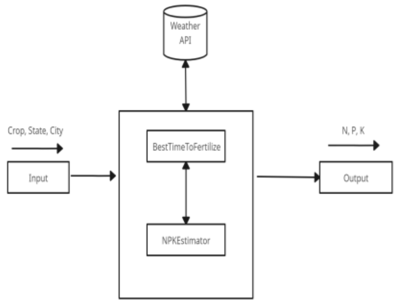

Fig. 2: Project Flow

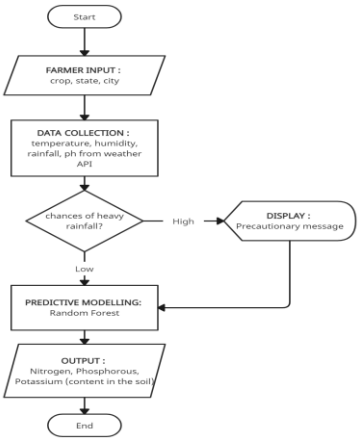

Fig 3: Flowchart of Eco-Fertilization Process

This project mainly concerned with the historical data of the customer. The main objective of this project is to use well known data mining techniques called Support Vector Machines (SVM) and K-Nearest Neighbor (KNN) to develop a suitable model for the acquisition of suspicious customers, depending on their usage history of the water meters. CRISP-DM (Data Mining Standards for Data Mining) was commissioned to conduct this study.

IV. Result

Eco-Fertilization, a user-friendly system, has been implemented in the form of a website to provide cross-platform functionality and suggest appropriate timings and amount of nutrients required for an inputted crop with alert system for heavy rainfall (as shown in Fig 7.1-7.5).

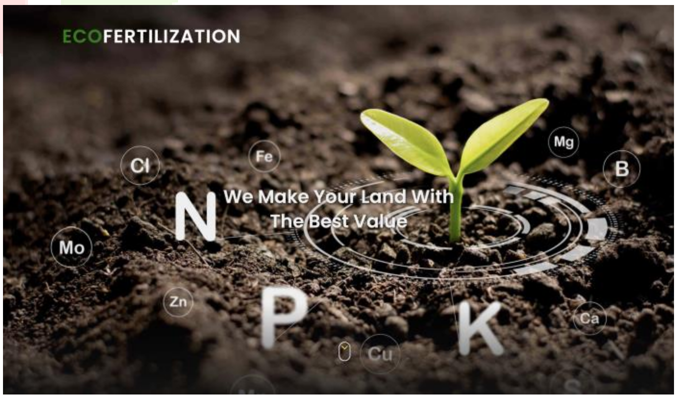

Fig 4: Homepage of Eco-Fertilization

Fig 5: Input Details

Fig 6: Details filled using the drop-down menu

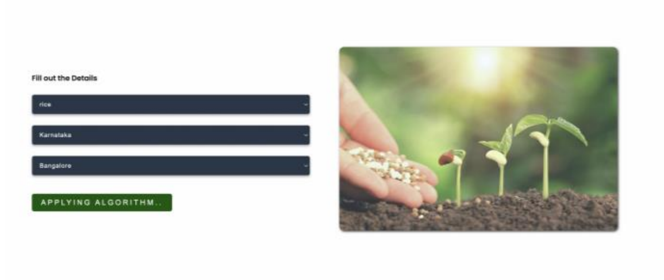

Fig 7: Applying Algorithm to inputted details

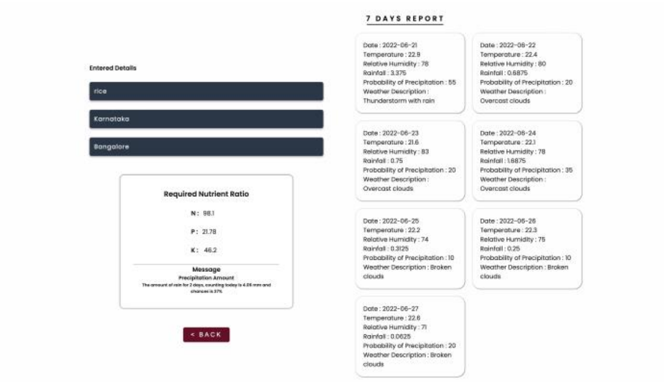

Fig 8: Output with seven days of weather forecasts & alerts/messages

CONCLUSION

The proposed paper is able to achieve 92% of accuracy, which is quite good for any predictive model. It provides information about the use and the amount of nutrients required by the crops for satisfactory crop growth and production with respect to weather conditions. It provides weather alerts and messages. Alerts are displayed in the output of this application in case of bad weather conditions. The accuracy can be improved further with development in technologies.

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