Soil Nutrient Prediction Model in Hybrid Farming Using Rule-Based Regressor

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Abstract. Agriculture is the supreme trade of India. Inefficiency and imprecise input controls such as nutrients of the soil, water, and usage of hazardous manure have caused devasting consequences to the biosphere. Various plant species are generated daily, however, they are deficient in all the necessary nutrients compared to the crop that is grown organically. To overcome this situation, an integrative hybrid approach is proposed in this paper, to combine both precision farming and organic farming which involves growing and fostering crops without the use of non-natural fertilizers and pesticides to elevate and enhance the quality and quantity of the crops. This paper proposes a machine learning (ML) model to predict nutritional values in Ballarat (Centella Asiatica) in both conventional farming and pro-biotic farming. This Hybrid system predicts the nutrient values such as nitrogen, phosphorus, and potassium with the supplement of banana peel powder prediction accuracy, mean absolute Error (MAE), Root mean squared error (RMSE), and R^2 for potassium evaluate the performance of the model. The results reveal that random forest regressor performs well in probiotic farming with 91% and RMSE is 1.7475 and MAE is 0.6361 than decision tree regressor.

Keywords: Organic farming · Precision farming · Pro-Biotic farming · Soil sensor (ECa) · IoT-based technologies

1 Introduction

Agriculture is a popular vintage of mankind. The fundamental aim of agriculture is to uplift growth by improving the soil, water, and other nutrient composition. In spite of the worldwide rapid growth of industrialization and urbanization, nearly one-half of the working population is still engrossed in agriculture [5]. In India, there are around 215.6 million acres (82.6 million hectares) of farmland used for agriculture, 48.92 lacks which are in Tamil Nadu. The UN Food and Agriculture Organization depicts that "The world has to produce 70% more food in 2050 than in 2006" [1]. The agricultural methods followed all over the globe are subordinate to the widespread use of insecticides and

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fertilizers that incorporate synthetic formulations will therefore improve the crop quality and help feed the world's population [2]. On the other hand, it is impossible to ignore the numerous negative effects of chemical fertilizers and pesticides. Fertilizers have the ability to stay in the soil for a longer period of time and have negative drastic on a variety of biotic and abiotic elements, including the soil, the environment, and even human health [3]. Soil standards are often compromised by these man-made pesticides, leading to further environmental degradation. Agriculture is particularly vulnerable to devastating natural hazards such as insect damage and adverse weather conditions that affect crop yields. Financial Express states that about 16–20% of the total crops produced in India were wasted each year [4]. Analyses of suitable environmental conditions can improve yields and reduce damage and crop loss. Soil fertility management is the most important factor in maintaining good crop yields. The microelement or microbes is influential production of the plant life cycle. Lack of micronutrients in the soil results in abnormal growth of the plants which may lead to crop failure [6]. However, harvest losses can be minimized, and yields are increased by integrating with any kind of combinational farming method. Precision agriculture is the use of innovative technologies and principles to manage the geographic and terrestrial variability associated with all aspects of agricultural production, improve crop performance, increase crop productivity, to improve the quality of the environment [7, 9]. IoT-based precision agriculture improves livestock production by predicting fertility patterns and diagnosing eating disorders, and cattle behavior based on ML models [12]. Plant probiotic microorganisms (PPM), also known as biofertilizers, are useful microbes that suggest a favourable alternative method that reduces health problems and environmental degradation. The use of plant probiotics serves as an alternative soil fertilizer which has been the focus of several studies. The use of probiotic in farming upgrade nutrient values, sustain a suitable environment for field management, and creates no unfavorable effects [10]. From the different research work carried out so far, it is inferred that the conventional farming method is specific to either precision farming or organic farming. Integration of both precision farming and organic farming is proficient in sustaining higher crop productivity and enhancing soil quality on an unceasing basis. Therefore, this research work is motivated to compare and contrast the soil nutrient values i.e., Potassium(K) in two different types of soil in conventional farming and pro-biotic farming in AI IoT-enabled Soil Nutri farm situated in the Centre for Machine Learning and Intelligence in our university premises. With the advancement of sensor-based technologies along with organic farming monitors the field 24*7 and updates the values in the cloud server. Therefore, proper monitoring of soil conductivity, soil moisture, and soil temperature is predicted to enrich the nutrient values such as Nitrogen, Phosphorous, and Potassium of the crop to increase productivity.

The rest of the article is formulated as follows, Sect. 2 Literature study, Sect. 3 Data Acquisition, and Experimental Setup depict a detailed description of the data collection method. Section 4 Methodology, Sect. 5 describes about performance metrics, Sect. 6 denotes, Results and discussion and finally Sect. 7 includes conclusion.

2 Literature Study

The applications of advanced technology in precision farming have rapidly increased over a decade. The promising research works on the technological evolution of farming are summarized below.

Monteiro et al.[8] The control system is governed by Arduino and sensors such as the DHT11 sensor, soil moisture sensor (REES52), sound module(buzzer), and PIR sensor (HC-SR501), which provide the temperature, humidity, and moisture are used. Precision agriculture proves to be an efficient method to manage the resources such as crop yields, livestock, seeding, and fertilizer.

Reddy et al. [11] The paper proposed a two-feasibility study on IoT-based solutions for automated irrigation and animal monitoring. Each component comprises a temperature sensor (DHT11), Soil moisture sensor (REES52), and solar power cells with rechargeable batteries with a ZigBee module. A web interface is used for visualizing the irrgation schedule. It is also used to set threshold values on the web interface to automate the scheduling. A SQL database is used for storing the data.

Heiniger, et al. [13] conducted an experimental setup is done in 15 different field sites with 12 different soil series in three regions of North Carolina. Nutrient value and attributes of the soil are compared with electrical conductivity with the help of Correlation analysis and PC-stepwise regression analysis. The result states that few convincing relationships are found between electrical conductivity and nutrient concentrations.

The above reviews showed that the usage of precision farming is convenient with refinement over the traditional method. Soil electrical conductivity (EC_a) plays a major role in soil health. It is an indirect indicator of nutrient concentration in the soil. An experimental study was initiated to demonstrate whether (EC_a) could predict the NPK in two different types of soil.

3 Data Acquisition

3.1 Preparation of the Field

Prior to the seeding, the selected field is AI-IoT Based Nutri Garden in front of CMLI at our university. The selected field is 20 feet in length and 10 feet in height. The soil is a mixture of sand and clay with a soil conductivity of 0.11 (dsm^{-1}), pH value of the soil is 7.86. The soil test has been carried in Tamil Nadu Agricultural University, Coimbatore, India. The Micro and Macro nutrients are calculated and the results state that the soil has a higher potassium rate of 165(mg/g), mild phosphorous with a rate of 6.7 (mg/g), and lower Nitrogen with a rate of 53(mg/g). The seeds were collected from the Tamil Nadu Agricultural University seed center, Coimbatore. The seeds like Horse gram, Fennel, Fenugreek, Coriander, Amarnath, and Vallarai seeds are sowed in the selected field. The field area is divided into two types of farming i.e., one is conventional Farming and the other one is probiotic farming. In conventional farming, six different Indian crops like Horse gram, Fennel, Coriander, Fenugreek, Amarnath, and Vallarai. In the probiotic farming method, the six different Indian crops along with banana peel powder which acts as a microbe are sown. When banana waste is reapplied to the plant, it will keep the soil moist [19]. Banana is one of the most popular fruits for their high nutritional content and it also has a significant economic influence [20]. Furthermore, banana waste can be used as a natural fertilizer which alternative to synthetic fertilizers. With the inference of the above literature, it is found that banana peel powder boosts the soil nutrient level. The banana peel powder is prepared by us by the following two methods i) Preparation of raw materials ii) Preparation of Banana peel fertilizer.

3.1.1 Preparation of Raw Materials

Banana peels are available in all seasons. Banana peel wastes are collected from chips shop located in Madhampatti, Coimbatore, Tamil Nadu, India. Banana peels are considered garbage, smell bad, and contain many chemical elements or compounds that are obviously beneficial to plants. Banana peel powder fertilizer is rich in potassium and magnesium, both of which enhance stem and plant root growth and improve plant nutrient levels.

3.1.2 Preparation of Banana Peel Fertilizer

Organic fertilizer helps in boosting up agricultural productivity in terms of both quality and quantity. It reduces soil pollution and increases soil quality naturally [14]. Banana peels should be cut into little squares that are about an inch wide. It should be dried in sun for 5 days at 29.8 °C. Then, it grounded into fine powder form. This fine powder of banana peel is ready to use in agriculture farms to enhance the nutrient content of soil particularly nitrogen, phosphorus, and potassium [15]. Figure 1 depicts the preparation of banana peel fertilizer i.e., (Fig. 1). Figure 2 (a) represents the Sowing of seeds (Fig. 2).

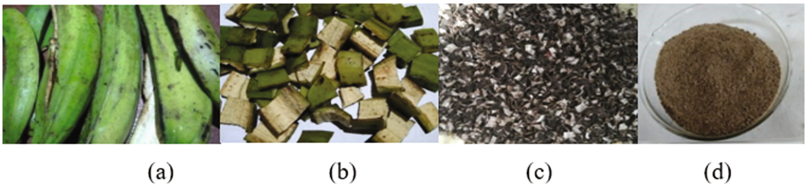


Fig. 1. Preparation of Banana Peel Fertilizer a) banana peel b) Cut into small pieces c) dried banana peel d) banana peel powder

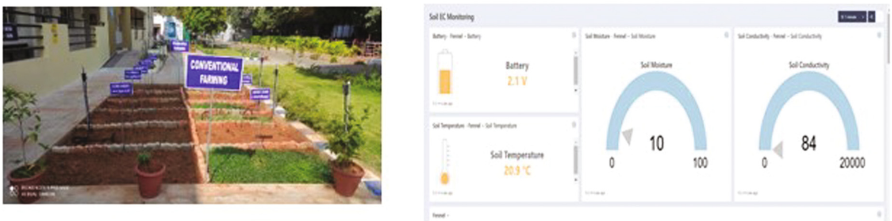
3.2 Configuration and Deployment of IoT-Based Sensors in the Field

Precision farming is one kind of farming method employed to implement sensor-based farming. As an initial study, The LSE01 is a LoRaWAN Soil Moisture Sensor which is used for IoT in Agriculture is purchased and deployed. Sensor consists of two probes to calculate soil moisture, soil conductivity, soil temperature. Nitrogen, Phosphorous and Potassium values are observed in wet lab in Food Science and Nutrition laboratory. This sensor is used to measure soil moisture in saline-alkaline and loamy soils. The soil sensor uses the FDR method to calculate soil moisture by calibrating soil temperature and conductivity. It is also manufactured to identify soil types of industrial minerals.

(a) (b)

Fig. 2. (a) Sowing of seeds (b) Discussion of the nutrient content

It detects soil moisture, soil temperature and soil conductivity and NPK. The collected data is sent to LoRaWAN IoT Server. LSE01 - soil conductivity sensor is deployed in both conventional farming and pro biotic farming. Figure 3 a) shows the deployed 5 sensors each of them in probiotic and conventional farming b) shows the dashboard.



(a) (b)

Fig. 3. a) Configuration of soil sensor in the farm b) Data monitoring of fennel seed cropping in the dashboard

3.3 Dashboard Creation

The dashboard has been created to visualize the data from anywhere in the world. The dashboard was developed in the Go programming language, which is an open-source programming language which is supported by google. It is a strong platform that supports Windows, Linux, and macOS. The Front end of the dashboard is developed in GO and the Back end is developed in React JS. The dashboard is an interactive toolkit, where we can monitor the parameters and status of the battery. The values can be extracted in three main file formats such as CSV, Excel and TSV file formats can be downloaded with the given user credentials. With the stipulated given time frequency, the datasheet can be downloaded in the desired file format.

4 Methodology

Innovative technological-based modelling, such as AI-IoT-based techniques can improvise and adopt vast amounts of data and acquire an inference for the future. From the above-proposed framework, the opportunities for deploying AI-IoT-enabled farming are demonstrated in Fig. 4.

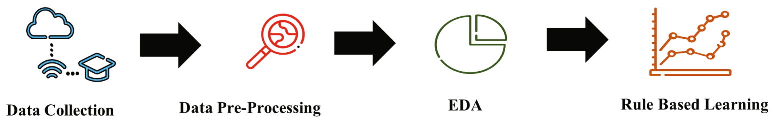


Fig. 4. Framework for the proposed methodology

4.1 Data Collection

As an initial study, the data is collected from Vallarai (Centella Asiatica) in both conventional farming and pro-biotic farming. The time series data is extracted for the period of 31 days i.e., from 1.05.2022 to 31.05.2022, for every 30 min, the data will be collected and stored in the dashboard. The collected dataset is extracted as a comma-separated value file (CSV) format which is readily available in the dashboard. The data set consists of 1919 records with eight attributes Date Time, Soil Temperature, Soil Conductivity, Soil Moisture, Battery level from the field, and Nitrogen, Phosphorous, and Potassium from lab results. Two different datasets are collected from the field, one is probiotic farming, and another one is a traditional farming method. Table 1 depicts the sample dataset of conventional farming. Table 2 depicts the sample dataset of probiotic farming. It contains soil moisture, soil temperature, soil conductivity, N, P, and K values with respect to data and time (Table 1 and 2).

Table 1. Sample dataset for Conventional Farming

Date time	Soil moisture (%)	Soil temperature (Â°C)	Soil conductivity (dsm^{-1})	N	P	K
31-05-2022 21:24	12.42	26.92	150	50	33	80
31-05-2022 21:04	12.46	27.01	150	50	33	80
21-05-2022 23:44	20.32	26.31	276	54	32	82

Table 2. Sample dataset for Pro Biotic Farming

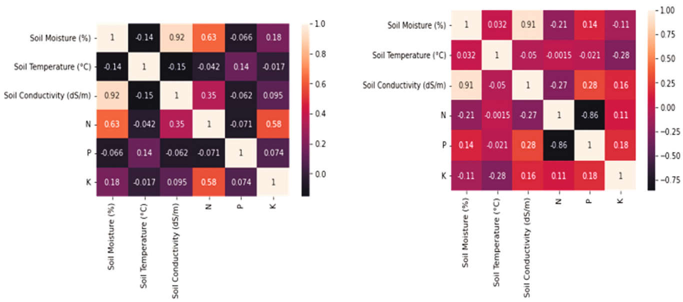
Date time	Soil moisture (%)	Soil temperature (Â°C)	Soil conductivity (dsm^{-1})	N	P	K
31–05-2022 21:24	15.29	27.4	192	58	49	157
31–05-2022 21:04	15.34	27.66	194	59	49	157
21–05-2022 23:44	21.25	29.19	297	59	46	156

4.2 Data Pre-processing

Data pre-processing is a technique for preparing data and creating models suitable for developing machine learning models. Data Cleansing is done by removing insignificant parameters such as the Battery (V) of the sensor, Date, and Time. The data is converted to a data frame using Panda's package in python. With the help of the panda's package insignificant field has been removed. The data format now consists of parameters like soil conductivity, soil temperature, soil moisture and Nitrogen, Phosphorous and Potassium.

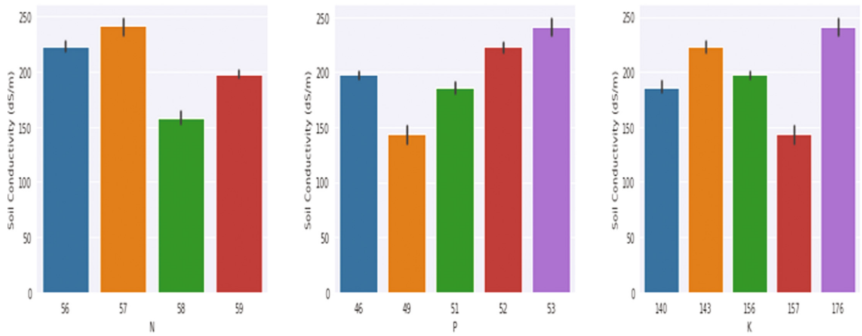
4.3 Exploratory Data Analysis

Exploratory Data Analysis is done to evaluate and visualize the data. By choosing the most important features in the model. The correlation coefficient is used to measure the interrelation between two or more variables. It is also used to find the relationship between the two data and estimate how strongly dependent to each other. Correlation between two or more variables is calculated, where the total sample size is N.



(a) (b)

Fig. 5. Correlation between variables a) conventional farming b) probiotic farming



(a) (b) (c)

Fig. 6. Soil Conductivity Vs Nitrogen, Phosphorous, and Potassium in Pro Biotic Farming

Figure 5 represents the correlation between variables in two different dataset. To evaluate the relationship between soil conductivity and nutrient values such as NPK, a bar plot from the seaborn library is used to plot with the respect to each nutrient values and soil conductivity. From the above Fig. 6, it is inferred that nutrient values with respect to soil conductivity and NPK are found higher in pro-biotic framing when compared with conventional farming.

4.4 Rule-Based Learning

One of the data mining techniques extensively used in classifiers to classify or predict categorical class names. Classification algorithms have the potential to handle large amounts of information. It is used to hypothesize category names for classifying knowledge based on training data and class labels for classifying newly acquired data. Machine learning classification algorithms include multiple algorithms, and this paper focuses on the popular decision tree algorithm.

4.4.1 Decision Tree

A decision tree is widely used due to the following factors such as ease to use, clarity, and strong in detecting outliers [16]. The usage of a Decision Tree is much easier than numerical weights in neural networks. Decision Tree acts well in both discrete and continuous variables. Furthermore, in Data Mining DT is the most widely utilized a classification model. It maps the non-linear model quite well, when to compared to a linear model. It works on the divide and conqueror rule, where the hierarchical tree structure is formed.

A simple decision tree consists of target variable Y i.e. (0 or 1) and two continuous variables $\times 1$, $\times 2$. The components of a tree are nodes, branches, and importantly splitting, stopping, and pruning.

Algorithm

Training dataset: x_i ,

Label vector: $\widehat{y_i}$

$threshold_c = 110 - 570$ ds$\boldsymbol{m^{-1}}$, $threshold_t = 20 - 30$℃ $threshold_m = 10 - 45\%$

Load the dataset: Load the data sample, it consists of 1919 rows and 8 Columns.

1. **Split the dataset:**

Let the data at node m be represented by D_m with nm samples

The data is split as 80% for training and 20% for testing, for each node spilt ω=(f,$threshold_m$) where f is feature and limit $threshold_m$, spilt the data as

If x_i is empty then

Return leaf node:

End if

If $\vee_m^{left}$ $soil\ Conductivity(\theta) = \{(x, y)x_j \leq threshold_c\}$ ***then***

Create node $\vee_m^{left}$ $soil\ Conductivity(\theta)$

if $\vee_m^{centre}$ $soil\ temperature(\theta) = \{(x, y)x_j \leq threshold_t\}$ ***then***

Create node $\vee_m^{centre}$ $soil\ temperature(\theta)$

if $\vee_m^{left}$ $soil\ moisture(\theta) = \{(x, y)x_j \leq threshold_m\}$ **then**

Create a node $\vee_m^{right}$ $soil\ moisture(\theta)$

End If:

If $\vee_m^{left}$ $soil\ Conductivity(\theta)\ is \leq 110 - 570$ $\mathbf{ds}\boldsymbol{m^{-1}}$ || $\vee_m^{centre}$ $soil\ temperature$ $20 - 30$ ℃ || $\vee_m^{right}$ $soil\ moisture(\theta) \leq 10 - 45\%$

Create a node **Nitrogen**, **Potassium**, **Phosphorous**

3.Compute Impurity function

The quality of a split of node m is can be computed using an impurity function or loss function H()

$$G(D_m, \theta) = \frac{n_m^{left}}{nm} H \vee_m^{left} soil\ Conductivity(\theta) + \frac{n_m^{centre}}{nm} H \vee_m^{centre} soil\ temperature(\theta) + \frac{n_m^{right}}{nm} H(\vee_m^{right} soil\ moisture(\theta)$$

$$\theta^* = argmin_\theta G(D_{m,}\ \theta)$$

For each node:

Calculate Standard deviation

$$SD(S) = \frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y}_i)^2 ,$$

Where y_i is target values, $\bar{y} = \frac{\Sigma}{n}$ is mean value and n is the number of splits.

$$S(T, P) = \sum_{n \in x_i} X(c)S(c)$$

Where S is SD, x_i is dataset is Target variable potassium, P is Predictor variable

$$\boldsymbol{S(potassium, x_i) = X(Soil\ Conducitivity) * S(Soil\ Conductivity) + X(Soil\ Moisture) * S(Soil\ Moisture) + X(Soil\ Temperature) * S(Soil\ Temperature)}$$

Return Outcome Potassium

Repeat until n=7

End

4.4.2 Random Forest

Random Forest is a grouping technique which is capable to perform both classification and regression. Random Forest outperforms technique called ensemble or bagging approach, which combines a one or more classifiers to solve a complex problem and improves the performance of the model. Random Forest [18]. The greater number of trees in Random Forest, greater the predictions. Advantages of Random Forest algorithm prevents the data from over fitting. The approach associates several randomly generated trees and sum their prediction by averaging. In addition to it, it is adaptable to many large-scale problems and flexible to different extemporary learning task. Random forest can be applied in various sectors like banking, healthcare to predict and classify the outcome. Random forest is also known as group of decision trees which is a flexible algorithm in this machine learning era. Bagging is common grouping strategy which groups the samples from the original dataset, build a predictor model from each of its sample and determine by averaging.

A Random Forest is a forecasting method, which consists of group of T randomized regression-based trees. For the i_{th} tree in the group, the predicted value at the query point a,is represented as $t_n(a; \theta_i, D_n)$where$\theta_1 \ldots, \theta_t$ are independent random variables, distributed as common random variable θ which is independent of Dataset Dn. The variable θ is used to resemble the training is set prior to the growth of individual trees and helps in selecting right path for splitting. In mathematical form, i_{th} tree will be estimated as

$$T_n(a; \theta_i, D_n) = \sum_{j \in D_n^*(\theta_i)} \frac{1 a_i \in_{A_n}(a; \theta_{i,D_n)B_i}}{N_{n(}a; \theta_{i,D_{n)}}} \quad (1)$$

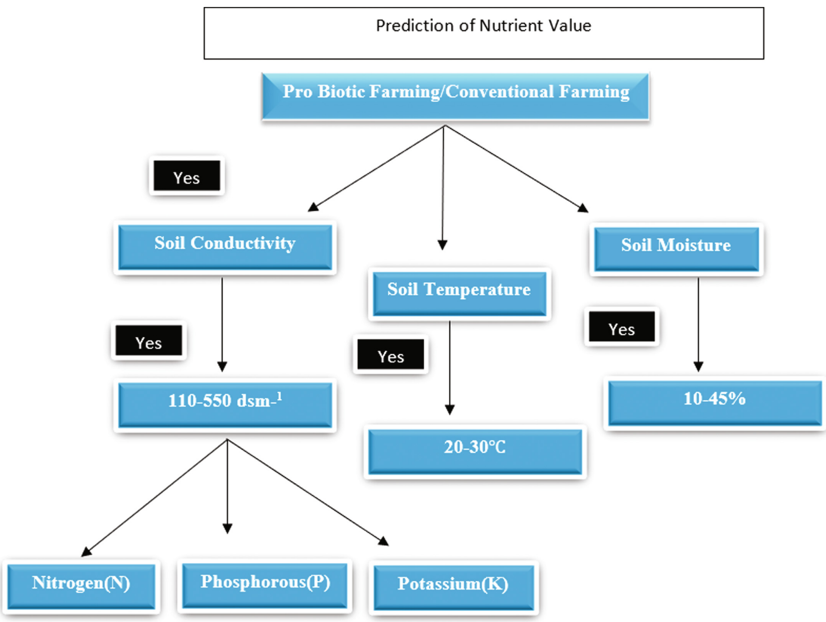


Fig. 7. The prediction of nutrient values

where $D_n^*(\theta_i)$ is the set of data selected for construction of the tree, $A_n(a; \theta_{i,} D_n)$ a is the cell containing, $N_n(a; \theta_{i,} D_n)$ is the number of points which fall into $A_n(a; \theta_{i,} D_n)$.The trees are combined to form a finite forest (Fig. 7).

$$t_{T,}n(a; \theta_1, \ldots \theta_T, D_n) = \frac{1}{T} \sum_{i=1}^{T} Tn(a; \theta_{i,} D_n) \quad (2)$$

Algorithm

Inputs

Training dataset: $D = x_{1,}y_1 \ldots x_{n,}y_n$ $threshold_c = 110 - 570\mathbf{dsm^{-1}}$, $threshold_t = 20 - 30°\text{C}$, $threshold_m = 10 - 45\%$

1. **Load the dataset**: Load the data sample, it consists of 1919 rows and 8 Columns.
2. **Split the dataset:**

Let the data at node m be represented by D_m with nm samples. Random Forest constructs many decision trees The data is split as 80% for training and 20% for testing, for each node spilt.

3. Sample S sets of n elements from D with replacements

Construct a Tree

If V_m^{left} $soil\ Conductivity(\theta) = \{(x, y)x_j \le threshold_c\}$ **then**

Create node V_m^{left} $soil\ Conductivity(\theta)$

if V_m^{centre} $soil\ temperature(\theta) = \{(x, y)x_j \le threshold_t\}$ ***then***

Create node V_m^{centre} $soil\ temperature(\theta)$

if V_m^{left} $soil\ moisture(\theta) = \{(x, y)x_j \le threshold_m\}$ ***then***

Create a node V_m^{right} $soil\ moisture(\theta)$

End If:

$IF\ V_m^{left}\ soil\ Conductivity(\theta)\ is \le threshold_c\ ||\ V_m^{centre}\ soil\ temperature \le threshold||\ V_m^{right}\ soil\ moisture(\theta) \le threshold_m$

Create a node **N**, **P**, **K**

For each $D_{i=1\ldots,}$ S

obtain a sequence of S outcome

N(x), P(x), K(x)…N_t(x) P_t(x) K_t(x)

For each tree:

Calculate Feature's Importance

$f_i = \sum_{j:node\ j\ splits\ on\ features\ i} S_j\ C_j,$

where f_i *is important*,Sj number of sample reaching node j Cj, impurity of node j

Compute Final Feature importance

$$RFfi_i = \frac{\sum_j normfi_{ij}}{\sum_{j \in allfeatures, k \in\ all\ trees} normfi_{jk}}$$

End

5 Performance Metrics

Accuracy is a simple metric that measures the number of correct predictions over the total number of predictions.

$$\text{Accuracy} = \frac{\text{Number of Correct predictions}}{\text{Total Number of predictions}} \tag{3}$$

R-Squared (R^2) is a common statistical measure used in regression model which determines the proportion of variations in the dependent variable by the independent variable, also r-squared illustrates how good the data is fit in the regression model.

$$R^2 = 1 - \frac{UnknownVariations}{TotalVariations} \tag{4}$$

Root Mean square (RMSE) is the square root of variance of the predicted errors. RMSE is the popular method of identifying the error rate in the model.

$$\text{RMSE} = \sqrt{\sum}(Pi - \frac{Oi)^2}{\text{n}} \tag{5}$$

where $\sum$ denotes Sum, P_i denotes predicted value in the dataset, O_i observed value in the data set.Mean Absolute the simplest error metric to evaluate the error rate of model[17]. It is effectively used in all data mining problems. It is approximately the sum of the average absolute differences between the predicted and actual values MAE = $\frac{1}{n}\sum|\text{X} - \text{X}|^\wedge$ where $\sum$ denotes Sum, X denotes predicted value in the dataset, value in the actual value set.

6 Results and Discussion

In this research work, as an initial study with Vallarai (Centella asiatica) is considered to perform the comparative analysis between conventional farming and hybrid farming. This paper provided an inference that, soil conductivity plays a major role in enriching the nutrients NPK of the soil. It is inferred that when soil conductivity is within threshold of 110–150 dsm^{-1}, temperature is between 20–30 °C, soil moisture is within 10–45% the values of nitrogen, potassium and phosphorous is found higher than usual. The carried work uses regression analysis to predict the nutrient value (NPK) with the respect to soil conductivity. The Decision Tree Regressor and Random Forest Regressor has been implemented to compare between pro biotic farming and conventional farming and their limitations were conducted. In Decision tree and Random Forest soil conductivity is higher in pro biotic farming compared with conventional farming. Results proved that the banana peel powder acts as an immune booster for the soil which enhanced the potassium level to the greater extent. Performance metrics such as accuracy, RMSE and MAE is calculated for Decision Tree. R^2, RMSE and MAE is calculated for Random Forest. In conventional farming the soil has less conductivity than probiotic farming. Accuracy rate for Decision Tree in Pro Biotic farming is 85% whereas, conventional farming it is 69%. R square rate for Pro Biotic farming R^2 is 88% whereas, conventional farming it is 80%. Below Table 3: Performance Metrics of the Random Forest and depicts the results of the models performed. Random forest performs better in both datasets (Table 4 and Fig. 8).

Table 3. Performance metrics of the random forest

Conventional farming (random forest)	Pro biotic farming (random forest)
R2 83%	91%
RMSE 0.2401	1.7475
MAE 0.0833	0.6361

Table 4. Performance metrics of the decision tree

Conventional farming (decision tree)	Pro biotic farming (decision tree)
Accuracy 73%	84%
RMSE 0.6914	0.0484
MAE 0.1937	0.0015

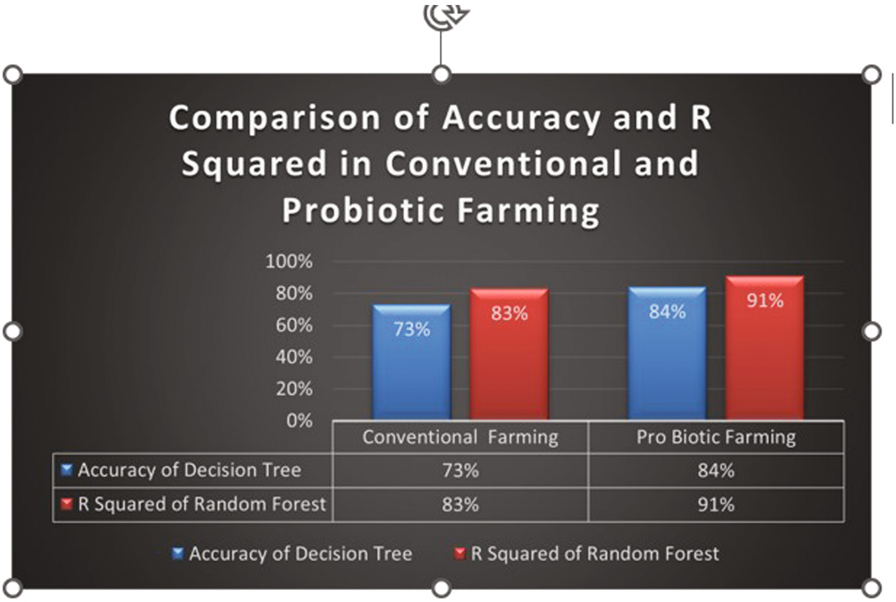


Fig. 8. Comparison of Accuracy and R Squared in conventional farming and probiotic farming

7 Conclusion

In this proposed methodology, a detailed analysis of environmental condition and significant attributes for the growth of the crop is measured and described briefly. Improper monitoring and controlling of crops in traditional farming method fails to result a good yield and fails to maximize the nutritional values in the crop. From the experimental study, it is found that soil electrical conductivity, soil moisture and temperature play's a major role in enhancing NPK in the crop. This review accentuates synergistic characteristics of soil in hybrid farming that could contribute to urban strength, human wellbeing and improved productivity and enhanced nutritional content. With the advancement of precision farming, growth of the crop can be monitored and controlled remotely to enrich the nutritional value. Limitation of the proposed experimental study is the amount of dataset extracted from the dashoard.in future we may extract the dataset for periods of six months to one year. The proposed study carried only for Vallarai (Centella asiatica), in future, this methodology will be carried out for all the six crops in Nutri Garden. This proposed study is highly beneficial for researchers and farmers to evaluate the nutritional conduct in the soil with level of soil conductivity in their own soil.

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