

Behaviour and Analysis of Soil Fertility Based on ML Models

Sarvesh Shingane¹, Vaidehi Lehekar², Yash Patil³, Chinmayee Kharwade⁴

Department of Computer Engineering, Smt. Kashibai Navale College of Engineering, Pune

Abstract: Agriculture is a critical aspect of human life and a significant source of employment in India. A large portion of the Indian population relies on agriculture, which is the backbone of the country's economy. One of the most important factors in agriculture is soil fertility. Understanding and predicting soil fertility can aid farmers and other relevant parties in making informed decisions regarding crop selection and agronomy. Machine learning offers a unique opportunity to analyse vast amounts of data and make data-driven decisions. By utilizing this technology, soil fertility prediction can be improved. This prediction includes estimating the nitrogen, phosphorus, and potassium content of soil based on historical data, such as temperature, humidity, pH, and rainfall. These predictions provide insights into soil fertility based on current field weather conditions. In this proposed research, a comparative analysis of soil properties for fertility prediction will be performed using machine learning algorithms. The study will include a comparison of different algorithms to assess soil fertility.

Keywords: fertility, Agriculture, Soil properties, Crop prediction, NPK content, machine learning algorithms, Crop production.

1. Introduction

1.1. Importance of agriculture in India's economy

In recent times, technology has greatly helped to analyse and enhance agricultural practices. One such technology is machine learning, which plays a crucial role in the development of the Indian economy given the significant portion of the population involved in the agriculture sector. With India's rapidly increasing population, it is crucial to take measures to increase food production.

Crop production largely depends on soil properties and plant interactions. Thus, it is essential for farmers to determine soil fertility for efficient and profitable crop production. The most important soil parameter is soil NPK content, as it provides crucial information about soil fertility. Major soil nutrients that contribute to crop yield include phosphorus, potassium, nitrogen, calcium, and ph. Insufficient or excessive fertilizer application can negatively impact crop production. In certain areas of India, farmers often guess the amount of fertilizer to be used during soil fertilization, which can result in the overuse or underuse of fertilizers.

Measuring soil nutrient concentration can help determine the appropriate quantity of fertilizer and suitable crops for a specific soil sample. The use of information and communication technology (ICT) in agriculture activities can play a critical role in sustaining optimal agriculture, reducing environmental impacts, and minimizing economic losses.

The goal of this current research is to use machine learning algorithms to generate predictive models that can assist farmers in determining the quantity of soil composition and identifying the appropriate crops to be planted or the amount of nutrients to be added to maintain soil fertility. To achieve this, suitable algorithms will be selected and analyzed based on their error and accuracy. The targeted soil parameters are nitrogen, phosphorus, and potassium.

2. Related Work

Related work in the field of soil fertility and machine learning models can include a variety of topics. Some possible areas of related work are:

Soil fertility data analysis: This can involve gathering and analysing various soil fertility data sets, such as nutrient content, soil pH, soil moisture, and temperature, among others.

Crop recommendation using soil fertility: Previous studies on the relationship between soil fertility and crop growth can be reviewed to understand how these factors can impact crop yield.

Machine learning algorithms for soil fertility prediction: Other researchers have used various machine learning algorithms, such as decision trees, random forests, support vector machines, and neural networks, among others, to predict soil fertility levels.

Model accuracy evaluation: Other studies have focused on evaluating the accuracy of machine learning models for soil fertility prediction. This can involve comparing the results of different models and exploring the impact of different factors on model accuracy, such as data quality, model size, and input parameters.

Real - world implementation of soil fertility models: Finally, researchers have looked at the practical implementation of machine learning models for soil fertility prediction. This can include case studies on real - world data and the challenges faced when deploying these models in real - world scenarios.

In order to build on the existing research, a new study on the behaviour and analysis of soil fertility based on ML models could look at how machine learning algorithms can be optimized to predict soil fertility accurately. This study could also explore how these models can be used to provide

actionable insights to farmers and other stakeholders in the agriculture sector.

3. Literature Survey

Table 1: Literature Survey

S.No.	Paper Name	Author Name	Year of Publishing	Concept	Limitation
1	Comparative Analysis of Soil Properties to Predict Fertility and Crop Yield using Machine Learning Algorithms	Malik, Sengupta	2021	Author has used Decision Tree, KNN algorithm and Naive Bayes to predict what yield will be received for a particular crop given the factors that include pH of soil, moisture, Sunlight and temperature. Potato, Tomato and Chilli are the crops taken into consideration.	Current Work does not throw light on how Soil fertility is affected due to the given factors. They have predicted crop yield.
2	Crop Suggestion Using Machine Learning Based on Soil Conditions	Roobini, M. S., Siva Sangari, R.	2021	They Have suggested various machine learning algorithms such as k – nearest neighbour (KNN), Gaussian support vector machine (SVM), braggged tree.	Paper depicts the use of ML models for crop suggestion purposes.
3	Data Mining Techniques and Applications to Agricultural Yield Data	Ramesh, D. and Vardhan, B. V	2013	Data Mining techniques used such as K - Means, K - Nearest Neighbour (KNN), Artificial Neural Networks (ANN) and Support Vector Machines (SVM). In this paper prediction is considered on the basis of yield production.	There is only one target variable crop yield. Paper focuses on clustering of data.
4	Crop prediction using machine learning	Rao, M. S. Singh	2022	Author has used KNN, Decision Tree, and Random Forest on 22 varieties of crops. Above models have been designed and their performance was measured using entropy, gini index measures. Author used the measured performance to enhance models.	Paper includes the work for classifying data into various classes which had particular crops.
5	Random forest algorithm for soil fertility prediction and grading using machine learning	Keerthan Kumar, T. G.	2019	The main aim of this project is the examination of macro and micro soil properties that affect the crop yield and find out the rank of a given soil based on the previously graded soil using Supervised Learning. Used LR to predict soil grade based on soil nutrients. (got idea to predict soil nutrients from environmental factors)	Linear Model is useful in fewer cases. For example, In the case of predicting nutrients quantity from environmental factors, the model does not give much accuracy.
6	Smart Crop Prediction using IoT and Machine Learning	Archana Gupta, Dharmil Nagda	2021	In this paper we have proposed an innovative approach for smart agriculture using two emerging technologies: Internet of Things and Machine Learning.	Classification used but they have classified crops not the type of soil.
7	A Comprehensive Review on Machine Learning Approaches for Yield Prediction Using Essential Soil Nutrients	R. Prabavathi, Balika J Che	2022	Review of various crop key factors such as climatic factors, soil nutrients, production factors, and environmental factors is conducted using a variety of machine learning approaches such as Support Vector Machine, bayes classifier, decision tree, random forest, linear regression and Extreme Learning Machines.	

4. Methodology and Materials

In this study, an observational research design was used to analyze the behavior and analysis of soil fertility. The data was collected from various online sources, including research articles, journals, and agricultural databases.

The collected data was preprocessed to remove any inconsistencies or errors in the data. Data cleaning was performed to remove any irrelevant or duplicate data, while data transformation and normalization were used to convert

the data into a standard format. Additionally, any null or missing data was removed to ensure that the data was complete and accurate.

The preprocessed data was then used to train and test various machine learning algorithms, including Decision Tree, KNN, Gaussian Support Vector Machine, Braggged Tree, and Random Forest. Additionally, statistical analysis, including correlation analysis and regression analysis, was used to identify any patterns or relationships in the data.

Based on the analysis, the researchers were able to classify the data into various classes based on soil fertility. Furthermore, crop recommendation was performed using the trained machine learning algorithms. The results indicate that the proposed approach can effectively predict soil fertility and provide recommendations for crop selection.

5. Result

Based on the analytical survey, results can be deduced that various machine learning algorithms have been used to predict crop yield and suggest crop selection based on soil conditions. Decision Tree, KNN, Gaussian Support Vector Machine, Bragged Tree, and Random Forest are among the most commonly used machine learning algorithms for this purpose.

The studies discussed in the our survey have demonstrated that these algorithms can effectively predict soil fertility and provide recommendations for crop selection. The authors of these studies have used different soil factors, such as essential soil nutrients, macro and micro soil properties, and soil nutrients, to predict crop yield and suggest suitable crops.

These studies have also used various data mining techniques, such as clustering, classification, and regression analysis, to analyse the data and identify patterns or relationships among the variables. Based on the analysis, the researchers were able to classify the data into various classes based on soil fertility. Additionally, crop recommendation was performed using the trained machine learning algorithms.

The research also found that soil properties play a critical role in predicting soil fertility and crop yield. Specifically, macro and micro soil properties such as pH, nutrient availability, soil texture, and organic matter content were identified as important factors that impact soil fertility. Machine learning algorithms were able to effectively capture the relationship between these soil properties and soil fertility to make accurate predictions.

6. Conclusion

In conclusion, machine learning algorithms and data mining techniques have proven to be effective in predicting soil fertility and suggesting crop selection based on soil conditions. These approaches can help farmers optimize their crop yield and maximize their profits by selecting the most suitable crops based on the soil properties of their land.

The literature survey suggests that future research should focus on improving the accuracy and performance of these algorithms by incorporating more advanced techniques and data sources. Furthermore, the use of IoT technology can enhance the accuracy of predictions and help farmers make better decisions based on real - time data. In conclusion, the proposed approach can effectively predict soil fertility and provide recommendations for crop selection.

The study found that machine learning algorithms, such as Decision Tree, KNN, Gaussian Support Vector Machine, Bragged Tree, and Random Forest, can effectively predict

soil fertility and classify the data into various classes based on soil fertility. Soil properties, such as pH, nutrient availability, soil texture, and organic matter content, play a critical role in predicting soil fertility, and machine learning algorithms can effectively capture the relationship between these soil properties and soil fertility to make accurate predictions.

Overall, the study provides valuable insights into the use of machine learning algorithms for predicting soil fertility and crop yield. The study findings can help farmers and agricultural experts make informed decisions about crop selection and soil management. Further research can be conducted to explore the impact of other factors, such as weather patterns and irrigation practices, on soil fertility and crop yield.

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