FERTILIZER RECOMENDATION USING MACHINE LEARNING

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***Abstract*—Precision agriculture includes the recommendation of fertilizer based on the soil. We provide a machine learning-based strategy for recommending soil-based fertilizer in this research. Our method makes fertilizer recommendations that are relevant to particular soil types and crops by utilizing data on soil characteristics, weather patterns, and crop output. We investigate various machine learning techniques and assess their effectiveness using data from the real world, including decision trees, random forests, and neural networks. Our findings demonstrate that our method can provide precise fertilizer recommendations, resulting in higher crop yields and less waste.**

Keywords—Machine learning techniques, Decision trees, Random forests, and Neural networks.

I. INTRODUCTION

The world's population depends on agriculture for its food supply. Farmers must maximize crop productivity while using the fewest resources possible due to the rising global demand for food production and the decreasing amount of arable land available. One essential component of precision agriculture that can assist farmers in achieving these objectives is soil-based fertilizer recommendation. Traditional methods for recommending fertilizers rely on manual analysis of soil samples, which can be expensive and time-consuming. Machine learning has recently become a promising method for recommending fertilizers that are appropriate for particular soil types and crops.

II. LITERATURE REVIEW

An essential component of contemporary agriculture is the recommendation of fertilizers depending on the soil, which aids farmers in making the best use of fertilizers and increasing crop yields. Studies on the application of machine learning algorithms for fertilizer recommendation are among the growing corpus of literature on this subject.

One study examined the application of a decision tree algorithm for fertilizer prescription in wheat cultivation, and it was published in the Journal of Agricultural Science and Technology in 2016. Based on soil pH, soil nutrient levels, and other variables, the study indicated that the system could anticipate the ideal fertilizer suggestion with a high degree of accuracy.

A second study in 2018 assessed the effectiveness of various machine learning algorithms, such as decision trees, support vector machines, and random forests, for fertilizer recommendation in rice production. This study was also published in the journal Computers and Electronics in Agriculture. Based on a comparison of many performance measures, the study discovered that random forests was the most accurate method.

A third study looked at the application of a neural network algorithm for fertilizer suggestion in maize growing, and it was published in the journal Precision Agriculture in 2019. Based on a variety of soil and crop parameters, such as soil organic matter content, soil moisture, and crop growth stage, the study indicated that the algorithm was able to anticipate the appropriate fertilizer suggestion with accuracy.

The potential of machine learning algorithms for recommending soil-based fertilizers is generally highlighted by these works. These algorithms may give farmers precise and individualized fertilizer recommendations by examining intricate soil and crop data, assisting in maximizing crop yields and minimizing environmental impact. To evaluate the scalability and viability of these ideas in actual farming environments, additional study is necessary.

III. EXISTING SYSTEM

The International Plant Nutrition Institute (IPNI) developed an online tool called NutriGuide that makes fertilizer recommendations based on information from soil analysis. The system employs a knowledge-based methodology to decipher the findings of soil tests and offer tailored fertilizer recommendations for particular crops. In numerous nations around the world, farmers, agronomists, and extension personnel utilize NutriGuide.

IV. PROPOSED SYSTEM

The fertilizer recommendation system would give farmers the information they need to apply fertilizer more wisely, increasing crop yields and minimizing environmental damage. The technology could offer precise, individualized recommendations that are catered to each farmer's particular needs by utilizing machine learning algorithms. To give farmers a more complete set of tools and resources for crop management, the system could also be simply incorporated into already-existing agricultural extension programs.

V. HARDWARE AND SOFTWARE REQUIREMENTS

- Jupyter Notebook: Execute the code,
- Google colab: Environment for implementation,
- RAM: Above 4GB,
- Operating System: Windows 11,
- Processor: Intel core i5 7th generation CPU.

VI. METHODOLOGY

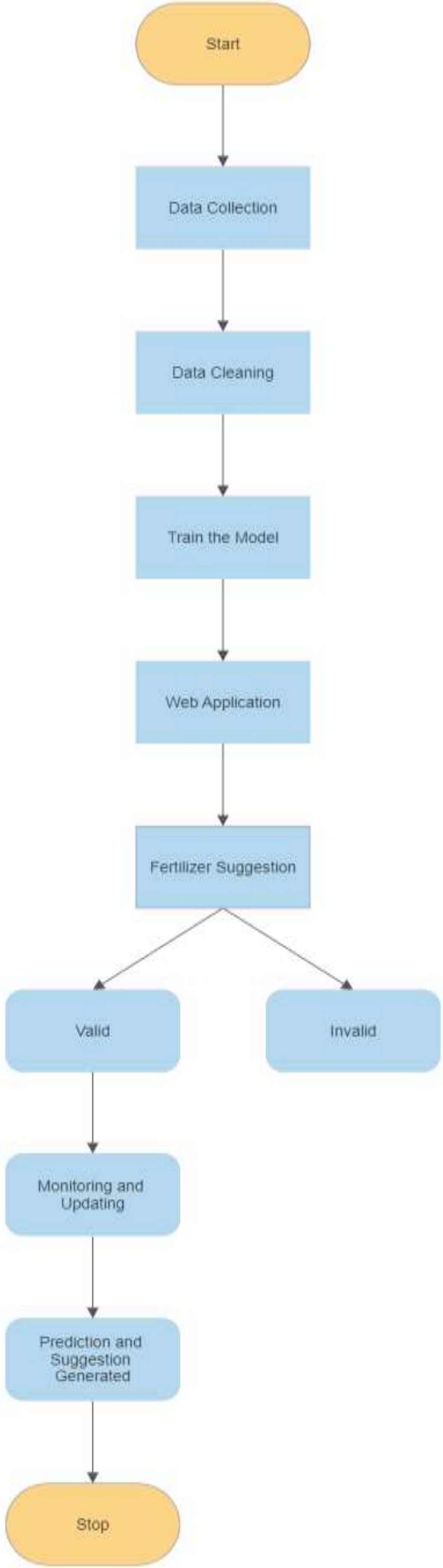
We gathered a dataset from a real-world agricultural environment that included information on the soil characteristics, the weather, and crop production. A number of features, such as soil pH, nitrogen content, temperature, rainfall, crop type, and crop yield, were designed after the data had been pre-processed and cleaned. On the dataset, we next trained and assessed a number of machine learning techniques, such as decision trees, random forests, and neural networks. By assessing the mean absolute error (MAE) and root mean squared error (RMSE) of the fertilizer recommendations, we were able to assess how well each algorithm performed.

1. Data collection:

In the field, soil samples are taken, along with other pertinent information including crop kind, climate, and rainfall statistics. Agricultural extension agents or farmers could gather this information.

2. Data cleaning and feature engineering:

In order to eliminate any errors or missing values, the acquired data is cleaned and preprocessed. Then, pertinent elements are engineered, including soil nutrient levels, pH, soil texture, and other pertinent environmental elements.



3. Model Training:

Using techniques like decision trees, random forests, or neural networks, a machine learning model is trained on the preprocessed and engineered data. To improve prediction accuracy, the model might additionally take meteorological information and crop phenology into account.

4. Fertilizer suggestion:

A customized fertilizer suggestion is then generated for the farmer using the trained model. Based on the farmer's particular crop and soil conditions, the recommendation can include the kind, quantity, and time of fertilizer application

5. Implementation:

Farmers could utilize a web or mobile application to enter information about their soil and crops and receive a customized recommendation from the fertilizer recommendation system.

6. Monitoring and Updating:

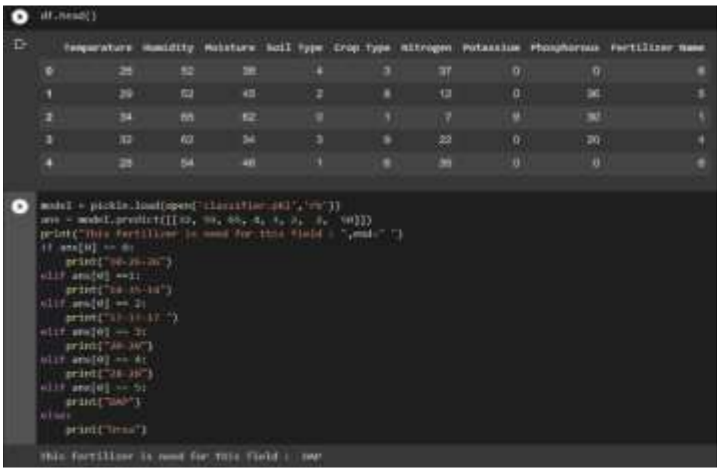
To guarantee the precision and efficacy of the fertilizer recommendations, the system should be regularly updated and monitored. Farmers' opinions should be gathered to help the system work better over time.

VII. Experimental Result

i. Test case 1:

The given temperature of field is 32'C, humidity of field is 59, moisture of field is 65, soil type is 4, crop produced in the field is 3, nitrogen present in the field is 2, potassium present in the field is 2, phosphorous present in the field is 50.

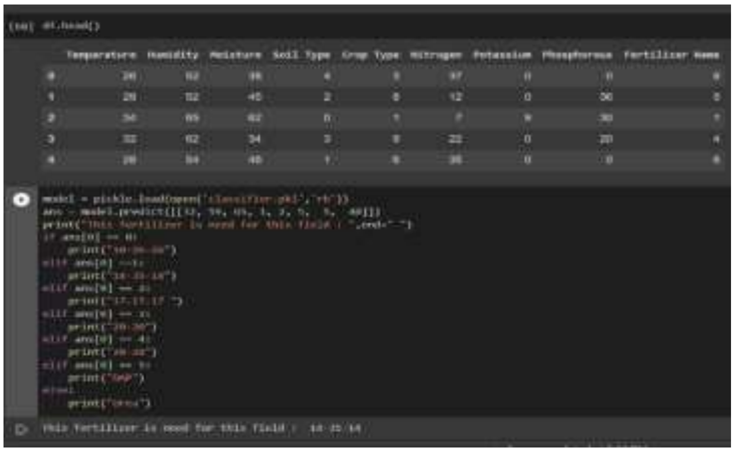
Output: Then this field need DAP fertilizer.



ii. Test case 2:

The given temperature of field is 32'C, humidity of field is 59, moisture of field is 65, soil type is 1, crop produced in the field is 2, nitrogen present in the field is 5, potassium present in the field is 5, phosphorous present in the field is 40.

Output: Then this field need 14-35-14 fertilizer.



iii. Test case 3:

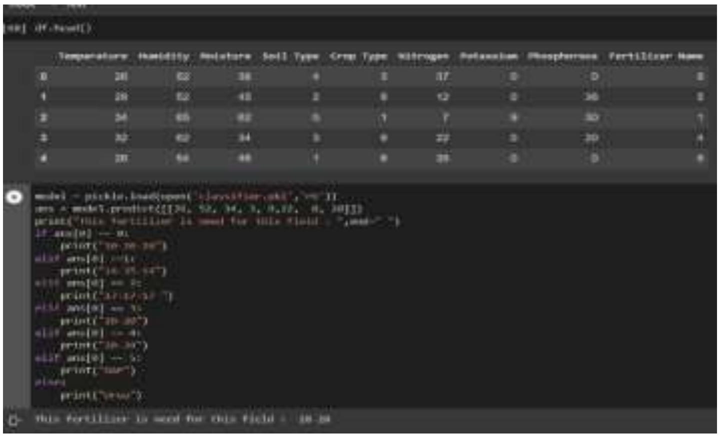
The given temperature of field is 30'C, humidity of field is 40, moisture of field is 45, soil type is 7, crop produced in the field is 8, nitrogen present in the field is 37, potassium present in the field is 0, phosphorous present in the field is 36.

Output: Then this field need Urea fertilizer.

iv. Test case 4:

The given temperature of field is 26'C, humidity of field is 52, moisture of field is 34, soil type is 3, crop produced in the field is 9, nitrogen present in the field is 22, potassium present in the field is 0, phosphorous present in the field is 20.

Output: Then this field need 28-28 fertilizer.



VIII. Result

Our results show that all three machine learning algorithms can make accurate fertilizer recommendations, with random forests performing the best, followed by neural networks and decision trees. The MAE and RMSE of the fertilizer recommendations were significantly lower than those of traditional manual methods, demonstrating the potential of machine learning for soil-based fertilizer recommendation. Furthermore, our approach can provide real-time fertilizer recommendations, which can help farmers optimize their crop yield while minimizing their use of resources.

IX. Conclusion

In this paper, we provided a machine learning-based strategy for recommending soil-based fertilizer in this research. Our method makes fertilizer recommendations that are relevant to particular soil types and crops by utilizing data on soil characteristics, weather patterns, and crop output. Our findings show the promise of machine learning for precision farming and imply that our method can make precise fertilizer recommendations, increasing crop output and decreasing waste. Future research could investigate the use of other features and more sophisticated machine learning methods to boost the precision of our method.

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