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ESTIMATION AND IMPROVEMENT OF SOIL NUTRIENT DEFICIENCIES USING MACHINE LEARNING

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Abstract:

Organic farming has been a rising concern in today's world in order to restore balance and increase lifetime. Many environmental aspects along with product yield are to be considered while undertaking organic farming. Our solution primarily aims at utili zing machine learning algorithms in recommending suitable organic fertilizers that promotes plant growth without causing major damage to soil health. The proposed system obtains soil's nitrogen, phosphorous and potassium values followed by basic soil data like soil moisture content, temperature and soil type with the help of a Stream lit UI along with type of crop the user wants to grow and these values are used further to determine nutrient deficiencies and suitable organic fertilizer combinations to improve them. Primarily used machine learn ing algorithm that has better accuracy score is the random forest algorithm. Support vector machine algorithm was also tested on dataset for prediction although accuracy score was less when compared to random forest algorithm.

Keywords — **Stream lit, Organic fertilizer, Prediction, Accuracy, Nutrient, Deficiencies.**

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The proposed system obtains soil's N,P,K values along with Ph and temperature with the help of a Streamlit UI along with type of crop the user wants to grow and these values are used to further determine nutrient deficiencies and suitable organic fertilizer combinations to improve them. The latter part focuses on suggesting next crop suitable for crop rotation. The models need to be trained using datasets, where the out-comes are represented based on past experience.[2] Organic fertilizer is one of the most recommended fertilizers because of many diseases that occur due to the chemical that are being added in the food we eat and in the vegetables we eat. The main reason of cancer is said to be chemicals that are added in our food we intake. Advantages are

- Sustainable and Environmentally Friendly
- Reduce Fertilizers and Pesticides
- Plant Damage Threat Avoided
- Preserve fertility

A lot of existing solutions deal with predicting suitable fertilizer, crop cycle prediction and crop yield prediction using machine learning and deep learning algorithms. Other set of solutions deal with pesticide control, identifying plant diseases through image processing and many more. Some also include IOT devices to obtain real time data and process the data acquired further. In fertilizer recommendation systems developed using machine learning the major drawback observed was that soil health is observed to be depleting after a time. All over the world organic farming has obtained a boom as result of this. The proposed system obtains soil's N,P,K values along with Ph and temperature with the help of a Streamlit UI along with type of crop the user wants to grow and these values are used to further determine nutrient deficiencies and suitable organic fertilizer combinations to improve them. The latter part focuses on suggesting next crop suitable for crop rotation. Using machine learning algorithm, we can predict the organic

fertilizer. At first, we need to get the value of nitrogen, Phosphorus and potassium from the agriculture field with which we can predict which organic fertilizer is suitable for the field so that it can enhance a better and safe organic crop which is not harmful for anyone. This all-inputs data applies to machine learning predictive algorithms like Support Vector Machine (SVM) and Decision tree to identify the pattern among data and then process it as per input conditions.[1]

II. LITERATURE SURVEY

1) Manoj Kumar D P, Neelam Malyadri, Srikanth M S, Dr. Ananda Babu J designed **A Machine Learning model for Crop and Fertilizer recommendation**, In which the model proposed Farmers are growing same crop in the season rather than growing different varieties in various seasons, also applying more quantity of fertilizers without knowing actual contents and India is ranked under the world's five largest producers of over 80%. quantity India is currently the world's second largest producer of several dry fruits, agriculture-based textile raw materials, roots and tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. [1]

2) Thomas van Klompenburga , Ayalew Kassahuna , Cagatay Catal, designed **Crop yield prediction using machine learning: A systematic literature review**, In which the model Several machine learning algorithms have been applied to support crop yield prediction research. In this study, we performed a Systematic Literature Review (SLR) to extract and synthesize the algorithms and features that have been used in crop yield prediction studies.[2]

III. PROPOSED SYSTEM

The proposed system obtains soil's nitrogen, phosphorous and potassium values followed by basic soil data like soil moisture content, temperature and soil type with the help of a Streamlit UI along with type of crop the user wants to grow and these values are used further to determine nutrient deficiencies and suitable organic fertilizer combinations to improve them. The latter part focuses on predicting expected time after which a nutrient loss would occur for the crop based on harvest time and climatic conditions. Primarily used machine learning algorithm that has better accuracy score is the random forest algorithm. Support vector machine algorithm was also tested on dataset for prediction although accuracy score was less when compared to random forest algorithm. The prediction results are also made available on the same UI within a result field which gets activated by user's interaction with "Predict" button. The diagram below is the Architecture diagram for proposed solution

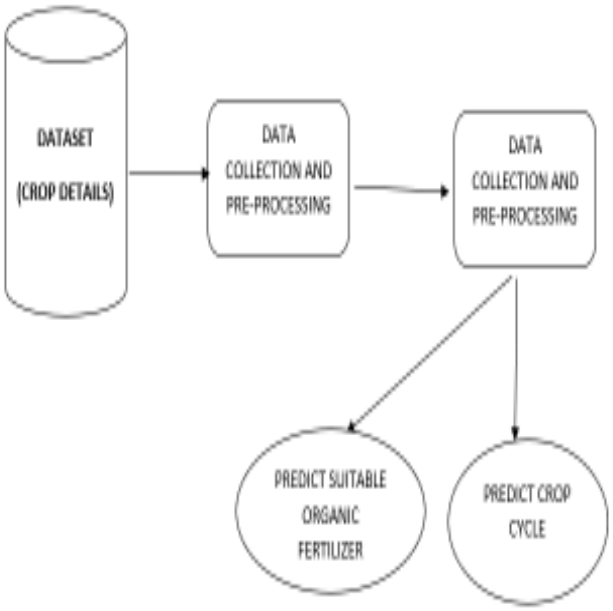

Fig. 1. Architecture Diagram for the Proposed solution

IV. IMPLEMENTATION

The system implementation involves four main modules or steps starting from data collection, processing, prediction of organic fertilizer and ends with suggesting the next crop that is suitable for crop rotation.

A. Data collection

Basic data like crop type, soil type and NPK values were obtained using Kaggle dataset while the suitable organic fertilizer and next crop details were formulated using data from TNAU (Tamil Nadu Agricultural University) Agri Portal.

B. Data Processing

Basic dictionary based encoding has been performed on the sample dataset in order to handle string data like crop type and soil type.Same encoding is performed on user input before passing it to the model created and saved using pickle python library.

C. Recommendation

This module uses the soil data and crop type from user and runs it against crop requirements dataset and organic fertilizer dataset using SVM and random forest algorithms to suggest suitable organic fertilizer according to the nutrient deficiency observed. The figure below shows the recommendation part.

D. Crop Rotation

This module focuses on predicting next crop suitable for growing after harvest of present crop so as to ensure the nutrient balance is restored to some extent naturally. In order to accomplish this a separate feature with suitable next crop has been included in the dataset based on the data from Organic Farming section in TNAU Agri Portal. Random forest algorithm has been used to perform this prediction.

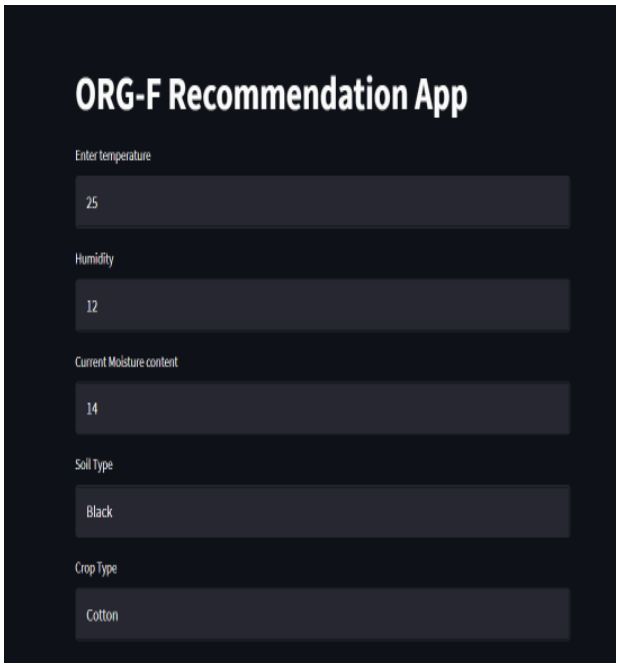

Fig.1 Output Snapshot

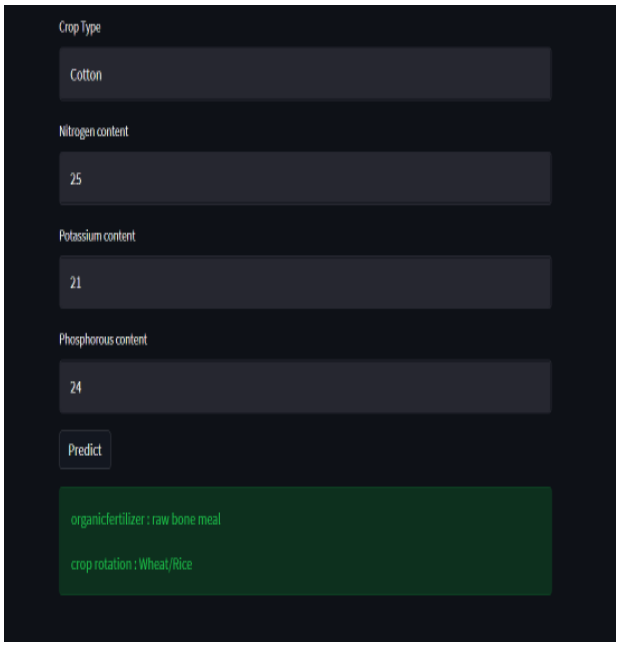

Fig.2 Output Snapshot

```
In [18]: plt.xticks(rotation=90)
         sns.countplot(df['FertilizerName'])
```

```
Out[18]: <AxesSubplot:xlabel='FertilizerName', ylabel='count'>
```

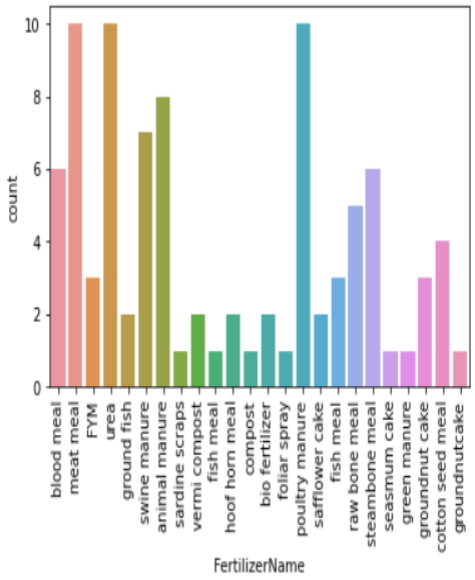

Fig.3 Graph representation (**OrganicFerilizerName Vs Count)**

```
plt.xticks(rotation=90)
sns.boxplot(x=df['FertilizerName'],y=df['CropType'])
```

```
<AxesSubplot:xlabel='FertilizerName', ylabel='CropType'>
```

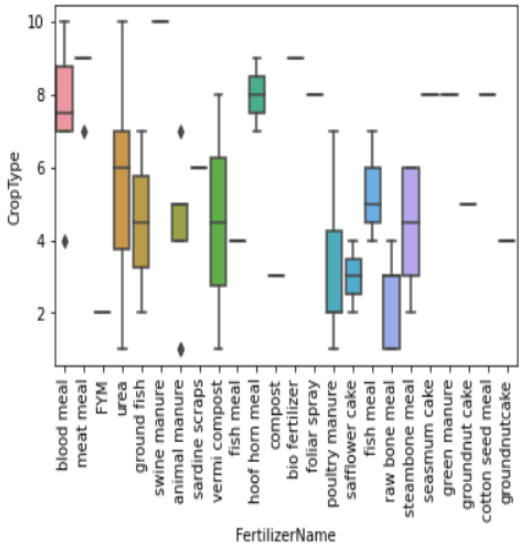

Fig.4 Graph representation (**OrganicFerilizerName Vs Crop type)**


```
plt.xticks(rotation=90)
sns.boxplot(x=df['Temparature'],y=df['FertilizerName'])
```

```
<AxesSubplot:xlabel='Temparature', ylabel='FertilizerName'>
```

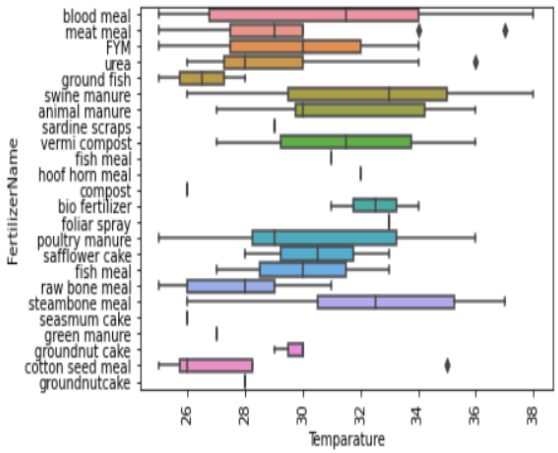

Fig.5 Graph representation (**OrganicFerilizerName Vs Temperature)**

V. CONCLUSION

Based on training set created using Agri Portal of TN and other Kaggle datasets suitable decision tree algorithm was applied to obtain 100% accuracy in providing organic fertilizer recommendation for certain set of crops. Python libraries like Streamlit and Scikit Learn were utilised to do this successfully. Based on the analysis and predication done, the study shows that proper choice of organic fertilizers can improve soil health conditions and can be effective just like chemical fertilizers.

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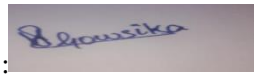
Author's signature(s) : 

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