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Intelligent Farming Techniques Using Machine Learning

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Abstract

Agriculture is critical to India's socioeconomic system. Agriculture is one of the most important industries in the Indian economy, accounting for more than 18% of GDP. Almost 58% of India's population relies largely on agriculture for a living, making India a prominent participant in the global agriculture business. Farmers plant the same crop every season rather than farming various sorts in different seasons. They also utilize extra fertilizers without understanding their exact composition or dose. Giving farmers timely access to insightful information would allow them to apply best practices and manage their property more effectively, reducing losses and increasing revenues. The proposed method assists farmers in selecting the best crop for their requirements while accounting for all aspects such as sowing season, soil, geographic location, and the best fertilizer to seed based on soil and weather conditions. This improves agricultural productivity and revenues. As a consequence, farmers may use our technology to produce fresh crops throughout the year at a better profit while reducing soil deterioration. This is possible because to the use of several machine learning algorithms. This strategy is implemented utilizing machine learning (ML) algorithms such as Decision tree, Random forest, Nave bayes, and KNN.

1. Introduction

Agriculture provides a living for about 58% of the people in our country. Weather, environmental changes, rainfall, and fertiliser application all have an impact on crop yield. As a result, farmers are unable to achieve the expected agricultural yield (Priyadharshini et al.). Taking into consideration significant environmental variables, geological location, and soil composition, our proposed technique leverages machine learning to aid farmers by selecting the best crop for their land and, based on those recommendations, the appropriate fertiliser for their field. (Varsha) Using technology to maximise profit, enhance crop quality, and significantly boost output. Farmers may benefit from having a successful production with minimal failures. (Viswanathan et al.) This study employs a variety of machine learning approaches, including Random Forest (Shaurya, Aishwarya, and Rohilla). technology to optimize profit, improve crop quality, and bring about major production increases. Having a successful output with few failures might be advantageous to farmers. Many machine learning techniques, including Random Forest, are used in this work. (Wickramasinghe et al.)This is a real world agricultural problem that is solved by using ML. Our project can help farmers in following ways:

- **Food Security:** Precise crop prediction can contribute to food security by helping farmers to plan their crops ahead of time and change planting and harvesting dates depending on projected yields. This contributes to a consistent supply of food and reduces the possibility of food shortages. (Jeevaganesh, Harish, and B. Priya)
- **Economic Development:** Crop prediction can also aid economic development by assisting farmers in making more educated decisions regarding when to plant, when to harvest, and what crops to cultivate. This can result in larger yields, higher quality crops, and, eventually, higher revenues for farmers. (K. D. Priya et al.)
- **Environmental Sustainability:** Fertilizer forecasting can also aid in the promotion of sustainable agricultural practices by limiting fertilizer runoff into waterways and lowering the danger of soil damage. (Jadhav et al.) This can assist to maintain ecosystems and enhance agricultural long-term viability. (Bhansali et al.)
- **Resource Efficiency:** Fertilizer prediction can assist farmers in making better use of resources by lowering the quantity of fertilizer required to achieve targeted crop yields. This can assist to cut production costs while also reducing agriculture's environmental effect. (Premasudha, T. D. K, and T. K)
- **Increased Agricultural Productivity:** Precise fertilizer forecast can assist farmers in applying the appropriate quantity of nutrients to their crops at the appropriate time. This can result in higher yields, better crop quality, and, ultimately, higher production. (Sivanandam et al.)

1.1. Problem Definition

Crop forecasting assists farmers in selecting the best crop to produce in order to maximise productivity and, hence, profit. We typically use the concept of fertiliser advice since there have been several cases of crop failure in the past owing to a lack of knowledge about proper fertilisers and pesticides. This might be highly beneficial in providing a good output and resolving this problem. Our system captures and mitigates escalating risk by steering farmers towards optimal output and profit maximisation.

1.2. Scope

In terms of societal impact, digital agriculture technology will be a game changer. Farmers will profit the most since they will incur less losses while producing and earning more. Furthermore, this technology provides farmers with better fertiliser guidance. It assists farmers in selecting the crop that will thrive best in the location and at the appropriate time of sowing. As a result, it will have a huge impact on society or the environment.

2. Methodology

We are creating a web application that will serve as a user interface for this project. This gives farmers access to the project's fundamental implementation component. The application we are developing is user-friendly, taking user input and passing it via the backend to produce projected results in the interface. Based on soil composition and environmental characteristics such as temperature, humidity, soil ph, and rainfall, the suggested method would estimate the best crop and fertiliser for a specific plot of land.

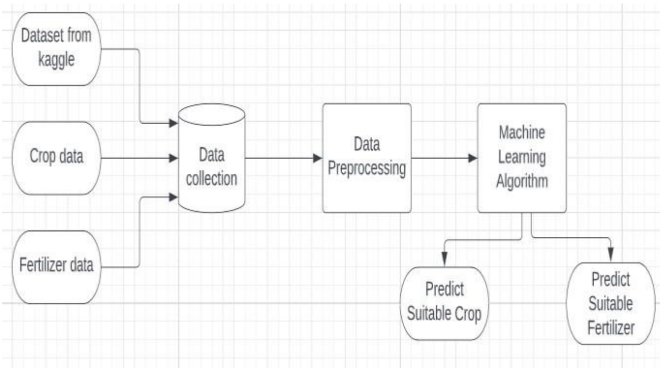

FIGURE 1. Overall Architecture

2.1. Data Collection

One of the most important processes in machine learning is data acquisition. We obtained the crop dataset and the fertiliser dataset from the Kaggle.com website. The following characteristics are included in this dataset: Soil PH, temperature, humidity, rainfall, NPK levels, crop type, and fertiliser names are all variables to consider. The crop dataset has 2200 rows and 8 columns, whereas the fertiliser dataset has 205 rows and 9 columns.

2.2. Data Preprocessing

Following the collection of the dataset. Before feeding the dataset into a machine learning model, it must be pre-processed. Data preparation can be done in steps, which involve reading the obtained data, cleaning it, dealing with null and duplicated entries, and removing undesirable properties. The primary goal of data preparation is to increase model performance. Following this phase, the dataset will be divided into training and test data.

2.3. Machine Learning Algorithms

Machine learning employs a variety of algorithms to construct mathematical models and make predictions based on past data or information. It is a method for predicting future events using past data. In our case, we choose a supervised machine learning technique since classification algorithms are best suited to it. We employed machine learning methods such as the Decision Tree Classifier, KNN Classifier, and Naive Bayes Classifier to forecast acceptable crop. We employed the Decision Tree Classifier, Random Forest Classifier, KNN Classifier, and SVM Classifier to forecast fertiliser.

2.4. Crop Prediction

During this stage, we predict which crop will be grown in the soil. It accepts factors such as NPK content, temperature, humidity, ph, and rainfall as input. This procedure begins with the import of the dataset, followed by feature selection and data cleaning. Following that, data is visualized using Python tools such as matplotlib and seaborn. Following the completion of all pre-processing processes, we train the model using machine learning methods such as decision trees, KNN, and naive Bayes. The model is then fed the input to anticipate the optimal harvest.

2.5. Fertilizer Prediction

We are guessing the optimal fertilizer for the soil at this stage. It accepts factors like NPK concentration, temperature, humidity, moisture, soil type, and crop kind as inputs. The method begins with importing the dataset, followed by feature selection and data cleaning, and then, the categorical column crop type in the dataset is transformed to an integer using a label encoder. Following that, data is visualized using Python tools such as matplotlib and seaborn. Following the completion of all pre-processing processes, we train the model using machine learning techniques such as the random forest, KNN, and decision tree. The model is then fed the input to estimate the optimal fertilizer.

3. Results and Discussion

The Results show that Gaussian Naive Bayes algorithm is best suited for crop recommendation system with the accuracy of 99.54%. And Random Forest algorithm is best suited for fertilizer recommendation system with accuracy of 100%.

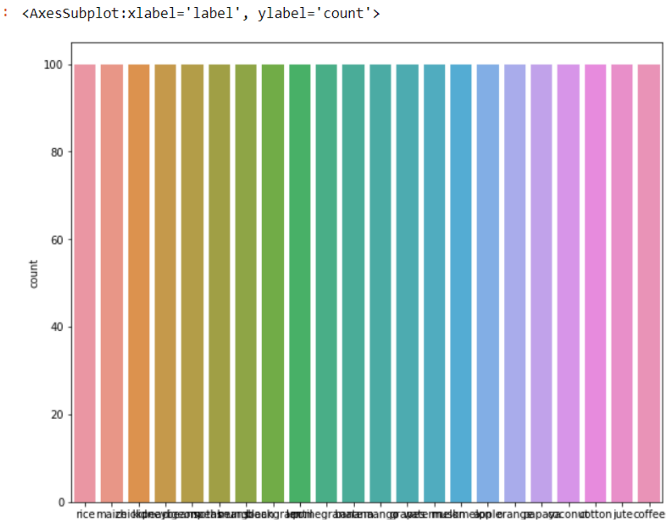

FIGURE 2. Count plot

The value counts visualization for unique crop type in target column of the dataset. Performed using seaborn library.

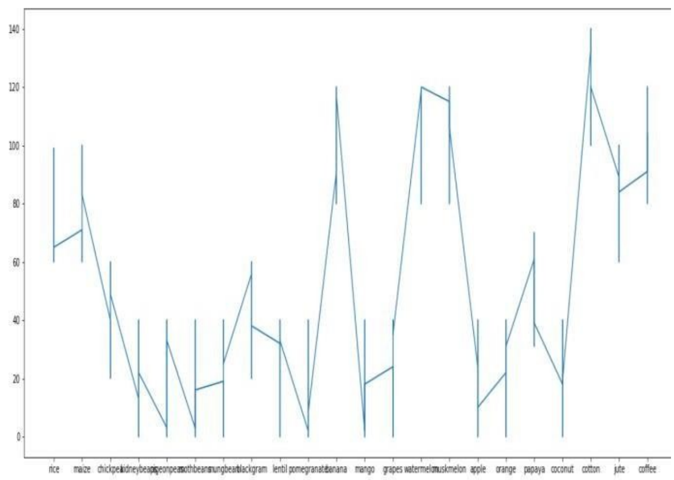

FIGURE 3. Nitrogen requirement

Figure 3 shows the requirements of nitrogen for various crops.

The heatmap is draw to show the relationship between two variables, one plotted on each axis. using this we can easily observe if there are any patterns in value for one or both variables.

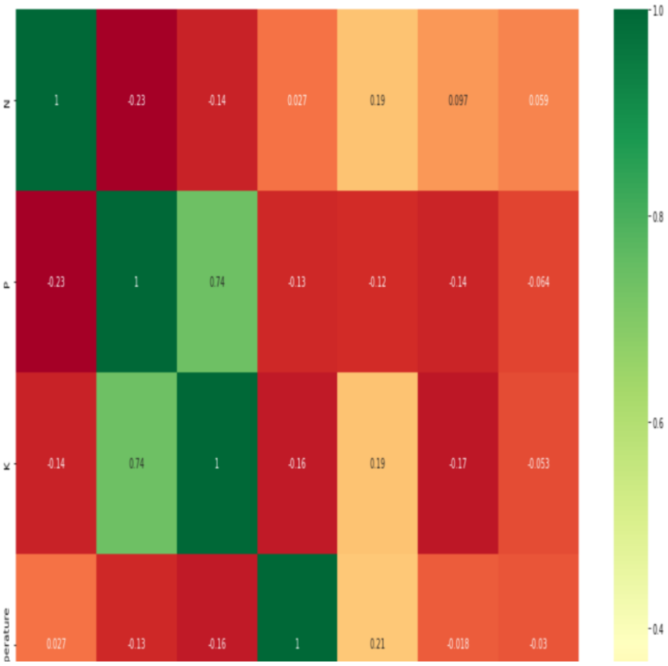

FIGURE 4. **Heat map**

	precision	recall	f1-score	support
apple	1.00	1.00	1.00	28
banana	1.00	1.00	1.00	29
blackgram	1.00	1.00	1.00	35
chickpea	1.00	1.00	1.00	30
coconut	1.00	1.00	1.00	33
coffee	1.00	1.00	1.00	37
cotton	1.00	1.00	1.00	36
grapes	1.00	1.00	1.00	23
jute	0.96	0.92	0.94	26
kidneybeans	1.00	1.00	1.00	33
lentil	1.00	1.00	1.00	42
maize	1.00	1.00	1.00	30
mango	1.00	1.00	1.00	29
mothbeans	1.00	1.00	1.00	29
mungbean	1.00	1.00	1.00	26
muskmelon	1.00	1.00	1.00	28
orange	1.00	1.00	1.00	33
papaya	1.00	1.00	1.00	26
pigeonpeas	1.00	1.00	1.00	23
pomegranate	1.00	1.00	1.00	28
rice	0.94	0.97	0.96	34
watermelon	1.00	1.00	1.00	22
accuracy			1.00	660
macro avg	1.00	1.00	1.00	660
weighted avg	1.00	1.00	1.00	660

FIGURE 5. **Classification report**

Final Classification report for the crop prediction model using a Gaussian Naïve Bayes algorithm with an accuracy of 99.54%.

Above plot used to check for outliers in various temperature values in dataset. A boxplot displays the distribution of a data using quartiles. The box represents the middle 50% of the data, with the median value *(the value that separates the top 50% from the bottom 50%)* shown as a horizontal line within the box.

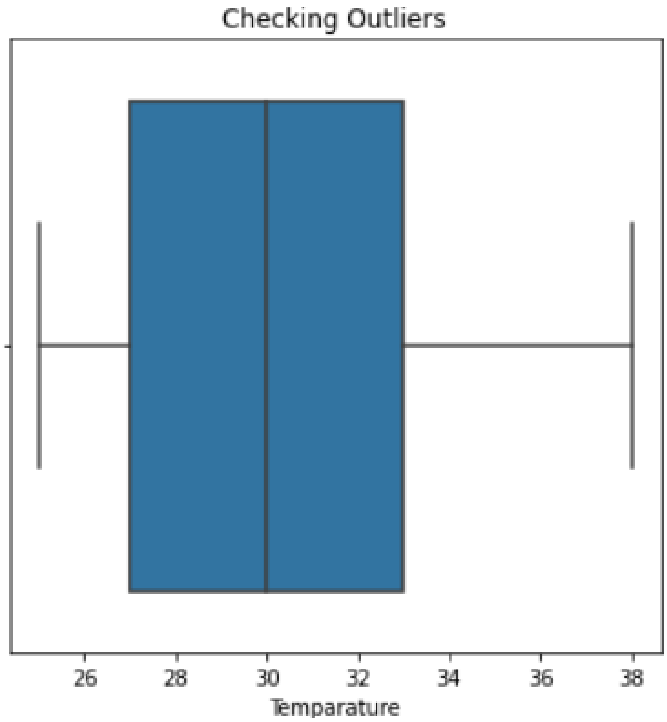

FIGURE 6. **Boxplot**

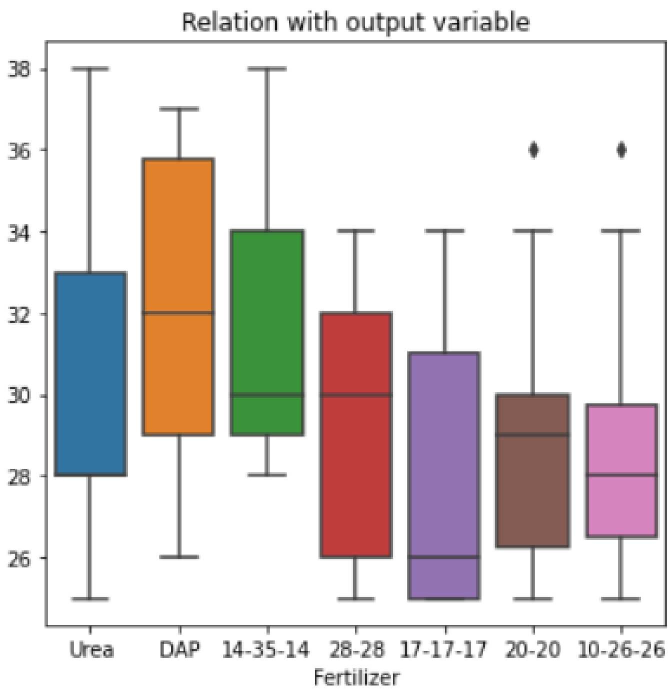

FIGURE 7. **Boxplot for two columns**

The above box plot represents the variations of temperature for each fertilizer type.

Label encoding is done for crop type(string) column. label encoding is a technique used to convert

Original	Encoded
Barley	0
Cotton	1
Ground Nuts	2
Maize	3
Millets	4
Oil seeds	5
Paddy	6
Pulses	7
Sugarcane	8

FIGURE 8. Label encoding

categorical variables into numerical variables that can be used in a machine learning algorithm.

	precision	recall	f1-score	support
10-26-26	1.00	1.00	1.00	1
14-35-14	1.00	1.00	1.00	4
17-17-17	1.00	1.00	1.00	5
20-20	1.00	1.00	1.00	5
28-28	1.00	1.00	1.00	9
DAP	1.00	1.00	1.00	7
Urea	1.00	1.00	1.00	10
accuracy			1.00	41
macro avg	1.00	1.00	1.00	41
weighted avg	1.00	1.00	1.00	41

FIGURE 9. Classification report

Final classification report for fertilizer prediction model using Random forest classifier algorithm with an accuracy of 100%.

The algorithms which are used for the crop recommendation are Decision Trees , KNN and Gaussian Naïve Bayes with accuracy of 98.63%, 98.33%, 99.54% respectively. For a fertilizer recommendation we used Decision Trees , KNN and Random Forest with accuracy of 97.56%, 95% and 100% respectively.

4. Conclusion

The suggested approach assists farmers in selecting the appropriate crop and fertilizer by delivering insights that regular farmers must keep track of, reducing crop failure and boosting output. It also keeps them from losing money. Together with these projects, we want to integrate leaf disease detection in the future to benefit farmers.

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