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Crop Yield and Fertilizer Recommendation Using Machine Learning

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Abstract- It's no secret that the vast majority of India's 1.2 billion people make their living in the agricultural sector. Farmers grow the same crops year after year without trying any new types, and they use fertilizer in arbitrary amounts, often without realizing that they aren't using nearly enough of it. Soil acidity and damage to the soil's upper layer are two more consequences. Therefore, we developed the system with the use of machine learning algorithms to help farmers. Our system can determine the best crop to grow in a given area by analyzing the soil and weather. The system also provides information on the types and quantities of fertilizers and seeds that should be used. As a result, our technology can help farmers cultivate alternative crops, perhaps increase their profits, and lessen the risk of soil pollution.

Keywords- Agriculture, Yield Prediction, Machine learning, Support Vector Machine, Random Forest, Soil Nutrients.

I. INTRODUCTION

Agriculture is high on the list of important occupations in India. It's vital to the country's development as a whole and boasts the greatest variety of businesses. More than 60% of the land is used for agriculture to support the country's population of 1.3 billion. As a result, adopting cutting-edge agricultural technology is essential. Our country's farmers will be guided towards economic prosperity [1].

Predictions of past harvests and yields were made using the collective wisdom of the farmers in a certain region. Since they aren't well-versed in the subject of soil nutrients like nitrogen, phosphate, and potassium, they tend to favor the more well-established or trendy crop in the area. As things are, yields are low, soil pollution (acidity) is rampant, and the top layer is being damaged since crop rotation is not being implemented and the soil is not getting enough nutrients. We created the solution using machine learning to address these concerns and perhaps improve the farmers' predicament.

The use of machine learning (ML) is changing the agriculture sector in profound ways. New opportunities for data-intensive science in the interdisciplinary field of agritechnology have emerged because of the development of artificial intelligence (AI), which encompasses machine learning, big data, and high-performance computing.

In the context of agriculture, for example, machine learning is not some mysterious trick or magic, but rather a set of well-defined models that collect specific data and use specific methodologies to anticipate results [7]. The optimal crop for a given piece of land, as determined by the system. dependent on weather conditions such precipitation, temperature, humidity, and soil pH.

The data comes from V C Farm Mandya, the government's website, and the meteorological service. Sensors collect information from farmers or other sources, like pH, humidity, and temperature. Two examples of machine learning prediction algorithms that take all of the input data and utilize it to detect patterns and then process the data according to the input criteria are Support Vector Machine (SVM) [5] and Decision Tree [6]. The approach advises the farmer on what to grow and how much of certain nutrients to put in the soil. The system also shows the current market price of the crop, the expected yield in q/acre, and the amount of seed required for cultivation in kg/acre.

For a small field of area, the traditional model with data from manual surveys and historical knowledge of earlier years is useful, but it is challenging to predict for bigger regions or countries. Data collection, processing, and storage have become more effective because to recent technological advancements. The agriculture industry is expanding quickly, necessitating new processing techniques that can handle complicated data. With regard to crop categorization and crop production prediction, machine learning (ML) has demonstrated its powerful performance in data and agricultural investigation [11].

Data analysis and machine learning (ML) together create opportunities for better understanding and reconnaissance of the agricultural area. Tom Michael claims that ML is a collection of computer instructions that gains knowledge from prior experience related to the task, is measured based on that performance and the task, and gets better with experience and task [2].

According to Samuel, machine learning (ML) is a scientific field of study that gives machines the ability to learn without being explicitly programmed. In numerous

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domains, including bioinformatics [3], anatomy [4], cheminformatics [5], economics [6], robot locomotion [7], speech recognition [8], information retrieval [9], and neuroscience [2], machine learning has been widely utilized throughout time. Predictions made using ML approaches allow farmers to plan ahead by reducing the impact of noisy data and illuminating non-linear relationships [2].

Because the algorithms get more efficient as the amount of input data increases, ML can handle enormous amounts of data and generate insightful results.

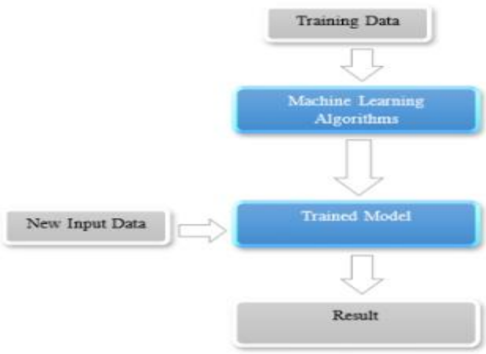

Fig 1. data and generate insightful results.

1. Machine Learning Approach:
Crop yield, sometimes referred to as agriculture production, is crucial to meeting the demands of the expanding population and machine learning (ML) is frequently used to identify and predict the yield. Agriculture crop output or productivity depends on a variety of variables, including the weather, the state of the soil, the water, the temperature, the amount of rainfall, and the algorithm that is used. Machine learning techniques are used for categorization and prediction in different ways. Regression is one of the most often used ML algorithms for predicting the dependent variable or output variable. Regression methods are used to determine the relationship between the independent variables—rainfall, temperature, and area—and the dependent variable—crop yield. Although the statistical information used to estimate agricultural yields is made available for research purposes, it has some restrictions. The significance of the remote sensing data increases in predicting agricultural productivity.

II. SYSTEM STUDY

1. Existing System:
Agriculture is high on the list of important occupations in India. It's vital to the country's development as a whole and boasts the greatest variety of businesses. More than 60% of the land is used for agriculture to support the country's population of 1.3 billion. As a result, adopting cutting-edge agricultural technology is essential. Our country's farmers will be guided towards economic prosperity [1]. Predictions of past harvests and yields were made using the collective wisdom of the farmers in a certain region.

2. Disadvantages:
- High cost.
- Man power required.

3. Processed System:
The suggested technique predicts the optimal crop for a given plot of land by analyzing soil composition in addition to climatic factors such as temperature, humidity, soil PH, and rainfall.

4. Advantages:
Our technology will advise you on the best crop to grow in a certain area of land based on the specifics of the soil and the weather.More precise.

III. PROPOSED WORK

The aim of the proposed system is to help farmers to cultivate crops for better yield. The crops selected in this work are based on important crops from selected locations. The selected crops are Rice, Jowar, Wheat, Soyabean, and Sunflower, Cotton, Sugarcane, Tobacco, Onion, Dry Chili etc. The dataset of crop yield is collected from the last 5 years from different sources. There are 3 steps in proposed work.

1. Soil Classification:
Soil classification can be done using soil nutrients data. Two Machine learning algorithms used for soil classification are Random Forest and Support Vector Machine. The two algorithms will classify, and display confusion matrix, Precision, Recall, f1-score and average values, and at the end accuracy in percentage as output.

2. Crop Yield Prediction:
Crop Yield Prediction can be done using crop yield data, nutrients and location data. These inputs are passed to Random Forest and Support Vector Machine algorithms. These algorithms will predict crops based on present inputs.

3. Fertilizer Recommendation:
Fertilizer Recommendation can be done using fertilizer data, crop and location data. In this part suitable crops and required fertilizer for each crop is recommended. · Third Party applications are used to display Weather information, Temperature information as well as Humidity, Atmospheric Pressure and overall description.

4. Linear Regression:
The machine learning methods used for predictive analysis that involve regression are the simplest. The training

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dataset for the regression method is (x1,y1), (xi,yi), etc. * Here, f(x) is the function that locates the input pattern space and determines the training data-optimizing function.

In the literature, regression models are recommended for forecasting the man-hours-measured effort of software projects. On the training data, a line of separation is found to maximize the squared error summation. 2011 (Pedregosa).

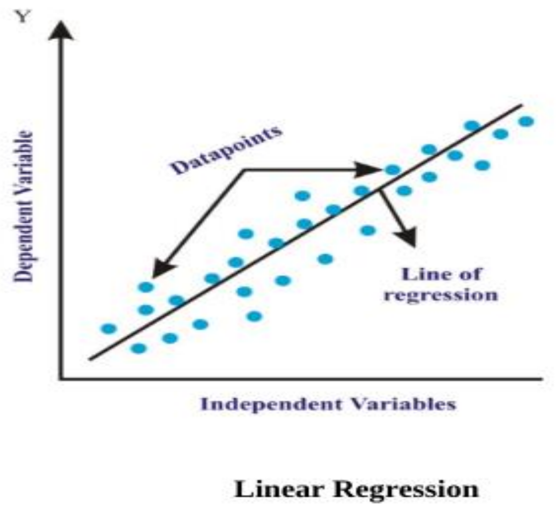

Fig 2. **Text Here Your Fig Title.**

5. Logistic Regression:
Logistic regression is used when the target variable's values are binary. It makes use of the sigmoid function, a logistic function with a value range of 0 to 1. Thus, we may conclude that when there is linearly separable data, logistic regression performs better. Furthermore, since no parameter adjustment is necessary, training the model based on logistic regression is quite simple. 2018 (Cournapeau).

IV. METHODOLOGY

The implementation can be done in two steps:
- Dataset collection and pre-processing
- Building the Model

In the first step, data is collected from Kaggle. There are 1600 datasets. So select anyone's dataset, or we can take the dataset from the district agriculture college or any government agriculture organization.

The features considered in the dataset are calcium (Ca), magnesium (Mg), potassium (K), sulphate (S), nitrogen (N), lime (L), carbon (C), phosphorus (P), moisture (M), and target (class). Depending on the soil type, or taking into account the weather in that area, as well as which village or its soil properties based on the crops, are divided into four classes or "targets." After data collection, data preprocessing is done by removing redundant and missing values and replacing the null values. Because data is not always ready for analysis, it must undergo some processing, which is completed in the data preprocessing setting.

V. CHALLENGES AND CONSIDERATIONS

1. Data Quality:
Ensuring accurate and up-to-date data is crucial for building reliable models.

2. Feature Selection:
Identifying the most relevant features (variables) that affect crop yield and fertilizer requirements is a critical step.

3. Model Complexity:
Different algorithms might perform differently based on the complexity of the data and relationships.

4. Interpretability:
In some cases, it's important to have interpretable models that can provide insights into the reasoning behind predictions.

5. Generalization:
Models should be able to perform well on new, unseen data (future crop seasons).

VI. DATA SOURCES

The success of these machine learning applications relies heavily on the quality and quantity of data. Data sources often include historical crop yield data, weather data, soil samples, satellite imagery, and even data collected from sensors deployed in the field. Integrating various data sources can provide a more comprehensive picture of the factors influencing crop growth and yield.

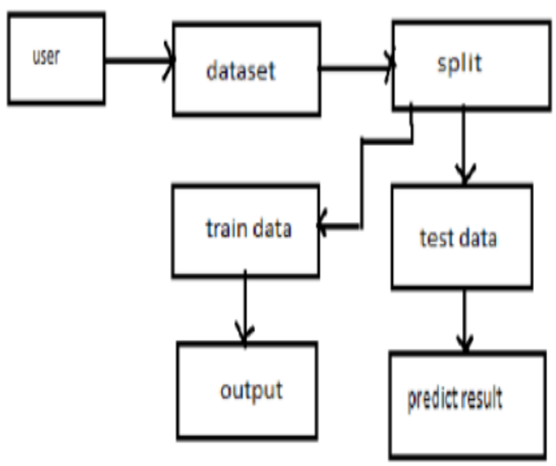

Fig 3. System Architecture Diagram.

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VII. RESULTS

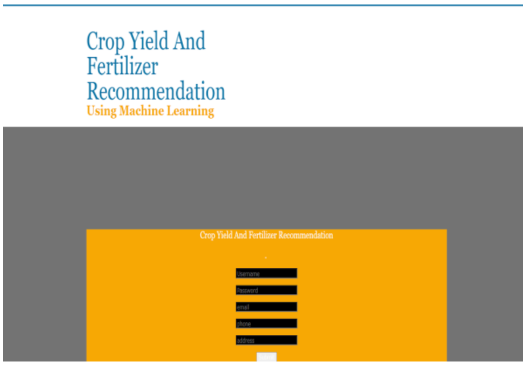

Fig 4. Register page.

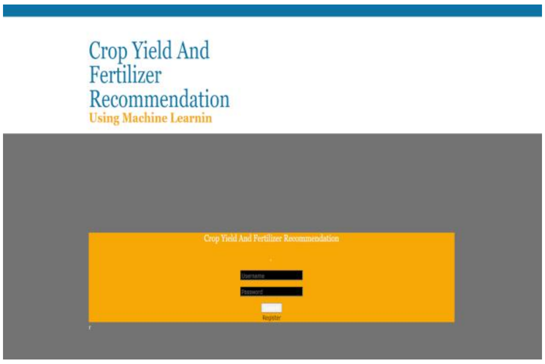

Fig 5. Login page.

Fig 6. Main page.

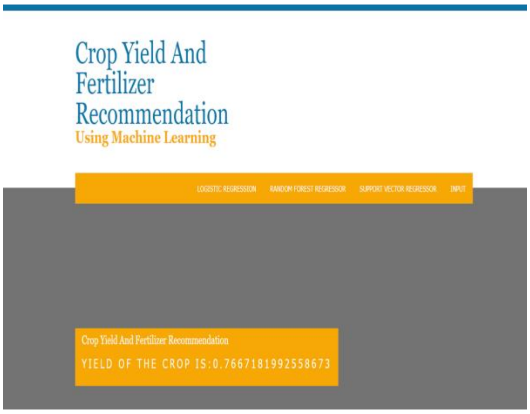

Fig 7. Predictions.

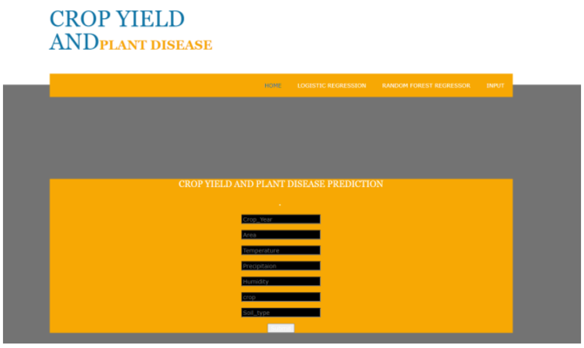

Fig 8. Inputs.

VIII. EXPERIMENTAL OUTCOME

Taking into consideration characteristics like annual rainfall, temperature, humidity, and soil pH, the proposed method recommends the best crop for a given plot of land. While the system can automatically forecast one of these features (annual rainfall) using historical data and the SVM algorithm, the other features require human intervention.

The input area's NPK levels are used to determine the suggested crop's required NPK, crop suitability, seeding rate per acre, market price, and estimated yield.

IX. CONCLUSION

As things stand, our farmers aren't making the most of available data and technology, which increases the risk that they'll grow the incorrect crop and reduces their income. We've developed a farmer-friendly system with a GUI to determine which crop is best suited for a given piece of land, as well as details about the necessary nutrients, seeds, cultivation methods, expected yield, and market price.

As a result, this motivates farmers to be strategic in their crop selection, which ultimately boosts the agricultural industry through innovation. Prospectively, we can predict harvests with no more information collection beyond supplying GPS coordinates for a plot of land and obtaining access to the government's rain predicting system. To avoid both food scarcity and excess, we can design a model.

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