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Optimizing Yield with Machine Learning and IoT in Smart Farming: Precision agriculture

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Abstract—

In nations such as India, the primary occupation remains agriculture. It continues to support India's economic expansion as a major source of income in a number of states. Even with the farmers' best efforts, crop productivity is known to be disrupted by a few factors, including pests, rainfall, unpredictability in the weather, and poor soil. Precision agriculture, which promises a higher yield but also helps farmers monitor their crops, makes decisions, and automates various agricultural processes, is made possible by technologies like machine learning and the internet of things. This study aims to assess soil fertility, forecast rainfall, and identify the optimal environmental conditions for popular cereals cultivation ensuring a higher yield.

Keywords—Machine Learning, IoT, Linear Regression, Random Forest, SVC, Precision Agriculture,

I. INTRODUCTION

Agriculture is the main industry in India, and it is currently in dire need of intelligence due to the projection that there will be 9.5 billion people on the earth by 2050, meaning that more agricultural production would be needed to feed everyone. It is sad to hear that a tiny number

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of farmers commit suicide as a result of their crops failing. The concept of precision agriculture involves using automation to manage farms and developing a helpful decision support system for various farming operations. The primary goal is to maximize returns on input. Precision farming has improved farming practices by utilizing cutting-edge technologies such as the internet of things and machine intelligence.

By guaranteeing that farmers can fulfill their daily needs, these technologies enable them to more effectively meet the world's food demands. Fig. 1 illustrates the connection between IoT, machine learning, and smart farming. Climate conditions and weather patterns can be predicted, and sensors are available to gather data on soil temperature and acidity. Farmers can remotely keep a careful eye on their equipment and crops. Important information about agricultural diseases and pests, soil fertility and nutrition, etc., can be gathered. This data collecting is only the beginning—it is not the end. The next stage is to determine what to do with the data and how it will help with smart farming. Many analyses are conducted using the gathered data, taking into account numerous important elements that influence crop production and enhance total crop productivity.

Fig 1. Smart Farming through IoT and ML

A . Factors influencing Agriculture

It is crucial to realize that a number of different elements, when concentrated upon, lead to the ultimate success, or yield. Here are a few elements that have a significant impact on agriculture:

Fertility of soil: The elements that make up soil include calcium, magnesium, sulfur, nitrogen, and other essential additional minerals that aid in the growth of crops. Crop to crop may differ in these elements' soil composition. The specialists in agroeconomics gather precise samples in order to assess the nutrient content and determine whether it is sufficient for growing a specific crop type or if there are any inadequacies.

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Climate: An ideal climate is necessary for the cultivation of crops. In this instance, temperature, humidity, wind, and rainfall are all important factors. The unpredictable weather and changing environment may have an effect on crop yield.

Water availability: The act of watering crops, or irrigation, has an impact on crop productivity as well. Rainfall that falls too little or too soon has an impact on the irrigation process overall. Farmers experience large losses as a result of these unpredictable rains. As a result, farmers kill themselves, taking lives with them.[4]

Disease management and pests: Pests have an impact on crop quality and pose a serious risk to agricultural production as a whole. Early detection of plant pests would greatly assist farmers in containing the infestation by helping them choose the right insecticides.[3] Pests can be identified by image processing, and pesticides or herbicides can be sprayed with guidance to manage the pests.

II Smart Farming through Machine Learning

Having identified a few areas that contribute to the overall crop quality and crop yield it is now necessary to implement smart farming with the usage of technologies like machine learning and IoT.

A generalized ML model should be used . The overall procedure is categorized into three major phases and depicted in Fig 3:

Phase 1: Data Collection: During this procedure, the data is collected from various sensors deployed in the field. The data collection is a continuous activity that occurs periodically.

Phase 2: Data Classification: The collected data is now classified according into well defined categories. For Ex. Soil fertility, soil moisture, rain fall, temperature are all belonging to various categories.

Phase 3: Data Processing and Decision making: This is the most vital phase where in Machine Learning Algorithm comes into operation and the collected data is input to the algorithm and the predictions are noted and based upon the accuracy , decisions are taken.

Fig 2: A Generalized ML Model for a smart Farming

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Machine learning is a significant component of artificial intelligence, which trains itself to not only adapt but also get better at it. It displays a distinct way of working. With this method, the algorithm is trained using the available data to create a model that allows for precise forecasting. ML-based sustainable agriculture is shown in Fig. 3. While machine learning is a subfield of artificial intelligence, it may be further divided into numerous subdomains, the more well-known being supervised learning and unsupervised learning.

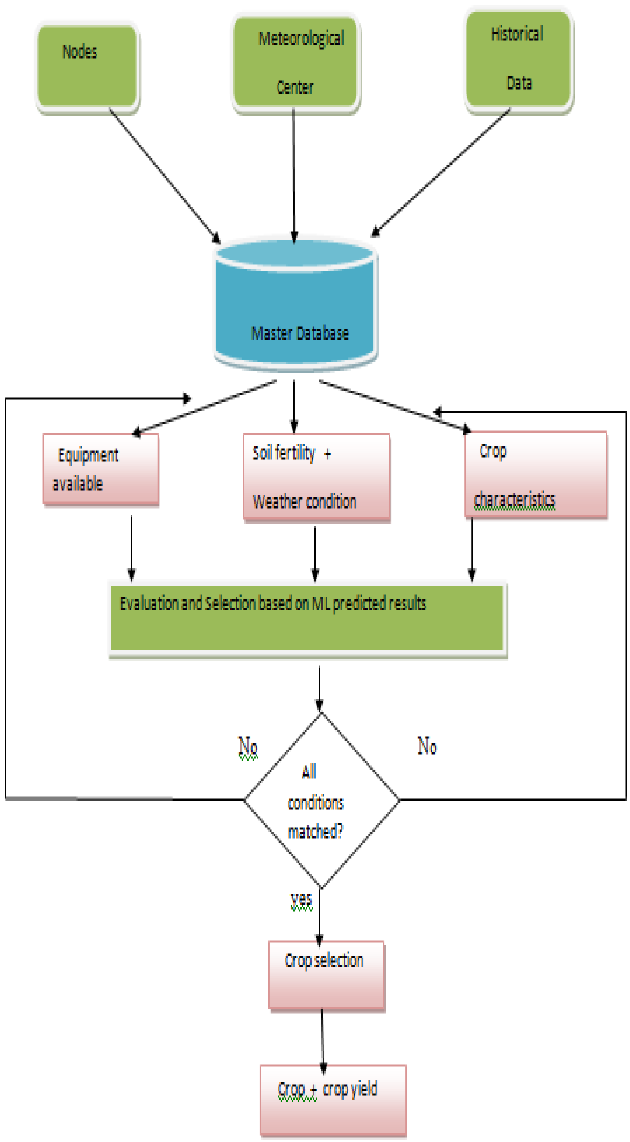

Fig 3. ML based sustainable Agriculture

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A. *Supervised learning:*

To clarify, this kind of learning is predicated on an understanding of the anticipated outcomes. The ultimate goal in this situation is to identify approximations and interoperational linkages between the training data's inputs and outputs. The primary attribute is that the input dataset is categorized and allocated to the group according to data properties and rules. On the other hand, choosing the right classification algorithms may be more difficult and dependent on how well the suggested mechanism works.

*B.*Unsupervised Learning:

Unsupervised learning develops models by taking advantage of the dataset's hidden patterns. The datasets have no previous labels, and the model looks for patterns in the data to enable grouping or finds similarities between the data. Therefore, dimension reduction, primary data analytics, and data pattern recognition are the main applications of unsupervised learning.[1]

III. ANALYSIS OF SOIL FERTILITY USING MACHINE LEARNING ALGORITHM FOR IDENTIFYING IDEAL CROP CULTIVATION AND BEST CROP YIELD

As was covered in section 1, a number of factors affect every crop's potential yield, the most significant of which is soil fertility. Using a variety of machine learning techniques, a comprehensive investigation is being conducted to examine the soil's fertility and nutritional supplementation. In order to determine the best soil and optimal environmental conditions for the cultivation of cereal crops like rice, rainfall prediction was also conducted. The following factors were taken into account in order to determine the ideal soil: components such as nitrogen, potassium, and phosperous are examined for in the soil. Predicting environmental factors like humidity and rainfall is also possible with a variety of machine learning methods, including SVC, Random Forest, Logistic Regression, and Linear Regression.

The results of the prediction are depicted in Fig 4.

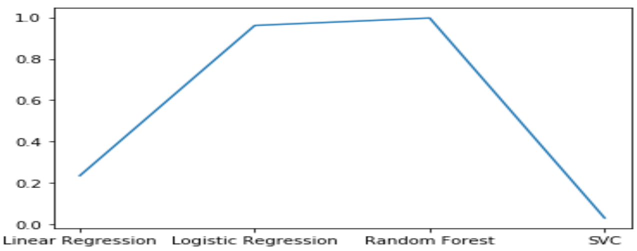

Fig 4. Ideal Rice cultivation environment as predicted by ML algorithms

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Sl.No	Algorithm	Accuracy
1	Linear Regression	0.2346
2	Logistic Regression	0.961
3	Random Forest	0.997
4	SVC	0.03

It can be further observed that the random forest model could predict and produce 99.7% accurate result. Given below in table 1 are the prediction accuracy and the algorithm that predicted that

IV. CONCLUSION

The population of our country is growing at an exponential rate, making it challenging to produce enough food and crops to feed everyone. Crop development and yield are impacted by the unpredictable nature of the weather as well as environmental elements including temperature, wind, and rain. The result of traditional farming being elevated to a new level through the use of IoT and machine learning technologies is precision agriculture. The optimal techniques needed for crop production are chosen with the farmer's help. Farmers can operate their machinery and crops remotely. It is possible to automate some processes, such as irrigation and pest control. The goal is to maximize agricultural productivity.

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