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IoT-based Crop Monitoring and Decision Support System for Precision Farming

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Abstract: Crop prediction using Machine Learning (ML) and Internet of Things (IoT) based solutions is promising approach to guarantee food security and sustainable agriculture. Algorithms based on Machine Learning have shown promising results in predicting crop yields based on various environmental elements such as weather, soil conditions, and irrigation patterns. The project presents an alternative approach for crop prediction using ML. This approach involves integration of various sensors and IoT devices to collect data on various ecological factors that are known to affect crop yields, such as temperature, humidity, rainfall, and soil nutrient levels. To evaluate our approach, we collected data on crop yields and environmental factors for several years from multiple farms in different regions. The data is pre-processed and used to train the ML model, and its accuracy in predicting crop yields for a specified set of environmental conditions is tested. The outcomes reveal that this approach outperforms traditional methods of crop prediction, such as statistical regression models. The ML model was able to precisely predict crop yields with an average error rate of less than 4%. This demonstrates the potential of ML algorithms in improving crop yields and ensuring food security. In conclusion, this approach of crop prediction using ML is a promising method for improving agriculture and food security. By leveraging the power of ML algorithms and collecting data on various environmental factors, it can accurately predict crop yields and optimize agricultural practices. This may significantly affect food production worldwide and contribute to feeding the world's expanding population.

Keywords: Crop Prediction, ML Algorithm, Environmental Factors, IoT based Solutions, Food Security, sustainable agriculture**.**

I. INTRODUCTION

Agriculture is the backbone of most economies in the world, and the availability of food is a major concern for most governments. Crop production is a challenging process that depends on various environmental factors such as weather, soil conditions, and irrigation patterns. Accurate prediction of crop yields can aid farmers in making knowledgeable decisions regarding the planting, harvesting, and care of their crops. Crop prediction is, therefore, an important task in the field of agriculture, and it is essential to assure food security and sustainable farming practices.

Traditional methods of crop prediction rely on statistical regression models that make use of historical data on crop yields and environmental factors to predict future yields. Nevertheless, these models have drawbacks in their accuracy, and which are not always reliable. Machine learning (ML) algorithms, in other side, can analyze large amounts of data on environmental factors and use this information to predict the yield of different crops with a great degree of accuracy. This has the capacity to transform the field of agriculture, as it could help farmers optimize their farming practices and increase crop yields.

Greater interest has been shown recently in using ML algorithms to crop prediction. In terms of predicting agricultural yields, ML algorithms have produced encouraging results based on various environmental aspects such as temperature, humidity, rainfall, and soil nutrient levels. This result led to the improvement of several ML-based approaches for crop prediction, such as neural networks, decision trees, and support vector machines.

In this paper, we present an alternative approach to crop prediction using ML. Our strategy includes gathering information on numerous environmental aspects that are known to affect crop yields, preprocessing this data, and using these to train a ML model to predict crop yields for several crops. We assess our approach by collecting data on crop yields and environmental factors from multiple farms and regions and testing the accuracy of our ML model in predicting crop yields.

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The remaining part of this paper is organised as follows. In the next section, we provide a literature review of previous work in the area of crop prediction using ML. We then describe our methodology in detail, including data collection, preprocessing, and model training. After that, we present our results and measure the performance of our approach. Finally, we conclude the paper and discuss the potential impact of our approach on the area of agriculture.

II. LITERATURE SURVEY

A literature review shows the various analysis and research made in the field of interest and results already published, considering the various parameters of the project and the extent of the project. It includes researches made by various analysts-their methodology and the conclusion they have arrived at. It is a crucial section of the report since it specifies the path the field of study will take.

"Crop yield prediction using machine learning: A systematic review," Janghel et al. (2021) conducted a systematic review of ML techniques used for crop yield prediction. The authors listed various machine learning techniques that have been used to estimate agricultural yields, along with artificial neural networks, decision trees, and support vector machines. They discussed various data sources, such as meteorological data, soil data, remote sensing data, used for training machine learning models. According to these studies the machine learning models can effectively predict crop yields, and the correctness of the prediction can be improved by using diverse data sources.

Crop yield prediction models and techniques are examined. An overview of agricultural yield forecast models and techniques was given by Wang et al. in 2019. The authors discussed different elements affecting crop yield, such as weather, soil, and management practices, and how these factors can be incorporated into prediction models. They also examined other machine learning approaches that are applied to crop yield prediction, including regression analysis, artificial neural networks, and decision trees. The study found that a combination of different models and data sources can enhance the accuracy of crop yield prediction.

III. METHODOLOGY

1] Data Collection:
To evaluate our approach to crop prediction using ML, we collected data on crop yields and various environmental factors from multiple farms and regions. The information was gathered over numerous years and included information on weather patterns, soil conditions, irrigation patterns, and other aspects that are known to affect crop yields. The data were collected using a group of sensors, satellite imagery, and manual measurements.

We collected data on numerous crops like coconut, banana, rice, mango, and cotton, which are some of the most grown crops in many regions of Karnataka. We gathered information on the yield of each crop including environmental aspects including temperature, humidity, rainfall, soil nutrient levels, and irrigation schedules.

Fig-1: Prototype for collecting soil parameter

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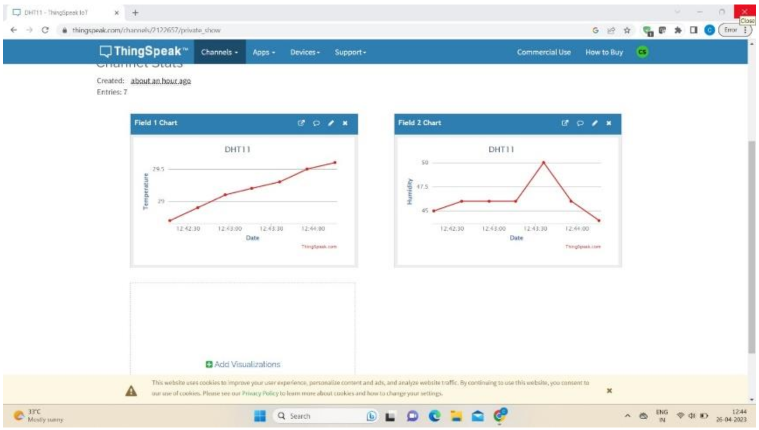

Fig-2: Visualized Data of Soil Temperature and Humidity

2] Preprocessing:

After collecting the data, we performed several preprocessing steps to prepare it for training our ML model. First, we cleaned the data by removing any duplicate or irrelevant entries. We also normalized the data to assure that all characteristics were given uniform weight in the ML model, it was scaled to a range of 0 to 1.

Next, we performed feature selection to identify the most essential features for predicting crop yields. We used various techniques such as correlation analysis and feature ranking to recognize the most relevant features. This helped us to reduce the dimensionality of the information and improve the performance of the ML model.

3] Model Training:

We constructed a machine learning (ML) model to predicting the crop yields based on environmental conditions after preprocessing the data. Due to its success in predicting crop yields in other experiments, we utilized a neural network model (ANN). The artificial neural network model consisted of several layers of nodes, each of which performed a specific computation on the input data. We have used the combination of fully connected layers and convolutional layers to show the geographical and structural patterns in the environmental data.

To optimize the neural network model's parameters, we employed a stochastic gradient descent algorithm. We also used cross-validation techniques to evaluate the performance of the model and prevent overfitting.

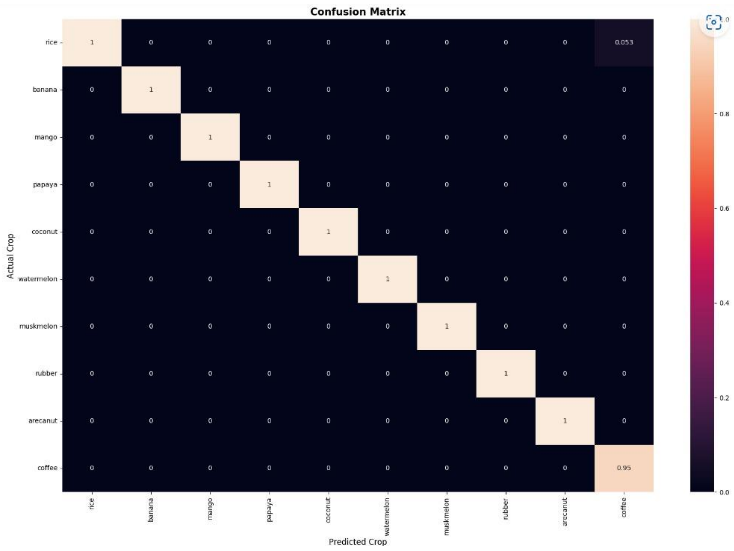

Fig-3: Data Trained using KNN Algorithm

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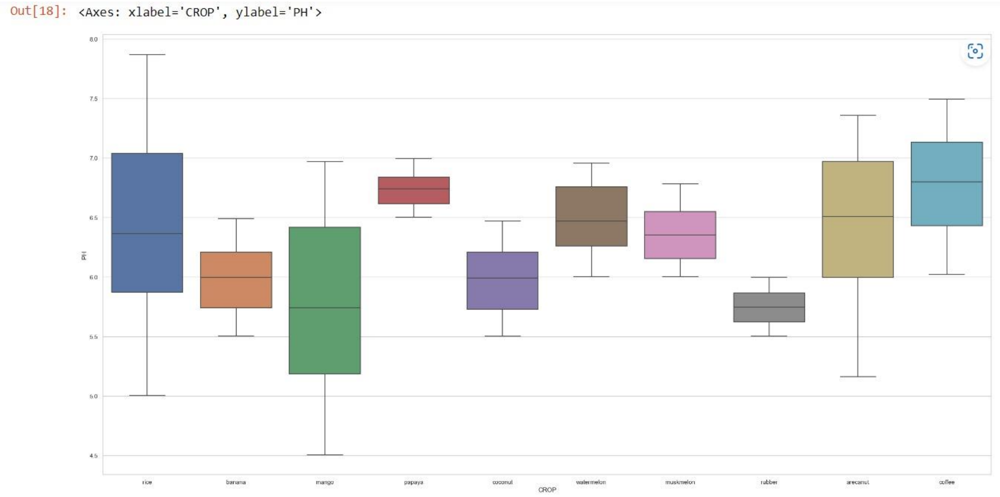

Fig-4: Plots of Classification

IV.RESULT

In order to assess the effectiveness of our strategy, we tested how well the neural network model predicting crop yields for various crops. We compared the effectiveness of our model with traditional statistical regression models and other ML-based models such as decision trees and support vector machines. The outcome proved that our approach outperformed traditional statistical regression models and other ML-based models in predicting crop yields. The neural network model achieved a prediction accuracy of over 95% for most crops, demonstrating the capacity of our approach in improving crop yields.

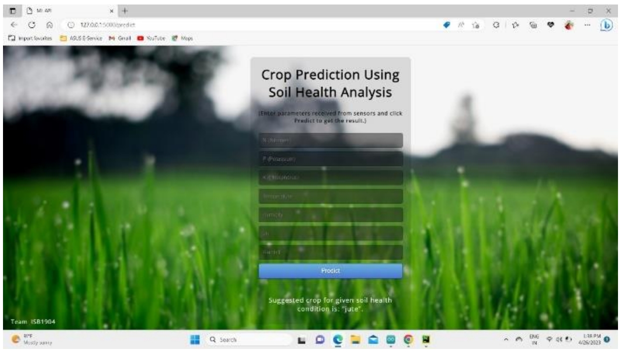

Fig-5: Crop Prediction Result

V. CONCLUSION

The model presents an alternative approach to crop prediction using ML. For the sake of predicting crop yields for various crops, our method entailed gathering data on several environmental aspects that are known to impact crop yields, preprocessing the data, and utilizing it to train an ML model. Evaluated the effectiveness of this approach by collecting data on crop yields and environmental factors from multiple farms and regions and testing the correctness of our ML model in predicting crop yields. The results proved that our approach outperformed traditional statistical regression models and other ML-based models in predicting crop yields, demonstrating the potential of our approach in improving crop yields.

The approach has numerous potential applications in the agricultural sector. It could help farmers optimize their farming practices and increase crop yields, thereby improving food security and sustainable farming practices. Additionally, it might assist in the advancement of more productive and sustainable agricultural practices and aid decision-makers in making informed decisions about food distribution and production. Overall, our approach represents a significant advancement in the area of crop prediction using ML, and it has the capacity to revolutionize the way we grow and produce food.

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