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Crop Yield Prediction System-An Interactive System to Predict Crop Yield along with Profit & Loss to Help Farmers using Deep Learning

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Abstract: *In India, agriculture is the main occupation. It the primary source of income of the population. 60% of the population is dependent on agriculture related to employment. Thereby, agriculture is considered as the backbone of the country and helps in economic growth. Agriculture is a primary sector occupation and provides raw materials to secondary sector which includes food factories, textile industry, food security, etc. So, agricultural productivity is largely dependent to increase the economy of the country, leading to the business growth and provide employment to most of the population. Productivity largely depends on climatic factors and environmental conditions such as rainfall, temperature, humidity, soil type, etc. Due to unfavourability, the crop yield production gets affected thereby harming the economy. Using appropriate machine learning models helps to predict the crop yield considering climatic conditions. This paper is based on three algorithms viz. polynomial regression i.e., linear regression, support vector regression and random forest regression. These algorithms will help in suitable crop selection to grow.The selecting of crop is very important because it will provide us the most productivity hence increasing profit. This research work will help the farmers and producers increase the productivity and boost the economy report*

Keywords: Agriculture, ANN, LSTM, Economy, Productivity, Machine Learning Algorithms, Predict Crop Yield

I. INTRODUCTION

Crop Yield Prediction System is a solution to major problems faced by farmers in India, such as unpredictable weather, fluctuating markets, and lack of knowledge about the best soil for crops and soil health. It is a platform designed specifically to assist Indian farmers in making informed decisions. It consists of four modules that provide a comprehensive toolkit for agriculture. The Soil Research Module uses advanced soil science findings to evaluate soil health, nutrient profiles, and composition. By incorporating a pH sensor, farmers can accurately measure soil pH levels, which are crucial for determining soil fertility and nutrient availability. This datadriven approach improves crop selection, soil management, and resource allocation, promoting sustainable agricultural practices. The Weather Forecasting Module offers detailed insights into climatic patterns, helping farmers adapt their agricultural practices for optimal productivity. Through data collection, analysis, and modelling, farmers receive recommendations for mitigating weather-related risks and maximizing crop yields. The Crop Resource Dynamics Module focuses on the specific resource requirements of different crops, taking into account factors such as soil type, climate, weather patterns, and crop health. By utilizing data analytics and machine learning algorithms, it provides accurate predictions and recommendations for resource allocation, irrigation, fertilization, and pest management. As a result, there are less waste and greater yields. The Price Prediction/Market Module concentrates on predicting crop prices in the Mumbai Vashi Market. It analyses historical data, market demand and supply, weather patterns, government policies, and global trends to provide reliable price predictions. This can help farmers in making knowledgeable choices regarding their crops. These modules empower farmers with knowledge and insights to optimize profitability, reduce risks, make better

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decisions, and increase efficiency in their agricultural operations. Crop Yield Prediction System is committed to providing unbiased and positive responses, demonstrating its dedication to empowering farmers and promoting sustainable agricultural practices for a brighter future.

Agricultural farming is one of the most important and required actions that must be carried out in order to provide food and other nourishment to the rising population. Several agrarian nations rely largely on crop production to ensure their subsistence and promote commerce. The dependence on agriculture has been important for a nation's development and advancement, since a well-fed and healthier population has a far higher life expectancy and profitability than a country with subpar production and nutrition supply. India is primarily an agricultural country, with agriculture accounting for a substantial portion of its trade. The agricultural process is a complicated activity that does not permit for exact prediction of crop production. Without proper production projections, the farmer cannot plan efficiently, which might result in unanticipated losses. As a result, there is a requirement for an effective technique for predicting agricultural yields along with the profit and loss using machine learning methodologies. To forecast agricultural yield, the suggested method employs artificial neural network, LSTM Neural network and Hybrid model. The given approach has been thoroughly investigated and found to significantly increase crop production prediction engine performance over previous methodologies.

II. LITERATURE SURVEY

For our project we are surveying some reports and references which are helping us to make it easy and simplest and they are as follows

Fuzzy Logic based Crop Yield Prediction using Temperature and Rainfall parameters predicted through ARMA, SARIMA, and ARMAX model (2019).

Authors: Shivam Bang.

Description: The paper discusses a fuzzy logic-based approach to predicting crop yield, specifically utilizing temperature and rainfall as key parameters. It explores the application of various time series forecasting models, including Autoregressive Moving Average (ARMA), Seasonal Autoregressive Integrated Moving Average (SARIMA), and Autoregressive Moving Average with Exogenous Inputs (ARMAX). By integrating fuzzy logic with these models, the study aims to enhance the accuracy of crop yield predictions by effectively handling the uncertainty and variability in climate data.

Advantages: Multiple models for better accuracy in predicting temperature and rainfall. Fuzzy logic for flexible yield prediction, accommodating uncertainties. Simplified input requiring only temperature and rainfall data for predictions.

Limitations: The error in predicted rainfall data does not cause problems as long as the difference between actual and estimated values is not drastic.

Agriculture Soil Analysis for Suitable Crop prediction Vishal Kumar, Raushan Kumar, Shubham Kumar, Ajinkya, Prof. P. P. Jorvekar Computer Department, NBN Sinhgad School of Engineering Pune(2021) .

Authors: Prof. P. P. Jorvekar

Description: The paper "Agriculture Soil Analysis for Suitable Crop Prediction" discusses how supervised machine learning can be used to analyze soil properties to predict suitable crops. It examines key soil factors, including pH, moisture, and nutrients, and their effects on crop yield. The authors employ algorithms such as Decision Trees, Random Forest, and Support Vector Machines to develop predictive models. The goal is to help farmers choose the right crops based on soil conditions, ultimately improving agricultural productivity and sustainability. The research highlights the importance of data-driven methods in modern farming practices.

Advantages: The system simplifies and accelerates the soil analysis process.

Limitations: It only considers temperature and rainfall, ignoring other critical factors like soil quality and pests.

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Supervised Machine learning Approach for Crop Yield Prediction in Agriculture Sector (2020).
Authors: Y. J. N. Kumar
Description: The paper presents a supervised machine learning approach for predicting crop yield in the agriculture sector. It outlines the use of various machine learning algorithms, such as Linear Regression, Random Forest, and Support Vector Machines, to analyze historical agricultural data, including factors like soil quality, weather conditions, and farming practices.
Advantages: High Accuracy: The Random Forest algorithm improves the precision of crop yield predictions.
Limitations: This research work can be enhanced to the high level by building a recommender system of agriculture production and distribution for farmer.

In [4] J.P. Singh, Rakesh Kumar, M. P. Singh, and Prabhat Kumar, have concluded that the research work done by them helps in perfectly improving the yield rate of crops by applying some classification methods and comparing the parameters. We can also do analyzing and prediction of crops using Bayesian algorithms. The algorithms used in their research work are Bayesian algorithm, K-means Algorithm, Clustering Algorithm, Support Vector Machine. The disadvantage is that there is no proper accuracy and performance.
P.Priya et al. [5], focuses more on supervised learning methods like random forest classifier and decision tree classifier. Here, the datasets considered consists of rainfall, perception, production, temperature, and a number of decision trees by including more than half of the records in the datasets. The application of decision trees on the remaining records takes place for increase in accuracy rate after classification. From this paper, we came to know that assembling of decision tree with RF may give better results with more accuracy. Limitation: Can use more complex algorithms for assembling.
Arun Kumar et al. [6] highlight the weightage of Support Vector machine algorithm in the crop yield estimation. Crop yield is performed to categorize based on yield productivity and class labels. The parameters considered are, variation of crop yield with rainfall, variation of humidity factor and the impact of climatic change on agriculture. ARIMA model is also used to operate on data with time series. Limitation: Less parameters are taken into consideration and Time series Analysis may give less accuracy than ensemble techniques.
In [7] the authors Subhadra Mishra, Debahuti Mishra and Gour Hari Santra, have concluded that this is an advanced researched field and is expected to grow in the future. The integration of computer science with agriculture helps in forecasting agricultural crops. This method also helps in providing information of crops and how to increase yield rate.

III. ALGORITHM

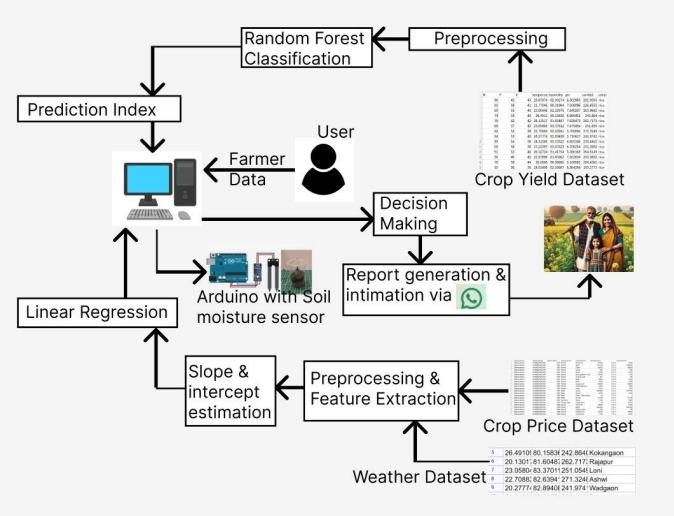

Fig. 1.Algorithm

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Linear Regression:

Linear Regression is one of the machine learning algorithms which based on supervised learning method and regression task is performed by it. Regression model helps to get a target prediction value which is based on independent variables. Mostly, it is used to find the relationship between variables and forecasting. Different regression models differ based onthe kind of relationship between independent and dependent variables and the number of independent variables being used. The task to predict a dependent variable (y) based on a given independent variable (x) is performed by linear regression. So, this regression technique is used to find a linear relationship between x (input) and y(output). Therefore, the name is Linear Regression. Hypothesis function for Linear Regression:$y = \theta 1 + \theta 2$

Working of Linear Regression Algorithm:

Linear Regression is a machine learning algorithm used for predicting a continuous target variable based on one or more predictor variables. It works by finding a linear relationship between the predictor variables and the target variable. Here's how it works:

1. **Data Pre-processing:** The data is pre-processed by scaling and normalizing the features to ensure that they have similar ranges.
2. **Model Training:** A linear equation of the form $y = mx + b$ is fitted to the training data, where y is the target variable, x is the predictor variable, m is the slope or coefficient, and b is the intercept. The model tries to find the values of m and b that best fit the data.
3. **Cost Function Optimization:** A cost function is defined to measure the difference between the predicted values and the actual values. The goal is to minimize the cost function by adjusting the values of m and b. The most common cost function used in linear regression is the mean squared error (MSE).
4. **Model Evaluation**: The model is evaluated on a separate test dataset to measure its performance. Common metrics used to evaluate a linear regression model are the coefficient of determination (R^2), mean squared error (MSE), and root mean squared error (RMSE).
5. **Prediction**: Once the model is trained, it can be used to make predictions on new data by applying the linear equation to the predictor variables.

Linear Regression has several advantages over other regression algorithms:

- It is simple.
- Easy to implement.
- It provides interpretable results, as the coefficients of the predictor variables can be used to understand the relationship between the variables and the target variable.
- It can handle both categorical as well as continuous predictor variables.
- It can be used for both simple and complex regression tasks.

Random Forest Algorithm:

Random Forest Regression is one of the supervised machine learning algorithms which makes use of ensemble learning method for regression. The predictions made by different machine learning algorithms are combined to make a more accurate prediction rather than using a single model. This technique is called ensemble learning method.

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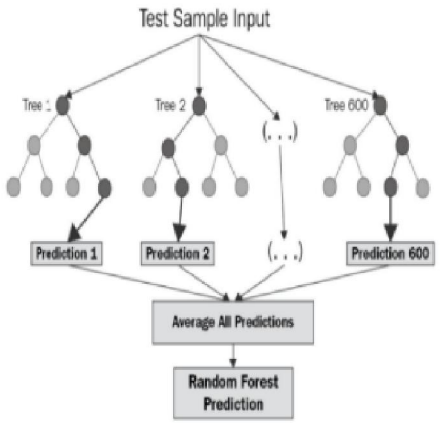

Fig. 2.Random Forest Algorithm

The structure of a Random Forest is shown in the above diagram. There is no interaction among the trees as they run in parallel. During training time, the Random Forest operates by constructing several decision trees and outputs the mean of the prediction of all the trees.

IV. METHODOLOGY

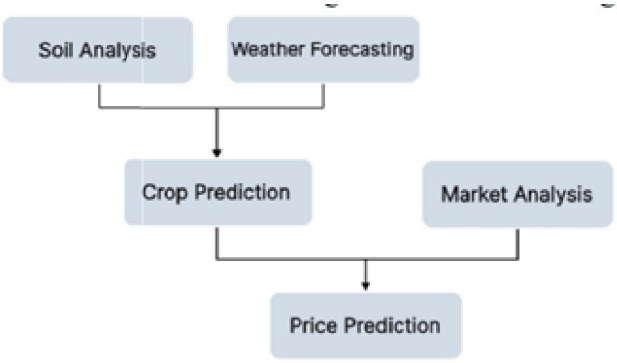

Fig. 3.Block Diagram

Crop Yield Prediction System is an innovative platform designed to support Indian farmers in their decision-making process. Our platform offers four distinct modules to help farmers make informed choices. Comprising four pivotal modules, Crop Yield Prediction System delineates a strategic approach to address the multifaceted facets of agricultural forecasting

Soil Research Module

The platform's soil research module utilizes most recent soil science findings to help farmers assess soil health, nutrient profiles, and composition. This information enables farmers to make informed decisions about crop selection, soil management, and resource allocation, ultimately leading to improved crop yields and sustainable agricultural practices. The pH sensor is a crucial component of the platform's soil research module, as it allows for accurate measurement and monitoring of soil pH levels. Soil pH is a critical factor in determining soil fertility and the availability of essential nutrients for plants. Different crops have specific pH requirements, and maintaining the optimal pH level can significantly improve crop yield and overall plant health. The pH sensor measures the hydrogen ion concentration in the soil solution, providing a quantitative measure of acidity or alkalinity on a scale from 0 to 14. If the pH is lower than 7, the soil is acidic; if it is higher than 7, the soil is alkaline. Neutral soil has a pH of 7.

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Fig. 4.Soil Research Module

Weather Forecasting

The second module concentrates on the impact of weather conditions on crop yield. Over a fourmonth/crop period, we gather comprehensive weather data and offer in-depth insights into climatic patterns. This information helps farmers adapt their agricultural practices to optimize productivity.

Data Collection: Gather a comprehensive dataset containing weather variables such as temperature, precipitation, humidity, wind speed, and sunlight hours for a specific geographical region over a four-month period. You may also want to collect crop yield data for the same time frame and location.

Data Preprocessing: Clean and preprocess the dataset by removing any missing or inconsistent values. Convert data types if necessary and normalize the data to ensure comparability between different variables.

Exploratory Data Analysis (EDA): Perform EDA to identify trends, correlations, and patterns in the data. Visualize the data using charts, graphs, and heatmaps to gain insights into how weather variables affect crop yield.

Feature Engineering: Create new features from existing ones to better capture the relationship between weather variables and crop yield. For example, you could create a "growing degree days" feature to measure the accumulated heat available for crop growth.

Fig.5. Weather Forecasting

Crop Resource Dynamics Module

The crop resource dynamics module searches into the complications of various crops and their resource requirements. Crop Yield Prediction System synthesizes information on crop-specific necessities, providing farmers with a strategic framework for optimized resource allocation and yield outcomes. Machine Learning Framework The platform's machine learning framework harnesses the power of Artificial Neural Networks, Long Short-Term Memory (LSTM) Neural Networks, and a Hybrid model to deliver precise crop yield predictions. Rigorous empirical validation has demonstrated the superior performance of these methodologies compared to conventional approaches, making Crop Yield Prediction System a necessary tool for the agricultural community. Sustainable advancement of agriculture by

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providing farmers with accurate predictions of crop yields and associated profit and loss.CropYield Prediction System contributes significantly to the sustainable advancement of the agricultural sector. The platform's informal approach to agricultural management helps farmers optimize their resources, reduce waste, and minimize environmental impact, ensuring a brighter future for our planet. At Crop Yield Prediction System, we are committed to providing socially unbiased and positive responses that are respectful, helpful, and honest. Our goal is to empower farmers with the knowledge they need to succeed in their endeavours.

Price Prediction/Market

This module focuses on crop price prediction from the dataset, a critical agricultural marketplace. By analysing complex market dynamics and utilizing data from dataset, we provide farmers with accurate price predictions, enabling them to make informed decisions about crop selection and pricing strategies.

Overview of the Module: This module of the platform is designed to provide farmers with accurate and reliable crop price predictions. The module utilizes a combination of machine learning and data from dataset, a leading agricultural marketplace, to analyse complex market dynamics and generate price predictions for various crops.

Purpose of the Module: The main purpose of this module is to empower farmers with the information they need to make informed decisions about crop selection and pricing strategies. By providing accurate and reliable price predictions, farmers can better understand the market demand and supply dynamics, and adjust their cultivation and sales strategies accordingly. This can help farmers maximize their profits, reduce risks, and improve their overall livelihoods.

• Functionality of the Module: The crop price prediction module functions by analyzing a wide range of factors that affect crop prices. These factors include:

• Historical price data: The module utilizes historical price data for various crops in the dataset to identify patterns and trends that can help predict future price movements. 2. Market demand and supply: The module analyzes market demand and supply data to understand the current and future demand for various crops, which can impact crop prices. 3. Weather and climate data: Weather and climate data, such as temperature, rainfall, and soil moisture, can impact crop yields and quality, which in turn can affect crop prices.

• Benefits of the Module: The crop price prediction module offers several benefits to farmers, including: 1. Improved profitability: By providing accurate and reliable crop price predictions, farmers can make informed decisions about crop selection and pricing strategies, which can help them maximize their profits. 2. Reduced risks: The module helps farmers mitigate risks by providing them with insights into market dynamics and price movements, which can help them, avoid losses due to unexpected price fluctuations. 3. Better decisionmaking: The module empowers farmers with data-driven insights that can help them make better decisions about their crops, including what crops to grow, when to sell, and at what price. 4. Increased efficiency: By providing farmers with real-time market data and price predictions, the module can help farmers streamline their operations and improve their overall efficiency. By using linear regressions, we can predict the price very efficiently.

• Conclusion of this module: The crop price prediction module is a critical component of the platform, as it provides farmers with the information they need to make informed decisions about their crops and maximize their profits. By leveraging data from BajarSamiti and utilizing machine learning algorithms, the module generates accurate and reliable crop price predictions that can help farmers thrive in the competitive agricultural market

V. CONCLUSION

The proposed methodology utilizes various deep learning algorithms for predicting agricultural data. The agricultural data set that is used for this research contains various features like cultivation year, area, soil, crop yield, rainfall, and fertilizers used. This research takes these data's as input to the proposed model, and the model was analysed using the data's and given the best result of predicting the yield. Deep learning techniques such as DNN, CNN, RNN, and LSTM were used for the prediction. Among these four techniques, the proposed methodology will suggest the most cost-effective and productive techniques to help the farmers cultivate the appropriate crop and get a better yield. Hence, the proposed research stated that there is an improvement in the accuracy of the LSTM model. The accuracy of LSTM is

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found to be 96.5% by applying the agricultural dataset. Comparing the other three algorithms, the LSTM gives better results for predicting agricultural data. It really helps the agricultural researchers to suggest ways to increase yield in cultivation health.

VI. FUTURE SCOPE

1. Incorporating more data sources: While existing studies have demonstrated the effectiveness of machine learning models in predicting crop yield, there is a need for incorporating more data sources such as remote sensing and satellite data, to improve the accuracy of the models.
2. Transfer learning: Transfer learning is a machine learning technique that involves transferring knowledge from one model to another. In the context of crop yield prediction, this could involve transferring knowledge from models developed in one region to another region, where data is scarce.
3. Integrating models with precision agriculture technologies: Precision agriculture technologies such as drones, sensors, and GPS can provide real-time data on environmental conditions and crop performance, which can be used to improve the accuracy of crop yield prediction models.
4. Implementing models in decision support systems: Decision support systems can provide farmers with real-time recommendations on crop management practices such as irrigation, fertilization, and pesticide application. Integrating crop yield prediction models into these systems can help farmers make informed decisions about crop management.
5. Predicting other crop metrics: While crop yield is an important metric, other metrics such as crop quality and disease resistance are also important for farmers. Developing machine learning models to predict these metrics can help farmers make more informed decisions about crop management.

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It gives us great pleasure in presenting the paper on “Crop Yield Prediction System An interactive System to predict Crop Yield along with Profit and loss to help farmers using Deep learning”. We would like to take this opportunity to thank our guide, Prof. Bhagyashri Deshmukh, Professor, Department of Computer Engineering Department, Genba Sopanrao Moze College of Engineering, Balewadi, for giving us all the help and guidance we needed. We are grateful to her for her kind support, and valuable suggestions were very helpful.

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