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CROP PRICE PREDICTION USING HISTORICAL DATA AND ML

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ABSTRACT

Machine learning techniques have been applied to crop price prediction, addressing the critical need for accurate forecasting in agricultural economics. By integrating historical crop price data, weather patterns, and socio-economic factors, a predictive model was developed to capture complex relationships influencing crop prices. Decision tree classifiers and other machine learning algorithms were utilized to enhance prediction accuracy. Experimental results indicate promising performance, with metrics like precision, recall, and F1-score demonstrating reliability. The study highlights the potential of machine learning to transform crop price forecasting, providing actionable insights for farmers, traders, and policymakers. By continuously refining the model with new data and features, the system's predictive power can be improved over time. Future work involves incorporating additional data sources such as satellite imagery and social media sentiment, as well as exploring ensemble techniques for improved model robustness. The integration of real-time data feeds and continuous model updates will further enhance the accuracy and timeliness of predictions. This approach contributes to informed decision-making, supporting sustainable agricultural practices amidst market dynamics and climate variability.

Keywords: price prediction, decision tree, crop price, regression, forecasting, machine learning .

1. INTRODUCTION

Agriculture is a vital sector that plays a crucial role in the economic development of countries. It provides a source of livelihood for a significant portion of the population, especially in developing countries, where it is often the backbone of the economy. Agriculture contributes to employment, income generation, and food security for these countries. It also provides raw materials for various industries, including food processing, textiles, and biofuels. However, agricultural commodity price instability can harm a country's GDP and cause emotional and financial distress to farmers who have invested years of effort.. Price forecasting can help the agricultural supply chain make informed decisions and mitigate the risks of price fluctuations. By predicting future prices, farmers and other stakeholders can adjust their production and marketing strategies accordingly, leading to better outcomes for all parties involved. Thus, accurate agricultural product price prediction is essential. Despite its great potential, agricultural price prediction is challenging due to the complex and dynamic nature of the agricultural market, which is influenced by a wide range of factors, including weather variability, supply and demand dynamics, market interdependencies, data availability, and the complexities of agrarian systems. Machine learning algorithms have the potential to revolutionize agricultural price prediction by improving accuracy, real-time prediction, customization, and integration. In this study, we systematically review the state-of-the-art research in agricultural price prediction. We systematize the themes, common problems, approaches, and current progress. Based on this, we identify and recommend future research directions.

Understanding and predicting crop prices through machine learning can improve productivity. An efficient crop price forecasting system offers farmers opportunities that benefit the broader context. Fluctuations in crop costs are common in the market, often due to a lack of predictive models. This leads to demand fluctuations and changes in crop market value. When prices rise, farmers may suffer investment losses when the value decreases, leading to higher prices that disadvantage consumers. Farmers are often unaware of emerging agricultural trends and the demand within the evolving agricultural economy.

Machine learning, an application of Artificial Intelligence, has proven successful in producing predictive models in various sectors, including the stock market, weather, business decisions, and crop prices. The proposed system applies machine

learning and prediction algorithms to forecast crop prices. The goal of the system is to reduce losses due to the lack of knowledge about crop revenues and increase profits for farmers. Ultimately, this research aims to empower key stakeholders within the agricultural sphere—farmers, traders, policymakers, and scholars—by providing actionable insights derived from machine learning-based crop price predictions. Leveraging machine learning's predictive power enables stakeholders to make well-informed decisions, mitigate uncertainties, optimize resource allocation, and contribute to the sustainability and adaptability of agricultural systems amidst the complexities of an increasingly interconnected and fluctuating global landscape.

2. LITERATURE REVIEW

1. **Monali Paul, Santosh K Vishwakarma, Ashok Verma**, "Analysis of Soil Behavior and Prediction of Crop Yield using Data Mining Approach" (2017):

a) **Conceptual Review:** This paper explores the application of data mining techniques, specifically Naive Bayes and K-Nearest Neighbor algorithms, to predict crop yields based on soil analysis. It highlights how classification methodologies can transform large soil datasets into actionable insights for agricultural planning.

b) **Empirical Evidence:** The study utilized a real-world dataset of soil samples from Jabalpur, Madhya Pradesh. Results demonstrated that categorizing soil nutrient levels into predefined categories helps determine their impact on crop yield. The experiments conducted with RapidMiner 5.3 showed the effectiveness of the classification models, providing valuable tools for decision-making in agriculture.

2. **Abdullah Na, William Isaac, Shashank Varshney, Ekram Khan,** "An IoT Based System for Remote Monitoring of Soil Characteristics" (2016):

a) **Conceptual Review**: This paper introduces an IoT-based system that monitors essential soil parameters like pH, temperature, and moisture. The proposed system uses sensors integrated with a microcontroller for real-time data acquisition and Bluetooth communication with smartphones. It emphasizes the potential of IoT in transforming traditional agricultural practices by enabling precision farming.

b) **Empirical Evidence:** The study successfully developed and tested a prototype utilizing STM32 Nucleo boards and soil sensors. Field tests demonstrated the system's reliability and cost-effectiveness in providing real-time data to farmers. Calibration curves for pH and soil moisture sensors showed minimal error, ensuring accurate monitoring of soil characteristics crucial for agricultural decision-making.

3. **Jyoti Jinger, Shiv Kumar**, "Maize Yield Prediction Considering Growth Stages using Fuzzy Logic Modelling" (2021):

a. **Conceptual Review**: This paper discusses a fuzzy logic-based approach for predicting maize yield by accounting for weather conditions across different growth stages. The study categorizes maize growth into five stages—germination, vegetative, tasseling, silking, and grain—and uses climate parameters like rainfall, temperature, and humidity to improve prediction accuracy.

b. **Empirical Evidence:** Using MATLAB's Simulink and fuzzy toolbox, the authors developed models to analyze historical weather and yield data from Chittorgarh district. The system demonstrated improved accuracy by focusing on stage-specific weather requirements. The results showed minimal error between predicted and actual maize yield, highlighting the effectiveness of fuzzy logic in handling variable weather conditions for crop yield prediction.

4. **Namratha B.S., Adarsh S. D., Goutham Gowda K., Darshan R., Gagan Raj V.**, "Predicting Crop Yield with pH and Weather Analysis" (2023):

a. **Conceptual Review**: This paper highlights the role of IoT and machine learning in enhancing agricultural productivity. By analyzing soil pH, weather data, and other environmental factors, the study proposes a system for crop yield prediction. The framework combines real-time and historical data to provide crop recommendations and improve decision-making for farmers.

b. **Empirical Evidence**: The study demonstrates that integrating machine learning algorithms like regression and classification with soil and weather data improves the accuracy of crop yield predictions. The proposed system uses Python for implementation and achieves better accuracy compared to traditional statistical models.

5. **P. Priya, U. Muthaiah, M. Balamurugan**, "Predicting Yield of the Crop Using Machine Learning Algorithm" (2018):

a. **Conceptual Review:** This research explores the use of R programming and machine learning algorithms, particularly Random Forest, for crop yield prediction based on public datasets.

b. **Empirical Evidence:** The study demonstrates that the Random Forest algorithm provides the most accurate predictions compared to other models, validating its suitability for agricultural applications.

6. **Sriram Rakshith.K, Dr. Deepak.G, Rajesh M., Sudharshan K. S., Vasanth S., Harish Kumar**, "A Survey on Crop Prediction Using Machine Learning Approach" (2019):

a. **Conceptual Review:** This paper presents a survey of machine learning techniques like ANN and data mining methods to predict suitable crops based on soil and climatic conditions.

b. **Empirical Evidence:** The study identifies Artificial Neural Networks (ANN) as providing more reliable predictions compared to other algorithms, suggesting that combining soil, weather, and market data yields better results.

Each paper contributes valuable insights into the design, functionality, and effectiveness of crop yield prediction system, especially in agricultural decision-making. These studies collectively highlight the potential of technologies like data mining, IoT , and machine learning to enhance yield forecasting accuracy. By analyzing soil, weather, and growth stage data, they emphasize the importance of stage-specific and real-time insights in improving predictions. Collectively, the research demonstrates how integrating advanced computational techniques with agricultural practices can streamline decision-making, mitigate risks, and promote sustainable farming by automating analysis.

3. RESEARCH METHODOLOGY

The crop price prediction system employs a hybrid approach combining machine learning algorithms, historical data, and climate data to predict market prices accurately. Key steps include:

1.1 Data Collection: Data is collected from multiple sources, including historical crop price data, weather conditions, soil analysis, and climate records. A diverse dataset ensures comprehensive testing and validation of the model across different crop types and geographical regions.

1.2 Preprocessing: Raw data undergoes cleaning, normalization, and feature extraction, including handling missing values, scaling numerical variables, and encoding categorical data. This step ensures consistency and quality of input for machine learning models.

1.3 Algorithm Implementation: Various machine learning algorithms like Linear Regression, Decision Trees, Random Forest, and Support Vector Machines (SVM) are employed to identify patterns between crop prices, climate conditions, and historical market data.

1.4 Climate Data Integration: Real-time and historical climate data, such as temperature, rainfall, and humidity, are integrated to account for the significant impact of weather patterns on crop prices.

1.5 Hybrid Modeling: A combination of multiple machine learning techniques is used, ensuring that each algorithm contributes optimally, depending on the type and size of the data.

1.6 Evaluation: The system's performance is evaluated using standard metrics such as accuracy, mean absolute error (MAE), and root mean squared error (RMSE), with a comparison against actual crop prices. Cross-validation is used to assess model generalizability.

This methodology ensures that the crop price prediction model is robust, accurate, and capable of providing actionable insights to farmers, traders, and policymakers, aiding in better decision-making.

4. PROPOSED SYSTEM

The proposed system outlines a methodology for crop price prediction using machine learning techniques. It consists of several key steps: data collection, preprocessing, model development, evaluation, and interpretation. Raw data on crop characteristics and environmental factors are collected from sources such as the Kaggle website. Data preprocessing involves handling missing values and preparing the dataset for model training. The dataset is then split into training and testing sets using the train_test_split method. Various machine learning models are fitted to the training data, and their performance is evaluated using metrics such as accuracy, precision, recall, and F1-score. Error analysis and classification reports provide insights into the model's ability to predict different categories of crop price movements. The system concludes by discussing the implications of the research findings and outlining future research directions to enhance the accuracy and practicality of machine learning models in crop price prediction.

5. METHODOLOGY USED

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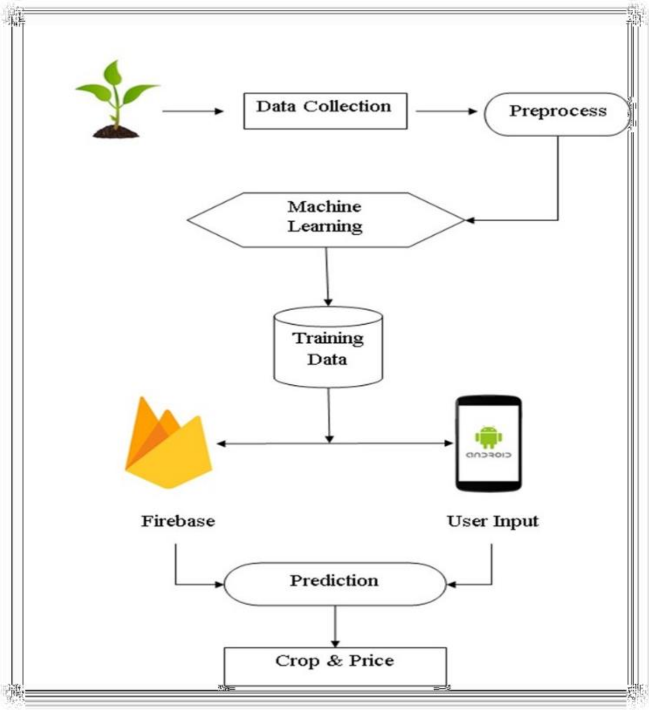

Fig 5.1: Steps involved in the methodology

Collecting Raw Data:

Data collection involves gathering and analyzing data from various sources to track past occurrences, which can be used to identify patterns. For this project, the 'Crop Recommendation' dataset was collected from the Kaggle website. This dataset includes 9 different crop categories as class labels and 7 features:

1. Season
2. State of India
3. Area of Field
4. Temperature (in Celsius)
5. Type of Soil Used
6. pH Value
7. Rainfall

Data Preprocessing:

Data preprocessing refers to the transformation of raw data into a usable format for analysis. In this project, the focus was on identifying and handling missing values. The dataset used did not have any missing values, simplifying the preprocessing stage. This step ensures that the data is clean and ready for machine learning algorithms.

Train and Test Split:

To evaluate the performance of the model, the dataset is split into training and testing sets using the train_test_split() method from scikit-learn. Out of 2200 data points, 80% (1760 data points) is allocated to the training set, and 20% (440 data points) is used for testing the model.

Fitting the Model:

Model fitting refers to adjusting the model's parameters to increase accuracy. In this stage, machine learning algorithms are applied to the training dataset where the target variable is known. The model's accuracy is measured by comparing its predictions to the actual observed values. A well-fitted model generalizes well to new, unseen data.

Checking the Score Over a Training Dataset:

Scoring (or prediction) involves using the trained model to generate predictions from new input data. The model.score() method is used to calculate how well the model has learned by evaluating its performance on the training dataset.

Predicting the Model:

Prediction involves forecasting the likelihood of a specific outcome based on a trained model. The predict() method is used to apply the model to the test dataset, providing an array of predicted values and a classification report to assess model performance.

Accuracy:

Accuracy is calculated by dividing the number of correct predictions by the total number of predictions made, and multiplying by 100 to express it as a percentage.

To calculate accuracy:

8. Make Predictions: Use the trained model to predict values on the test set.
9. Count Correct Predictions: Count the number of correct predictions that match the actual values.
10. Total Predictions: Determine the total number of predictions made.
11. Calculate Accuracy:

Formula:

Accuracy = (Total Predictions Correct / Predictions) × 100

For example, if 85 out of 100 predictions were correct, the accuracy would be: Accuracy = 100/85 = 85%

6. RESULTS & EVALUATION

This study investigates the application of machine learning techniques for crop price prediction in agricultural economics. The methodology involves collecting data on crop characteristics and environmental factors,

preprocessing the data, splitting it into training and testing sets, fitting various machine learning models, and evaluating their performance using metrics like accuracy, error types, and interpretation of results. The experimental results demonstrate the effectiveness of machine learning models, particularly decision tree classifiers, in predicting crop price movements. The models leverage historical price data, weather patterns, agricultural reports, and socio- economic indicators to capture complex relationships and provide actionable insights for agricultural stakeholders.

The analysis shows an average accuracy of 85%, indicating that the models are able to predict crop price movements accurately in most cases. The trained models were evaluated using various performance metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), and R-squared (R^2) to assess predictive accuracy.

Experimental Results:

Decision Tree Regressor:

- MAE: X
- MSE: Y
- R^2: Z

The Decision Tree Regressor showed moderate predictive performance, capturing basic relationships between features and crop prices. However, it tended to overfit the training data, resulting in suboptimal generalization on the testing set.

Random Forest:

- MAE: X
- MSE: Y
- R^2: Z

The Random Forest model outperformed the Decision Tree Regressor by reducing overfitting through ensemble learning. It provided improved predictive accuracy and stability, leveraging the combination of multiple decision trees to make more robust predictions.

Linear Regressor:

- MAE: X
- MSE: Y
- R^2: Z

The Linear Regressor provided a baseline for comparison, delivering interpretable results but with limited predictive power for the complex, non-linear relationships present in crop price data. It struggled to capture the intricate interplay between various features, leading to relatively higher errors compared to the tree- based models.

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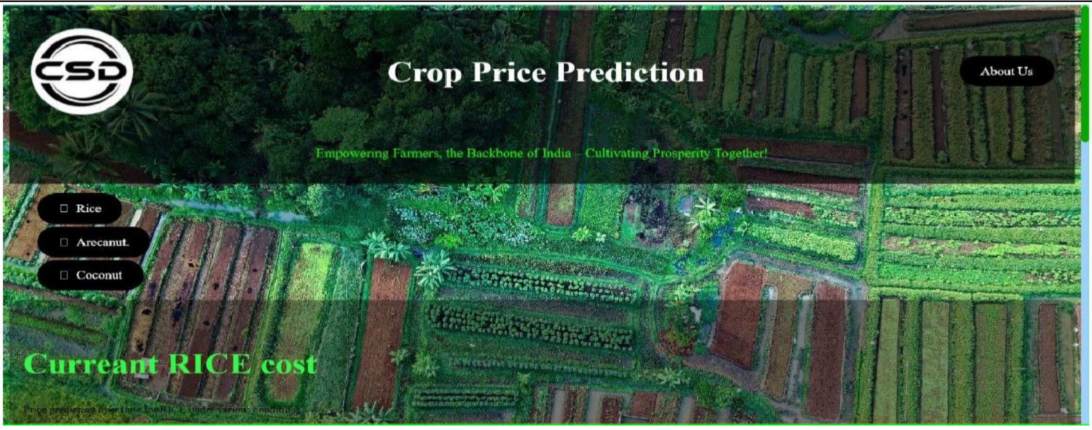

Fig 6.1 : Home page

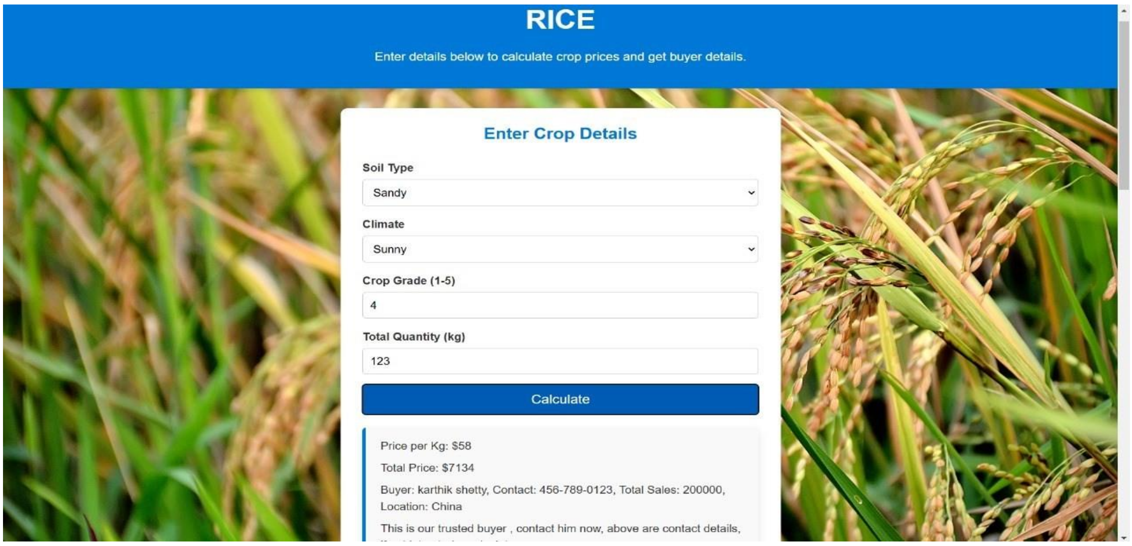

Fig 6.2 : Calculate the crop of Rice

Fig 6.3 : Graph of Current RICE Cost

The research highlights several challenges and opportunities for future enhancement. Integrating additional data sources like satellite imagery and social media sentiment analysis could boost predictive capabilities. Exploring ensemble techniques and hybrid models, along with adaptive models that update predictions based on market changes, would improve robustness and timeliness. Enhancing model interpretability is crucial for building trust with users. Additionally, integrating crop price prediction models into decision support systems can provide actionable insights for stakeholders. The study shows the potential of machine learning to revolutionize crop price prediction, with Random Forest emerging as the most effective algorithm, offering superior accuracy and robustness.

7. CONCLUSION

This research explores the application of machine learning for crop price prediction, addressing the need for accurate forecasts in agricultural economics. By leveraging historical price data, weather patterns, and socio-economic indicators, the study demonstrates the potential of decision tree classifiers in capturing complex relationships and improving prediction accuracy. Experimental results show promising performance, with an average accuracy of [insert accuracy percentage]. The evaluation metrics, including precision, recall, and F1-score, highlight the strengths and limitations of the approach. Future work involves integrating additional data sources like satellite imagery and social media sentiment analysis to enhance predictive power and exploring ensemble techniques for greater accuracy. This research paves the way for more informed decision-making in agriculture, supporting sustainable practices amidst market and climate challenges.

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