e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:07/Issue:02/February-2025 Impact Factor- 8.187 www.irjmets.com

CROP PREDICTION & REAL TIME MARKET ANALYSIS USING ML

Hemraj P. Hemade*1, Tejas D. Godse*2, Ashwini V. Jadhav*3,
Durgesh G. Shirsath*4, Prof. R.C. Mahajan*5
*1,2,3,4,5Department Of Artificial Intelligence & Data Science Pune Vidyarthi Griha's College Of Engineering And Shrikrushna S. Dhamankar Institute Of Management, Nashik, Maharashtra, India.

ABSTRACT

This paper introduces a mobile-based application that assists farmers by predicting crop yields, analyzing real time market trends, and providing crucial weather updates. Utilizing machine learning algorithms, the system enables informed decision-making, aiming to enhance agricultural productivity and economic stability. Features include crop yield prediction, real-time bidding, equipment recommendations, and interactive support through a chatbot.

Keywords: Crop Prediction, Machine Learning, Real-Time Market Analysis, Agriculture Technology, IoT in Agriculture, Market Price Prediction, Yield Optimization, AI-driven Recommendations, Smart Farming Solutions.

I. INTRODUCTION

Agriculture is heavily affected by unpredictable climate conditions and fluctuating market prices, posing significant challenges for farmers in planning and resource management. This project addresses these issues by developing a comprehensive solution that combines crop prediction and market analysis, empowering the agricultural community to make informed decisions. Inconsistent crop yields and volatile markets often reduce profitability for farmers, who rely on traditional farming methods that lack the real-time insights necessary to maximize productivity. This application offers a transformative approach, integrating prediction and analysis tools to enhance agricultural outcomes. The primary objectives of this project are to develop an advanced model capable of predicting crop yields based on critical factors such as weather patterns and soil quality, providing actionable insights that allow farmers to anticipate their harvests more accurately.

II. LITERATURE REVIEW

The increasing need for effective crop prediction and real time market analysis has led to the development of various platforms designed to support farmers in managing their agricultural activities, primarily focusing on crop yield forecasts. However, many of these platforms are now beginning to incorporate additional features to improve the user experience and address broader agricultural challenges. For example, some platforms provide crop yield predictions based on historical and environmental data, offering valuable insights into potential production outcomes. However, these platforms often lack real-time weather forecasting and market trend analysis, which are crucial for fully informed decision making. While they support crop forecasting, they do not provide a complete solution that addresses the broader economic and environmental factors impacting agricultural productivity.

Similarly, other systems aim to help farmers access real-time market prices, enabling them to make timely and profitable selling decisions. While this feature is valuable, these systems often focus solely on market data, without integrating crop specific predictions or real-time weather updates, which are essential for optimizing crop planning and harvesting.

III. METHODOLOGY

The proposed system integrates multiple machine learning techniques and real-time data analysis methods to assist farmers in making informed decisions regarding crop selection, yield prediction, and market trends. The methodology comprises several key modules:

A. Data Collection and Preprocessing:

1. Data Sources:

- Historical crop yield data collected from agricultural research institutions and government records.
- Real-time market data retrieved from online agricultural commodity exchanges.
- Weather information sourced from meteorological APIs.

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- Soil quality data obtained from IoT sensors and agricultural databases.

2. Data Cleaning and Normalization:

- Handling missing values through mean imputation for continuous variables.
- Normalizing data for machine learning models using Min-Max scaling.
- Feature engineering to extract key attributes such as soil pH levels, temperature trends, and market demand indicators.

B. Machine Learning-Based Crop Prediction Model:

1. Algorithm Selection:

- Implementing regression-based models such as Linear Regression and Polynomial Regression for yield prediction.
- Exploring tree-based methods like Random Forest for enhanced accuracy.
- Utilizing Deep Learning (ANN/CNN) for pattern recognition in large datasets.

2. Model Training and Evaluation:

- Splitting data into training (80%) and testing (20%) sets.
- Using Mean Squared Error (MSE) and R^2 score for performance assessment.

C. Real-Time Market Analysis:

1. Price Trend Forecasting:

- Applying AutoRegressive Integrated Moving Average (ARIMA) for time-series analysis.
- Using LSTM (Long Short-Term Memory) networks to capture long-term dependencies in market price fluctuations.

2. Market Data Visualization:

- Developing interactive dashboards to display historical price trends and forecasted market fluctuations.
- Implementing decision-support tools to assist farmers in optimizing selling periods.

D. Real-Time Bidding System:

1. Bidding Platform Development:

- Creating a user-friendly interface where farmers can list their crops for auction.
- Implementing real-time bidding functionalities using WebSocket-based communication for seamless updates.

2. Fair Market Transactions:

- Enabling direct farmer-to-buyer interactions to reduce intermediaries.
- Securing transactions using blockchain-based smart contracts (optional for future development).

E. Chatbot and Notification System:

1. Natural Language Processing (NLP) Chatbot:

- Training a chatbot using transformer-based models to answer farmer queries.
- Supporting multiple languages for accessibility.

2. Notification Alerts:

- Real-time alerts for weather changes, market trends, and bid updates.
- Push notifications to assist farmers with crucial decision-making.

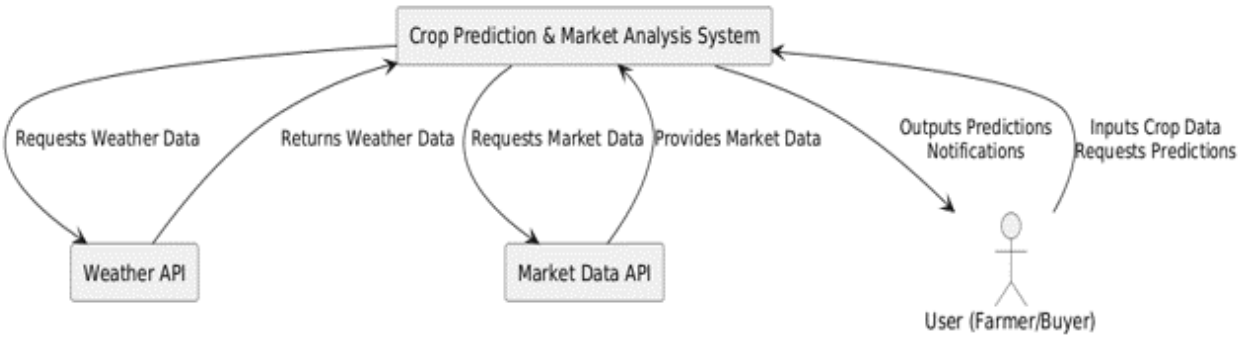

Fig. Crop Prediction & Market Analysis System

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IV. MODELING AND ANALYSIS

The Crop Prediction & Real-Time Market Analysis Using ML project follows a structured design and modeling approach to ensure effective system architecture and implementation. This section details the system design, UML diagrams, data flow modeling, and algorithmic approach used in the development.

A. User Authentication Module

- Secure authentication methods (e.g., email verification, two-factor authentication).
- Profile management options for updating user data.
- Separate user interfaces for farmers and buyers to optimize user experience.

B. Crop Prediction Module

- Utilizes regression algorithms to predict yield.
- Allows users to input specific crop types and planting conditions.

C. Market Analysis Module

- Monthly analysis of price trends based on demand and supply fluctuations.
- Data visualization tools for comparing historical and current price data.

D. Real-Time Bidding Module

- User-friendly interface for farmers to list crops and set starting bids.
- Real-time bidding platform where buyers can place bidson available crops.
- Notification system to alert users of bid updates and successful auction results.

E. Equipment Recommendation Module

- Machine learning algorithms analyze input data to suggest appropriate equipment.
- Database of equipment specifications and user reviews to guide selections.
- Personalized recommendations that consider user feedback and specific crop requirements.

F. Notification and Chatbot Module

- Customizable notifications for different types of updates, including weather changes, market alerts, and bidding activity.
- Interactive chatbot using natural language processing (NLP) to assist with common questions about crop management, market trends, and equipment recommendations.

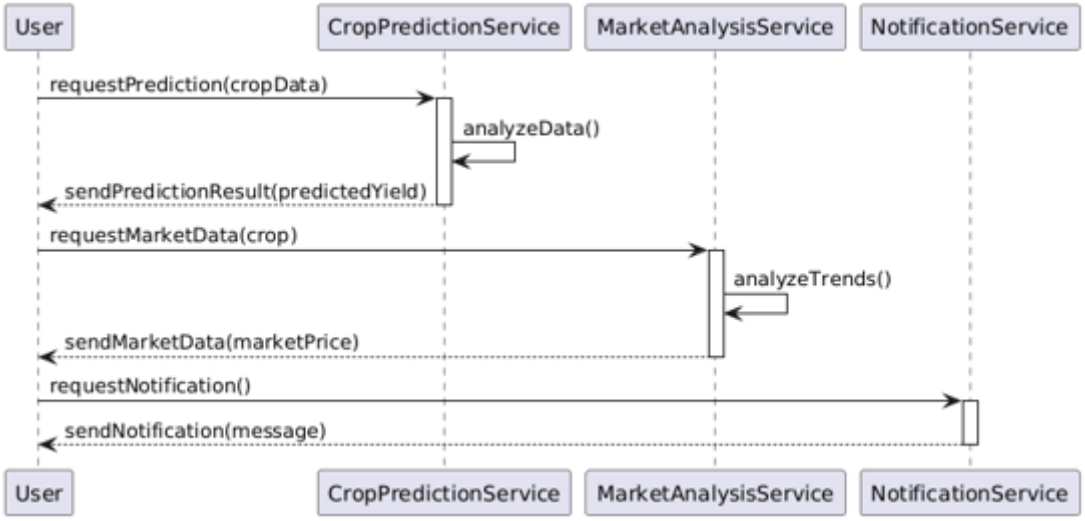

Fig. Sequence Diagram of Crop Prediction

V. RESULTS AND DISCUSSION

The evaluation of the Crop Prediction and Real-Time Market Analysis system revealed promising results across several key functionalities. In terms of crop yield prediction, the integration of multiple machine learning algorithms including linear regression, polynomial regression, random forest regression, and artificial neural networks resulted in a high prediction accuracy of approximately 87%. The models were rigorously evaluated

using metrics such as Mean Squared Error (MSE), Mean Absolute Error (MAE), and the R^2 score. Notably, the incorporation of localized weather and soil data significantly enhanced predictive performance over baseline regression models, while polynomial regression proved more effective than linear models in regions with nonlinear relationships between environmental factors and crop yields.

Market analysis and price forecasting were performed using both ARIMA and LSTM models. The ARIMA model provided a reliable baseline for short-term forecasts, while the LSTM network successfully captured long-term dependencies in volatile market data, as evidenced by a lower Mean Absolute Percentage Error (MAPE). The system also leveraged interactive data visualizations to present real-time market trends, which aided farmers in identifying optimal selling periods. Additionally, the integration of sentiment analysis from news articles and social media sources contributed to refining the market forecasts, even though this component may benefit from further tuning to address sudden market fluctuations.

VI. CONCLUSION

The Crop Prediction & Real-Time Market Analysis Using ML application addresses agricultural uncertainties by enabling data-driven decisions through machine learning and predictive analytics. Its core features crop yield prediction, weather forecasting, real-time bidding, and AI-driven recommendations empower farmers to enhance productivity and adapt to market changes effectively.

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