AI MODEL FOR PREDICTING CROP PRICE FLUCTUATIONS

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College	:	*Srinivas University Institute of Engineering and Technology, Mukka, Mangaluru*
Branch	:	*Department of Artificial Intelligence and Machine Learning*
Guide(s)	:	*Prof. Anand S Uppar*
Student(s)	:	*Ms. Chinmayi Banakar* *Ms. Pooja S Hanji* *Ms. Yallamma Y Byadagi*

Keywords:

Crop Price Prediction, Machine Learning, AI, Random Forest, LSTM, Agricultural Data, Market Forecasting.

Introduction:

1. Agriculture plays a crucial role in the economies of developing nations, where a large proportion of the population depends on farming as a primary source of livelihood. Farmers rely heavily on the income generated from selling their crops, making price stability extremely important for their financial well-being. However, one of the major challenges they face is the unpredictable nature of crop prices in the market. These prices fluctuate frequently due to various factors such as changing weather conditions, seasonal variations, supply and demand imbalances, transportation costs, storage limitations, and government policies or regulations.
2. Such uncertainties make it difficult for farmers to make informed decisions regarding the selection of crops, timing of harvest, and the most suitable time to sell their produce. As a result, farmers often incur financial losses by selling crops at unfavorable prices. Traditionally, farmers have depended on personal experience, local market observations, and informal advice from traders to estimate future prices. However, these methods are not reliable or accurate, as they fail to consider the complex interactions of multiple influencing factors.
3. With the rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML), new opportunities have emerged to address these challenges effectively. These technologies are capable of analyzing large volumes of historical and real-time agricultural data to identify hidden patterns and trends. By using predictive models such as regression analysis, decision trees, and neural networks, it is possible to forecast crop prices with improved accuracy.
4. This project aims to leverage these advanced technologies to develop a practical and user-friendly crop price prediction system. The proposed system is designed to bridge the gap between complex data analytics and real-world agricultural applications. It will assist farmers and stakeholders in making better decisions, thereby improving profitability and promoting sustainable agricultural practices.

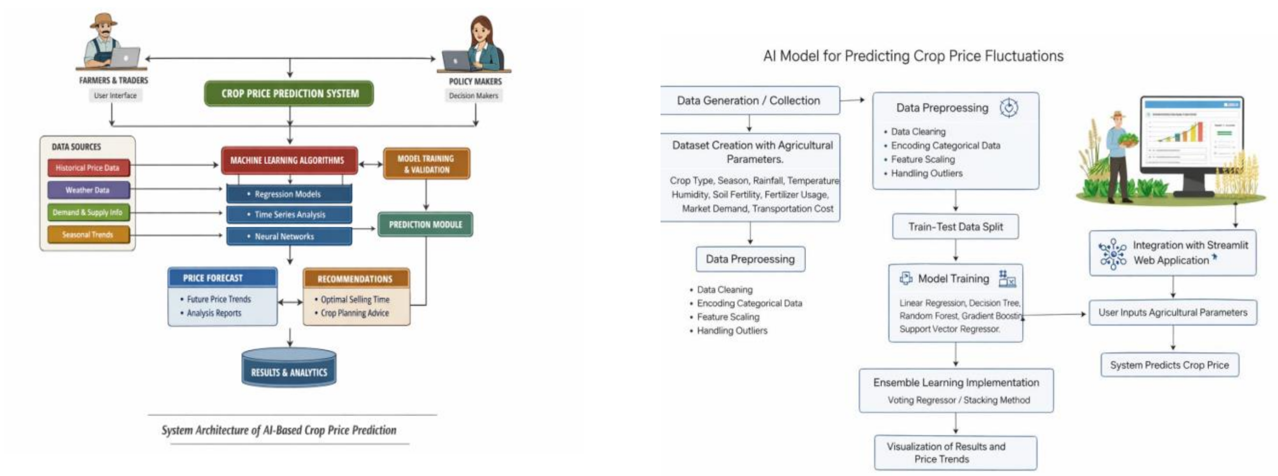

Figure 1: System architecture of the proposed AI Crop Price Prediction.

Objectives:

1. Develop a machine learning model that accurately predicts future crop price fluctuations by analysing historical agricultural market data.
2. Collect, integrate, and preprocess multi-source agricultural data including market prices, weather records, seasonal patterns, and supply-demand indicators.
3. Apply and compare multiple ML and time-series algorithms—Random Forest, LSTM, Linear Regression, and Gradient Boosting—selecting the best-performing model.
4. Improve decision-making for farmers and traders by providing reliable, data-driven price forecasts presented through intuitive visual dashboards.

Methodology:

1. The development of the crop price prediction system follows a structured pipeline consisting of five key phases.
   The first phase is **Data Collection**, where historical price data for crops like rice, wheat, maize, cotton, and sugarcane is gathered and stored in CSV format.
   Additional factors such as rainfall, temperature, humidity, soil fertility, fertiliser usage, market demand, and transportation costs are also included.
2. The second phase is **Data Preprocessing**, which involves cleaning the dataset by removing duplicates, handling missing values, and correcting inconsistencies.
   Categorical variables are encoded into numerical form, and numerical data is scaled for better model performance.
   The dataset is then split into training (70%) and testing (30%) sets.
3. The third phase is **Exploratory Data Analysis (EDA)**, where correlations, patterns, and seasonal trends are analyzed using visualization techniques.
   This helps in identifying important features and improving model accuracy.
4. The fourth phase is **Model Training and Ensemble Learning**, where multiple models such as Linear Regression, Decision Tree, Random Forest, Gradient Boosting, SVR, and LSTM are trained.
   An ensemble method combines their outputs to improve prediction accuracy, and performance is evaluated using RMSE and R^2 metrics.

5. The final phase is **Web Application Deployment**, where the selected model is integrated into a Streamlit app.
   Users can input parameters and receive predicted crop prices along with graphical insights.

Result and Conclusion:

In conclusion, the project demonstrates that combining Artificial Intelligence and Machine Learning with agricultural data analysis significantly improves the accuracy and reliability of crop price forecasting. The implemented system successfully generated predictions for diverse input conditions, showing stable and consistent performance across multiple test scenarios. The use of an ensemble learning approach outperformed individual models in terms of RMSE and R^2, highlighting the effectiveness of combining different algorithms. The system also stores prediction records in a structured database, allowing historical comparison and trend analysis. Additionally, the Streamlit-based interface is user-friendly and provides real-time predictions with graphical visualizations, making it accessible to non-technical users. This platform enables farmers to make informed decisions regarding crop planning, storage, and selling, thereby reducing financial risks. It also offers valuable insights for policymakers to develop better market strategies. Overall, the project presents a robust and practical solution that connects advanced AI techniques with real-world agricultural applications.

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Future Scope:

The future scope of this project includes:

1. Real-Time Data & Accessibility: Integrate live market data, weather APIs, and develop a mobile application with regional language support to improve real-time predictions and accessibility for farmers.
2. Advanced AI Models: Incorporate advanced techniques such as Transformer models, attention mechanisms, and hybrid models like XGBoost-LSTM to enhance prediction accuracy.

3. Scalability: Extend the system to support multiple crops and different geographical regions for broader applicability.
4. Government Integration: Connect the platform with government systems to assist in policy-making, price stabilization, and subsidy planning.
5. Explainable AI (XAI): Implement tools like SHAP values to improve transparency and help users understand prediction factors.