International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

Improving Crop Price Prediction Using Machine Learning: A Review of Recent Developments

G. Sridevi[1], M. Geetha[2], Bellamkonda Nuthana[3], Remalli Rohan[4]

[1]M.S.c -Data Science – PG Student, Department of Computer Science.

[2,3]Degree Lecturer, Department of Computer Science.

Telangana Social Welfare Residential Degree College for Women, Jagathgirigutta, Hyderabad, India.

[4]Researcher, Computer Science Educator, Hyderabad, Telangana, India.

---***---

Abstract - *This study examines current developments in machine learning (ML)-based crop price prediction models, with an emphasis on enhancing agricultural planning in areas where farming is the primary source of income for rural populations. Traditional approaches based on farmers' prior experiences are increasingly insufficient as agricultural economies deal with growing market and climate uncertainty. Researchers have created predictive models that consider a variety of data sources, such as past crop prices, soil types, weather trends, and socioeconomic characteristics, in order to address these issues. The review covers important research from 2019 to 2024, emphasizing the work of authors whose models, which included algorithms including Random Forest, Decision Tree, and Ensemble techniques, were able to predict crop prices with up to 97% accuracy. This excellent prediction accuracy facilitates well-informed choices for farmers, facilitating proactive crop selection and resource management, lowering financial risk, and increasing profitability. The paper also discusses the main drawbacks of the models that are currently in use, including the difficulty of generalizing forecasts across various geographic locations and restrictions in data availability. More flexible, hybrid models that can manage these constraints and expand to larger agricultural contexts should be investigated in future research. This paper highlights how ML-driven crop price prediction can promote data-driven, sustainable farming methods, which will ultimately help agro-based communities' food security and economic resilience.*

Key Words: Crop Price Prediction, Machine Learning, Risk Management, Agriculture, Random Forest, Decision Trees.

1. INTRODUCTION

Worldwide, the agricultural sector is vital to economies, but it is especially important in developing nations where it makes a substantial contribution to GDP and jobs. Crop price volatility, however, is a significant problem since it affects farmers' earnings, food security, and financial stability. Thus, policymakers, economists, and researchers are now concentrating on making accurate predictions about agricultural prices. The multifaceted influences, which include weather patterns, economic indicators such as stock market indexes, and different risk considerations, make it impossible to predict these values. The relationship between agricultural commodity prices and stock market performance—specifically, indexes like the Indian Sensex—is one of the newer viewpoints in crop price forecasting as showed in the below figure 1.

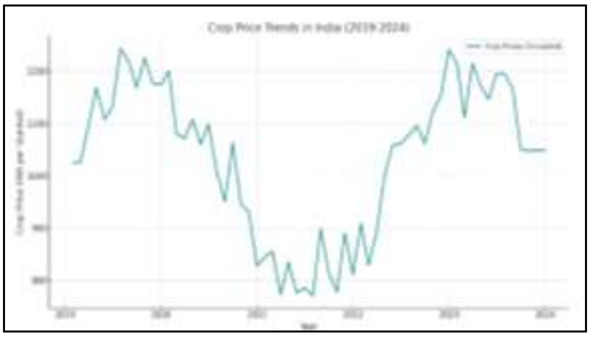

Fig.1: Crop price forecasting.

A measure of economic health, the Sensex considers a number of macroeconomic variables, including GDP growth, interest rates, and inflation that have an indirect impact on agriculture. Because they affect capital flows, agribusiness investment, and market confidence, Sensex fluctuations can be linked to variations in crop prices. In order to develop predictive models that incorporate economic signals and improve forecasting accuracy, it is imperative to comprehend this link. Weather conditions including temperature, precipitation, and extreme weather events have a significant impact on crop output in addition to economic indicators as showed in the figure 2. This affects supply, which in turn affects prices. Climate variability poses a serious threat to agricultural productivity and can have a substantial effect on commodity prices, particularly in areas where rain-fed agriculture is heavily reliant. A more complex understanding of crop price volatility is made possible by including weather data into predictive models, which capture supply-side dynamics that are not possible with just economic indicators.

Fig.2: Crop Price Prediction factors

The predicted path of agricultural prices in India from 2019 to 2024 is depicted in the graph, which shows both seasonal variations and an overall upward tendency. The recurring highs and lows draw attention to how seasonal factors, such as harvest and monsoon cycles, affect crop supply and costs. The mild variations in between could be caused by variations in demand, changes in the economy, and sporadic weather interruptions. A growing tendency in the later year's points to potential impacts of market demand, inflation, or environmental concerns on agriculture. The possibility of cumulative effects on crop prices is reflected in this trend, which suggests the presence of wider climatic and economic influences. Prediction models could be further improved by including real data with these variables, offering stakeholders in agricultural planning and investment insightful information.

2. LITERATURE SURVEY

The combination of machine learning algorithms, economic variables, and climatic data to improve forecasting accuracy is highlighted in the research on crop price prediction. Scholars have investigated models such as Random Forest, Decision Tree, and XG Boost to provide farmers with accurate, useful information for risk management and profit optimization. The main approaches and developments in predictive modeling that tackle agricultural issues and enhance decision-making in dynamic market situations are reviewed in this overview given in table 1.

Rachana et al. [1], and Pandit Samuel et al. [2] used machine learning techniques such as K-Nearest Neighbor (KNN), Naïve Bayes, Random Forest, and Decision Trees to anticipate agricultural prices and profits. In order to assist farmers in making well-informed financial decisions and lowering the risks associated with price swings and weather instability, they used variables such as rainfall, crop type, market pricing, and support prices.

Systems that predict crop prices based on market trends, weather data, and soil conditions were developed by Gangasagar HL et al. [3], Kakaraparthi et al. [5], and Ghutake et al. [6]. The goal of these models was to maximize farmers' profits by assisting them in choosing lucrative crops. By using techniques like Support Vector Regression (SVR), XGBoost, and Linear Regression, the systems were able to improve crop planning and offer valuable insights into market dynamics.

Prashantha et al. [4], Koparkar et al. [8], and Tushar Gupta et al. [17] stressed the value of utilizing a variety of data sources, including information on crop yield, weather, and soil moisture. Several machine learning methods, such as Random Forest and Decision Trees, were used to anticipate crop prices, reduce the danger of erratic weather, and enhance farmers' financial security.

To predict price trends, Kasa et al. [7], Harrykissoon et al. [9], employed time series models and Long Short-Term Memory (LSTM) networks. By offering forecasts that improve risk management and long-term financial stability, their study sought to assist farmers in adapting to changes in the market and weather.

Using historical trends and weather data in conjunction with machine learning models like Random Forest and Decision Tree Regressor, researchers such as Soni & Raut [13], Sumanth Kumar B et al. [10], and Ranjani Dhanapal et al. [11] concentrated on predicting crop prices to improve decision-making and lower financial risks related to agricultural price volatility.

International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

Research by Bopche et al. [18], Dr. Rajashree et al. [19], and sought to improve crop price predictions by time series analysis and regression. By providing more precise pricing projections that consider variables including crop characteristics, weather, and market data, their research aimed to assist farmers in increasing crop output and profitability.

In their research, Pooja Dl et al. [16], Sonali Antad et al. [21] investigated the ability of machine learning models, such as Random Forest and Decision Trees, to predict prices in response to environmental factors, such as temperature and rainfall. Their objective was to give farmers accurate pricing information so they could minimize risks and maximize output.

Finally, research like those done by Tushar Dhobal et al. [26], Ishika Sachin Narkhede et al. [25], helped create algorithms that forecast crop prices and recommend the optimal crop selection tactics. They developed models that assist farmers in maximizing yields and minimizing losses due to volatile market situations using information such as crop types, weather forecasts, and soil quality.

Table -1: Summary of methodologies

Author	Dataset	Feature Extraction	Algorithm	Result
Rachana P. S., et al. [1]	Agricultural data including rainfall, maximum trade prices, and minimum support prices (MSP)	Rainfall, maximum trade prices, MSP	K-Nearest Neighbor (KNN) for profit prediction, Naïve Bayes for price prediction	Supplied precise pricing forecasts, assisting farmers in making well-informed financial decisions and boosting profits.
Gangasagar HL, et al.[3]	Crop prices, market locations, historical sales data	Crop prices, market locations, historical sales	Support Vector Regression (SVR), Multi Linear Regression, Decision Tree Regressor, Random Forest Regressor	The Random Forest Regressor produced the most accurate results, providing farmers with valuable information on price and market choices.
Prashantha S., et al. [4]	Soil parameters, rainfall, soil moisture data	Soil characteristics, rainfall, soil moisture	Various machine learning algorithms	Provided accurate price forecasts, assisting farmers in making judgments about crop output and pricing while boosting their financial stability.
Kakaraparthi, G. S., et al. [5]	Historical crop prices, soil conditions, weather forecast	Soil conditions, historical crop prices, weather forecast, MSP	Various machine learning algorithms	Helped farmers choose profitable crops to maximize production and profits by offering crop suggestions and price projections.
Ghutake, I., et	Crop data based on	Crop type,	Decision Tree, Linear	Helped farmers choose

al. [6]	weather conditions and market prices	weather conditions, market prices	Regression	crops more wisely and plan market sales to maximize profits in the face of shifting market trends.
Kasa, V., et al. [7]	Historical crop prices, harvested area, yield data	Harvested area, crop yield, historical prices	Long Short-Term Memory (LSTM) networks	Forecasted crop prices, aiding farmers in managing risks and adapting to market changes for improved economic stability.
Koparkar, G. A., et al. [8]	Soil parameters, rainfall, soil moisture	Soil properties, rainfall, soil moisture	Various machine learning techniques	Aimed to lessen financial stress and enhance crop price forecasts, assisting farmers in making wiser financial choices.
Kumar, S. B., et al. [10]	Soil and agricultural meteorological data	Temperature, humidity, wind speed, rainfall, soil pH, organic carbon content	Random Forest Algorithm, Back Propagation	Improved crop production and price prediction accuracy will help farmers adjust to climatic variability and boost output.
Dhanapal, R., et al. [11]	Rainfall data, Wholesale Price Index (WPI), seasonal trends	Rainfall, WPI, seasonality patterns	Decision Tree Regressor	Supplied 12-month crop price projections to help farmers plan for financial security and manage risk.
Roshini, N., et al. [14]	Historical crop production and price data	Crop production, historical prices, rainfall, season, soil quality	Random Forest, Linear Regression	Predicting agricultural prices with great accuracy has helped farmers boost profits and lower financial risks.
Ranaweera, H. M. B. P., et al. [15]	Sri Lankan vegetable market data	Crop production, temperature, rainfall, fuel prices	Random Forest, Decision Tree	Reduced error metrics and improved vegetable price forecasts, which assist farmers in reducing losses due to market volatility.
Pooja Dl., et al [16]	Crop price and machinery rental data	Crop prices, machinery rental costs	Random Forest, Decision Tree Regression, Linear Regression, Gradient Boosting	For predicting crop prices, Decision Trees outperformed Linear Regression, while Linear Regression worked well for predicting machinery rental prices.

Gupta, T., et al. [17]	Environmental data (soil and weather conditions)	Crop types, soil conditions, weather data	Random Forest, Decision Tree	Suggested ideal crops, reducing soil deterioration and increasing productivity and profitability.
Bopche, A., et al. [18]	Historical market prices, climate data, supply-demand dynamics	Market prices, climate trends, supply and demand	Random Forest Regression	Helped improve crop selection and boost profitability by offering virtual farm management and precise pricing forecasts.
Dr. Rajashree et al. [19]	Historical data of crops (wheat, ragi, bajra, barley)	Rainfall, historical crop output	Decision Tree	Provided precise price forecasts for crops like as wheat, barley, ragi, and bajra, improving farmer profitability and decision-making.
Asha, D. S. R., et al. [20]	Environmental and market data	Environmental factors, market data	Decision Tree	Enhances yield and price forecasting; further research will incorporate genetic algorithms for accuracy and a price recommendation system.
Antad, S., et al. [21]	Historical price and weather data	Past price, weather data	Random Forest, Decision Tree	With its high crop price prediction accuracy, Random Forest helps control price volatility risk.
Borkar, B. S., et al. [22]	Market, weather, and soil data	Weather patterns, soil composition, market dynamics	Regression, Time Series Analysis, Ensemble	High forecast accuracy for price and yield, facilitating more effective resource allocation and policy choices.
Pandey, S., et al. [23]	Historical price, weather, socioeconomic data	Price, weather, socioeconomic factors	Regression, Ensemble	Gives farmers up-to-date price projections so they can take proactive measures for sustainable farming.
Kotkar, S. A., et al. [25]	Historical price, weather data	Historical prices, weather patterns	Multiple algorithms	Reduces weather-related uncertainty by assisting with well-informed planting and harvesting decisions.
Done, S., et al. [26]	Weather and soil data	Soil conditions, weather data	Decision Tree, Regression	Helps farmers choose the best crops while lowering

				losses with better farming methods.
Shirole, B.S., et al. [27]	Land, weather data	Land quality, weather conditions	SVM, Decision Tree	Improves fertilizer application and crop selection, lowering soil pollution and raising crop production and profitability.

3. CONCLUSIONS

By increasing the precision of crop price forecasts, machine learning (ML) is revolutionizing conventional farming, as this analysis examines. Through the integration of many information, including past prices, weather trends, soil data, and socioeconomic aspects, machine learning models offer predictive insights that enable farmers to make more informed choices. Profitability rises, financial risk falls, and resource allocation becomes more effective as a result. Although models like Random Forest, Decision Tree, and Ensemble methods have demonstrated great promise—in certain studies, they have achieved up to 99% accuracy—their performance is frequently constrained by the availability of data and the difficulties in scaling across diverse agricultural locations. The potential of these models to promote sustainable agricultural methods and economic stability, particularly in rural communities that rely heavily on agriculture, is highlighted by research conducted between 2019 and 2024. In the future, improving these models' resilience will necessitate creating hybrid strategies that incorporate several techniques for adaptability to various geographical and climatic circumstances. Real-time information from IoT sensors and satellite photos may help improve forecasts and allow for dynamic changes. Increasing the number of environmental and socioeconomic indicators in datasets would also increase the accuracy of predictions. Furthermore, creating forecasting models that are specific to a given crop or region would increase their applicability to nearby farmers. Last but not least, developing user-friendly interfaces will be crucial to assisting rural farmers with little technical know-how and encouraging a data-driven, sustainable method of agricultural planning.

REFERENCES

1. Rachana P. S., et al, "Development of a Crop Price Prediction System using Machine Learning Algorithms", Agricultural Data Science Journal, Vol 6(3), Pg. 45-52, 2019.
2. Pandit Samuel, et al, "Predicting Crop Prices for Optimal Profit Maximization Using Machine Learning", 2020
3. Gangasagar HL, et al, "Predicting Crop Prices and Market Optimization Using Machine learning ", Research Paper, 2020.
4. Prashantha S., et al, [Dataset: Soil parameters, rainfall, soil moisture data],2020
5. Kakaraparthi, G. S., et al," Machine Learning System for Crop Recommendation and Price Forecasting Based on MSP and Environmental Factors", [Dataset: Historical crop prices, soil conditions, weather forecast],2021.
6. Ghutake, I., et al, "Machine Learning Model for Crop Price Forecasting Based on Weather and Market Trends", [Dataset: Crop data based on weather conditions and market prices], 2021.
7. Kasa, V., et al, "Predicting crop prices for informed farmer decision-making", [Dataset: Historical crop prices, harvested area, yield data], 2021.
8. Koparkar, G.A., et al, "Efficient framework for crop price prediction using machine learning techniques", [Dataset: Soil parameters, rainfall, soil moisture], 2021.
9. Harrykissoon, K., & Hosein, P., "Forecasting crop prices for agricultural planning using time series models", Agricultural Economics Journal, Vol.58 (3), Pg.112-123, 2021.
10. Kumar, S. B., "Minimizing losses in agriculture through accurate prediction of crop yields and market prices", 2022.
11. Dhanapal, R., et al," Predicting crop prices to assist farmers in making profitable decisions", 2022.
12. Sajithabanu, S., et al," Implementing machine learning algorithms for accurate agriculture price predictions and market forecasting", 2022.

13. Soni, N., & Raut, J.," Crop price prediction using historical rainfall and Wholesale Price Index data: A machine learning approach,"2022.
14. Roshini, N., et al, "Predicting future crop prices using historical yield and price data of various crops", Journal of Agricultural Economics, Vol.11(2), Pg. .45-55,2024
15. Ranaweera, H. M. B. P., et al, "Predicting vegetable prices in Sri Lanka using data mining techniques", Journal of Agricultural Research, Vol. 15(3), Pg. 23-30,2023.
16. Pooja Dl," Improving predictions for crop prices and machinery rental", Journal of Agricultural Economics, Vol.15 (4), Pg. 67-75, 2023.
17. Gupta, T., et al," Weather and soil condition data for optimal crop selection", International Journal of Agriculture and Food Science Technology,2023
18. Bopche, A., et al, "Predicting Crop Prices and Providing Cultivation Guidance to Farmers Using Data Science Techniques", [Dataset: Historical data on market prices, climate patterns, supply and demand dynamics],2023
19. Dr. Rajashree et al, [Dataset: Historical data of crops (wheat, ragi, bajra, barley)], 2023.
20. Asha, D. S. R., et al, "Enhancing Agricultural Yield and Price Forecasting with Machine Learning Techniques", Journal of Agricultural Innovation and Technology, Vol.12(2), Pg.150-160,2024
21. Antad, S., et al, "Predicting Agricultural Commodity Prices Using Weather and Market Data with Machine Learning", Journal of Agricultural Data Science, Vol.15 (3), Pg.210-220, 2024.
22. Borkar, B. S., et al," Crop Yield and Price Prediction Model Using Machine Learning Techniques", International Journal of Agricultural Data Science, Vol.15 (2), Pg. 221-23, 2024.
23. Pandey, S., et al, "Crop Price Prediction System for Sustainable Agriculture", Journal of Agricultural Data Science, Vol.12(3), Pg.345-352,2024
24. Adilakshmi, T., et al, "Stacking Ensemble Techniques for Crop Price Prediction", International Journal of Agricultural Science and Technology, Vol.15(2), Pg. 210-217,2024.
25. Kotkar, S. A., et al," Crop Price Prediction using Machine Learning", International Journal of Innovative Science and Research Technology, Vol. 9(3), Pg.2698,2024.
26. Done, S., et al," Survey on Crop Price Prediction and Recommendation Using Machine Learning and Weather Forecasting", International Journal for Research in Applied Science & Engineering Technology, Vol.12(5), Pg.5466,2024
27. Shirole, B.S., et al, "Smart Crop Planning System for Improved Crop Selection and Fertilizer Advice", 2024.