

AI-Enabled Forecasting and Its Influence on the Agricultural Commodity Market in India

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Abstract

The growing adoption of Artificial Intelligence (AI) in financial and commodity markets has altered the accuracy of forecasts, the effectiveness of decision-making, and the overall market's performance. Within the agricultural commodities sector, where price fluctuations, seasonality, and supply-chain interruptions continue to be key issues, AI-based predictive technologies represent a drastic shift away from traditional statistical frameworks toward more adaptive, data-driven prediction systems. This paper will analyse how AI-driven forecasting impacts the agricultural commodity markets and specifically the effect of market efficiency and price discovery as well as the impact of machine-learning-driven predictive signals on trading behaviour. A comparison is made between the forecasting performance of the AI models and the traditional methods of autoregressive on the basis of historical price and volume data of major Indian commodity exchanges and the results assessed in terms of subsequent impact on volatility patterns and directional accuracy. The results indicate that AI-based predictions have the potential to improve the short-term predictability and sensitivity to market shocks, which can improve the effectiveness of agricultural derivatives market. Nevertheless, there are also potential behavioural and structural implications identified in the study such as volatility cluster as a result of an algorithm, and change in trader expectations. Altogether, this paper can be seen as an addition to the emerging debates on the role of intelligent forecasting systems in transforming the dynamics of the commodity market and provides insights into policymakers, exchanges, and market participants who want to use AI responsibly in agricultural markets.

Keywords: Artificial Intelligence (AI); Machine Learning Forecasting; Agricultural Commodity Markets; Commodity Derivatives; Predictive Analytics

1. Introduction

The agricultural commodity markets are very important to price stability, production risks, and effective distribution of resources in the extended agri-food ecosystem. These

markets are however volatile by nature since there are uncertainties about supply side, climatic fluctuation, shifting consumption trends, and even global policy upheavals. Proper forecasting is thus a core of proper decision-making in agriculture among farmers, traders, processors, as well as policymakers. Historically, econometric time-series predictive models, including ARIMA, GARCH, and VAR, have been the basis of forecasting in agricultural commodity markets, but these have nonetheless had difficulties in modeling nonlinear and fast-changing, and complex market trends.

The advent of Artificial Intelligence (AI) and machine learning has brought a new opportunity to predict precision and market elasticity. It has been demonstrated that AI-based models such as neural networks, random forests, and deep learning architectures can acquire complex patterns using extensive data, combine different variables, and respond dynamically to market shocks. Their growing utilization in the financial and commodity markets has changed the manner in which financial trade trends are foreseen, the volatility is measured, and the trading plans are implemented. The AI-based prediction models used in the production of agricultural products, where informational inefficiencies are even more evident, are an enormous jump compared to the traditional ones because they would guarantee a higher predictive accuracy and help in real-time decision-making.

With the increasingly common use of AI-generated predictive signals, they have not only an effect on accuracy in applying forecasts but also on how the market operates in general. The increased predictability could lead to better price discovery, increased efficiency of the market, and hedging strategies (Box & Jenkins, 1976; Zhang, 2003). Simultaneously, the rise of algorithmic involvement can change trading behaviour, increase the adjustment of high-frequency volatility, or change the volatility pattern. Such dynamic factors underpin the necessity to explore the way in which AI-based forecasting interacts with market forces and affects the efficiency and stability of agricultural commodity derivatives.

It is on this background that this paper examines how AI-based predictive analytics has affected agricultural commodity markets with specific reference to the Indian market. The study will compare the AI-based prediction models and the conventional statistical methods and explore the implications of the findings on the price discovery and volatility dynamics to give subtle insights into the transformative nature of intelligent forecasting systems (Hastie et

al., 2009). The results are aimed at adding to the current discussion of digitalisation and technological innovation in the commodity marketplace, providing designers of exchanges, policymakers, and industry players with implications applicable to the effective and responsible use of AI to integrate it into the market.

Moreover, the quick pace of digital trading infrastructure and informed decision systems in India has hastened the urgency of AI-based prediction in the commodity exchange in MCX and NCDEX. Prior studies on Indian commodity exchanges highlight the evolving structure and performance of agricultural derivatives markets, emphasizing the importance of advanced analytical tools for understanding market trends and efficiency (Fathima & Pasha, 2025; Fathima, 2025). Since traders, hedgers, and managers in the market are finding it more and more important to trust algorithmic insights when they make trading decisions, hedge, and manage their portfolios, it is vital to comprehend the behavioural and structural implications of AI-based predictions. This paper thus not only examines the technical excellence of AI models but also explores their overall application in market dynamics, such as liquidity, volatility transfer, and the possibility of new market distortions caused by algorithms. Incorporating both empirical and theoretical insights, the paper strives to provide a full-fledged evaluation of the way AI-powered forecasting is changing the current landscape of the agricultural commodity market and how this can be applied to the future business of designing, regulating, and sustainably growing the market.

2. Review of Literature

2.1 Machine Learning and AI in Forecasting

Artificial Intelligence has massively increased predictability in the financial and commodity markets. Initial studies identified the limitations of conventional linear models, particularly when nonlinear and high-frequency data are involved (Box and Jenkins, 1976). Machine learning algorithms like the Artificial Neural Networks (ANNs), the Support Vector Machines (SVMs), and the random forests are superior predictors, because they can capture nonlinearities and hidden patterns that are not addressed by conventional models (Hastie, Tibshirani, and Friedman, 2009). Other studies have affirmed that AI-based models are superior to the ARIMA and GARCH models in predicting price changes, fluctuations, and market orientation (Zhang, 2003; Pai and Lin, 2005).

Application of AI in the prediction of commodity prices has grown at an incredible rate, particularly in those markets that are volatile due to weather forecasts, supply issues and global market forces. Research using neural networks to predict the price of agricultural commodities demonstrates a better forecasting capability than the classic econometric models (Garcia, Roh & Leuthold, 1995). Recent research notes the benefits of hybrid models, i.e. machine learning in conjunction with econometric models, especially in the case of commodities such as crude oil, wheat, and soybean (Yu, Wang, and Lai, 2008). The machine learning tools have also been able to improve the modelling of seasonality and structural breaks, which are prevalent in agricultural markets (Taylor, 2010). Models based on AI are now used to forecast volatility spikes and regime changes (Makridakis, Spiliotis, and Assimakopoulos, 2018). Research indicates that improved machine learning approaches like the Long Short-term Memory (LSTM) networks are capable of capturing long-range relationships over the GARCH models, leading to superior volatility predictions of agricultural products (Siami-Namini, Tavakoli & Namin, 2019). These results indicate that AI forecasting could have an impact on market behaviour, hedging, and risk management.

2.2 The effect of AI and Algorithmic Trading on the behaviour of the market

With AI applications being introduced to commodity markets via algorithmic trading and predictive analytics, microstructure market research results are inconsistent. Algorithms may enhance liquidity and reduce the bid-ask spreads (Hasbrouck and Saar, 2013), but also cause volatility clustering and market noise, especially when high-impact events occur (Kirilenko et al., 2017). Researchers observe in agricultural futures markets that the enhanced automation has an impact on the quality of order-flow patterns and rapid information adoption in prices (Adämmer & Bohl, 2018). Price prediction is not the only type of forecasting used in agricultural systems, as yield prediction, crop infections, and supply-chain optimization are also in use. Gradient Boosting and Convolutional Neural Networks (CNNs) are machine learning models that have performed well in crop yield and production uncertainties prediction (Khaki and Wang, 2019). The developments apply to commodity price forecasting since the shocks in supply have a direct impact on the dynamics of prices. Research has shown that AI-based predictions of the yield help market participants to predict supply changes, which facilitates effective inventory control and efficient price formation (Basso and Antle, 2020).

3. Significance of the Study

The increasing use of Artificial Intelligence in the financial and commodity markets is a significant change in the manner in which the pricing, risk management, and implementation of trading decisions are made. In the markets of agricultural commodities, where climatic fluctuations, supply disruptions, seasonality, and world uncertainties are the main volatilities, precision in forecasts is essential in improving stability in the market and sustaining the lives of producers and traders. The research paper is important as it conceptually analyzes how AI-based predictive tools can change these markets by providing higher predictive abilities than conventional econometric models. To the market players, including the farmers, processors, exporters, and institutional traders, AI-oriented predictions would result in improved planning, minimized uncertainty, and increased efficiency in resource allocation. In the case of exchanges such as MCX and NCDEX, it is crucial to learn about the impact of AI tools to develop a strong trading system, improve liquidity, and make the market activities fair and transparent.

Regulators and policymakers will also find the study important. Due to the increasing use of AI-based predictive systems, one might hear the issues of algorithmic trading behaviour, amplification of volatility, and information asymmetry. Through conceptual analysis of these factors, the study offers significant knowledge on how to formulate proper regulatory systems, risk-based systems, and ethical AI application standards in commodity markets.

4. Research Methodology

The research design used in this paper is a conceptual research design by investigating the impact of AI-based forecasting in the operations and behaviour of agricultural commodity markets. Since the study is aimed at a theoretical and not an empirical study, the approach will rely on a systematic review and synthesis of academic articles, reports published by institutions, and existing theories on Artificial Intelligence, future predictive models, derivative products in markets, and market microstructure. By combining the knowledge about machine learning forecasting, the price discovery theory, and behavioural finance, this paper develops a conceptual framework, which explains how the impact of the AI-driven predictions on efficiency, volatility, liquidity, and hedging performance in agricultural commodity markets can be achieved. There are no main or numerical secondary data involved, but the paper constitutes arguments and conceptual connections based on the available literature as the factors that justify future empirical research.

5. Conceptual Framework

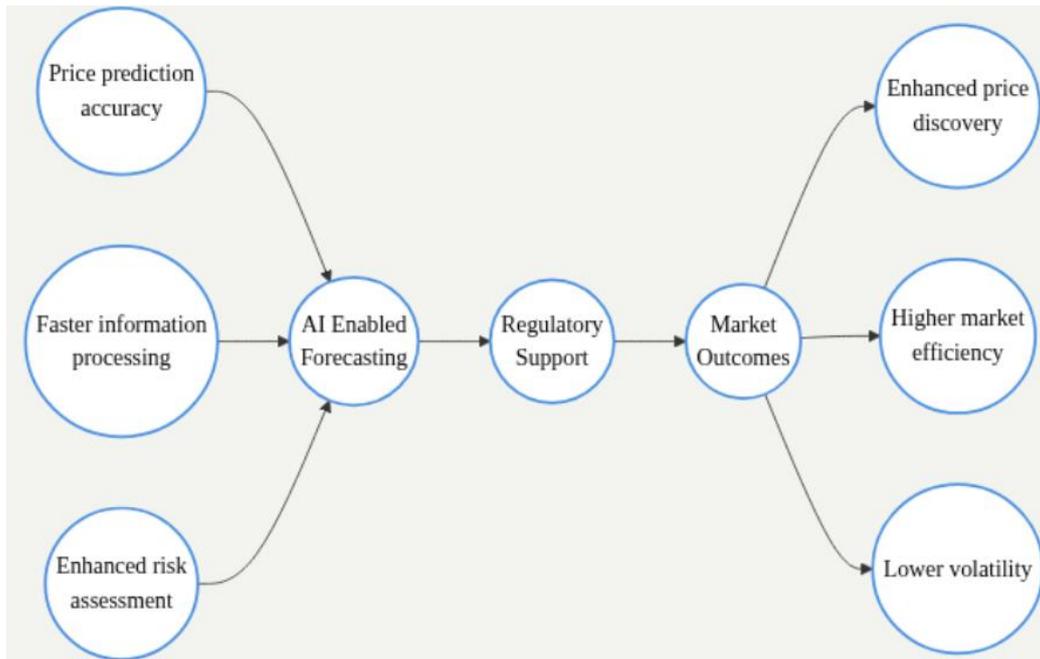
The theoretical foundation of this research is the premise that AI-driven forecasting is an innovative information process in the agricultural commodity market, which affects the behaviour of the market participants and the fundamental market features, such as price discovery, volatility patterns, and trading efficiency. The framework is based on the existing theories of the efficiency of the market, diffusion of information, and behavioural responses of the market, and adopts them in conjunction with new technological views on machine learning and algorithmic predictions.

In this context, AI predictions affect the behaviour of the market in two major ways, which include informational effects and behavioural effects. The informational impacts consist of the accuracy and timeliness of better predictions, which may enhance price discovery due to the reduction of noise, decreased information asymmetry, and enhanced informed trading. The behavioural impacts are visible when traders, especially algorithmic and high-frequency, have AI signals in their strategies.

The last element of the conceptual framework is the study of the market-level consequences of these AI-mediated informational and behavioural channels. The enhanced predictability could be used to contribute to better price discovery, better hedging policies, and market adjustment. Simultaneously, volatility structures might change, and market power might shift to traders with better technology, and there might also be new regulatory issues associated with transparency and fairness and systemic risk, due to increased dependence on AI-based predictions. The framework accepts these dual possibilities and places AI as a facilitator of efficiency as well as a possible source of the new complexities in the market.

This framework serves as a theoretical framework to comprehend the wider sense and implications of the adoption of AI in the agricultural commodity ecosystem in India, and it guides future research on the empirical and policy-oriented studies.

5.1 Conceptual Model



This theoretical framework depicts the effects of AI-powered forecasting systems on different market outcomes in the world of agricultural commodities. The model places AI methods, including machine learning algorithms, deep learning models, and predictive analytics, at the core of enhancing the accuracy of price prediction, risk, and decision-making among the market participants. These gains then influence some important aspects of market performance, such as price discovery, market efficiency, volatility, and hedging performance.

According to the model, the level of AI-based forecasts efficiency is conditioned by data quality, technological infrastructure, regulatory frameworks, and market participants adoption. The degree to which AI outputs improve the performance of the market is dependent on these moderating factors. Basically, the model suggests a route connecting AI-predicting abilities, the behaviour of a trader, and market performance, and thus provides theoretical grounds to comprehend the revolutionary place of AI in the agricultural commodity markets.

6. Discussion

This theoretical framework is developed in this paper that predicts AI-enabled forecasting can be described as a sophisticated information-processing mechanism that transforms the mode in which agricultural commodity markets are conducted. The forecasts

made by AI can enhance price discovery and decrease the informational asymmetry among traders in the market by enhancing the speed and precision of interpreting market-relevant information. Predictive signals are more reliable and consequently, the traders and hedgers can predict price movements resulting in more informed trading decisions and better market efficiency. In theoretical terms, this can be explained by the Efficient Market Hypothesis according to which better information processing leads to an increase in the speed of the incorporation of the information available in the prices, especially in the future markets where expectations are primary. Meanwhile, it is also pointed out in the discussion that the impact of AI-enabled forecasting is not limited to efficiency but also behavioural and structural market results. The growth in usage of algorithmic predictions can change the intensity of trading, pattern of liquidity and dynamics of volatility particularly when a number of individuals are acting in response to the same predictive template. Although this behaviour can increase liquidity in typical market situations, it might also play a role in the concentration of volatility in the short run when the market is in a state of stress. These two implications explain why the regulation of AI technologies and its balanced use in the agricultural commodity markets should be taken seriously. In general, the discussion highlights that AI-powered forecasting is not only a technical breakthrough but a structural disruption, which has the potential to redefine the behaviour of the market, the ways of risk management, and the stability of the markets in the long term.

7. Conclusion

This paper conceptually analysed the place of AI-driven forecasting in determining the operation and behaviour of agricultural market commodities. Through synthesis of available theories and literature the paper has listed the benefits of AI-based predictive tools in terms of information processing, price discovery and also lead to increased market efficiency. The presented conceptual framework is used to show how AI-enabled forecasting affects not only the accuracy of forecasting but also trading behaviour, liquidity conditions, and dynamics in volatility, as well. Such developments are of special importance in the markets of agricultural commodities, where uncertainty and lack of information are commonplace and contribute to the enhanced functioning of the markets and facilitating the making of informed decisions. Simultaneously, the paper has highlighted that the increasing use of AI-based forecasting has brought additional issues with behavioural clustering, algorithm-driven volatility and regulatory regulation. These results indicate that although AI-enhanced anticipatory can have

the significant advantages, it should be deployed in commodity markets with a balance of reasonable governance practices to maintain the stability of the market and equity. On the whole, this conceptual discussion can be added to the growing literature of technological change in agricultural markets and offers a theoretical base to new empirical studies of the practical character of AI application to agricultural commodity derivatives.

8. Future Research Directions

- The conceptual relationships in this paper may be empirically tested using future research that utilizes AI-based forecasting models to forecast agricultural commodity markets based on spot and futures price data.
- This framework could also be expanded in future studies to cross-market analysis through the investigation of the spillover impacts of AI-driven forecasting between commodity markets and other financial markets.

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