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AGRICULTURAL PRICE PREDICTION THROUGH ARTIFICIAL INTELLIGENCE

Sandhu Dutt, *Prateek N Kulkarni, Shilpa Akilan M, Rishav Mishra, Pratik Khetan and Animesh Bhadora

A4 1214, Gokulam Apts, 8th Mile, Kanakapura Rd, Vasanthapura, Bengaluru 560062

ABSTRACT

Agriculture is a critical sector in India, contributing significantly to the economy and supporting the livelihoods of millions. However, the sector faces challenges due to the unpredictability of agricultural prices, which can fluctuate due to various factors, including global market trends, weather conditions, and government policies. In recent years, artificial intelligence (AI) has emerged as a powerful tool to forecast agricultural prices, offering the potential to improve decision-making and mitigate risks for farmers, traders, and other stakeholders. This research paper provides a comprehensive review and analysis of AI-driven agricultural price prediction techniques. It examines traditional methods and their limitations, highlighting the need for AI-driven solutions. The paper discusses various AI models, including machine learning algorithms like linear regression, random forest, and LSTM, and their application in predicting agricultural prices. It also explores the role of AI in enhancing market transparency, optimizing resource allocation, and improving decision-making in agriculture. Furthermore, the paper discusses the real-world impacts and benefits of AI-driven price prediction for agricultural stakeholders. It highlights how AI can help farmers increase profitability, reduce risk, and optimize resource allocation. The paper also discusses the challenges and ethical considerations associated with AI in agriculture, emphasizing the importance of creating policies to address these issues. Overall, this paper demonstrates the potential of AI in revolutionizing agricultural price prediction and its impact on the agriculture sector in India. It concludes with recommendations for policymakers, stakeholders, and researchers to further develop and implement AI-driven solutions for forecasting crop prices, ultimately supporting the prosperity of Indian farmers and ensuring food security.

INTRODUCTION

Agriculture has always played an important role in the economic structure of India and is the main source of livelihood for most of the population. Agriculture is an important part of the country's economy, with more than 58% of India's workforce engaged in agriculture. But the fate of farmers depends on the unpredictability of agricultural products, which fluctuate not only in the Indian market but also internationally. This presentation aims to explore the complexities of global change and indigenous agriculture in India and the huge impact of these changes on the lives and livelihoods of Indian farmers. Plants play an important role in the Indian economy, increasing the income of rural households. Since fruit and vegetable cultivation is a labour intensive business, it creates many job opportunities in rural areas. India has diverse soils and climates spread across various agro ecological zones, making it capable of producing a wide range of crops. Vegetables, fruits, tubers, roots, ornamentals, medicines, aromatics, flowers, condiments, spices, mushrooms and herbs form a significant part of the entire agricultural production area sector in the country (available at: www.businessworld.in Date: 17 August)., 2020). Tomato, Onion and Potato (TOP) crops are considered as a staple food in India. However,

abundant only for a short period of time and there are problems with storage, transportation and subsequent losses of harvested crops. This makes marketing of products difficult (available at www.nhb.gov.in visited 20 March 2020) and prices fluctuate significantly in stores. Fluctuations in TOP product prices have caused stress among households in the country (Kumar and Joshi Citation 2016). Operation Green is a project initiated by the Ministry of Food Processing Industries, Government of India, to sustain the production of top crops in India by increasing production every year in the absence of any change (cited in Kumar et al., 2012). Predictive forecasting models are widely used to help decision maker's better plan for the future. In a developing country like India, proper planning through good forecasting is essential for the development of the country. Keeping these recommendations in mind, we conducted a study to model and forecast wholesale and retail prices of the BEST crops in India. Moving average (MA), autoregressive (AR), autoregressive integrated moving average (ARIMA), autoregressive moving average (ARMA), exponential smoothing, etc. Traditional cultural models such as can all be used to estimate TOP. However, the linear statistical model works with the assumption of the relationship structure of the data over time. Therefore, this model is quite capable of capturing linear patterns present in time series data. However, these models generally do not perform well in nonlinear

nonlinear models, nonlinear learning models such as short-term neural network (LSTM), nonlinear neural networks (ANN) and support vector machines (SVM) are increasingly increasing in the literature. Both model-based statistical methods and nonlinear machine learning methods have achieved great success in their studies on linear and nonlinear time series forecasting (TSF). However, the use of nonlinear learning methods for linear time series and statistical methods for nonlinear time series often leads to poor predictions. Moreover, neither statistical models nor machine learning models can provide good results when they contain a set of linear and nonlinear models (Zhang Citation 2003). However, the use of hybrid models by combining statistical models with nonlinear models provides a good opportunity to capture integrated and nonlinear patterns over time. As a result, many hybrid systems have been developed that combine model analysis with non-machine learning models.

Agriculture in India: The basis of livelihood: Agriculture in India is more than a business; It represents lifestyle, culture and tradition. For generations, agriculture has been a vital occupation for millions of people, providing livelihoods and economic support to rural communities across the country. In this context, it is important to understand the changes in agricultural products because they directly affect the health of farmers.

Global Agricultural Price Volatility: The global agricultural market is a complex and interconnected system that plays a significant role in the impact on agricultural prices in India. Understanding global changes in agricultural products is important as it paves the way for changes in the Indian market.

Impacts on Indian farmers: Indian farmers are mostly small farmers and are particularly vulnerable to changes in agricultural products. Falling prices can force them to sell stocks at a loss, causing them to fall into more debt and financial trouble. Conversely, inflation may provide temporary relief, but is often followed by an unexpected crash. The plight of Indian farmers has been highlighted in recent years by strikes and protests demanding fair prices, loan waivers and financial assistance. Agrarian reforms. These incidents underline the urgent need to address the problems faced by Indian farmers due to lack of prices.

LITERATURE REVIEW

An important aspect of agriculture today is the forecasting of agricultural products, which enables farmers to be aware of financial risks and manage financial risk effectively. In recent years, artificial intelligence (AI) has become a powerful tool to improve the accuracy of agricultural product price forecasts. This literature review provides an overview of significant advances in informed agricultural cost estimation, as well as methods, issues, and human implications.

Traditional methods and their shortcomings: In the past, farmers relied on traditional methods and business information copy to estimate price, but often faced problems due to inconsistent and inaccurate information. These questions require research into AI-driven technology to supplement and in some cases even replace traditional methods.

Resources and Machine Learning: AI-based agricultural price prediction uses machine learning to process various data. These sources include historical price data, weather patterns, market trends, and even user sentiment on social media. By combining such a variety of devices, the power prediction model was developed.

Feature Engineering and Data Pre-processing: Preparation of data, including maintenance, design and architectural models, is an important stage. Model performance can be improved by using clean, high-quality data. The goal of feature engineering is to create new transformations or representations of data to identify important patterns and thus provide more accurate predictions. The tools and technologies driven by artificial intelligence, machine learning and

the Internet of Things mentioned above are just beginning to be recognized by people. This leaves the agricultural industry in need of greater potential and the ability to connect to many different markets.

Machine Learning Models: Many machine learning models have been used to predict the price of agricultural products. Linear regression provides the basics, while complex methods such as random forest and gradient boosting can handle nonlinear relationships. Time series forecasting models such as ARIMA are also important.

Neural Networks and Deep Learning: Recurrent Neural Networks (RNN) and Convolutional Neural Networks (CNN) are very good at recording physical and spatial patterns in data. Agricultural article. This model is well suited for tasks such as agricultural yield prediction and pricing.

Measurements: Measures such as root mean square error (RMSE), mean absolute error (MAE), and mean percentage error (MAPE) are often used to measure model performance. Secure predictions through competition and negative testing.

Case Studies: Many studies around the world show the value of artificial intelligence-based agricultural price forecasting. For example, one study compared LSTM-based neural networks to corn price prediction methods and achieved higher accuracy. These research articles show the benefits that farmers will gain.

Issues and recommendations for action: Despite progress, there are still problems in using artificial intelligence to forecast production. In some areas, the educational model is hampered by the lack of data, and the interpretation model is still a problem. Combine satellite imagery and IoT data to better understand the future of agriculture.

Ethical Issues: The use of artificial intelligence in agriculture raises ethical questions regarding impartiality, transparency and information. It is important to create policies and procedures to address these issues and ensure farmers have equitable access to AI technology. The daily announcement of the increase in tomato prices is added to the increase in vegetable prices, creating pressure on financial forecasts in the near future. While vegetable prices continue to increase, food prices also increased from 3.3% to 4.6% in June compared to the previous month. The share of the food budget in the total budget increased. The main reason for the increase in vegetable prices is the unpredictable monsoon rains that affected parts of the country. If vegetable prices rise further, the inflation target of the Reserve Bank of India (RBI) will be severely affected. Prices were not checked immediately. Consumer Price Index (CPI) inflation should not exceed the Reserve Bank of India's maximum tolerance of 6%. Latest data shows India's retail sales rate at 4.81%. India's food processing industry has huge potential to help reduce rising vegetable prices. The gross value added (GVA) of the food sector in 2019-20 was Rs 224 billion, accounting for 1.69% of the country's GVA. In addition, the economy attracted foreign direct investment (FDI), with $709.72 recorded during the period. Finally, AI-based agricultural yield forecasting offers new ways to support farmers to make informed decisions and successfully manage financial risks. This is a strong area with many research institutions, and by using the potential of knowledge, farmers can improve distribution, crop management and overall benefits, ultimately supporting global food security. Models have been improved through the development of machine learning, big data analytics and integration of external devices. Although issues with data quality and market volatility still exist, researchers are working to make forecasting models in this important area more robust and general.

RESEARCH METHODOLOGY

Data Collection: The research of this article will be mainly based on government documents, educational materials, agricultural organizations and secondary sources. Compiled from good sources.

The data will be used to understand the current status of AI-driven solutions for predicting price changes of crops in the Indian agricultural context.

Source: The following sources will be used to collect relevant information:

Government Reports: Reports from the Ministry of Agriculture and Farmers Welfare, Government of India, published understanding of agriculture, crop yield and cost generation.

Academic journals: Research articles in agricultural economics, computer science, and machine learning journals discuss predictive models, yields, and knowledge-based methods.

Agricultural organisations: Reports and publications from organizations such as the Food and Agriculture Organization (FAO) and the International Food Policy Research Institute (IFPRI) provide a global perspective on food security, increasing the cost of agriculture.

News: News from trusted sources reports the latest developments in AI-powered agricultural price forecasting, including success stories and challenges.

Data analysis: The collected data will be analysed to identify trends, patterns and insights regarding AI-based crop price forecasting in India. The analysis will include:

Comparison: Compare different intelligence models and techniques used for product price prediction to determine their advantages and disadvantages.

Study Analysis: Investigate specific scenarios to evaluate the effectiveness and impact of AI solutions in real-life situations.

CONCLUSIONS AND RECOMMENDATIONS

This study will summarize key findings and provide recommendations to policy makers, stakeholders in agriculture and other researchers for the development and implementation of AI-driven solutions for forecasting crop prices in India. The aim is to achieve an agreement that can lead to success and prosperity of Indian farmers in the face of price fluctuations.

OBJECTIVES

1. How to use artificial intelligence to predict price change of agricultural products?

Information is the change in agricultural products. Frequent and large price changes have affected the country's economy, people's health, cleanliness and social security. Agricultural product price forecasts relate not only to the financial stability of individual countries or regions, but also to the balance of global food supply and demand. As the world's population continues to grow, food security has become a global concern. Accurate forecasting of agricultural commodity prices can help international organizations, governments, and agricultural companies intervene in a timely manner to ensure food availability and maintain food security in the world. Therefore, studies on the forecasting of agricultural products are particularly important in terms of developing stable quantities of agricultural products and supporting the growth and relations of the economy [1]. Artificial Intelligence is bringing one of the oldest sectors into the age of artificial intelligence. in the future. The number of applications of artificial intelligence in agriculture is staggering. Artificial intelligence makes agriculture more efficient. AI can use data from machine learning to assist farmers with irrigation, planting, harvesting, crop selection, planting and pesticide application. Farmers can use intelligence to collect and process more information in less time. Additionally, AI can analyze business needs, predict prices, and determine the best time to plant and harvest crops. AI in agriculture can help detect soil health, collect feedback, monitor weather, and recommend fertilizers and pesticides.

Agricultural management is more efficient and effective, allowing farmers to make better decisions at all stages of cultivation. Agriculture is a labor-intensive business, and automation becomes more important with the increase in population and agricultural demand. Artificial Intelligence has greatly helped farmers in terms of equipment, technology and applications. Predicting and improving agriculture and crop management to ensure high quality crops and inputs. Thanks to satellite images and weather data, companies can make instant decisions about planting areas and monitor crop health. 28, 29 Companies can use big data, artificial intelligence, and machine learning to predict prices, calculate tomato and crop yields, and identify pests and diseases. They can inform farmers about demand levels, different types of crops to grow for good profits, pesticide use and future price patterns. Artificial intelligence will become an effective tool to help organizations solve the complex problems of agriculture today, as it can reduce resource and labor scarcity. The days when large companies invested in this field are now over. Many industries are using artificial intelligence technology to increase productivity and efficiency. 30, 31 Artificial Intelligence technology is helping people from all walks of society overcome traditional problems. Finance, transportation, healthcare and agriculture are industries that use artificial intelligence applications. 32

2. What are the most effective techniques for predicting price changes in agricultural products?

The estimated value of perishable crops such as vegetables is important to farmers, traders and consumers. Timely and accurate forecasts can help farmers move between other markets to sell their products and get good prices. Farmers can use this information to select business opportunities. Many statistical models have been used in the past to predict agricultural product prices, but these models have their own assumption limitations. Machine Learning (ML) is an application of artificial intelligence that allows computers to learn without being programmed. It has many mathematical algorithms that make learning possible. Machine learning algorithms are the process of fitting a mathematical model to a data set through training or learning. The learning model was used by independent data to determine its performance on data not used during testing (Witten et al., 2017). 2016). Mathematical models based on machine learning often improve when given more information. We will use the diagram in Figure 2 to describe an example of a project that uses machine learning to predict crop yields based on weather models and remote sensing vegetable indices. In recent years, machine learning has been introduced to build learning models and predict time through deep learning algorithms. Deep learning algorithms such as Recurrent Neural Network (RNN) [12] and Long Short-Term Memory (LSTM) [13] perform well in many disciplines, especially finance. Deep learning is used in time series forecasting by extracting hidden patterns from the target network to reveal patterns and patterns of the system, which are often complex and non-linear. In general, LSTM is used to estimate time, especially in business and finance fields [14]. Kurumatani [15] used RNN mechanism to predict agricultural products. It uses two RNN methods for forecasting, namely Time Point Time Aligned Forecast (TATP) and Direct Future Time Series Forecast (DFTS). Om [16] used RNN and LSTM models to model email traffic and process traffic according to runtime. Yoo and Oh [17] used a seasonal LSTM model to predict sustainable agriculture sales for supply and demand variables. Therefore, in the era of fast computation and complex data, research on comparing the accuracy and precision of model prediction models and deep learning algorithms seems to be a new field [18], [19]. Another area of machine learning that is gaining momentum is the combination of algorithms with statistics or other machine learning methods. The concept of mixed model is an old practice in the literature period. It allows researchers to leverage each model and effectively predict the order of the cell [20]. With a similar goal, we hybridize the popular ARIMA and LSTM models and achieve the LSTM business idea using the random forest algorithm, making the ARIMA-LSTM hybrid framework novel and effective. This is followed by a discussion on the importance of job selection and the necessity of random forests.

3. What are the real-world impacts and benefits of AI-driven price prediction for agricultural stakeholders?

- *Improved decision making:* AI-driven price predictions help agriculture participants gain better insight into the future market. Farmers can plan crop selection, planting times and harvest times based on cost estimates. This best way helps them adjust the product according to the needs of the business and make it more profitable. Traders and buyers can also benefit from making informed decisions about when and where to buy and sell agricultural products. Overall, improved decision-making can lead to more efficient use of resources and a better return on investment for agricultural stakeholders.

- *Increased profitability:* Using intelligence-based price forecasting, farmers can increase profits by increasing the profitability of their crops. For example, if the price forecast shows that more is needed for the next crop, the farmer may allocate more resources to his production. This focus allows them to invest in the market and achieve higher sales rates. Similarly, traders and buyers can use price estimates to negotiate better and increase profits. Ultimately, AI-driven price prediction can help create more efficient and profitable farms.

- *Reducing Risk:* Price fluctuations are an important risk in agriculture. AI-powered price prediction helps stakeholders mitigate this risk by providing early warning of price changes. Farmers can adjust production plans or hedge risks by contracting futures to avoid losses. Merchants and buyers can also use price forecasts to manage their inventory and pricing strategies more effectively. By identifying and mitigating risks, agricultural stakeholders can reduce exposure to business uncertainty and ensure financial stability.

- *Market Transparency:* AI-powered cost estimation increases market transparency by providing stakeholders with better information about market trends and trends. Farmers, traders and buyers have access to real-time price forecasts, historical data and market-driven decisions. This transparency benefits all participants by promoting fair competition and good business practices. In addition, market transparency reduces information asymmetry, which can lead to increased cost-finding efficiency and better allocation of resources throughout the agricultural supply chain.

- *Efficient allocation of resources:* AI-driven cost estimation enables agricultural stakeholders to allocate resources more efficiently. Farmers can optimize the use of inputs such as labor, fertilizer and water based on cost estimates and market conditions. These projects reduce waste and increase productivity, resulting in greater profitability and lower production costs. Merchants and buyers can also benefit from efficient allocation of resources through effective product management and distribution strategies. Overall, AI-driven cost estimation helps simplify the allocation of resources throughout the agricultural supply chain, increasing overall profitability and sustainability. 6. Supply chain optimization: AI-powered price prediction plays an important role in optimizing the agricultural supply chain. AI provides accurate cost estimates to stakeholders, allowing them to anticipate changes in demand and plan transportation accordingly. Farmers can coordinate planting and harvesting according to the needs of the economy to ensure the sustainability of agricultural products. Merchants and buyers can optimize their supply and distribution to reduce costs and maximize quality. This optimization can create a harmonious and functional farm that can meet the changing needs of consumers and businesses. 7. Food Security: AI-powered price prediction improves food security by ensuring availability of agricultural products at affordable prices. By accurately estimating costs, stakeholders can anticipate potential shortages or overages and take preventative measures. For example, farmers can adjust planting plans to avoid overproduction or underproduction. Merchants and buyers may stockpile valuable items in times of abundance to

ensure supplies in times of scarcity. Overall, AI-driven price prediction supports global health by helping maintain a balanced and efficient food supply.

DISCUSSIONS

The factors affecting the changes in world agricultural product prices in the world market are:

1. **Weather and climate**: Bad weather conditions such as droughts, floods and hot weather can disrupt crop production worldwide, affecting supply and increasing prices. Conversely, ideal weather can lead to overproduction and subsequent price declines.
2. **International Trade Policy**: International trade agreements, tariffs and export restrictions can have a significant impact on the cross-border flow of agricultural products. Changes in the international market will affect Indian farmers' access to international markets and hence their income.
3. **Technological Advances:** Agritech innovations, including improved seeds, farming and mechanization, have the potential to increase agricultural productivity worldwide. These increases can affect supply and demand and therefore global prices.
4. **Government Policies and Subsidies:** Interventions by various governments, such as subsidies, price controls, and agricultural policies, can affect international trade. These policies will impact the competitiveness and income of Indian farmers.
5. **Analysis of the Financial Market:** Forecasts made by financial traders in the agricultural market can lead to price changes that do not affect the supply of desired goods and services. These forecasts may impact international prices and directly impact Indian farmers.
6. **Pests and Diseases:** The spread of pests and diseases can affect agriculture worldwide. The result may be reduced supply and increased prices on the international market; this could impact the ability of Indian farmers to export their produce.
7. **Environmental Issues:** Increasing concerns about sustainability and environmental impact have led to changes in agriculture worldwide. Shifting consumer preferences towards sustainably produced food may create new opportunities and challenges for Indian farmers.
8. **Geopolitical events:** Geopolitical conflicts and tensions between countries will affect the world market economy by disrupting product chains, imposing trade restrictions, or affecting exchange rates.

Price fluctuations of agricultural products in India

Price fluctuations of agricultural products in India are affected not only by international products but also by domestic products:

1. *Monsoon Dependency:* Indian agriculture is highly dependent on weather, making it vulnerable to erratic rainfall patterns and weather conditions. A failed monsoon can cause crop failure and increase prices, affecting farmers' incomes.
2. *Government Policy:* Government interventions such as Minimum Support Price (MSP), public procurement and subsidies also play an important role in the sustainability of certain crops. However, the effectiveness of these policies may vary and some farmers may not receive equal benefits.
3. *Infrastructure and Logistics:* Inadequate infrastructure and logistics challenges in India can lead to post-harvest losses, reducing farmers' income. Good transportation and storage facilities are important to avoid price fluctuations.
4. *Access to market:* Access to market and updated price information is very important for Indian farmers. Restricted access can make them vulnerable to trading by intermediaries and uncertain markets.
5. *Land Fragmentation:* Land fragmentation is a common problem in Indian agriculture, with small holdings making it difficult for farmers to access modern agriculture and technology.

6. ***Input costs:*** Rising prices of agricultural inputs such as seeds, fertilizers and pesticides, especially low market prices, may reduce farmers' profits.

Impacts of Artificial Intelligence in Agriculture: Artificial Intelligence-based technologies can help increase efficiency in all operations and can help manage challenges from multiple sources. Business soil content, crop care, cultivation, cultivation, including many areas of agriculture such as crop yield, Irrigation, Analysis (Kim et al., 2008). Agricultural robots were born to provide useful applications of intelligence in the above fields. Agriculture faces challenges as the global population grows, but AI has the potential to provide much-needed solutions. Smart solutions enable farmers to achieve more production with fewer inputs, even increasing yields and getting products to market faster. Farmers will use 75 million connected devices by 2020. By 2050, the average farm is expected to produce an average of 4.1 million data points per day. There are many ways artificial intelligence can contribute to agriculture:

Image recognition and perception: Lee et al. (2017) stated that in recent years, there has been increased interest in autonomous drones and their applications, which include identification and surveillance, human detection and geolocation, search and rescue, and forest fire investigation (Bhaskaranand and Gibson, 2011; Doherty and Rudol, 2017). 2007; Tomic et al., 2012; Merino et al., 2006). We can do many things with this device, drone or Drones, due to their performance and having the best equipment (such as delivery to photography), the ability to fly using remote control and the ability of the equipment to work in the air. It should reach a good height and distance and be high enough for many uses. 2.2. Artificial intelligence and efficiency. Panpatte (2018) said that artificial intelligence allows farmers to collect more information from government and public websites, review all the information and give farmers the ability to solve confusing problems. Give us a smarter way to irrigate so we can make more money for farmers. Thanks to artificial intelligence, farming in the future will become the combination of intelligence and agriculture, which will not only bring good results for all farmers but also reduce their losses and jobs. The United Nations stated that 2/3 of the world's population will live in cities by 2050, which will reduce the burden on farmers. The application of artificial intelligence in agriculture can perform many operations, reduce risks, and provide farmers with the opportunity to do simple and efficient agriculture.

Maximizing Output: Ferguson et al. (1991) stated in his study that multiple selection and quality genes determine the best performance in all plants. New technologies can help select the best crop and also improve the selection of hybrid seeds best suited to the farmer's needs. It is used to understand how seeds respond to different climates and different soil types.

By collecting this information, the risk of plant diseases can be reduced. Now we can meet the market economy, annual profit, customer demand so that farmers can get the best profit from their products. 2.4. Chatbots for farmers. Chatbots are nothing but interactive virtual assistants that interact with end users. AI-powered chatbots, combined with machine learning, allow us to understand natural language and interact with users in different ways. They use the site, which is mainly used in marketing, tourism, social media and agriculture, to help farmers find answers to their unanswered questions, inform them and provide many recommendations.

Disadvantages: Changes in world agriculture and the Indian economy are having a huge impact on the livelihoods of the Indian people. These changes are driven by many factors, from international climate patterns and economic policies to local agriculture and government intervention. In the next section of this research paper we will introduce all the factors, present the research data and provide global models to show their impact on the response of Indian farmers. By better understanding these changes, we can better understand the challenges faced by Indian farmers and work to develop policies and strategies that support recovery and prosperity in the face of price fluctuations.

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