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Development of a Mobile Application for Connecting Farmers with Traders and a Price Prediction Model using Machine Learning

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Abstract: *In the realm of agriculture, farmers face multifaceted challenges that hinder fair trade and optimal profit realization. The absence of direct communication channels often compels farmers to sell their produce at reduced prices to intermediaries, leading to financial losses and exploitation. This paper introduces an innovative mobile application designed to address these issues and enhance the agricultural trading landscape.*

The proposed mobile platform serves as a transformative channel connecting farmers and traders directly. It facilitates seamless interactions, allowing farmers to market their products directly to consumers without any middleman. By eliminating intermediaries, farmers can ensure equitable pricing and retain a larger share of their profits. Additionally, traders benefit from direct access to a diverse range of produce, fostering transparent and efficient transactions. Furthermore, the integration of a machine learning-driven crop price prediction model augments decision-making capabilities. Leveraging historical data and relevant indicators, this model offers insights into future crop prices, aiding stakeholders in strategic planning and risk mitigation.

In this research endeavor, we seek to redefine agricultural trade dynamics by harnessing technological advancements. Through direct engagement, intelligent mapping, and predictive analytics, our mobile platform empowers farmers and traders alike. By mitigating financial losses, fostering transparency, and offering insights for prudent decision-making, this solution contributes to a more equitable and sustainable agricultural ecosystem.

Keywords: agricultural trade, mobile platform, direct communication, transparency, mapping, machine learning, predictive analytics

INTRODUCTION

India is understood as an Agrarian country as about 55% of India's population depends on agriculture or related activities for his or her livelihood. Agriculture features a significant contribution to the first sector of India's economy. Despite their pivotal role, farmers face challenges that hinder their ability to reap equitable rewards from their labour. One of the foremost predicaments is the lack of direct access to markets, leading to exploitative intermediaries and imbalanced trade dynamics. Prediction of expected price in the future is very much needed to manage and sell the products at the right time to maximize revenue and minimize loss. [2].

This research delves into a novel solution that addresses these challenges head-on: a revolutionary mobile application designed to empower farmers and revitalize agricultural trade. The application's conception stems from the recognition of the substantial disparities faced by farmers in traditional trading processes. Many farmers, driven by limited market knowledge and constrained by geographical barriers, often succumb to intermediaries who manipulate prices to their advantage. Consequently, farmers receive disproportionately lower returns for their produce, leading to income insecurity and perpetuating the cycle of dependence.

At the heart of the mobile application lie transformative features that cater to the needs of both farmers and traders. The incorporation of geolocation technology optimizes logistical efficiency by determining the shortest distance between farmers and traders. Moreover, the application employs machine learning algorithms to predict crop prices, empowering stakeholders with data-driven insights for strategic decision-making in an unpredictable market landscape.

The objectives of this research encompass a comprehensive evaluation of the impact of the mobile trading platform on the agricultural trade ecosystem. Price forecasting is important for farmers also as they base their production and marketing decisions on the expected prices that may have financial repercussions many months later. Through quantitative and qualitative analyses, we aim to assess the application's effectiveness in enhancing farmers' income, optimizing logistical operations, and providing accurate price forecasts. By shedding light on these aspects, we seek to contribute to a nuanced understanding of how technology-driven interventions can empower farmers and revolutionize agricultural trade dynamics.

The paper is structured as follows: Section 2 provides background, motivation and objectives of this research.

Section 3 delineates in-depth literature review, highlighting the challenges of agricultural trade. Section 4 presents the methodology employed in developing the mobile application and conducting the associated analyses. Finally, Section 5 encapsulates the findings, including the impact on farmers' income, and accuracy of price predictions along with the conclusions drawn from the study and discusses the broader implications and potential for future research.

BACKGROUND

Agricultural trade, which forms the bedrock of many societies, has long been marked by inefficiencies and information asymmetry. Farmers, who toil relentlessly to cultivate crops and produce, often find themselves ensnared in a cycle of suboptimal pricing due to their limited market reach and inadequate knowledge of prevailing market prices. Intermediaries and local brokers exploit this informational gap, procuring agricultural products at reduced prices and subsequently selling them at higher rates, siphoning off profits that rightfully belong to the farmers. This exploitative practice not only hampers the financial well-being of farmers but also perpetuates a cycle of dependency and unequal market access.

MOTIVATION

The agricultural sector, a linchpin of global economies, sustains livelihoods and ensures food security. However, farmers face persistent challenges that hinder equitable trade and profitability. The prevailing disconnect between farmers, traders, and consumers often results in unfair pricing, exploitation, and income instability for farmers. These issues underscore the critical need for innovative solutions that empower farmers and reinvigorate agricultural trade.

Moreover, the integration of machine learning-based crop price prediction addresses the volatility of agricultural markets. By offering accurate price forecasts, farmers and traders can make informed decisions, minimizing risks and optimizing their trading strategies. The potential impact of this research extends beyond the immediate stakeholders, affecting economies, food security, and the livelihoods of those dependent on the agriculture sector.

OBJECTIVES

- To enhance direct trade by developing a mobile application that facilitates direct interactions between farmers and traders,
- To empower farmers to independently market their produce and enabling traders to procure products directly from the source.
- To optimize logistics by streamlining transportation routes and minimizing logistical costs.
- To integrate machine learning algorithms to predict crop prices with accurate insights for strategic decision-making amidst market fluctuations.

LITERATURE REVIEW

Santosh G. Karkhile et.al [1] in their research study provided an entire idea about developing a mobile phone-based solution that helps in farm management, leads to agricultural yield improvement, and helps in farm maintenance. Researchers explain that modern farming provides the expected environment by weather forecasting as compare to traditional farming. Traditional farming requires large amounts of labor and different activities for conducting farming. Alternatively, modern farming does not require a huge quantity of labor as mobile, machines, and new technology take care of the whole thing. This mobile application provides real-time weather information, news, and market prices at diverse locations and all information is provided in local languages. Outcomes of the researcher's application helps farmers to improve their agriculture yield. The author expands the System Architecture with additional feature which includes different operations like registration of farmers, weather forecasting, news and feeds, multiple language support, and market trading.

Iffco Kisan [3] is farming app for Kisan. It utilizes less memory and gives easy interface. This android mobile application gives diverse information to farmers like latest mandi prices, latest agriculture advice, farming tips to make farming easy. It moreover provides agriculture alerts to farmers in different Indian languages. The farmers can effortlessly take help from crop growing experts using this app.

Shailaja Patil et.al [4] orchestrated survey based on Precision Agriculture in 2015. The paper explores how different mobile phone application and precision agriculture services have impacted the farmer's life in their agricultural activities. Agriculture is one the most vital fields with a growing need of decision support systems. Precision agriculture comprises of different systems which offer the variety of service areas such as information services, traceability systems, precision irrigation, monitoring, controlling and management of the agricultural field. This paper discovers how precision agriculture services and related mobile apps have impacted the farmers in their farming actions.

Arshad P. Muhammed et. al [5] designed and developed an AGRIO APP. It's an Advanced Android Application for Farmers. The review records that traditional farming methods can result in slow progress and that many farmers are not aware of technical advancements in the field or the various schemes available to them. With the emergence of mobile phones and the internet, there is an opportunity to provide farmers with essential information through an Android application called AGRIO APP. The app also

provides a platform to sell crops on profits without marketing, identify the current market rate of crops, understand climate conditions, and learn about new methods. By utilizing mobile technology, the AGRIO APP has the potential to empower farmers and improve the efficiency of the agriculture industry in India.

Shubham Sharma and Chirag Shah [6] designed and developed an E-Agro Android application. This application is a combination of fashionable net and mobile communication systems with GPS for economical and smooth farming. The paper highlighted the theories and analysis of DBMS and also use of Smartphones in agriculture to address some common problems faced by the farmers across the nation.

Patel K. et.al [7] carried out a comparative analysis of Supervised Machine Learning Algorithm for Agriculture Crop Prediction and developed a crop production model in which they proposed to manage the produced crop using machine-learning algorithms to help farmers in developing countries, who are still using traditional methods and are still not able to recognize the correct market value of their products. The proposed system is based on three scenarios; firstly, choosing the best crops based on the farmer's location, secondly, providing guidance on soil preparation, and thirdly, providing the best way of crop marketing from farmer to consumer. The authors applied Support Vector Regression, Voting Regression techniques, and Random Forest Regression algorithms along with proper real data for climate, weather, and soil.

P. Priya, et.al [8] proposed predicting yield of the crop using machine learning algorithm based on the central theme that certain factors like weather conditions, soil parameters and the historic details of the crop has an effect on the yield of the crop in the present. So, it is important to take these factors or the parameters into consideration and predict the yield of the crop planted. Certain Machine Learning algorithms are considered for developing the models of the data obtained from the past historical yield of the crop and reflecting them in predicting the yield of the crop planted in the present. This paper focuses on predicting the yield of the crop by using Random Forest algorithm. Real data of Tamil Nadu were used for building the models and the models were tested with samples. The prediction will help to the farmer to predict the yield of the crop before cultivating onto the agriculture field. To predict the crop yield in future accurately Random Forest, a most powerful and popular supervised machine learning algorithm is used.

Rachana P. S. et.al developed a crop price forecasting system using supervised machine learning algorithms. In this paper, Crop Price Forecasting System Using Supervised Machine Learning Algorithms revolves around two main issues of agriculture- Profit and Price. This paper takes these two factors into consideration and develops a system which accurately predicts the price of the crop as well as the profit of the crop. The system comprises of two actors, the Administrator and the Agricultural Department. The Admin maintains the entire System. The Department performs two main roles, Price Prediction and the Profit Prediction. The Parameters considered for Price Prediction are- Rainfall, Maximum-trade, Minimum Support Price (MSP), Yield. The Parameters considered for Profit Prediction are- Crop Price, Yield, Cultivation Cost, Seed Cost. To predict the Price of the Crop we use Naïve Bayes Algorithm which is a Machine Learning Classification technique. To predict the Profit of the Crop they used K Nearest Neighbor (KNN) which is a Supervised Machine Learning Classification Algorithm. This system gives a beforehand prediction to the Farmers which increases the rate of profit to them and in turn the country's economy. [9]

Saranya C. P. et.al [10] conducted a survey on Crop Prediction using Machine Learning Approach. In this research paper, they focused about the idea of implementing techniques with the help of technical knowledge and improve the conditions of the farming sector by making it more reliable and instructing it among the farmers to correctly predict the suitable crops according to the results obtained using certain machine learning techniques which takes into consideration of the factors like- soil, weather and the trends in the market. Certain conditions are also taken into consideration as the pH, Nitrogen levels and the nutrients constitution in the soil. The machine learning algorithms are used for the prediction which are Artificial Neural Networks, Information Fuzzy Network and Data Mining techniques. Finally, it is seen that Artificial Neural Network is the suitable technique for the project.

Pranay Malik et.al [11] conducted a study on "Comparative Analysis of Soil Properties to Predict Fertility and Crop Yield using Machine Learning Algorithm" in 2021. They used algorithms like Random Forest and Decision Tree Regression and targeted all officials whose main duties include water resources and agricultural management. They used Weather Research Forecasting (WRF) model as reference data for overcoming the limitations of a non-dense monitoring network. Also, they used Performance measures of the mean absolute error as well as classification accuracy. The WRF outputs reflect the topography of the area. Hybrid models showed better performance than simply bias-corrected forecasts in most cases. The model based on Extra-Trees trained using the WRF model outputs performed the best in most cases. [11]

METHODOLOGY

The Farm-Mitra Android application was meticulously developed to revolutionize agricultural trade dynamics. Leveraging the versatile Flutter framework and Firebase database, the application underwent a comprehensive development lifecycle, encompassing software engineering, database architecture, deployment, and rigorous testing.

The Farm-Mitra user interface was expertly crafted using Flutter, an open-source UI software development toolkit developed by Google. It was possible to develop a user-friendly interface that works well on Android devices, providing a smooth experience for all users. Flutter's rich widget library and plugins were harnessed to design and implement various application screens. The pivotal aspect of user security was upheld through Firebase Authentication, ensuring robust user authentication and authorization. This allowed farmers and traders to securely register and log into the application, fostering trust and data integrity.

Firebase Real-time Database, a cloud-hosted NoSQL database, constituted the foundation of efficient data management. Data about farmers, traders, products, and warehouses were accurately stored within a well-designed schema. This minimized data redundancy and maintained data consistency across the application. Firebase Cloud Functions enriched the application by executing server-side operations. These operations included the automated generation of selling tickets and timely notifications to traders when products became available, ensuring real-time engagement.

The incorporation of a machine learning price prediction model further bolstered the application's capabilities. Leveraging the Vector Auto-regression (VAR) model, the application was equipped to forecast crop prices. This involved data preparation, model fitting, and warehouse recommendation. Simulated datasets were generated using Pandas, a data manipulation library, and lagged datasets were constructed to capture time-series relationships. The VAR model was implemented using the stats model's library, enabling dynamic analysis and predictions. Incorporating data visualization, forecasted prices, and recommended warehouses were seamlessly integrated into the application's interface using Plotly, an interactive data visualization library. Additionally, libraries such as NumPy and Pandas facilitated efficient data processing and manipulation.

DISCUSSION

The Farm-Mitra application's multifaceted methodology, encompassing Flutter's user interface, Firebase's database management, and the integration of a machine-learning price prediction model, collectively shapes an innovative platform that empowers farmers and traders while facilitating informed decision-making and real-time engagement within the agricultural trade ecosystem.

The development and implementation of the Android mobile application for farmers and traders, along with the integration of a Price Prediction machine learning model, involved a systematic and iterative approach. The methodology can be broken down into following key stages:

Requirement Analysis and System Design: At the outset, a thorough analysis of the requirements for the mobile application was conducted. This involved identifying the features essential for connecting farmers and traders effectively. The system design phase encompassed defining the architecture, user interface design, and database schema.

Front-End and Back-End Development: The mobile application was developed for the Android platform, utilizing modern programming languages and frameworks. The front-end development focused on creating an intuitive and user-friendly interface for farmers and traders. The back-end development involved designing APIs, setting up the database for user profiles, crop listings, and chat functionality.

Geolocation Integration: To enable farmers to locate the nearest trading warehouse, geolocation services were integrated into the application. This allowed the app to determine the user's current location and display the relevant trading options and distances.

Crop Listing and Chat Features: The core functionality of the app involved allowing farmers to list their crops for sale and traders to list their crop requirements. Additionally, a built-in chat function was implemented to facilitate direct communication between farmers and traders, enhancing the trading experience.

Machine Learning Model Integration: The Price Prediction machine learning model was integrated to forecast crop prices. Historical data on crop prices and relevant market indicators were used to train the model. The model's predictions were then made available to farmers, aiding them in making informed decisions about selling their crops.

Testing and Feedback Iterations: Rigorous testing of the application was conducted to identify and rectify any bugs or usability issues. Feedback from potential users, including farmers and traders, was invaluable in refining the application's functionality and user experience.

RESULTS

The implementation of the Android mobile application, designed to connect farmers and traders while incorporating a Price Prediction machine learning model, yielded promising results:

Enhanced Connectivity: Farmers and traders were able to connect seamlessly through the application, resulting in increased opportunities for crop trading.

Fig 1. Home-screen for farmer users

Location-Based Services: The integration of geolocation services enabled farmers to identify the nearest trading warehouses and find the shortest possible distance to them, enhancing convenience and cost-effectiveness.

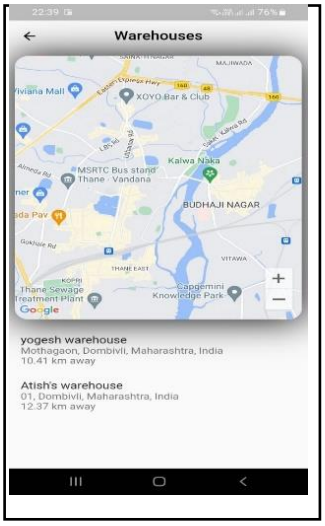

Fig 2.Warehouse locations on map

Crop Listing and Chat Functionality: The ability to list crops for sale and communicate directly with potential buyers or sellers through the built-in chat function streamlined the trading process.

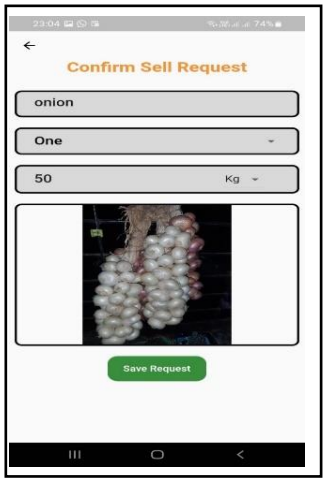

Fig 3. Crop listing feature

Price Prediction Model: The Price Prediction machine learning model demonstrated its effectiveness in forecasting crop prices. Overall, the result of the analysis is a set of forecasted prices and recommended warehouses for a particular time period, based on the VAR model and the input variables. The accuracy of these forecasts can be evaluated using metrics such as mean squared error, which measures the average of the squared differences between the forecasted and actual values. The accuracy achieved in this ML model is 89% which is considered as best in scale for general prediction models.

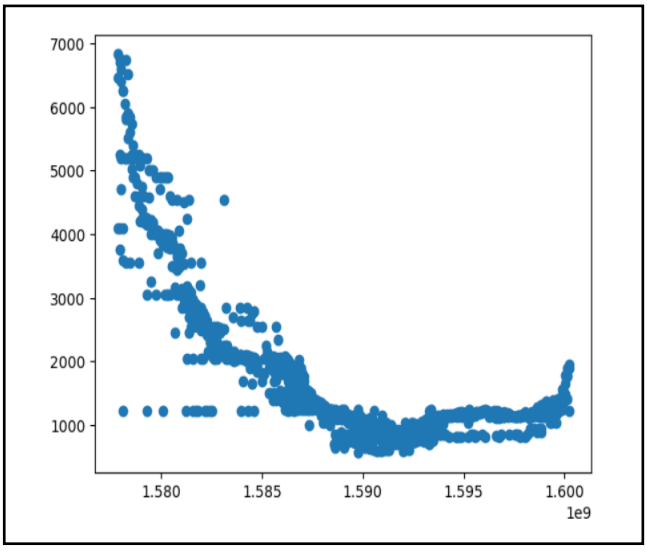

Fig 4.1 Scattered chart of real time data

The innovative warehouse suggestion feature within the mobile application plays a pivotal role in optimizing farmers' profits and resource utilization. By intelligently recommending the nearest trading warehouses, this feature effectively reduces travel distances, leading to significant fuel savings.

By minimizing transportation costs and travel time, farmers can channel their resources more efficiently, ultimately contributing to higher profit margins. This proactive approach to warehouse selection not only streamlines operations but also empowers farmers to make informed decisions, ensuring their crops reach the market swiftly and profitably.

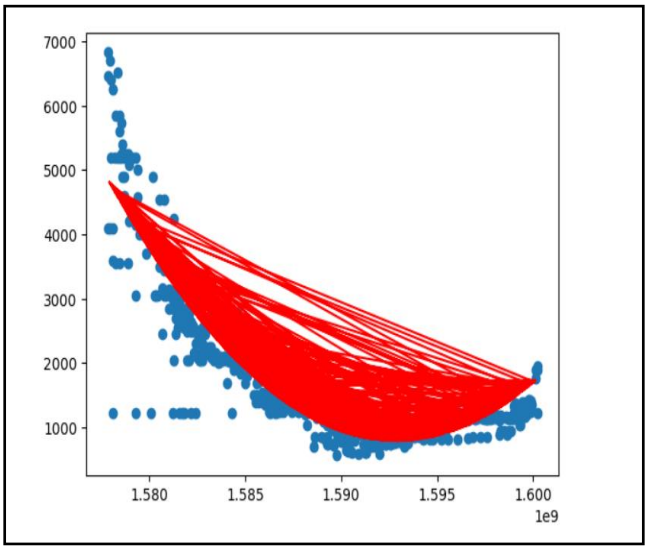

Fig 4.2. Machine Learning model results

```
Mean squared error: 170219.3966183645
R-squared score: 0.8924844417034705
```

Fig 4.3 Accuracy of the result

1.0	24.0	NaN	NaN
3.0	16.0	NaN	NaN
3.0	19.0	NaN	NaN
3.0	11.0	NaN	NaN
1.0	18.0	NaN	NaN
2.0	13.0	NaN	NaN
3.0	18.0	NaN	NaN
1.0	25.0	NaN	NaN
NaN	NaN	78.773667	C
NaN	NaN	76.818979	B
NaN	NaN	77.048078	B
NaN	NaN	76.440091	B
NaN	NaN	76.214096	A

Fig 5.1. Warehouse suggestion results

Out[12]:

	Price_1
0	78.773667
1	76.818979
2	77.048078
3	76.440091
4	76.214096

Fig 5.2 Price Forecasting of the next 5 Days

Based on initial user feedback, it has been noted that the application's features and usability have received high levels of satisfaction. This observation suggests that the application holds significant potential in becoming a valuable tool for farmers and traders within the agricultural sector.

CONCLUSION

In conclusion, the developed Android mobile application, bolstered by the Price Prediction machine learning model and warehouse suggestion feature, stands as a promising solution for modernizing agricultural trade. By facilitating seamless connections between farmers and traders, offering predictive insights, and optimizing resource allocation, this innovation has the potential to reshape the industry landscape. The successful fusion of technology and agriculture showcased in this project underscores the power of data-driven decision-making and its capacity to drive efficiency, profitability, and collaboration within the agricultural ecosystem.

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