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Farmsmart: Expert Recommendations, Disease Prediction, and Farmer Market using Machine Learning and Deep Learning

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ABSTRACT: FarmSmart is an integrated digital agriculture platform that seeks to empower farmers with data-driven, intelligent decision-making. It brings together six must-have modules such as crop recommendation, fertilizer recommendation, crop disease forecasting, farmer-to-farmer marketplace, live commodity price tracking, and multilingual conversational chatbot into one integrated, easy-to-use solution, specifically designed for rural environments. With the combined strength of machine learning, computer vision, natural language processing, and real-time APIs of government data, FarmSmart is a holistic end-to-end solution for enabling farmers right through the farming process. It includes suggesting the optimal crop in terms of environment and soil, suggesting the application of certain fertilizers, detection of crop disease using leaf image analysis through deep learning algorithms (ResNet-9), and enabling informed decisions regarding the time and place of sale of crops through live mandi price comparison.

FarmSmart seeks to maximize productivity and profitability. In addition, the integrated e-commerce platform supports direct farmer-to-farmer transactions for farm produce, equipment, and produce sales and purchases, essentially doing away with intermediary functions. The platform has a multilingual AI chatbot, created by GROQ, that provides conversational assistance and voice assistance, thus improving usability for farmers from different linguistic backgrounds. Lastly, FarmSmart bridges the critical information gap in rural farming communities, increasing precision agriculture, reducing wastage of resources, and improving livelihoods through the integration of modern technology into traditional farming practices.

KEYWORDS: Crop Recommendation System, Fertilizer Recommendation, Plant Disease Detection, Deep Learning, Smart Farming, Open Government Data (OGD), Multilingual Chatbot, AI in Agriculture, Data Visualization in Agriculture.

I. INTRODUCTION

Agriculture is the pillar of many economies, and millions of farmers live off their livelihood depending on prompt and wise choices regarding selecting crops, use of fertilizers, disease control, and the dynamics of markets. But through conventional farming approaches, decision-making mostly involves guesses or obsolete details, which reduce productivity and results in losses. With the contemporary world being dominated by data and technology, what the world today requires is a smarter, holistic system that could support farmers making better agricultural choices.

FarmSmart is a full solution designed to address these challenges by integrating a variety of various technologies into a single solution. It offers crop recommendation modules depending on environmental and soil conditions, fertilizer guidance according to the needs of the crops, detection of disease through image analysis, a unique online marketplace to buy and sell farm products, real-time commodity price updates, and an interactive chatbot offering real-time assistance. Each of the modules is designed to reduce uncertainty and infuse precision into the practice of agriculture. Farmers are given guaranteed, timely, and customized support to increase crop yield, minimize losses, and improve linkage with the agricultural system through FarmSmart.

II. LITERATURE SURVEY

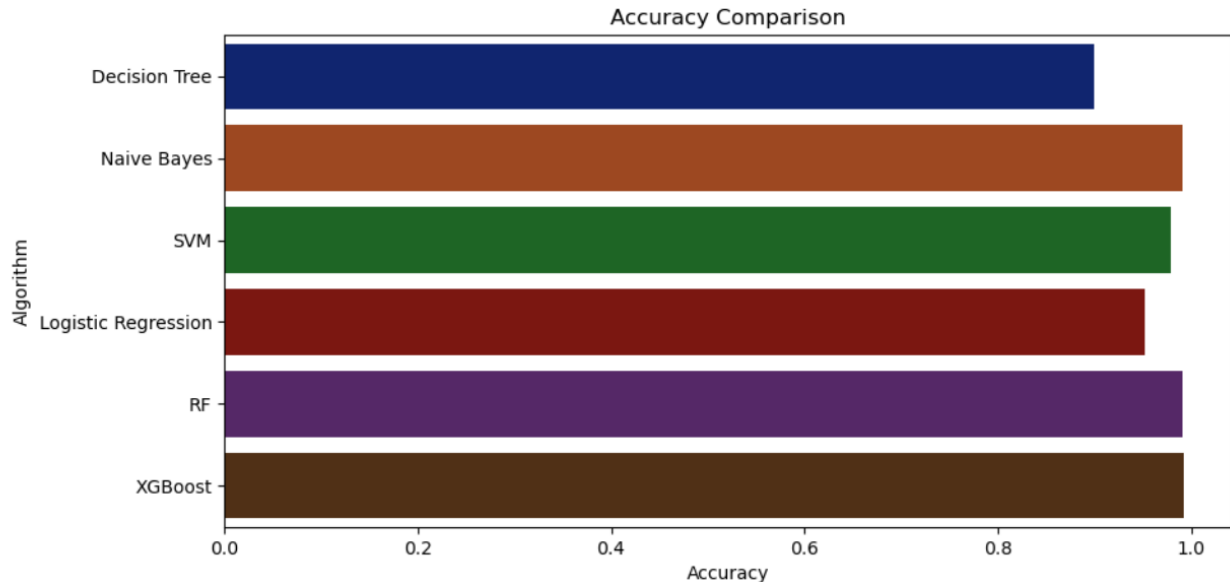
Recent advances in Machine Learning (ML) and Artificial Intelligence (AI) have made significant contributions to the agricultural industry, particularly in crop management, disease identification, and the development of decision-support systems. Numerous research efforts and technological advancements have been directed towards improving crop yields, reducing the cost of inputs, and making farming more sustainable and data-driven.

- **Crop Recommendation Systems:** A number of studies have introduced ML-based models for crop prediction depending on parameters such as soil type, pH, temperature, and rainfall. A study by [Patel et al., 2015] demonstrated the use of decision trees and Naïve Bayes classifiers for suggesting suitable crops. Improvements in algorithms such as Random Forests and XGBoost have indicated improved performance in multi-class crop prediction scenarios, enabling farmers to make more efficient decisions.
- **Fertilizer Recommendation Models:** Fertilizer recommendation systems have utilized soil nutrient information (NPK values), pH, and crop to recommend the right fertilizers. Systems like [R. K. Samudrala et al., 2018] have utilized statistical models and threshold analysis to identify overuse or lack of nutrients. Utilization of such information in adaptive systems reduces excessive chemical application, thereby supporting sustainable agriculture.
- **Deep Learning-based Plant Disease Detection:** The application of convolutional neural networks (CNNs) to detect plant disease has been established. The PlantVillage dataset is a landmark contribution in the field, with thousands of images of labeled leaves for training the model. Models such as ResNet, VGG, and Inception have been used to achieve high-classification accuracy. A study by Mohanty et al. (2016) demonstrated above 99% accuracy with the use of CNNs, strengthening their credibility to use in real-time crop disease diagnosis.
- **Electronic Agricultural Marketplaces:** Farmer-to-farmer online business platforms are gaining prominence for their ability to eliminate intermediaries and create direct selling channels. FAO and World Bank ICT studies on agriculture suggest that online markets improve price transparency and access to agriculture inputs. eNAM (National Agriculture Market) platforms have set the foundation for digital business in Indian agriculture.
- **Monitoring Real-Time Commodity Prices:** Price prediction and mandi data visualization have been carried out using APIs such as AGMARKNET and Open Government Data (OGD) Platform India datasets. The research has sought to integrate such data with the inputs of the farmers through advisory services so that farmers can derive price comparisons within markets for optimum profit margins.
- **AI-powered Conversational Chatbots for Farmers:** Artificial Intelligence-based Farming Chatbots Conversational AI platforms trained in local languages are being used more and more to spread agricultural information. Recent research has investigated the application of chatbots based on large language models (LLMs) specifically designed for domain-specific queries. Research has emphasized the role of multilingual and voice-based assistants in addressing literacy challenges among rural farmers.

III. METHODOLOGY

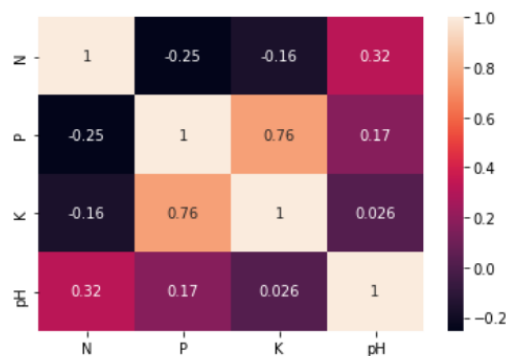
Crop Recommendation System: In this module, the values of soil nutrients (Nitrogen, Phosphorus, Potassium), rainfall (in units of mm), pH value, and the respective state and city are to be entered by the users. The chosen location is used to fetch the current humidity value using the OpenWeather API. While training the model, the data set of 2200 records of 22 crops was employed. The dataset was split into training and test sets in the ratio of 80:20. Different classification models were used and tested, including Decision Tree, Naive Bayes, Support Vector Machine (SVM), Logistic Regression, Random Forest (RF), and XGBoost. Out of these models, XGBoost recorded the highest accuracy rate of 99.31%, followed by Naive Bayes and Random Forest at 99.09%, thus establishing the strength of the model.

Methodology – Crop Recommendation System In this module, the users are required to input values of soil nutrients, i.e., Nitrogen, Phosphorus, and Potassium, and rainfall readings (in millimeters), pH level, and their current residing state and city. The provided location is accessed to retrieve the real-time humidity value through the OpenWeather API. In training the model, a total of 2200 instances based on 22 different crops have been utilized for training. For features, we utilized N, P, K, temperature, humidity, pH, and rainfall, and utilized the crop name as the target variable.



Fertilizer Recommendation System: For the development of the Fertilizer Recommendation System, two different data sets have been combined: crop data (environmental data) and fertilizer data (best NPK and pH per crop). User input is taken for N, P, K, values and what crop to grow. This input is compared with optimal levels of nutrients for the chosen crop.

A heatmap was developed to display correlations among different nutrients and pH levels. Random perturbations (+/- values) were applied to the raw data to simulate variation in soil conditions, forming 2200 samples. The model then finds out if a nutrient—Nitrogen, Phosphorus, or Potassium—is in surplus or shortage and recommends corrective fertilizers. Such recommendations are drawn from a predefined dictionary that has every situation of imbalance (for example, N_low, P_high) translated into appropriate fertilizer recommendations.



Plant Disease Prediction System: The Plant Disease Prediction module exploits a ResNet-9 convolution neural network model that has been trained on an expanded version of the PlantVillage dataset consisting of over 87,000 images spread across 38 classes. Normalization is performed on the dataset split into training (80%) and validation (20%) subsets along with a test dataset used for measurement.

The architecture is constructed with residual blocks to enhance feature learning and address the vanishing gradient problem. Cross-entropy loss is used to train the process and monitor accuracy after each epoch with custom training and validation procedures. For optimal convergence, a learning rate scheduler is employed.

After deployment, the user uploads an image of a leaf, and the model accurately predicts the disease (if any) with a 99.2% accuracy, giving specific prevention and cure strategies. If no disease is found, it assures that the plant is healthy.

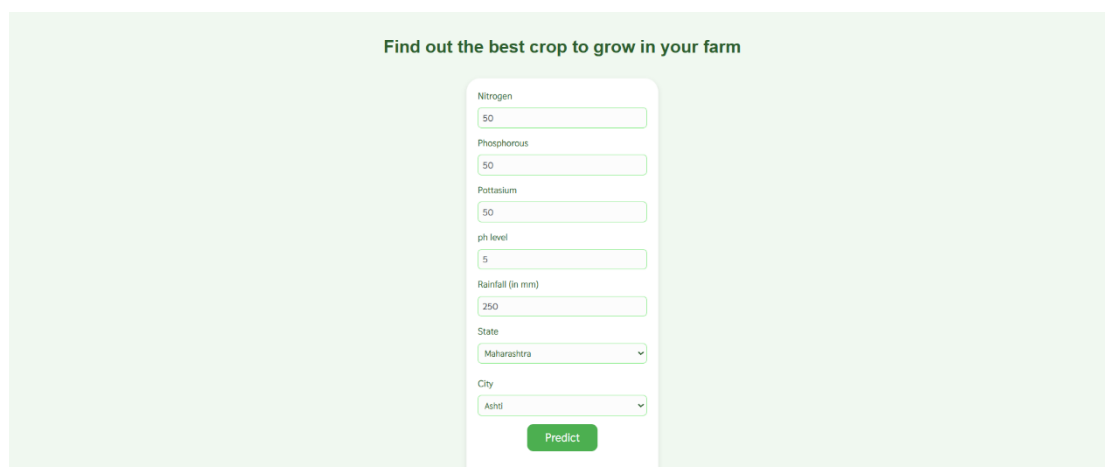
Farmers' Marketplace: The Marketplace module establishes a specific online e-commerce platform to enable direct exchange of farm products and inputs between farmers. Farmers can become sellers and list products for sale, such as farm machinery, seeds, fertilizers (Khad), harvested crops, and other necessary farm inputs. When selling a product, sellers can provide: Product pictures, Descriptive details, Price details, Address and location of Seller. The catalogue of the platform shows these listings, allowing other producers of agriculture (buyers) to see, sort, and search by product category or by location. Once the purchase has been confirmed, the platform redirects the buyer to a secure payment gateway to complete the transaction. This system establishes a localized and community-based trading system that eliminates middlemen and delivers farmers better prices and access.

Chatbot for Farmers: The Chatbot module has been engineered to offer immediate, multi-language assistance to farmers using Groq's AI inference engine, which has been trained on farm questions themselves. The platform is multi-language to offer support for Indian farmers' multiple languages for ease and accessibility. In the case of English queries, the chatbot has Text-to-Speech (TTS) capabilities, offering voice-based responses to add value to user experience. With Groq's ultra-low latency response engine, the chatbot gives immediate, accurate, and contextually appropriate responses. It is implemented via an API and placed on the frontend of the platform.

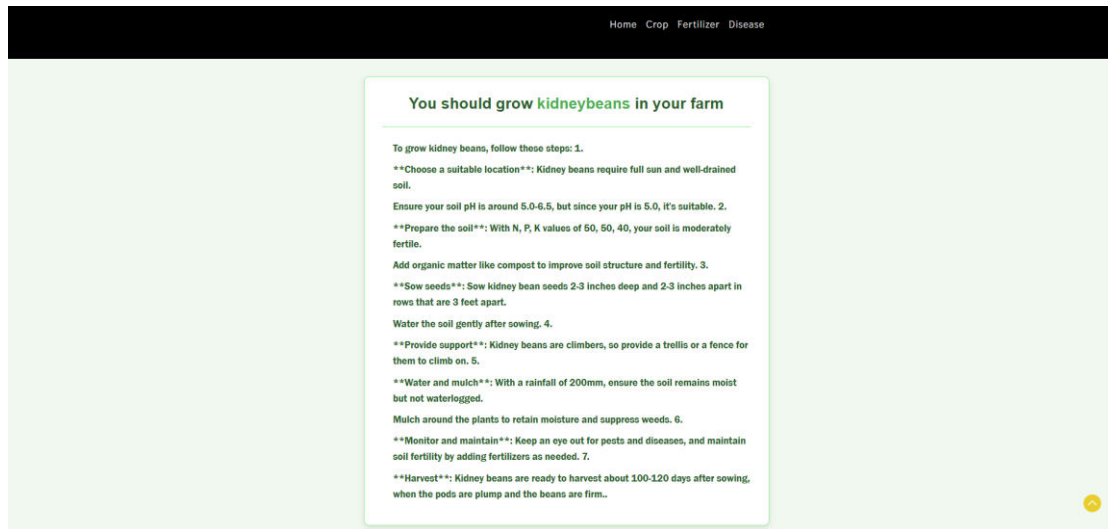
Live commodity prices and comparison: Commodity Prices module allows farm producers to have access to live market prices of different crops and farm products from different mandis (markets) of India. State, Commodity, and Mandi are input by users, and the system fetches comprehensive price information via the "Variety-wise Daily Market Prices of Commodity" API from the Open Government Data (OGD) Platform India. The information gathered includes State, District, Market, Commodity, Variety, Grade, Arrival Date, Minimum Price, Maximum Price, and Modal Price. Individuals have the capacity to compare similar goods in two distinct markets, hence facilitating the identification of potential for more profitable buying or selling. For easier analysis, price data is presented in the form of bar charts, making it simple to understand trends and enabling the formulation of informed decisions.

IV. EXPERIMENTAL RESULTS

Fig. 1. Fig. (a) shows the Crop Recommendation System input form, where the user provides key parameters such as soil nutrient levels (Nitrogen, Phosphorous, Potassium), pH level, rainfall, and location details including state and city. Fig. (b) displays the prediction result, suggesting the most suitable crop for the given conditions. Along with the crop name, detailed cultivation guidelines are also provided to assist the farmer in implementation.

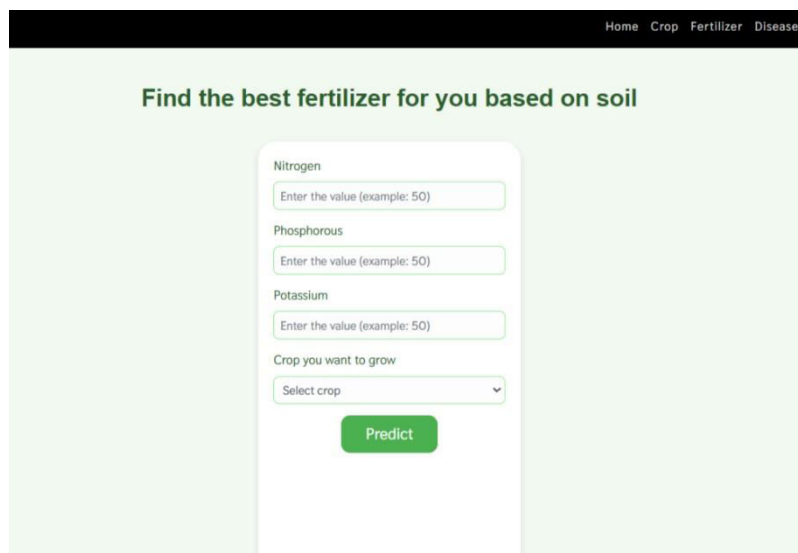


(a)



(b)

Fig. 2. Fig. (c) shows the Fertilizer Recommendation System input form, where the user enters essential soil nutrient values of Nitrogen, Phosphorous, and Potassium, along with selecting the crop they intend to grow. Fig. (d) displays the recommendation results, providing specific guidance on how to amend the soil nutrient levels. These suggestions include practical methods such as using compost, specific fertilizers, and crop rotation techniques to enhance soil fertility and crop yield.



Home Crop Fertilizer Disease

Find the best fertilizer for you based on soil

Nitrogen
 Enter the value (example: 50)

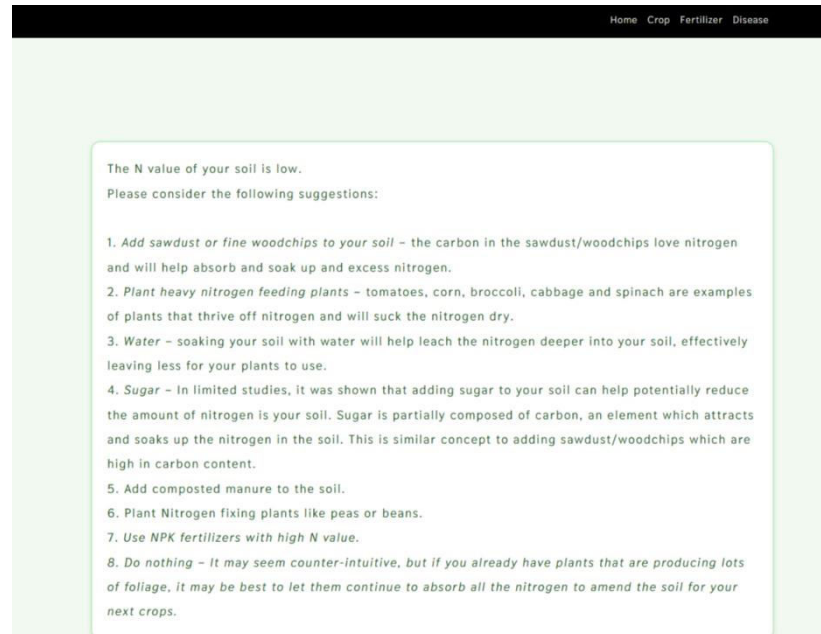
Phosphorous
 Enter the value (example: 50)

Potassium
 Enter the value (example: 50)

Crop you want to grow
 Select crop

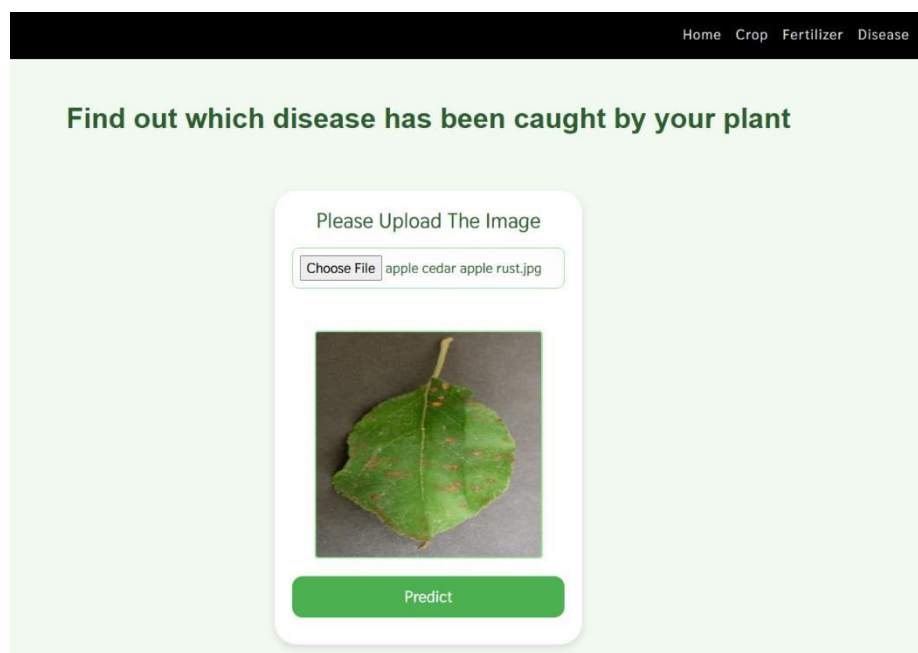
Predict

(c)



(d)

Fig. 3. Fig. (e) enables farmers to upload images of diseased crops through the Crop Disease Prediction module which uses ResNet to analyze the uploaded image. A 'Predict' button initiates the diagnosis process. Fig. (f) Displays the output of the disease prediction system. Once a disease is detected, the system provides the name of the disease along with comprehensive details about its symptoms, impact on crops, and recommended prevention and treatment methods to support effective farm management.

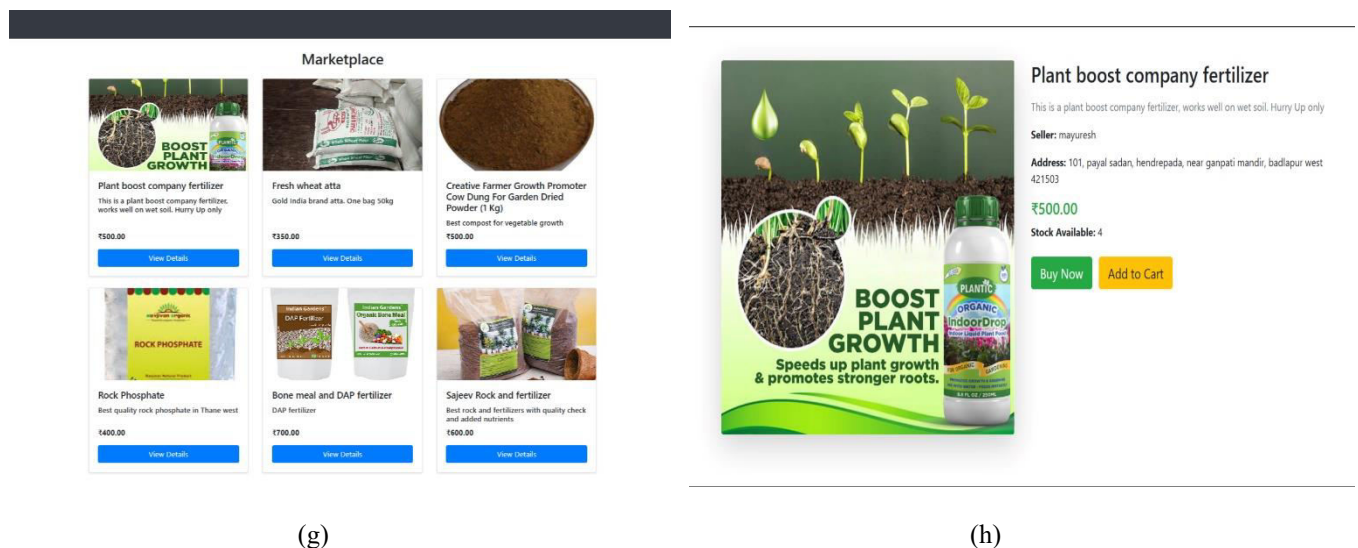


(e)



(f)

Fig. 3. Fig. (g) represents the homepage of the Farmers Marketplace, showcasing a range of listed products such as fertilizers, grains, and composts with their prices and brief descriptions. Fig. (h) displays the product detail page of a selected item, providing comprehensive information including product name, seller details, price, stock availability, and an option to either purchase immediately or add the item to the cart.



(g)

(h)

Fig. 4. Fig. (i) live commodity prices module, where farmers can view up-to-date market rates of various crops such as Rice, Wheat, Maize, and more. The interface shows essential parameters including the commodity name, market, modal price, minimum price, and maximum price. Fig. (j) This visual represents a bar chart comparison of selected commodities based on their modal prices. It allows farmers to easily compare current rates of different crops in a single view.

First Selection

Second Selection

Selection 1

State	District	Market	Commodity	Variety	Grade	Arrival Date	Min Price	Max Price	Modal Price
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	11/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	15/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	10/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	16/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	08/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	04/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	05/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	07/04/2025	₹3000	₹6000	₹4500
Maharashtra	Mumbai	Mumbai	Wheat	Other	FAQ	09/04/2025	₹3000	₹6000	₹4500

Selection 2

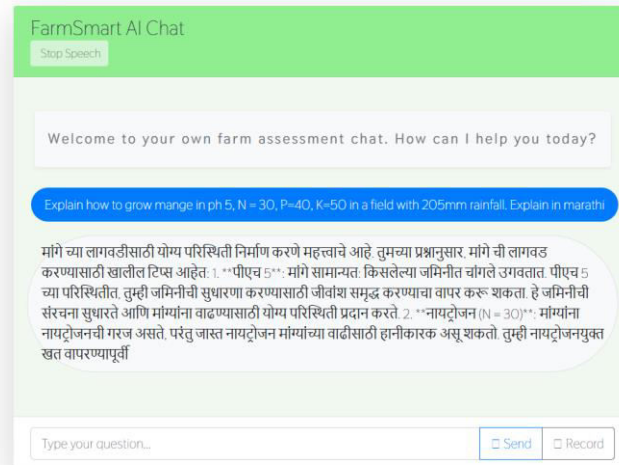
State	District	Market	Commodity	Variety	Grade	Arrival Date	Min Price	Max Price	Modal Price
Maharashtra	Thane	Kalyan	Wheat	Sharbati	FAQ	05/04/2025	₹4000	₹6500	₹4250
Maharashtra	Thane	Kalyan	Wheat	Sharbati	FAQ	07/04/2025	₹3000	₹3500	₹3250

(i)



(j)

Fig. 5. (k) figure illustrates the multilingual chatbot integrated into the FarmSmart platform. The chatbot assists farmers by answering queries related to agriculture, crop care, market trends, and government schemes in multiple regional languages. Its user-friendly interface and language flexibility ensure better accessibility and support for farmers across diverse linguistic backgrounds.



(k)

V. CONCLUSION

FarmSmart provides a comprehensive AI-powered platform that is meant to help farmers through every stage of the farming process—from choosing crops, using fertilizers, controlling diseases, accessing markets, and monitoring the current prices. With advanced machine learning algorithms like ResNet-9 for detecting plant diseases, GROQ for enabling smart chatbot conversations, and Open Government APIs for cross-comparison of commodity prices, the platform provides farmers with accurate, localized, and timely information. In addition, the marketplace integrated into the system encourages farmers to trade directly, thus ensuring transparency and fair pricing. Overall, FarmSmart successfully combines technology and farm-level agriculture, with increased efficiency, sustainability, and decision-making in agriculture.

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