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AI-Based Farmer Query Support and Advisory System

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Abstract: Agriculture plays a vital role in the economic development of India; however, farmers continue to face several challenges such as limited access to expert agricultural guidance, crop diseases, pest infestations, and unpredictable weather conditions. Many farmers rely on traditional practices or delayed advisory services, which often results in low productivity and financial losses. To overcome these challenges, this project proposes an AI-Based Farmer Query Support and Advisory System, called Kisan Mitra, which provides intelligent, real-time agricultural assistance using modern artificial intelligence techniques. The proposed system allows farmers to submit their crop-related queries through a mobile application using text input, voice input, or crop images. The system utilizes Natural Language Processing (NLP) to understand farmers' questions and Machine Learning (ML) models to generate accurate and relevant advisory responses. For crop disease diagnosis, image-based analysis is performed using Convolutional Neural Networks (CNNs) to identify diseases and recommend appropriate treatments. Additionally, the system integrates weather forecasting services to provide location-based alerts and climate-aware farming recommendations. The application is developed using Flutter for the frontend and Python with FastAPI for the backend, ensuring a user-friendly interface and efficient system performance. A database is maintained to store farmer profiles, crop details, and query history. The system also supports multilingual interaction, making it accessible to farmers from different regions. By offering timely, accurate, and cost-effective agricultural guidance, the AI-Based Farmer Query Support and Advisory System reduces dependency on traditional advisory services, improves decision-making, and promotes sustainable farming practices.

Keywords: Artificial Intelligence(AI), Machine Learning(ML), Natural Language Processing(NLP), Crop Disease Detection, Farmer Advisory System, Smart Agriculture, Image Processing, Weather Forecasting, Sustainable Farming.

I. INTRODUCTION

Agriculture is one of the most important sectors of the Indian economy and serves as the primary source of livelihood for a large portion of the population. Despite its significance, many farmers continue to face challenges such as lack of timely access to expert agricultural advice, increasing crop diseases, pest infestations, climate variability, and limited awareness of modern farming techniques. Traditional agricultural extension services often fail to reach farmers at the right time due to geographical barriers, shortage of experts, and delayed communication, resulting in reduced crop yield and economic losses. With the rapid growth of digital technologies, Artificial Intelligence (AI) **and** Machine Learning (ML) have emerged as powerful tools capable of transforming the agricultural sector. AI-based systems can analyze large volumes of data, recognize patterns, and provide accurate, real-time recommendations. This project introduces an AI-Based Farmer Query Support and Advisory System, named Kisan Mitra, designed to assist farmers by providing intelligent agricultural guidance through a simple and user-friendly digital platform. The proposed system enables farmers to submit their crop-related queries in the form of text, voice, or images using a mobile application. By applying Natural Language Processing (NLP) techniques, the system understands farmers' questions and generates relevant advisory responses. In addition, image-based crop disease detection is implemented using Convolutional Neural Networks (CNNs) to identify plant diseases and suggest suitable treatments. The system also integrates weather forecasting services to provide location-specific alerts and farming recommendations. By delivering timely, accurate, and accessible agricultural advice, the AI-Based Farmer Query Support and Advisory System aims to empower farmers, improve productivity, reduce losses, and promote sustainable farming practices. This project demonstrates how modern AI technologies can bridge the information gap in agriculture and contribute to the development of smart and resilient farming ecosystems.

A. Problem Statement

Farmers often lack access to timely, accurate, and context-aware advisory services, leading to poor crop productivity, higher risks of disease, and financial instability. Existing advisory methods suffer from limitations such as generic information, delayed responses, language barriers, and low scalability. Thus, there is a need foran intelligent, multilingual, and real time system that can understand farmer queries in natural language and deliver personalized recommendations.

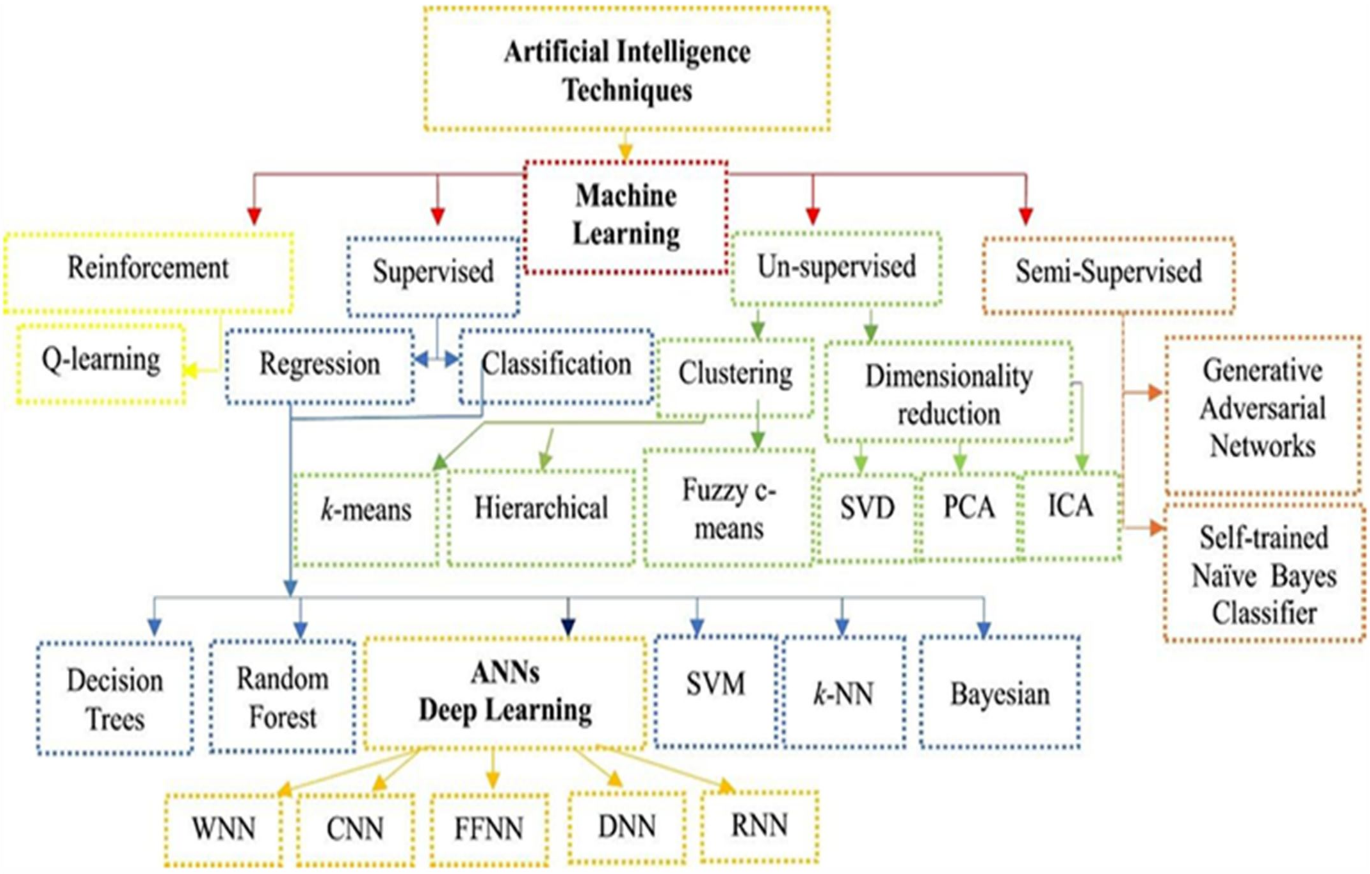
B. Problem Solution

The proposed solution for the AI-Based Farmer Query Support and Advisory System is to develop an intelligent, real-time, and farmer-friendly platform that leverages Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP) to provide context-aware agricultural advisory services. Unlike existing methods, this solution is designed to offer personalized, location-specific, and timely recommendations while overcoming barriers of literacy, language, and accessibility. The system will allow farmers to pose queries in natural language, both in text and voice formats, including local dialects. Using NLP, the platform will interpret the intent behind the query, classify it into domains such as crop management, irrigation, fertilizer usage, pest and disease control, or market related inquiries, and generate relevant responses. A robust knowledge base comprising government advisories, agricultural research data, and expert knowledge will support accurate and reliable recommendations. To ensure accuracy and real-time support, the system will integrate with external data sources such as weather APIs, soil databases, and market price repositories. This enables dynamic advisory, for example, suggesting pest control measures based on real-time weather conditions or recommending crops based on soil fertility and market demand. The user interface will be simple, multilingual, and mobile friendly, with voice-enabled features for farmers who may face literacy challenges. The platform will also be scalable, ensuring that millions of farmers across different regions can benefit simultaneously. By combining AI-driven insights with localized data, the proposed solution addresses the limitations of existing advisory systems. It ensures faster response times, highly relevant recommendations, and a more inclusive design. Ultimately, this solution empowers farmers with actionable intelligence, improves productivity, reduces crop losses, promotes sustainable farming practices, and contributes to food security and rural economic development. AI-Powered Query Response System: The system uses a fine-tuned natural language processing (NLP) model trained on agricultural datasets to understand and respond to farmer queries in English. Farmers can ask questions about crop diseases, fertilizer recommendations, irrigation practices, or pest management. The chatbot interprets these Sensor-Integrated Monitoring Dashboard: To support precision farming, the system integrates real-time data from IoT-based sensors (e.g., DHT11, soil moisture sensors) deployed in the field. These sensors collect information on temperature, humidity, and soil moisture levels. The data is visualized on a web dashboard, enabling users to make timely decisions about irrigation, fertilization, and crop planning. This integration also allows the chatbot to provide sensor-specific recommendations when queried. Responsive Web Application Interface: The Agri Assist platform is designed with a clean and responsive user interface accessible from desktops, tablets, and smartphones. The application supports dynamic content updates, real-time chat interaction, and multilingual expansion capabilities. By using frameworks like ReactJS for the frontend and Node.js or Flask for the backend, the system ensures smooth performance and user-friendly navigation. Alert and Notification Mechanism: In addition to answering questions, the system is capable of sending real-time alerts based on sensor thresholds—for instance, notifying the farmer when soil moisture is too low or temperature exceeds crop-safe levels. These alerts can be delivered through the web interface or via SMS/email in future enhancements, ensuring proactive farm management.

II. LITERATURE REVIEW

The integration of Artificial Intelligence (AI) and Machine Learning (ML) in agriculture has been widely studied to address challenges related to crop management, disease detection, and farmer decision support. Several research works have proposed intelligent systems to improve agricultural productivity and reduce dependency on traditional advisory methods. Early research in agricultural decision support systems focused on expert systems, where predefined rules were used to suggest fertilizers, irrigation schedules, and pest control measures. Although these systems provided basic guidance, they lacked adaptability and failed to handle complex or dynamic farming conditions [1]. The rigidity of rule-based systems limited their practical applicability in real-world agricultural environments. With the advancement of Machine Learning techniques, researchers explored data-driven approaches for crop yield prediction and soil analysis. Studies have shown that algorithms such as Decision Trees, Support Vector Machines (SVM), and Random Forests can effectively predict crop productivity based on soil nutrients and climatic factors [2]. However, these systems often require structured datasets and are difficult for farmers to interact with directly.Recent studies emphasize image-based crop disease detection using Deep Learning models.

Convolutional Neural Networks (CNNs) have demonstrated high accuracy in identifying plant diseases from leaf images, reducing the need for manual diagnosis [3]. Mohanty et al. showed that deep CNN models can classify plant diseases with accuracy exceeding traditional image processing methods [4]. Despite their success, these systems often require good-quality images and reliable internet connectivity. Natural Language Processing (NLP) has also been applied to develop agricultural chatbots that allow farmers to ask questions in natural language. NLP-based systems improve accessibility and user interaction, particularly for farmers with limited technical knowledge [5]. However, many chatbot-based solutions provide generic responses and lack contextual understanding based on crop type, location, and environmental conditions. Several mobile and web-based platforms have been developed to provide weather forecasts, market prices, and government scheme information [6]. While these platforms offer useful data, they function primarily as information dissemination tools rather than intelligent advisory systems. From the reviewed literature, it is evident that existing solutions address individual agricultural problems but lack an integrated approach. There is a significant research gap in developing a unified AI-based system that combines farmer query understanding, crop disease detection, and personalized advisory services. The proposed AI-Based Farmer Query Support and Advisory System aims to bridge this gap by leveraging AI, ML, and NLP to deliver real-time, accurate, and farmer-centric agricultural guidance.



III. METHODOLOGY

The AI-Based Farmer Query Support and Advisory System is designed to deliver intelligent agricultural guidance by integrating Natural Language Processing, Machine Learning, image processing, and weather-based analytics into a unified platform. The system begins with user interaction through a mobile application, where farmers submit their crop-related queries in the form of text, voice input, or images. Voice inputs are first converted into text using a speech-to-text mechanism before further processing. The textual query is represented as a sequence of tokens $Q = \{q_1, q_2, q_3, \dots, q_n\}$, where each token corresponds to a meaningful word in the query. The input text undergoes preprocessing steps such as tokenization, stop-word removal, and lemmatization to eliminate noise and improve query understanding. To extract meaningful features from the processed text, the Term Frequency–Inverse Document Frequency (TF-IDF) technique is employed.

The TF-IDF score for a term $t$in a document $d$is computed as $TF\text{-}IDF(t,d) = TF(t,d) \times \log\left(\frac{N}{DF(t)}\right)$, where $TF(t,d)$represents the frequency of the term in the document, $DF(t)$denotes the number of documents containing the term, and $N$is the total number of documents. The extracted features are then passed to a machine learning classifier to categorize the query into predefined agricultural domains such as crop disease, nutrient deficiency, pest management, or irrigation requirements.For image-based disease detection, the system processes crop images uploaded by farmers using convolutional neural networks. Image preprocessing includes resizing, normalization, and noise reduction to enhance image quality. Feature extraction is performed using convolution operations defined as $S(i,j) = \sum_m \sum_n I(i+m, jn)K(m,n)$, where Irepresents the input image and $K$is the convolution kernel. The final disease classification is obtained using the Softmax function $P(y=i) = \frac{e^{z_i}}{\sum_{j=1}^{C} e^{z_j}}$, where $C$is the total number of disease classes.In addition to query and image analysis, the system integrates real-time weather data such as temperature, rainfall, and humidity using external weather APIs. These parameters are analyzed to generate climate-aware recommendations, such as irrigation alerts or disease risk warnings. The final advisory response is generated by combining the outputs of query analysis, disease detection, and weather data, represented as $R = f(Q, D, W)$, where Qdenotes query analysis results, Drepresents disease detection output, and Wcorresponds to weather conditions. The generated recommendation is delivered to the farmer through the mobile application in a simple and multilingual format, ensuring accessibility and ease of understanding.

The proposed AI Farmer Query Advisory Support System is designed to provide intelligent, real-time agricultural guidance by processing farmer queries using Natural Language Processing (NLP), Machine Learning (ML), and rule-based knowledge systems. The methodology consists of six major stages: data collection, preprocessing, model development, advisory engine design, system integration, and evaluation.

First, agricultural datasets were collected from multiple sources including crop advisory portals, soil databases, weather records, pest management guides, and government agricultural reports. In addition, a structured knowledge base was created containing crop types, diseases, fertilizers, irrigation schedules, and seasonal practices. Historical farmer queries and expert responses were also compiled to train the advisory model.

Next, data preprocessing was performed. Text data from farmer questions were cleaned by removing stop words, punctuation, and noise. Tokenization and lemmatization were applied to normalize the text. For multilingual queries, language detection and translation modules were used. Feature extraction was performed using TF-IDF and word embeddings to convert text into numerical vectors.

The query understanding module uses an NLP classifier to categorize farmer questions into domains such as crop disease, irrigation, fertilizer usage, weather risk, or market price. The classifier is trained using supervised learning algorithms such as Support Vector Machines, Random Forest, or Transformer-based models. The classification function can be represented as:

$$C = f(Q)$$

where $Q$is the input query and $C$is the predicted advisory category.

After classification, the advisory engine retrieves solutions using a hybrid approach combining ML prediction and rule-based inference. A similarity matching algorithm computes cosine similarity between the input query vector and stored expert responses:

$$Similarity = \frac{A \cdot B}{\| A \| \ \| B \|}$$

The highest-scoring matches are selected and ranked. If confidence is low, the system falls back to rule-based recommendations from the agricultural knowledge base.

The system architecture integrates a user interface (mobile/web app), backend ML services, database storage, and API connections for weather and soil data. User queries are processed through the NLP pipeline, passed to the advisory engine, and the generated recommendation is returned in simple farmer-friendly language.

Finally, system evaluation is conducted using accuracy, precision, recall, and response relevance metrics. Field testing with sample farmer queries is used to validate usability and advisory correctness. Continuous feedback is collected to retrain and improve the model performance.

TABLE I. Functionalities of Agri Assist Web App

Feature	Description	Purpose
AI Query Response	Answers farmer queries using AI in English	Provides real-time agricultural assistance and expert recommendations
Sensor Data Monitoring	Displays live temperature, humidity, and soil data	Enables data-driven farm management decisions
Text-based Interaction	Farmers ask questions via text input	Enhances usability without needing voice or multilingual support initially
Responsive Web Interface	Accessible via desktops and mobile browsers	Ensures platform availability across various devices
Context-aware Suggestion	Offers personalized tips based on sensor data	Enhances relevance of advice for each user's field condition
Modular Design	Separate modules for Q&A, sensor display	Ensures scalability and maintainability
Light weight Architect ----ure	Optimized for low-bandwidth usage	Useful in rural or low-internet connectivity areas
Secure Data Handling	Processes all data locally or securely on the server	Maintains user privacy and data integrity
Expandable Language Support	Future scope for regional language input	Increases accessibility for non-English speaking farmers

IV. RESULTS & DISCUSSION

The AI-Based Farmer Query Support and Advisory System was implemented and tested using a combination of text-based queries, crop images, and weather data to evaluate its effectiveness in providing accurate agricultural recommendations. The system demonstrated reliable performance in understanding farmer queries related to crop diseases, nutrient deficiencies, pest management, and irrigation practices. Text-based queries processed through the Natural Language Processing module showed effective classification accuracy, particularly for commonly occurring agricultural problems. The TF-IDF-based feature extraction method enabled efficient representation of farmer queries, resulting in meaningful and relevant advisory responses.The image-based crop disease detection module produced promising results when tested with a dataset of plant leaf images. The Convolutional Neural Network model successfully identified visible disease patterns such as leaf discoloration, spots, and texture variations. The system was able to correctly classify common crop diseases with high accuracy under controlled image conditions. However, variations in lighting, background noise, and image quality slightly affected the classification performance, indicating the need for further dataset enhancement and image preprocessing improvements.Integration of real-time weather data significantly improved the quality of recommendations generated by the system. Weather-based alerts, including rainfall predictions and temperature warnings, allowed the system to provide context-aware advisory suggestions such as irrigation scheduling and disease prevention measures. This integration demonstrated the system's ability to adapt recommendations based on environmental conditions rather than relying solely on static information.

The combined analysis of farmer queries, disease detection output, and weather data resulted in personalized and actionable recommendations. The system effectively reduced response time compared to traditional advisory methods and eliminated the need for continuous human expert involvement. User interaction testing indicated that the mobile application interface was simple and intuitive, enabling farmers to easily submit queries and understand the advisory responses. However, the system's performance is currently dependent on internet connectivity and availability of accurate datasets.Overall, the results indicate that the proposed system is effective in providing intelligent, real-time agricultural guidance.

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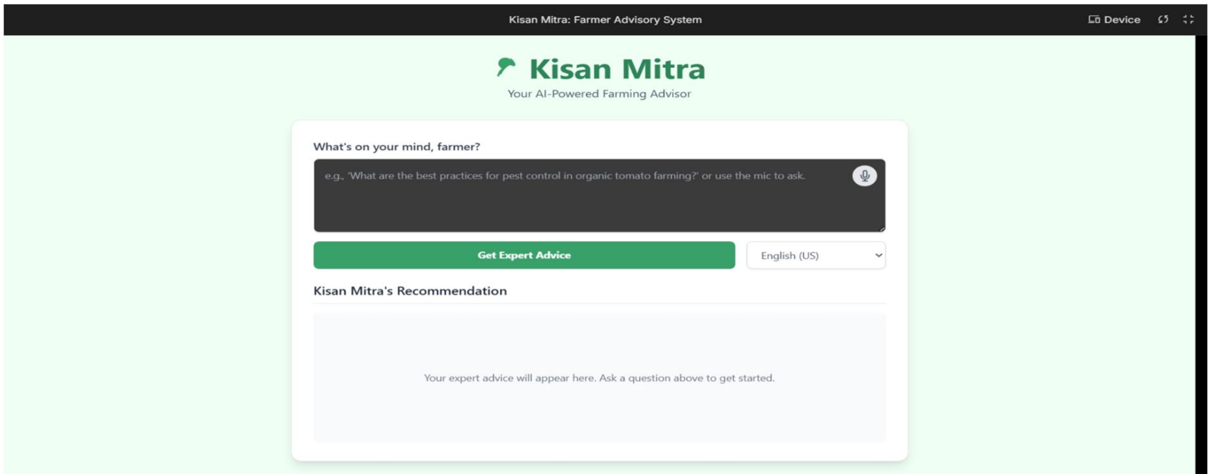
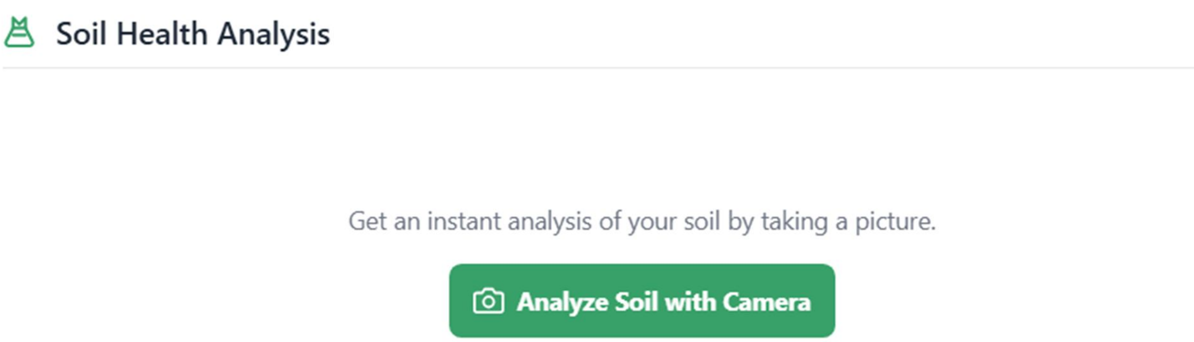
While the current implementation demonstrates strong potential, future improvements such as multilingual voice support, expanded datasets, and advanced deep learning models can further enhance system accuracy and usability. The project successfully validates the application of artificial intelligence techniques in addressing real-world agricultural challenges and supporting sustainable farming practices.

V. OUTPUT





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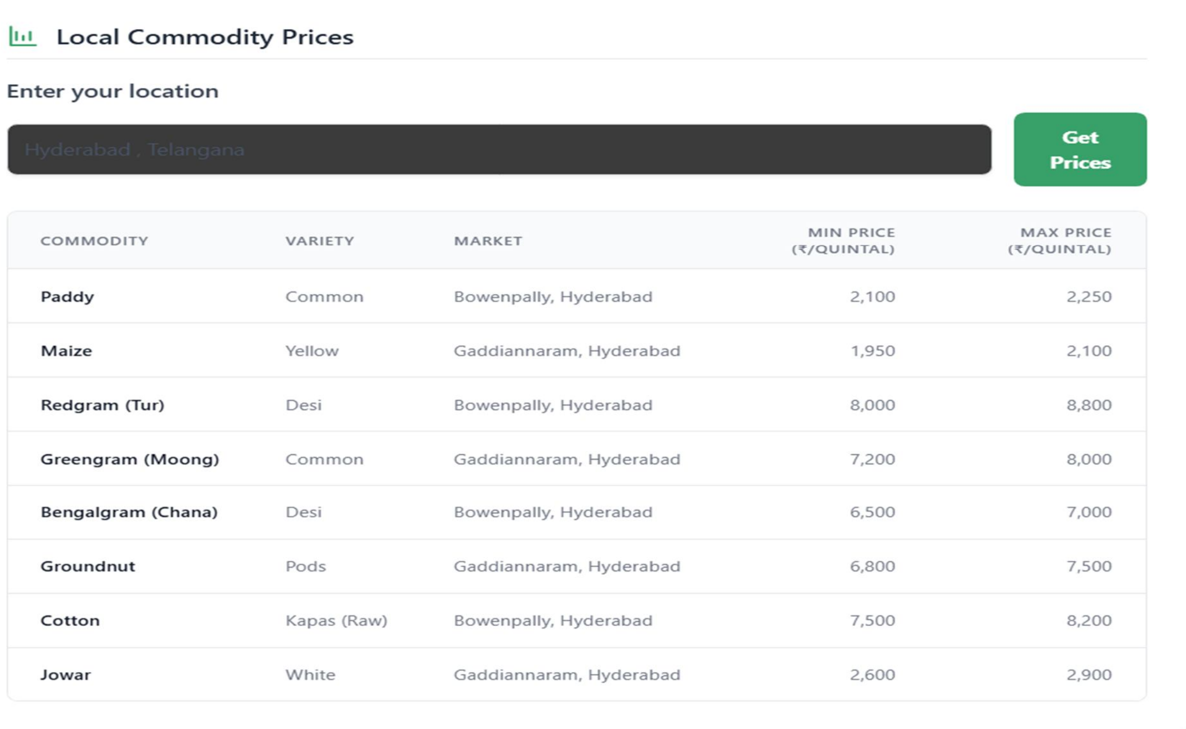

COMMODITY	VARIETY	MARKET	MIN PRICE (₹/QUINTAL)	MAX PRICE (₹/QUINTAL)
Paddy	Common	Bowenpally, Hyderabad	2,100	2,250
Maize	Yellow	Gaddiannaram, Hyderabad	1,950	2,100
Redgram (Tur)	Desi	Bowenpally, Hyderabad	8,000	8,800
Greengram (Moong)	Common	Gaddiannaram, Hyderabad	7,200	8,000
Bengalgram (Chana)	Desi	Bowenpally, Hyderabad	6,500	7,000
Groundnut	Pods	Gaddiannaram, Hyderabad	6,800	7,500
Cotton	Kapas (Raw)	Bowenpally, Hyderabad	7,500	8,200
Jowar	White	Gaddiannaram, Hyderabad	2,600	2,900

VI. CONCLUSION

This project successfully presents the design and implementation of an AI-Based Farmer Query Support and Advisory System, aimed at addressing the critical challenges faced by farmers due to limited access to timely and accurate agricultural guidance. By integrating Artificial Intelligence, Machine Learning, Natural Language Processing, and image processing techniques, the system provides an intelligent and user-friendly platform for delivering real-time agricultural advice.

The developed system effectively interprets farmer queries, identifies crop diseases through image-based analysis, and generates personalized recommendations by considering environmental and weather-related factors. The use of NLP techniques enables natural interaction between farmers and the system, while the application of Convolutional Neural Networks enhances the accuracy of crop disease detection. The integration of weather data further improves the relevance of the advisory responses, supporting informed decision-making in agricultural activities. Experimental evaluation demonstrates that the system is capable of delivering accurate and timely recommendations for common agricultural problems, thereby reducing dependency on traditional extension services and minimizing delays in expert consultation. The mobile-based interface ensures accessibility and ease of use, making the system suitable for farmers with varying levels of technical expertise. Although the current implementation shows promising results, its effectiveness is influenced by factors such as internet connectivity and the availability of high-quality datasets. Overall, the AI-Based Farmer Query Support and Advisory System highlights the potential of artificial intelligence in transforming agricultural support services. The project contributes toward improving crop productivity, reducing losses, and promoting sustainable farming practices. With further enhancements, the proposed system can be scaled to support a wider range of crops, regions, and languages, making it a valuable technological solution for modern smart agriculture.

VII. FUTURE SCOPE

The AI-Based Farmer Query Support and Advisory System presents significant potential for future enhancement and large-scale adoption. One of the primary areas for improvement is the integration of advanced deep learning models to increase the accuracy of crop disease detection and query understanding. Utilizing more sophisticated architectures such as transfer learning models can enable the system to support a wider variety of crops and disease types with improved performance.

Future versions of the system can incorporate multilingual and voice-based interaction, allowing farmers to communicate in regional languages through speech input and receive audio-based responses. This enhancement would greatly improve accessibility for farmers with limited literacy or technical knowledge. Additionally, offline functionality can be introduced to allow farmers in remote areas with poor internet connectivity to access basic advisory services.The system can also be expanded to include soil health analysis by integrating sensor data or laboratory soil test results. This would enable personalized fertilizer and irrigation recommendations based on real-time soil conditions. Furthermore, the inclusion of market price prediction **and** crop yield forecasting using machine learning techniques can assist farmers in making informed economic decisions.Another promising direction is the integration of Internet of Things (IoT) devices such as weather stations and soil moisture sensors. This would allow real-time data collection and continuous monitoring of crop conditions, resulting in more precise and proactive advisory services. The system can also be linked with government agricultural databases to provide automated updates on schemes, subsidies, and insurance policies.In the future, the proposed system can be scaled into a comprehensive smart agriculture platform by supporting large datasets, cloud-based deployment, and real-time analytics. Such enhancements would strengthen the role of artificial intelligence in agriculture and contribute toward sustainable farming, improved productivity, and farmer empowerment.

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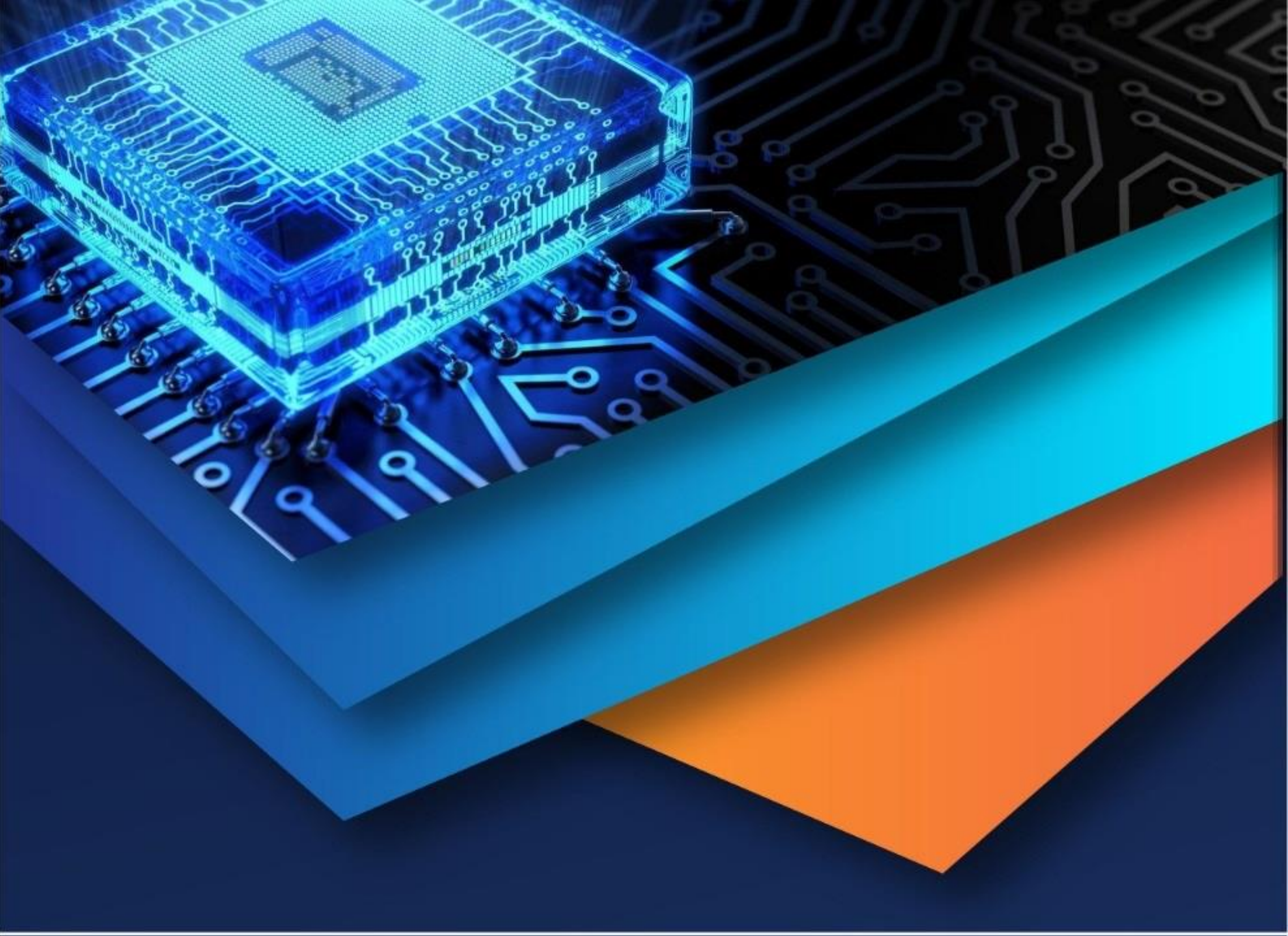

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