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Krishi Mitra: An AI-Powered Multimodal Query and Advisory System for Kerala Farmers

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Abstract: Agriculture in Kerala faces several challenges, including pest infestations, crop diseases, unpredictable weather conditions, and limited access to timely agricultural expertise. This paper presents Krishi Mitra, an AI-driven bilingual and multimodal agricultural advisory system designed to support farmers with real-time guidance. The application enables farmers to interact in their native language, Malayalam, through multiple input modes such as text queries, voice-to-text interaction, and crop image uploads. Krishi Mitra integrates Natural Language Processing (NLP) and Computer Vision (CV) techniques to understand farmer queries, analyze crop conditions from images, and generate context-aware recommendations. The platform provides concise, practical, and locally relevant advice related to crop protection, soil health, and sustainable farming practices. By offering a 24/7 accessible digital advisory service, Krishi Mitra aims to bridge the gap between farmers and agricultural expertise, improve decision-making, enhance productivity, and promote sustainable agricultural development in Kerala.

Keywords: Artificial Intelligence, Smart Agriculture, Multimodal Chatbot, Crop Disease Detection, Natural Language Processing

I. INTRODUCTION

Agriculture is the primary source of livelihood for millions, yet smallholder and marginal farmers face enduring challenges such as climate unpredictability, crop diseases, and lack of timely expert guidance. Traditional agricultural extension systems struggle to provide their services at scale, with ratios of extension agents to farmers often falling below 1 to 750 or 1000 in developing regions. While digital adoption is increasing, existing agricultural tools are often fragmented, text-heavy, and available primarily in English, creating a significant barrier for low-literacy users who prefer colloquial expressions or native languages. When farmers cannot access expert advice instantly, they risk delayed treatments resulting in crop loss, or improper treatments leading to health and environmental hazards.

Furthermore, the specific agro-climatic conditions of Kerala characterized by high humidity and diverse cropping patterns like rubber, spices, and coconut require specialized knowledge that generic AI models may overlook. Krishi Mitra addresses this localized need by bridging the gap between sophisticated machine learning architectures and the practical, on-ground realities of Kerala's farming community. By facilitating interaction in Malayalam and supporting image-based diagnostics, the system ensures that even the most remote farmers can leverage cutting-edge technology to protect their yields and improve sustainability.

To address these core problems, this paper introduces Krishi Mitra, a bilingual, multimodal AI mobile advisory application. Krishi Mitra is designed to provide real-time, contextual agricultural advice using text, voice, and image inputs. By leveraging advanced generative AI models, the system reduces the time-to-diagnosis, improves decision quality, and ensures that critical agricultural knowledge is accessible to farmers regardless of their literacy levels.

II. LITERATURE REVIEW

Jagadeesan et al. (2025) [1] explored how Artificial Neural Networks (ANN) and Natural Language Processing (NLP) can revolutionize agricultural advisory services by providing real-time accessible intelligence. The study optimized system performance by replacing traditional SQL databases with JSON-based structures to handle evolving agricultural data. While achieving a high accuracy of 99.54%, the research identified a gap in multimodal interaction, as the system primarily focused on text-based organizational structures. Krishi Mitra addresses this by integrating voice-to-text and image-based query modes.

The AIEP Initiative et al. (2026) [2] reported on technical learnings from five AI-based advisory MVPs deployed in Kenya and India. Their modular architecture utilized a reasoning component that combined Large Language Models (LLMs) with Retrieval-Augmented Generation (RAG) over curated corpora. Despite high user satisfaction, they identified a significant gap in latency for voice-based services, which often exceeded 5 seconds. Krishi Mitra builds on these findings by implementing a lightweight backend and conducting real-device testing to optimize performance under unstable network connectivity.

Harsoor and Hadagalimath (2025) [3] proposed a smart agriculture system by integrating Artificial Intelligence (AI) and Internet of Things (IoT) technologies with a chatbot interface. Their research utilized IoT sensors deployed in the field to continuously monitor environmental parameters, such as soil moisture, temperature, humidity, pH, and nutrient levels, to provide real-time data for crop recommendation and management. While their system achieved a high prediction accuracy of 92% and demonstrated the potential for modernizing agriculture, the reliance on specialized IoT hardware components, like Arduino Uno, NPK sensors, and RS485 modules, can be a major constraint for scaling such solutions in low-income rural regions. Krishi Mitra fills this void by delivering a high-functionality advisory platform that operates on standard mobile devices, leveraging their built-in capabilities like cameras and microphones to provide real-time, multimodal guidance without requiring external hardware.

Sinha and Garcia (2022) [4] analyzed the application of conversational Artificial Intelligence for agricultural advisory, focusing on how Natural Language Processing (NLP) can parse farmer inquiries to deliver context-specific responses. Their research identified that early agricultural chatbots relied heavily on predefined scripts, which limited their adaptability to the highly dynamic and unpredictable conditions of actual farming. These rule-based systems often failed to provide the nuance required for complex agricultural problem-solving. Krishi Mitra addresses this limitation by utilizing Large Language Models (LLMs) and standardized prompt templates to ensure that advisory responses are generative, safe, and context-aware.

Sardeshmukh et al. (2025) [5] explored the integration of supervised machine learning and natural language processing to create a smart crop recommendation and advisory framework. By evaluating various models, the study identified the Random Forest Classifier as the superior algorithm, achieving an accuracy of 87% in predicting crop suitability based on soil nutrients and climatic factors. The research uniquely combined these predictions with real-time market data from Agmarknet for profit estimation and utilized the Gemini API to provide interactive, personalized agricultural advice. While previous studies by Patil et al. (2022) and Bassine et al. (2023) established the effectiveness of soil-based predictors and IoT integration, Sardeshmukh et al. addressed the gap in multi-functional systems by incorporating alternative crop suggestions via Euclidean distance and scalable AI-driven advisory capabilities.

Kurre et al. (2025) [6] developed "Smart AI Farmer," a scalable web application designed to provide comprehensive decision support for small-scale farmers without the need for expensive IoT infrastructure. The study utilized a Random Forest Classifier for localized crop recommendations and a CNN-based MobileNetV2 architecture for image-based disease and pest recognition. The framework also integrated weather forecasting and a voice-enabled chatbot to assist users with varying literacy levels. While the research demonstrated high precision across its diverse modules—including smart irrigation and real-time advisory—the authors identified a gap in market-oriented features. Future iterations of the "Smart AI Farmer" aim to address this by incorporating AI-driven market price forecasting and crop rotation scheduling to further enhance the economic stability of rural farming communities.

Dindure et al. (2025) [7] developed an AI-powered Farmer Query Support and Advisory System (FQAS) to address the fragmentation in traditional agricultural services by integrating market intelligence, geospatial mapping, and government scheme accessibility. The research utilized real-time data analytics and multimodal query processing to provide farmers with holistic support, moving beyond isolated weather or price updates. While the system successfully optimized policy scheme discovery and market transparency, the study identified that existing frameworks often neglect integrated access to complex geospatial resources. The FQAS addresses this gap by offering a unified platform that combines real-time query resolution with localized resource mapping to empower small-scale farmers in a rapidly changing agricultural landscape.

Aryan et al. (2025) [8] developed an AI-powered integrated platform designed to provide real-time farming assistance to smallholder farmers without requiring expensive IoT infrastructure. The research utilized a multi-modular architecture, featuring a Convolutional Neural Network (Inception V3) for early-stage plant disease identification and a generative AI engine to deliver localized treatment recommendations. Furthermore, the system incorporated a crop recommendation engine and a predictive irrigation advisory tool by synthesizing localized weather forecasts and soil attributes through dynamic API integration. While the study achieved high precision in disease diagnosis and irrigation optimization, it noted that many existing solutions remain fragmented, often focusing on single-issue tasks. The platform addresses this limitation by offering a unified interface that combines automated diagnostic tools with an interactive NLP-powered consultation module, effectively bridging the knowledge gap for farmers with limited access to agricultural experts.

Sabhavath et al. (2026) [9] developed an "AI-Based Farmer Query Support and Advisory System" to address the critical information gap faced by farmers regarding crop management and disease control. The research utilized Natural Language Processing (NLP) to create an interactive chatbot capable of providing real-time, data-driven advice on soil health, pest management, and weather patterns. By integrating machine learning models, the system achieved significant accuracy in diagnosing plant diseases from leaf images, thereby reducing the reliance on scarce human experts. While the study demonstrated the effectiveness of a centralized digital advisory platform, the authors identified a need for further integration of regional languages and offline capabilities to better serve farmers in remote areas with limited internet connectivity.

Singh et al. (2025) [10] developed a smart crop advisory system that utilizes machine learning and deep learning to address agricultural challenges such as unpredictable weather and soil degradation. The research implemented a Random Forest algorithm for crop and fertilizer recommendation, achieving a high accuracy of 99%, and employed a Convolutional Neural Network (CNN) for plant disease detection. By integrating real-time weather data through the OpenWeather API, the system provides farmers with actionable insights to optimize resource usage and improve crop yields. While the study successfully demonstrated a robust, data-driven approach to precision farming, the authors identified a need for future enhancements in multimodal interaction and the integration of real-time market pricing to further support farmers' economic decision-making.

Patil et al. highlighted the effectiveness of soil-based crop prediction using machine learning techniques, improving decision accuracy in agricultural planning [11]. Bassine et al. demonstrated the role of IoT-enabled smart farming systems in enhancing sustainability and automation in agriculture [12]. The Food and Agriculture Organization (FAO) emphasized the importance of digital technologies in transforming agriculture and rural development [13]. Wolfert et al. discussed the impact of Big Data in smart farming, enabling better decision-making and predictive analytics [14].

Kamilaris and Prenafeta-Boldú provided a comprehensive survey on deep learning applications in agriculture, including disease detection and yield prediction [15]. Liakos et al. reviewed machine learning techniques in agriculture, focusing on their role in improving productivity and efficiency [16]. Zhang and Kovacs explored the use of unmanned aerial systems (UAS) in precision agriculture for monitoring and analysis [17].

III. METHODOLOGY

The development of Krishi Mitra follows a modular framework designed to ensure high availability, low latency, and accurate diagnostic capabilities. The system architecture integrates diverse computational modules, ranging from speech processing to computer vision, all orchestrated through a central generative AI engine. By following a structured pipeline of data acquisition, processing, and response generation, the methodology ensures that farmer queries are handled with high precision and local relevance.

A. System Components

Multimodal Input Layer: Captures text, voice, and images from the user.

- Processing Engine: Utilizes NLP and CV to interpret the data.
- Advisory Output: Generates context-aware recommendations in Malayalam or English.

B. Requirement Gathering

Secondary Research: Relevant agricultural extension documents, pest management guidelines, crop calendars, and existing digital advisory platforms related to Kerala agriculture were analyzed to understand domain requirements, common crop issues, and knowledge gaps faced by farmers.

C. System Design

- User Flow Design: Clear interaction workflows were defined for different input modes, including text-based queries, voice-to-text interaction, and crop image submissions.

- Prompt Templates: Standardized prompt templates were designed to ensure the Large Language Model (LLM) generates consistent, safe, and context-aware agricultural advice.

- Confidence and Fallback Mechanism: A structured response schema was developed to include confidence levels and fallback options, such as escalation to agricultural experts when the system is uncertain or when queries require specialized guidance.

D. Implementation

- Frontend Development: The user interface was developed using React Native, providing a chat-based interaction system with features such as voice input, camera integration for crop image capture, and file uploads.

- Backend Services: A lightweight backend service manages API requests, prompt construction, contextual data integration, logging, and rate limiting, ensuring secure communication with the AI models.

- LLM Integration: A Large Language Model (LLM) processes farmer queries, performs contextual understanding, and generates advisory responses. For image-based queries, computer vision techniques are used to analyze crop conditions and detect potential diseases or pest infestations.

- Post-Processing: The generated responses are formatted into a farmer-friendly layout, verified for language clarity, and translated into Malayalam where necessary to ensure accessibility.

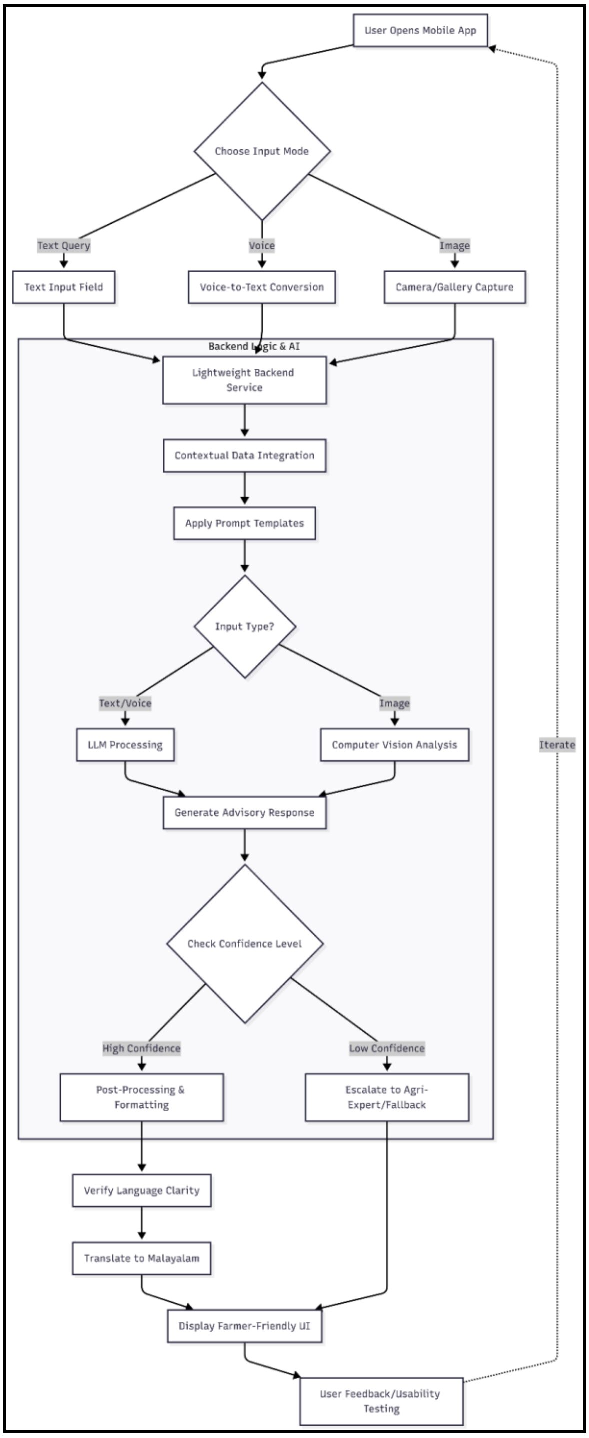

Figure 1. System Architecture of Krishi Mitra

IV. TESTING AND VALIDATION

- To ensure the reliability and effectiveness of Krishi Mitra, a comprehensive testing strategy was adopted covering functional performance, usability, and system security.
- Functional and Integration Testing:
  End-to-end system workflows were simulated to validate the proper functioning of text, voice, and image-based query pipelines. These tests ensured that user inputs are correctly processed and that the system generates appropriately structured responses through the integrated LLM and computer vision components. Additionally, real-device
- testing was conducted to evaluate microphone and camera performance under conditions of limited or unstable network connectivity.
- Usability Testing:
  Target users participated in moderated testing sessions where they performed tasks such as capturing images of diseased crops, submitting text queries, or using voice input to seek farming advice. Key usability metrics including task completion rate, response comprehension, and user satisfaction were collected to assess the overall accessibility and effectiveness of the platform.
- Security Testing:
  Security measures were evaluated by enforcing HTTPS-based secure communication, performing basic penetration testing of backend endpoints, and ensuring secure management of API keys through environment variables. These steps help protect user data and maintain the integrity of the system.

Table I. Performance Evaluation of Krishi Mitra System

Feature	*Accuracy (%)*	*Average Response Time (sec)*
Text Query	*92%*	*1.2*
Voice Query	*88%*	*2.8*
Image Analysis	*90%*	*2.0*

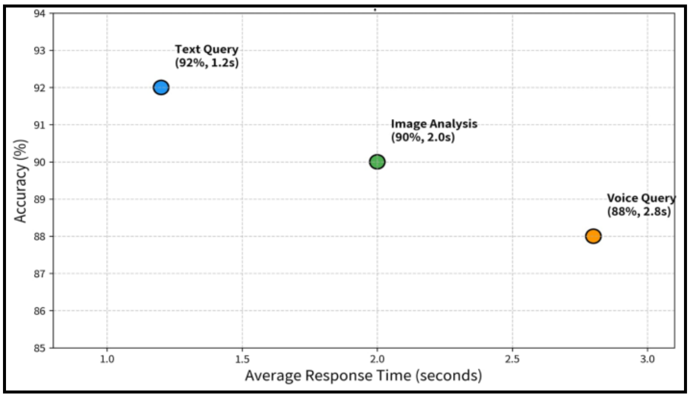

Figure 2: Accuracy vs. Response Time Trade-off across Multimodal Inputs in Krishi Mitra

V. CONCLUSION

The Krishi Mitra application presents a scalable and intelligent digital advisory platform aimed at supporting smallholder farmers by overcoming traditional barriers such as language limitations, limited literacy, and restricted access to expert agricultural guidance. By integrating multimodal interaction capabilities including text, voice, and image inputs with advanced artificial intelligence techniques, the system enables farmers to easily communicate their agricultural concerns and receive timely, context-aware recommendations.

The platform provides real-time advisory support for issues related to crop health, pest and disease identification, irrigation management, and sustainable farming practices. Through its user-friendly interface and support for the Malayalam language, Krishi Mitra enhances accessibility and ensures that farmers can understand and apply the recommendations effectively. Additionally, the system promotes environmentally responsible agricultural practices by encouraging safe, sustainable, and locally relevant farming solutions.

By bridging the gap between farmers and agricultural knowledge systems, Krishi Mitra facilitates faster problem identification, informed decision-making, and improved farm management. Such AI-enabled advisory platforms have significant potential to enhance agricultural productivity, resilience, and sustainability, particularly for smallholder farmers in developing agricultural regions such as Kerala.

VI. References

1. S. Jagadeesan, C. Revanth Krishna, and I. Hanumanth Reddy, "Agro-Bot: Leveraging ANN and NLP to Revolutionize Agricultural Advisory Services," Proc. Int. Conf. Intelligent Systems and Digital Transformation (ICISD 2025), pp. 261-272, 2025.
2. AIEP Initiative et al., "Building AI-based advisory services for smallholder farmers: Technical learnings from the AIEP Initiative," Gates Foundation, GIZ, and CLEAR Global, 2026.
3. A. Harsoor and B. S. Hadagalimath, "AI BASED REAL TIME CROP ADVISORY SYSTEM BY LEVERAGING IOT TECHNOLOGY," Int. J. Adv. Res. (IJAR), vol. 13, no. 09, pp. 988-1004, Sept. 2025.
4. A. Sinha and D. W. Garcia, "Application of Conversational Artificial Intelligence for Farmer's Advisory and Communication," in Artificial Intelligence and Smart Agriculture, pp. 63-86, 2022
5. V. S. Sardeshmukh, S. B. Patil, and S. Bedage, "An AI-Driven Smart Crop Recommendation and Advisory Framework," Int. Res. J. Adv. Eng. Hub (IRJAEH), vol. 03, no. 07, pp. 3209-3218, July 2025.
6. S. Kurre, P. Chandrakar, and S. S. Dadsena, "Smart AI Farmer- A Scalable AI-Based Web Application to Solve Real-World Agricultural Challenges Without IoT Dependency," Int. J. Innov. Sci. Res. Tech., vol. 10, no. 5, pp. 2036-2038, May 2025.
7. Y. Dindure, G. Jadhav, A. Mendgudle, V. Digge, and A. Hosale, "Farmer Query Support & Advisory System: Integrating Real-Time Market Intelligence, Multimodal Query Analytics, and Policy Scheme Optimization for Comprehensive Farmer Empowerment," IJSRED, vol. 8, no. 6, pp. 730-733, 2025.
8. Sharma, A., M. Patel, and M. Tiwari. "A comparative study to detect fraud financial statement using data mining and machine learning algorithms." International Research Journal of Engineering and Technology (IRJET) 6.8 (2019): 1492-1495.
9. Ajay Maru, Ajay Kumar Sharma, Mayank Patel, "Hybrid Machine Learning Classification Technique for Improve Accuracy of Heart", Proceedings of the Sixth International Conference on Inventive Computation Technologies [ICICT 2021], 2021, IEEE Xplore Part Number: CFP21F70-ART; ISBN: 978-1-7281-8501-9, pp. 1107-1110
10. S. L. Singh, A. Yadav, S. Ahmed, A. Maurya, V. Rana, and S. Ahmad, "Smart Crop Advisory Systems Using Artificial Intelligence and Machine Learning," Indian Journal of Computer Science and Technology, vol. 4, no. 3, pp. 269–275, Sep.–Dec. 2025.
11. Patil, S., et al. (2022). Soil-based crop prediction using machine learning techniques. International Journal of Data Science.
12. Bassine, F., et al. (2023). IoT-enabled smart farming systems for sustainable agriculture. IEEE Access.
13. FAO (Food and Agriculture Organization). (2021). Digital technologies in agriculture and rural areas. FAO Report.
14. Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M. J. (2017). Big Data in Smart Farming – A review. Agricultural Systems, 153, 69–80.
15. Kamilaris, A., & Prenafeta-Boldú, F. X. (2018). Deep learning in agriculture: A survey. Computers and Electronics in Agriculture, 147, 70–90.
16. Liakos, K. G., et al. (2018). Machine learning in agriculture: A review. Sensors, 18(8), 2674.
17. Zhang, C., & Kovacs, J. M. (2012). The application of small unmanned aerial systems for precision agriculture. Precision Agriculture, 13(6), 693–712.