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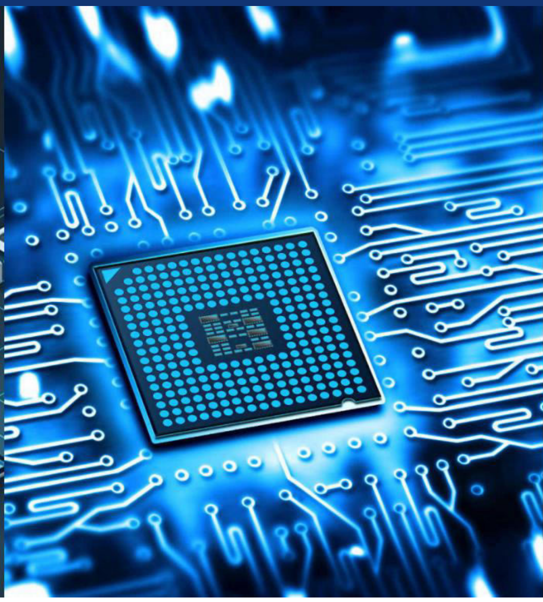


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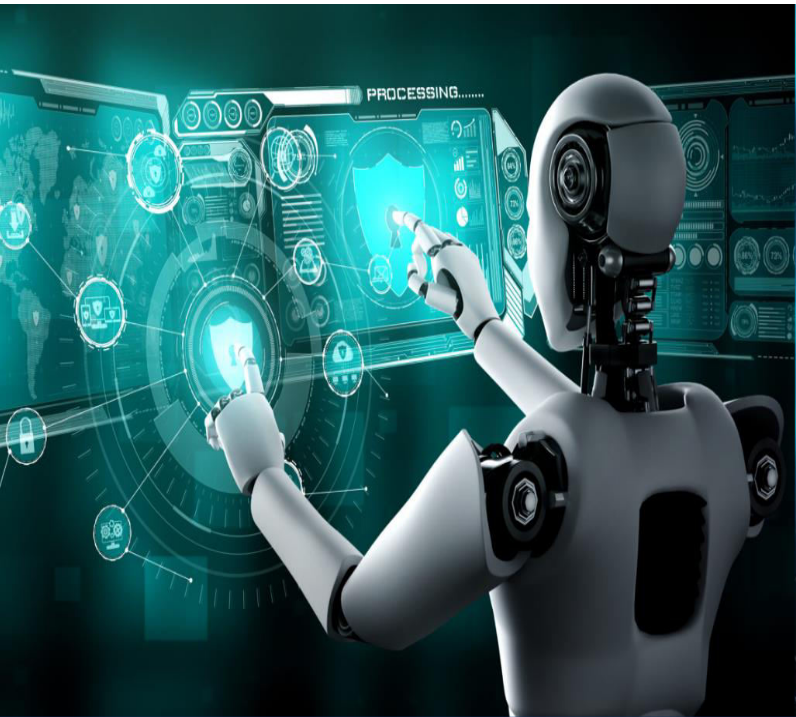

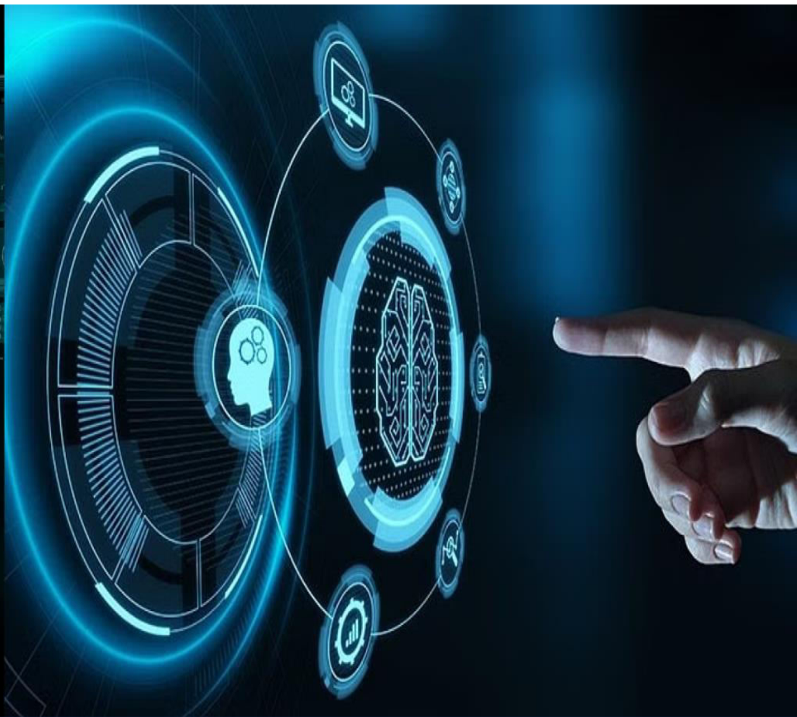

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AI- Based Farmer Query Support and Advisory System

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ABSTRACT: Agriculture remains the primary source of income for many developing countries, but farmers have enduring challenges such as climate unpredictability, crop diseases, water mismanagement, and inadequate tailored guidance. This paper presents a smart AI-powered web application developed specifically for small and marginal farmers that enables efficient farming decision-making without requiring expensive IoT gadgets. Important aspects are included such as a crop recommendation system, image-based disease and pest recognition, smart irrigation, weather forecasting, and answer chatbots that respond to various farming queries. It can take input in different forms, supporting various languages, and even voice commands for those who are illiterate or uneducated. The solution is scientifically and economically tested, user-friendly, and accessible to all intended users. The application is constructed in Python and employs real-time AI models tested extensively for precision. More features are planned in the future, such as AI-driven market price forecasting, personal dashboards for farmers, AI-driven crop rotation scheduling, entrepreneur networks for farmers, an AI-driven subsidy and loan advisory system, a digital crop calendar with AI, and numerous other features.

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 AIBased 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.

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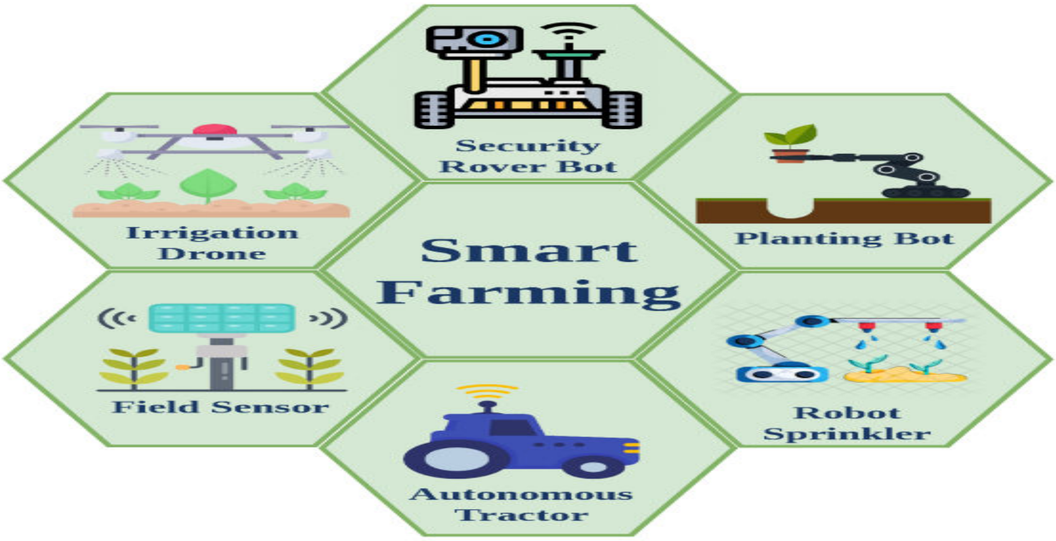

Fig 1: Optimizing Agricultural Data Analysis Techniques through AI-Powered Decision

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.

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

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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 imagebased 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 ଁ = {γୱ ଶγ , ଷγ , ,… , γ ,{□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 first portion applies deep learning with Convolutional Neural Networks (CNNs) for the automatic detection of plant diseases at the leaf image level. It is trained on a massive dataset where pictures are processed automatically which allows for quicker identification of diseases which improves early spotting and action by farmers. Another part predicts the best irrigation schedules by analyzing soil, crop, and weather information through machine learning methods like Random Forest. This saves water and improves its health by providing accurate watering advice in a timely manner. The crop recommendation module suggests the best suited crops depending on the soil's nutrients,

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weather conditions, and previous yields. It adapts to the different regions and farming conditions using supervised learning which makes crop planning more intelligent and profitable.

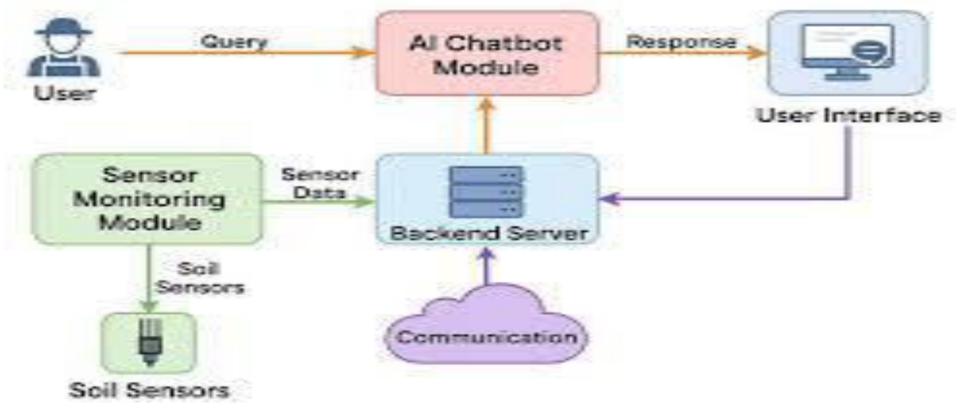

Fig 2: AI-DRIVEN AGRICULTURAL SUPPORT SYSTEM

To forecast weather, the system utilizes a simpler rulebased AI expert system blended with real-time access to weather information through publicly available APIs. This simplifies weather analysis giving clear guidance concerning weather conditions that farmers can easily comprehend and trust especially when there is limited connectivity. The last module is an AI powered chatbot trained using powerful language models that answer farmers' questions in their local dialects providing personalized assistance and guidance even for the less digitally savvy. Combining construction and design was integral to this system's development. The first phase was deeply understanding the barriers farmers encounter by conducting interviews as well as analyzing data from official reports. The second phase involved building AI models and testing them for accuracy, precision, and workability on low-end devices. The system's architecture is modular with features connected by APIs, allowing each attribute to function fully or in conjunction with others, and easily permitting future enhancements.

Interfaces are mobile, multilingual, iconbased, and designed for seamless access by farmers in rural regions. The system was shaped through expert reviews and user feedback A balanced approach of structured and agile development was implemented throughout the project. Requirements emerged through studying user needs alongside data. Datasets were scrubbed and prepared for training to construct fast, lightweight models. Predictive APIs were implemented, after which the frontend was designed with responsive frameworks for optimal user experience. Testing included real-world situations like low bandwidth AI model accuracy, which, as expected, surpassed usability standards. Initially, the system was deployed on a local server before transitioning to cloud hosting for accessibility and scalability.

IV. RESULT

By using non-expensive IoT devices, the AI-Powered Smart Agriculture Web Application has the capability to revolutionize farming for the small and marginal farmers in India. It assists farmers in making the best possible decisions that enhance yields and lessen losses by providing real-time, location-specific guidance on weather, crop selection, irrigation, disease detection, and more. The application aids in achieving a healthy balance between crop production and environmental protection as it minimizes the use of pesticides and optimizes crop cycle planning. This, in turn, ensures improved food quality as well as better crop yield. Moreover, it helps farmers financially by lowering dependence on informal credit, guiding subsidy access, and providing market price forecasts. As a testament to these benefits, it can be accessed across regions with just a smartphone making it easier for farmers. With expanding advancements and future features such as climate advisories and crop insurance, this platform intends to establish a digita farming solution that is affordable, advanced, and free of the burdens of expensive technology barriers, ensuring national food security.

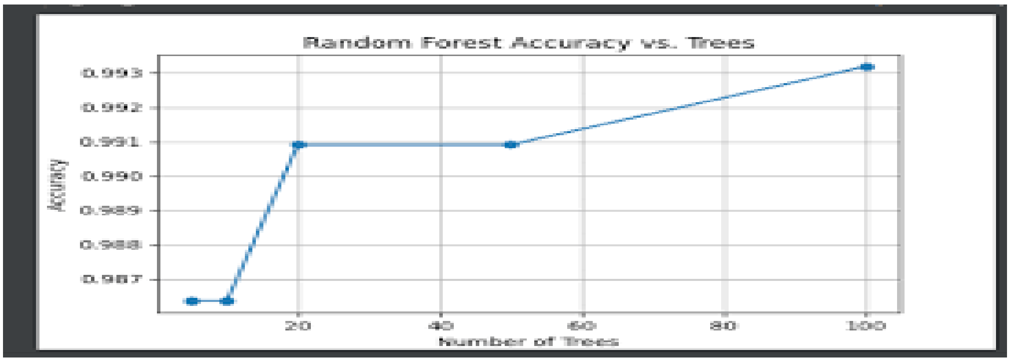

Fig 3: AI BASED REAL TIME CROP ADVISORY SYSTEM BY LEVERAGING

Ther by incorporating additional modules such as advanced farm management, subsidy guidance, and even pest control. The modular structure supports the addition of new functions without any alterations to the current operational functions. It is also planned that the app's offline functionalities will be enhanced so that farmers will be able to use the app without an internet connection. This will also help capture a larger market base. Improved localization in additional languages and dialects will broaden the limit. Better data management and real-time updates will be enabled, alongside stronger AI services with cloud deployment. Further, the evolution of the system with respect to changes in technology and systems will ensure it remains valuable with ongoing changes in the field of agriculture through continuous synergetic work with farmers and agriculture specialists.

V. CONCLUSION

This study demonstrates how an advanced non-IoT smart agriculture web application for AI can aid small and marginal farmers in developing nations like India by providing a scalable and affordable substitute for expensive IoT technology. With crop suggestions, disease identification, smart irrigation, weather updates, and a personal dashboard, farmers are provided with the guidance they need and are able to track their progress in a sustainable manner. As more people use the app, it could evolve into a fully-fledged digital farm management software. With widespread adoption, this system could strengthen food security, elevate farmers' incomes, foster growth in agricultural productivity, and increase the national GDP, all while enhancing climate-smart sustainable farming practices. This is not merely a technological solution; it has the potential to empower millions of farmers digitally, transforming their working landscape.

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