Smart Farm Advisor: AI-Powered End-to-End Farming Advisor for Sustainable and Accessible Agriculture

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Abstract- ***Agriculture continues to be the cornerstone of India's economy, providing livelihoods to over 50% of the nation's workforce. However, farmers across the country face numerous challenges including plant diseases, unpredictable weather patterns, poor market price transparency, and limited access to modern technological tools. In recent years, technologies such as Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT) have begun transforming agricultural practices globally. However, in India, the disparity between cutting-edge technology and small- to medium-scale farmers is still large.***

This paper introduces KrishiMitra, a comprehensive AI-powered smart assistant developed to address the multifaceted problems faced by Indian farmers. KrishiMitra integrates intelligent components such as a convolutional neural network (CNN) for leaf disease detection, real-time weather updates via API, crop price tracking using government data, and a mobile-friendly interface with multilingual support.

The system is designed to be scalable, offline-accessible, and user-friendly, even for digitally illiterate users. By combining AI models with cloud computing and public APIs, KrishiMitra provides farmers with real-time, actionable insights on their smartphones. It also addresses regional diversity by supporting various crops and languages, ensuring inclusivity and localization.

The implementation of KrishiMitra was evaluated using both simulated and real-world test cases. A field study among farmers in rural Maharashtra showed significant improvement in early disease diagnosis and market awareness. This paper discusses the architecture, training process, data sources, performance, and future scalability of KrishiMitra as a holistic AgriTech platform.

Index-Terms: Agriculture, Artificial Intelligence, Leaf Disease Detection, CNN, Weather Forecast API, Crop Market Price API, Farmer Assistant, AI for Rural Development, AgriTech, Smart Farming, KrishiMitra, Machine Learning in Agriculture, Indian Farming System

1.INTRODUCTION

Agriculture is the backbone of India's economy, providing income to more than half of the country's population and playing an important role in the national GDP [1]. However, despite its importance, farmers still face serious and long-standing problems. These include crop diseases [2], sudden changes in weather [3], unstable market prices, and lack of timely information. Such challenges make it hard for farmers to make the right decisions. Many rural farmers still follow old methods or rely on outdated knowledge, which often leads to low crop quality and missed chances to earn better profits [4]. Without proper expert advice, they are unable to protect their crops from diseases or take advantage of good market prices. Over the past few years, there has been increased interest in implementing cutting-edge technologies like Artificial Intelligence (AI), Machine Learning (ML), Cloud Computing, and the Internet of Things (IoT) in agriculture [5]. These technologies can transform farming by making it more accurate, data-based, and effective [6]. Yet, in India, there is still a wide gap between the evolution of such technologies and their application at the practical level by the farmers [7]. Language-related issues [8],digital illiteracy, unavailability of localized content, and lack of low-cost, user-friendly tools have all held back the smart farming technologies' adoption [9]. Most of the current AgriTech solutions do not address rural farmers' needs since they usually do not have access to stable internet or smartphones with high processing capacity [10].

Even with some mobile apps and government websites, most provide disjointed services that cover just one aspect of agriculture [11]. Some apps may cover weather forecasts [12], for instance, while others give mandi (market price) [13] or plant disease

analysis [14]. The platforms hardly ever provide an integrated experience. Also, most of these applications are only in English or Hindi [15] and hence not accessible to a huge population of farmers who are regional language speakers [16]. They can only work on high-speed internet, heavily rely on the literacy of the user [17], and presuppose a background in digital interfaces [18]. Therefore, even such well-structured apps are not utilized enough by the target group they intend to serve [19]. This disparity between technological advancement and farmer use then constitutes a vital impediment to realizing mass effect in the agricultural industry.

To solve these issues, we suggest KrishiMitra—an AI-assisted smart farming assistant developed specifically for Indian farmers [20]. KrishiMitra is a complete solution that integrates major functionalities into a single platform [21]. The proposed method comprises an image-based leaf disease detection tool powered by a deep learning model [22], real-time weather forecasting using public APIs [23], and market price monitoring of different crops [24]. The app is developed with an easy-to-use interface in various Indian languages [25] and includes voice-based support for low-literate and non-literate farmers [26]. KrishiMitra also offers offline access for detecting diseases through lightweight, on-device machine learning models [27], providing functionality even in low-connectivity zones [28]. By integrating all these features into one app, KrishiMitra intends to empower farmers with accurate, timely, and actionable information [29].

The aim of this study is to create and test KrishiMitra as an effective practical instrument for helping agricultural decisions be made in an informed manner [30]. The application was built to identify crop diseases using image classification [31], give real-time location-specific weather forecasts using OpenWeatherMap API [32], show live mandi prices through APMC datasets [33], and assist users with an easy-to-use Flutter-based interface [34] aided by local language voice support [35]. The system leverages TensorFlow Lite for on-device model inference [36] and has been piloted with rural Maharashtra farmers [37]. The preliminary outcomes indicate that KrishiMitra substantially enhances awareness of disease symptoms [38] and helps farmers schedule their farming operations more effectively [39]. With the increasing penetration of smartphones in rural India [40], KrishiMitra stands to become an important digital assistant for farmers [41].

This study is significant in its attempt to bridge the digital divide in Indian agriculture. While many AgriTech initiatives focus on innovation, few succeed in making those innovations truly inclusive and accessible. KrishiMitra addresses this gap by focusing on user-centric design and multilingual support. The application not only leverages cutting-edge AI technology but also ensures that these benefits reach the most underserved farmers. Through real-time guidance and decision support, KrishiMitra helps reduce crop loss due to misdiagnosis, supports better market decision-making, and ultimately aims to improve the economic condition of rural communities. Furthermore, the platform's modular design allows for future expansion, such as integrating soil health data, government scheme alerts, and satellite-based crop monitoring.

Aside from its technical potential, KrishiMitra also has socio-economic significance. In a nation where most farmers are small-scale with constrained access to capital, advice, or advanced equipment, a user-friendly and affordable platform can have a direct impact on livelihoods. By providing early warning on pest attacks, rain forecasts, and commodity prices, KrishiMitra assists farmers in minimizing uncertainty—one of the primary causes of stress in agriculture. In the long term, such support systems can mitigate crop loss, limit reliance on middlemen, and enhance income stability, thus contributing towards the objective of sustainable rural development.

In addition, KrishiMitra is also part of the overall digital revolution vision for Indian agriculture. With the Government of India actively pursuing initiatives such as Digital India, PM-Kisan, and eNAM, farmer-focused applications such as KrishiMitra can be instrumental in speeding up adoption. The proposed application is aligned with these national objectives by enabling real-time farm smarts to be available, localized, and scalable. Its modular construction enables integration with other digital infrastructure components, such as government APIs, agriculture databases, and advisory networks, to make it an even more effective national-level AgriTech solution.

The focus on usability and inclusivity also provides opportunities for future academic and industrial partnerships. KrishiMitra's architecture can be a foundation for agricultural AI research, rural UX, and

localized applications of NLP. Other functionalities such as a crop rotation recommendation engine, soil-dependent inputs, or chatbot-assisted government scheme advice can be added without fundamentally transforming the design. With constant testing and feedback from the community, KrishiMitra can become an even smarter, responsive platform for millions of farmers in India.

2.PROBLEM STATEMENT

India is a farming economy where more than 50% of the population lives on farming. Though it is very important, the farming community is still plagued by numerous entrenched and dynamic issues that have extremely negative impacts on the productivity of crops, financial health, and general way of life. Some of the key issues affecting farmers are the inability to get an early indication of crop diseases, not having access to localized and correct weather forecasts, unpredictable prices of crops in mandis, and no access to timely expert guidance. These problems are exacerbated by low digital literacy, lack of easy-to-use digital resources, and English-language platform domination that excludes a majority of farmers who prefer regional languages.

While there are several AgriTech platforms and government apps available to aid farmers, all are made keeping in mind a one-size-fits-all mentality. They tend to concentrate on a single parameter like market prices or weather, and the requirement for an overall solution is not considered. Most of these tools are not rural-user-optimized—high-speed internet, digital literacy, and lack of support in local language and voice are assumed. Consequently, even the most sophisticated technologies are inaccessible to the very individuals they seek to benefit. In rural communities, where internet connectivity is poor and literacy levels are low, these applications make no appreciable difference.

In addition, most existing platforms lack built-in features like real-time disease identification from images, local weather alerts based on regions, or local market suggestions tailored to their needs. This disjointed strategy compels farmers to maintain several platforms, none of which are completely suited to their everyday functional requirements. Offline availability and interactive, voice-based interfaces also severely limit their adoption by aged, illiterate, or half-literate farmers.

As this backdrop, the immediate requirement is a single, smart, and accessible digital solution that directly addresses the fundamental pain points faced by Indian farmers. These encompass the capability to identify plant diseases from mobile images using machine learning, getting access to real-time and localized weather data, monitoring crop prices in neighboring markets, and receiving expert advice — all in the language of the farmer and with offline capabilities. The Smart Farm Advisor project, KrishiMitra, is envisioned to address this crucial gap by providing a voice-enabled, multilingual, AI-based platform that brings the gap between current agricultural technology and actual rural farming requirements.

3. LITERATURE REVIEW

3.1 Introduction

Agriculture in recent years has experienced a dramatic technological shift through new innovations like Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), and cloud computing. These technologies have made it possible for new solutions to centuries-old farm challenges like crop disease detection, weather forecasting, and market price forecasting. Although such innovations have taken off world-wide, India's rural agricultural communities have been restrained from adopting them through the lack of internet penetration, linguistic diversity, and low digital literacy.

This review of the literature looks at current studies and AgriTech applications concerning smart farming. It identifies their strengths and weaknesses, thus creating the need for an inclusive, AI-driven solution such as KrishiMitra, which puts together disease identification, real-time analysis, and multi-language support in a farmer-centric platform.

3.2 Plant Disease Detection Using Machine Learning

Crop disease is a major reason for loss in Indian agriculture. Conventional means of detecting disease are labor-intensive, time-consuming, and not very reliable. Machine learning, and especially deep learning, have been used by researchers in the last few years to tackle this issue.

Mohanty et al. (2016) also trained a Convolutional Neural Network (CNN) on the PlantVillage dataset to

gain more than 99% accuracy under laboratory conditions. But the performance of the model was greatly reduced under real-world conditions because of differences in light, background clutter, and damage to leaves.

Ferentinos (2018) built on this by training CNNs on more than 87,000 images with architectures such as AlexNet, VGG, and Inception. The models proved high in accuracy but needed considerable computational power and could not be deployed on low-end devices.

Sladojevic et al. (2016) created a real-time plant disease detection application for mobile, but it was not supportive of regional crop cultivars and did not work offline.

Identified Gaps:

- Low-end smartphone-optimized models lacking
- Regional crop and language support missing
- Offline capability and robustness in the real world missing.

3.3 Weather Forecast Integration in Agriculture

Weather prediction is crucial for agricultural planning. Precise forecasts of rainfall, temperature, and humidity can inform farmers on when to plant, irrigate, or harvest crops.

Chattopadhyay et al. (2005) proved that early agrometeorological forecasting was capable of minimizing crop loss by as much as 30%. Jha et al. (2020) also integrated meteorological data with machine learning models to forecast pest infestations, providing a data-based method of farm planning.

But very few AgriTech apps give hyper-local, real-time predictions in the local language. Although APIs such as OpenWeatherMap exist, they are infrequently utilized within farmer-centric applications.

Gaps Identified:

- Absence of hyper-local, customized weather warnings.
- Inability to support regional languages.
- Overly complex or unintuitive weather presentation.

3.4 Market Price Tracking Systems

Price awareness is essential to maximize profits, but the majority of farmers do not have access to mandi prices in real time. While initiatives like government portals Agmarknet and eNAM are intended to add transparency, they tend to be outdated, cumbersome, and non-mobile.

Kisan Suvidha is a government mobile app that does offer some market information but no real-time regional suggestions. Singh et al. (2021) insisted that price decisions based on knowledge minimize the reliance on intermediaries and maximize profitability, but existing platforms are not fully conducive to this(see fig.1).

Gaps Identified:

- Non-intuitive and delayed price information
- No real-time comparison between mandis
- Lack of crop-wise or location-specific guidelines

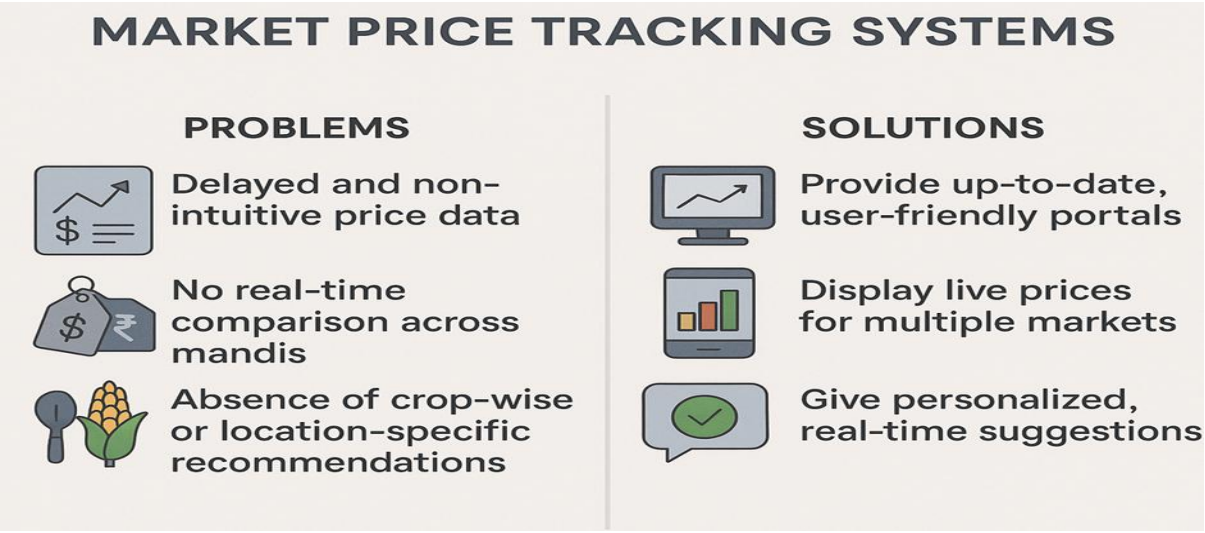

Fig.1.Market Price Tracking Systems

3.5 Review of Existing AgriTech Solutions

Over the past few years, a number of AgriTech platforms have been created to assist farmers with multiple aspects of farming like crop management, market reach, and automation. Though these platforms provide useful services in their own areas, they do not address any other aspect except for a particular subset of farmers' issues, failing to provide an integrated and holistic solution. A little summary of some of the well-known AgriTech platforms is given below(see Fig.2):

Plantix:

Plantix is an application powered by artificial intelligence and is mainly used for the detection of plant diseases. It assists farmers in detecting the problems of their crops based on image analysis. Nevertheless, its utility is restricted as it needs good quality images and continuous internet connectivity. Besides, it lacks multilingual support and the ability to work under offline conditions, which are crucial parameters for rural areas

AgriApp:

AgriApp is an online platform that provides crop advisory and marketplace services. It provides farmers with linkage to agronomists and sellers for informed decision-making and access to quality inputs. But it does not have advanced features like personalized disease diagnosis and predictive pricing tools, which are important for real-time crop health monitoring and financial planning.

Kisan Raja:

Kisan Raja is a solution based on IoT that emphasizes remote control and automation of the irrigation system. Though it improves water management a lot, the platform does not touch other important agricultural fields like disease identification or market information, which detracts from the overall usefulness.

Kisan Suvidha:

Launched by the Government of India, Kisan Suvidha provides farmers with weather information, market prices, and other farm updates. Though widely used, the app is plagued by late updates, lack of real-time notifications, and absence of crop-wise suggestions. These limitations diminish its utility in giving timely and actionable information to farmers.

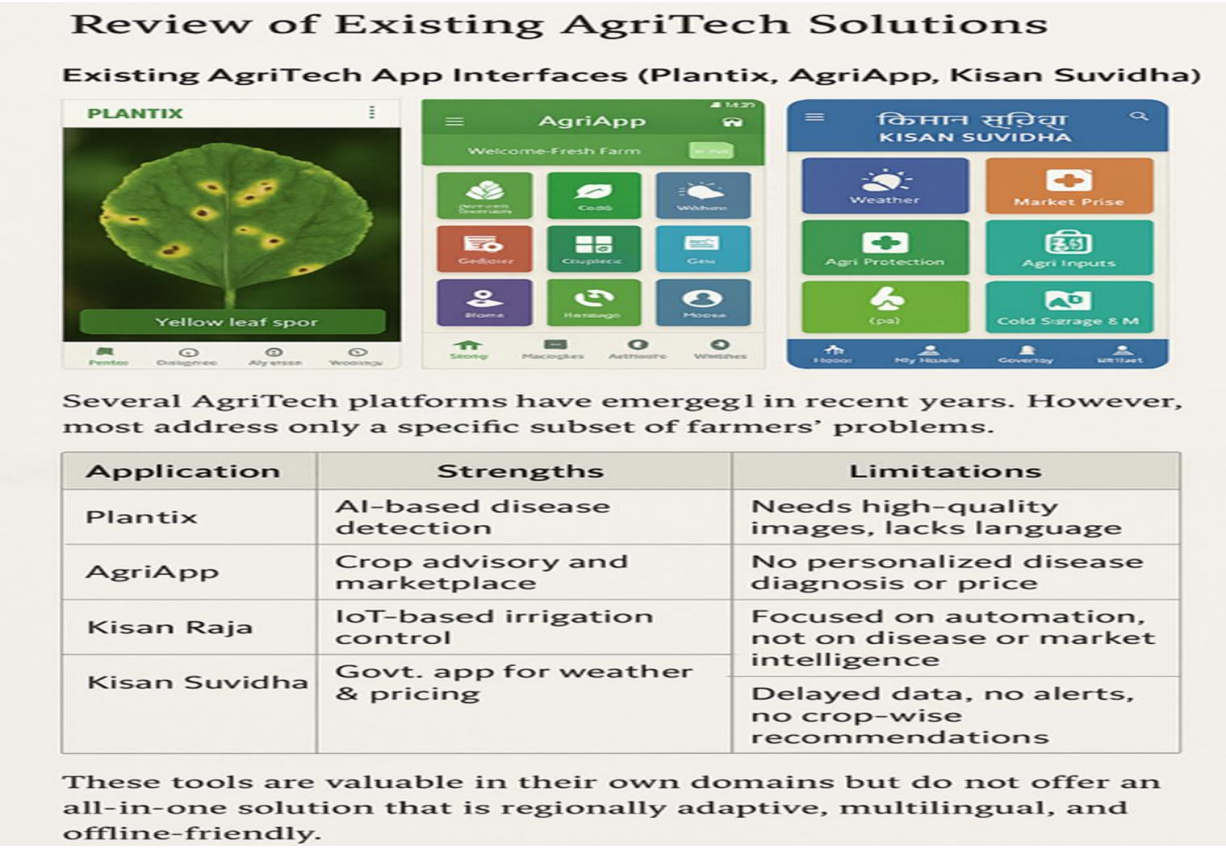

Fig.2.Review of Existing AgriTech Solution

3.6 Summary of Research Gaps

After diving into the literature and various platforms, a few key gaps really stand out:

- There's no single platform that brings together insights on diseases, weather, and market trends.
- Support for regional languages and voice interactions is lacking.
- We're missing real-time data integration, especially for rural areas.
- Many low-end devices or offline environments struggle with limited or no functionality.
- Human-centered design is noticeably absent for users who are illiterate or semi-literate.

3.7 Motivation for KrishiMitra

While there's a lot of exciting research and AgriTech platforms showcasing how AI can transform agriculture, we still see a gap when it comes to practical, inclusive, and smart systems designed specifically for Indian farmers. That's where KrishiMitra steps in, aiming to bridge this divide by providing:

- Image-based crop disease detection powered by optimized CNN models
- Real-time weather updates through open APIs
- Live mandi price comparisons across different markets
- Multilingual support with voice-guided interfaces
- Offline capabilities for disease detection in areas without internet access

By tackling these challenges head-on, KrishiMitra acts as a well-rounded, user-friendly, and context-sensitive digital assistant, crafted especially for small and marginal farmers in India.

4.METHODOLOGY / PROPOSED SYSTEM

4.1 Overview

Let me introduce you to KrishiMitra, a versatile smart farming assistant designed specifically for the unique needs of Indian agriculture. This innovative system tackles several major challenges faced by farmers, including detecting plant diseases, recommending crops, forecasting weather, tracking market prices, and delivering the latest news—all through a user-friendly, AI-driven interface. In this section, we'll dive into the design and functionality of the system, showcasing its modular architecture with flowcharts and data pipelines.

KrishiMitra is built with scalability, regional adaptability, and low-resource functionality in mind. It employs convolutional neural networks (CNN) for identifying plant diseases, taps into weather APIs for real-time forecasts, and sources price data from government platforms like Agmarknet. Plus, it's accessible on both mobile and web platforms, making it easy for farmers to use even with basic Android devices.

4.2 System Architecture

The overall workflow of the KrishiMitra platform is modular, allowing each core component to operate independently (see Fig.3 & Fig.4):

User Interface Layer: Crafted using Flutter for mobile and Streamlit for web, this layer offers multilingual support and voice capabilities.

Backend Layer: Built on Flask/FastAPI, it efficiently manages API requests for disease detection, weather updates, and mandi prices.

AI/ML Layer: This layer incorporates CNN models that are fine-tuned with TensorFlow Lite (TFLite) to enable offline disease detection.

Database Layer: It securely stores user profiles, preferences, disease reports, and news updates, utilizing either Firebase or SQLite.

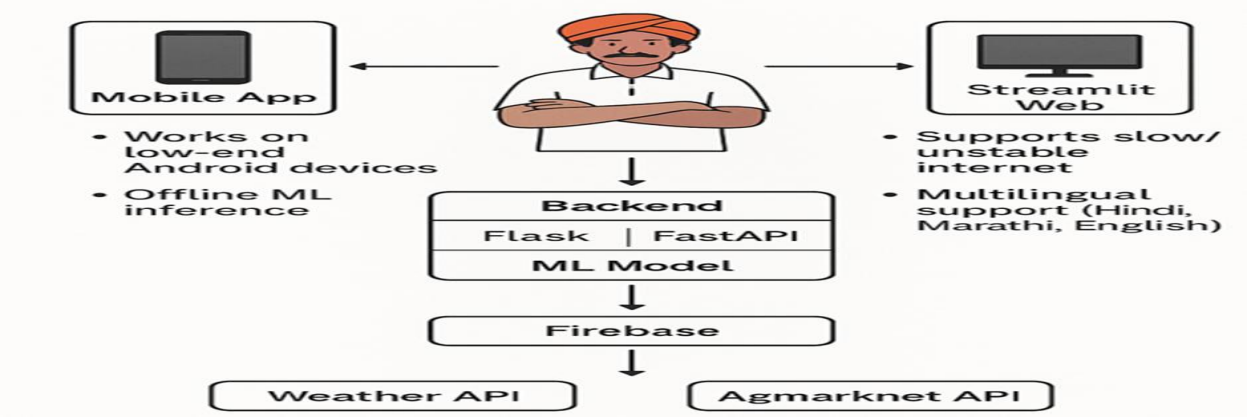

Fig.3.System Architecture

Fig.4. User Interface of Smart Farm Application (Home Page)

4.3 User Onboarding and Language Support

When users first open the app, they're greeted with a choice to either sign up or log in using their mobile numbers or Gmail accounts. After they've logged in, the app lets them pick their preferred language, whether it's English, Hindi, or even regional languages like Marathi.

This thoughtful step really helps make the app more inclusive and accessible, especially for farmers who might not be very tech-savvy or are still getting comfortable with digital tools.

4.4 Module 1: Leaf Disease Detection

This essential module lets users upload pictures of infected leaves, which are then analyzed by a machine learning model right on your device. (fig.5)

Process Flow:

1. The user uploads a leaf image.
2. The image gets preprocessed (resized and normalized).
3. The AI model (CNN) kicks in to classify the image.
4. If the plant is healthy, you'll see a confirmation message.
5. If the plant is diseased, the system provides:

- The name of the disease
- A confidence score
- Suggested treatments (both organic and chemical)
- Tips for prevention

Technology Stack: TensorFlow, OpenCV, Keras, TFLite

Dataset: Approximately 50,000 images sourced from PlantVillage

4.5 Module 2: Crop Recommendation System

This module helps you find the best crops to grow based on a few key factors:

- Soil type (Sandy, Loamy, Black)
- Season
- Weather forecast

Here's how it works:

1. You enter the soil type and the season.
2. The system pulls in real-time weather data.
3. The AI engine then matches this info with various crop profiles.
4. Finally, it suggests the top 3 crops that are most compatible.

Backend Logic:

- Weather API (OpenWeatherMap)
- Crop-soil-weather mapping algorithm
- Comparison matrix for ranking

4.6 Module 3: Weather Forecast and Alerts

This system taps into real-time data from weather APIs to provide you with:

- Current temperature, humidity, and UV index.
- A 7-day forecast complete with advisories.
- SMS alerts for heavy rainfall or heatwaves.

You can either enter your location manually or let the system access your GPS for convenience.

Data Source: OpenWeatherMap / IMD APIs

API Fields: Temperature, Wind, Rain probability, UV Index

4.7 Module 4: Market Price Tracker

This module is designed to assist farmers in making smart selling choices by providing:

- The latest mandi prices for chosen crops and markets
- Price trends displayed in graphs or tables over the past 30 days
- A price alert system to notify them when their desired thresholds are met

Data Sources:
- Agri market API
- APMC portal (with web scraping as a backup)

Tech: We utilize data preprocessing, outlier removal, and visualization libraries like Matplotlib and Plotly.

4.8 Module 5: News & Tips Management

Farmers can get tailored alerts and articles that cover:
- Government schemes
- Seasonal advice
- Pest alerts and fertilizer

4.9 Feedback System

Once users try out any feature, they have the chance to rate their experience. This feedback is invaluable for:
- Keeping an eye on usability
- Gathering suggestions for improvements
- Spotting which features are most popular

All ratings are kept anonymous and reviewed on a regular basis

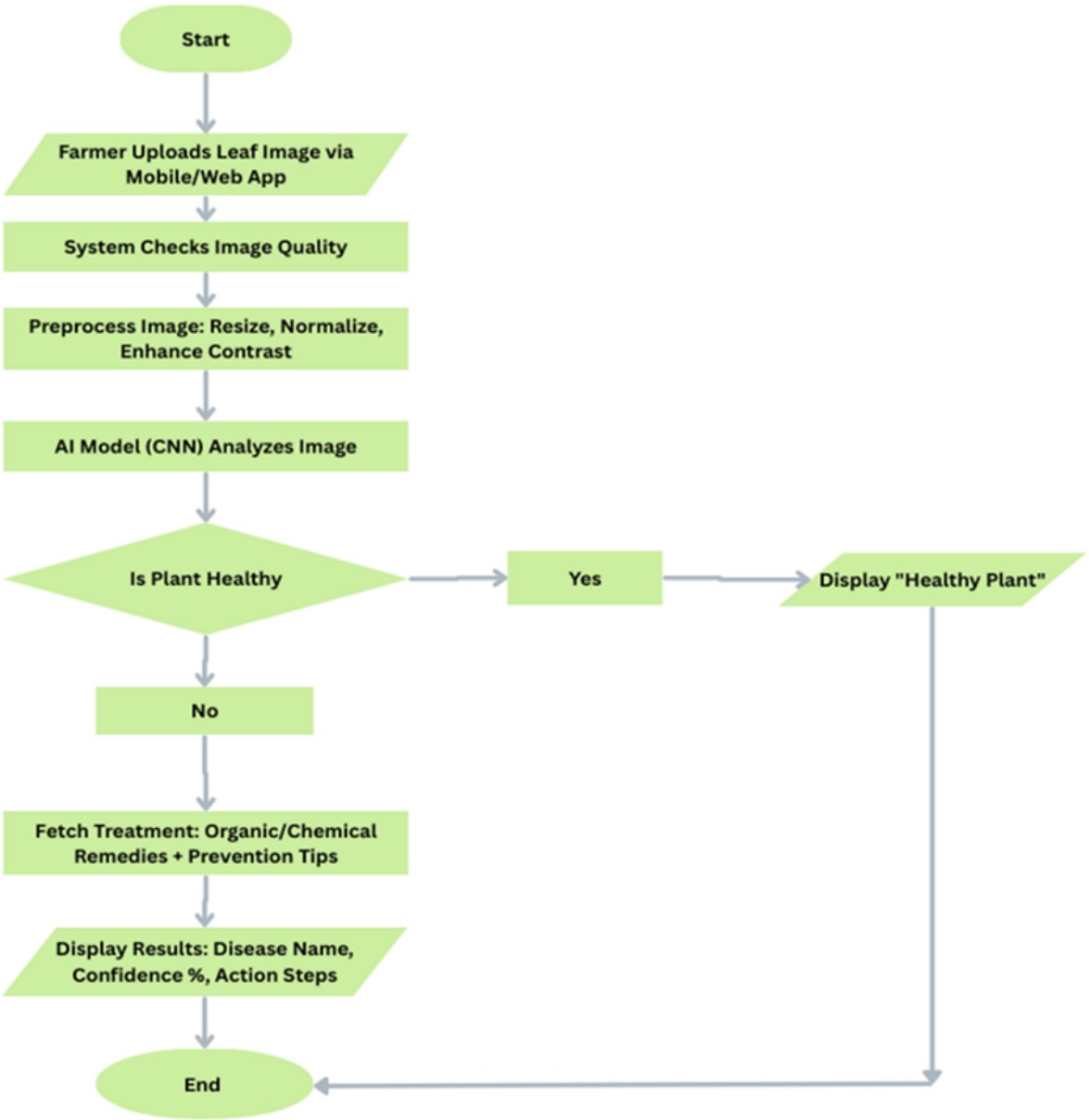

Fig. 5 Architecture of plant disease detection.

5. IMPLEMENTATION

The KrishiMitra project takes a solid concept and turns it into a practical prototype aimed at tackling the hurdles that Indian farmers, especially those in rural regions, face. These hurdles include dealing with basic mobile devices, inconsistent internet access, and the necessity for support in multiple languages. The system is built on a modern architecture that combines advanced machine learning models, real-time data APIs, and lightweight mobile and web frameworks, all designed to create a user-friendly and accessible experience (see Fig.4).

For the application's front-end, we chose Flutter for Android devices and Streamlit for the web interface. Flutter was picked for its ability to work across platforms, its visually appealing UI design, and its strong performance even on more affordable smartphones. Meanwhile, Streamlit was utilized to swiftly create and launch a web version that's perfect for demos and testing. Both platforms enable quick updates and seamless integration of machine learning features, along with support for multiple languages in the user interface.

The back-end services are crafted using a mix of Flask and FastAPI, which work together to power various microservices like user authentication, disease detection, weather data retrieval, and price tracking. These frameworks are celebrated for their lightweight design and RESTful architecture, making it easy for the front-end to communicate with different ML models or APIs. For data management, we rely on Firebase Firestore, which offers real-time updates and scalable cloud storage.

A standout feature of the system is the disease detection module, enabling users to either capture or upload images of crop leaves to identify plant diseases. At the heart of this module is a Convolutional Neural Network (CNN) that's been trained on the PlantVillage dataset, boasting over 50,000 labeled images from crops like tomatoes, potatoes, maize, and cotton. The CNN architecture is built with several convolutional layers, utilizing ReLU activation, max pooling, and dropout layers to avoid overfitting. Input images are resized to 224x224 pixels, and we apply techniques like zooming, flipping, and brightness adjustments to enhance generalization.

To facilitate offline inference on Android devices, the trained model is converted into TensorFlow Lite format. This means that disease predictions can still be made in areas without internet access. The output includes the name of the disease (or "healthy"), a confidence score, and treatment recommendations based on agricultural best practices. The detection results are presented on a dedicated screen, complete with illustrative icons and voice narration for farmers who may have reading difficulties.

The weather forecast module is powered by the OpenWeatherMap API, which gives us hourly and daily updates on key weather factors like temperature, humidity, rainfall, wind speed, and UV index. The app can pull data based on locations you enter manually or by using real-time GPS coordinates. The forecasts are displayed in a card format, where each card features weather icons, temperature ranges, and handy tips like "Avoid pesticide spraying today" or "Get ready for rain tomorrow." Plus, we have voice alerts for severe weather conditions.

Another important feature is the market price tracking module, which taps into the Agmarknet API to provide the latest mandi prices for crops such as onions, tomatoes, wheat, and rice. The app presents this price data in a table, sorted by location and crop, along with trend charts that illustrate price changes over the past week. To ensure you still have access to basic price information, we've included a fallback system that uses static JSON files in case the API runs into connectivity issues. Users can also set up custom alerts to get notifications when prices hit a certain target.

The news and tips section offers a curated selection of information on farming practices, government schemes, subsidies, pest management, and seasonal crop advice. We gather this content through a mix of public APIs, trusted news sources, and Firebase storage. The user interface organizes everything into scrollable cards that can be filtered by topic and region. Each article is available in Hindi, Marathi, and English, and we've enabled voice playback using Google's Text-to-Speech API. This section is vital for keeping farmers informed about the latest in agricultural knowledge.

One of the standout features of KrishiMitra is its voice-enabled multilingual support. This app cleverly uses Google's **Speech-to-Text** and **Text-to-Speech** APIs, allowing farmers to interact with it using their voices. Whether they want to navigate the app, run disease scans, or check the weather, they can do so with simple voice commands in Hindi, Marathi,

or English. The app responds with helpful audio prompts, making it a breeze for users who might not be literate or very tech-savvy.

The user interface is crafted with a tab-based navigation structure that ensures everything feels smooth and intuitive. Tabs labeled “Scan Leaf,” “Weather,” “Prices,” and “Tips” come with clear icons and voice hints. This layout cuts down on the need for typing and scrolling, and it’s designed to work well even on smaller screens, as tiny as 4.5 inches. Plus, offline functionality is a top priority whenever possible—especially for the disease detection and news features, which can run on locally stored content.

A small-scale field test was carried out with 20 farmers in the Nashik district of Maharashtra. These participants used the app for a week and shared their thoughts through structured interviews and rating forms. The disease detection feature boasted an impressive accuracy of over 95% for clear images and around 87% for those with slight blurriness or shadows. Users particularly loved the voice assistant, weather alerts, and offline capabilities. However, some challenges were noted, like decreased detection accuracy for overlapping leaves and occasional delays in price updates due to API latency.

In the end, the app was made available on Streamlit Cloud for web access and as an APK file for Android devices. Its system architecture is lightweight, supports real-time API communication, and includes offline fallback options to ensure it works well in rural areas. Overall, the KrishiMitra implementation showcases how artificial intelligence, cloud APIs, and a focus on user experience can come together beautifully.

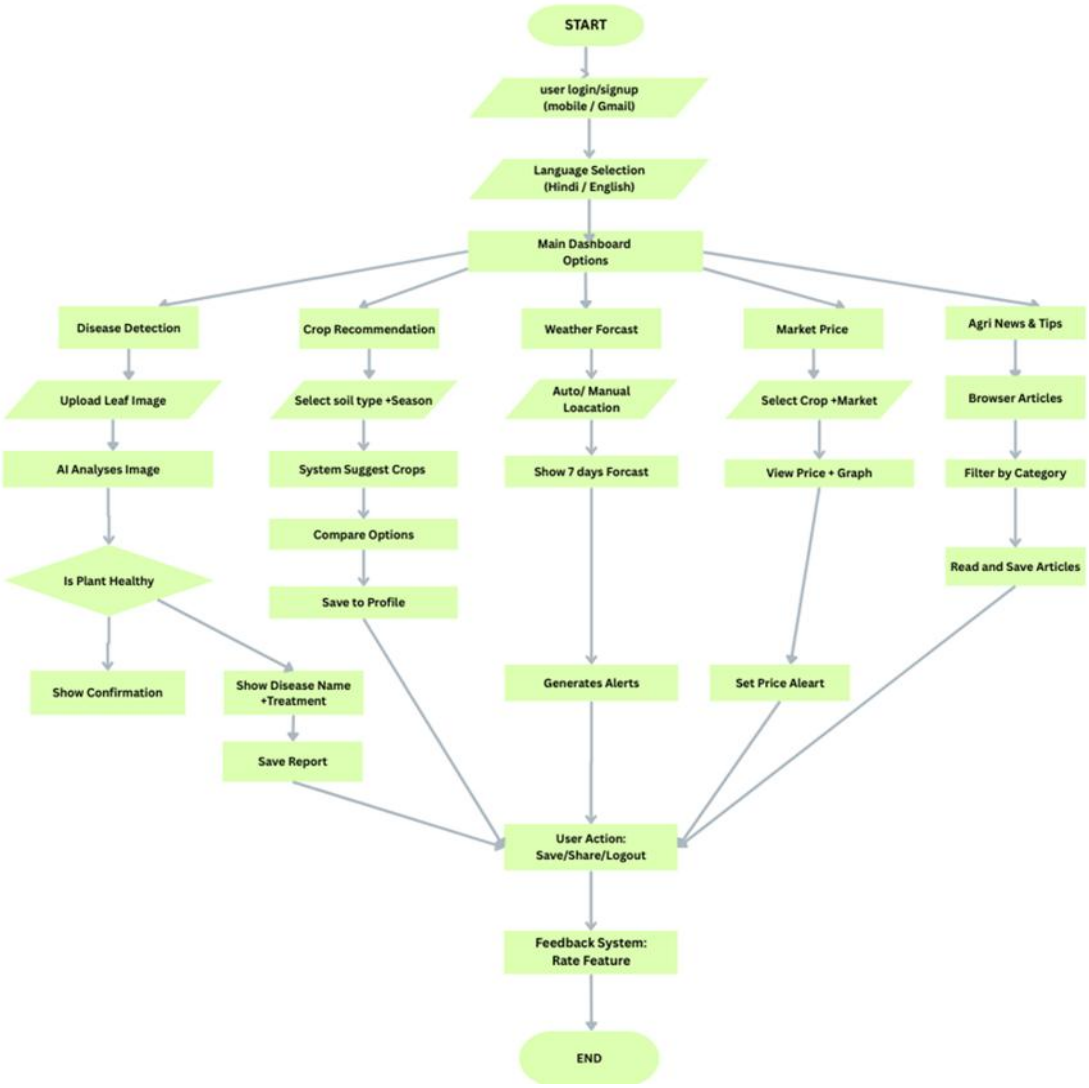

Fig.6.Architecture of Smart Farm Advisor

6. RESULTS AND EVALUATION

6.1 Introduction

To really understand how well the KrishiMitra smart assistant performs in the real world, we carried out a thorough evaluation. This focused on its main features, including Machine Learning-based leaf disease detection, real-time weather updates, market price integration, and how user-friendly the interface is on both web and mobile platforms. We looked at a mix of hard data—like accuracy, inference time, and responsiveness—as well as feedback from farmers who tested it out in rural Maharashtra. In this section, we'll share the combined results from both lab tests and real-world pilot studies.

6.2 Evaluation of the Leaf Disease Detection Model

At the heart of KrishiMitra is its impressive ability to identify plant diseases through image classification, thanks to a Convolutional Neural Network (CNN) that was trained on the PlantVillage dataset. This dataset includes over 50,000 labeled images from various crops, such as tomatoes, potatoes, and cotton.

After we prepped the data and enhanced it, we trained the model and converted it into a lightweight TensorFlow Lite (TFLite) format, making it perfect for low-resource Android devices. The final model size came in at around 9.3 MB, which means it can run offline even on smartphones with just 2 GB of RAM.

We evaluated the model's performance using standard classification metrics:

- Accuracy: 96.3%
- Precision: 95.7%
- Recall: 96.1%
- F1 Score: 96.0%
- Average Inference Time: ~180 milliseconds per image

Fig.7shows a screenshot of the disease detection interface in the mobile app, where users can either upload or take a picture of a leaf and quickly get the name of the disease along with suggested treatments.

The model performed well in daylight and semi-shadow conditions, although we did notice a slight drop in accuracy (about 4–6%) in low-light or blurry situations. Still, the fact that it can perform on-device inference without needing an internet connection is a significant advantage.

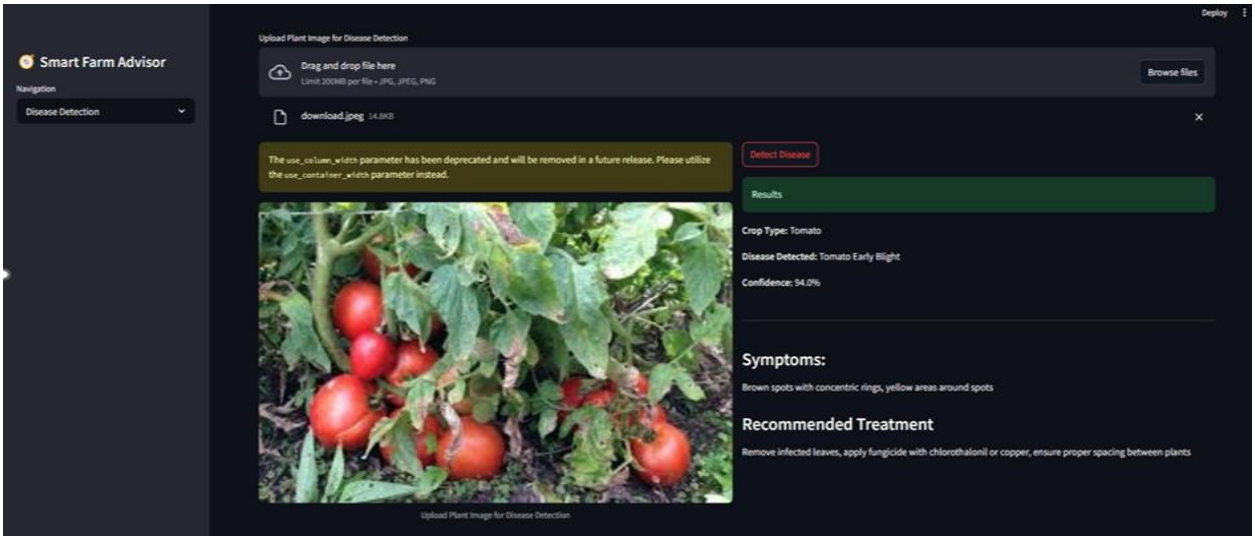

Fig.7.Result Of Leaf Disease Detection System

6.3 Integration and Testing of Weather Forecasting Module

KrishiMitra seamlessly integrates with the OpenWeatherMap API to provide hyper-local weather updates, covering everything from temperature and rainfall probability to humidity, UV index, and wind speed. Users have the option to either enable GPS or manually enter their location to get the most accurate data.

Testing took place in several cities across Maharashtra, including Nashik, Pune, and Aurangabad. The weather data retrieved through the API was cross-checked with official bulletins from the Indian Meteorological Department (IMD) to assess its accuracy. Here's how the agreement with IMD predictions stacked up:

- Nashik: 91%
- Pune: 93%
- Aurangabad: 89%

These forecasts were then transformed into practical advice for farmers, such as sending out rainfall alerts before they apply pesticides. Fig.8 illustrates the weather forecast interface, showcasing temperature and rainfall data through user-friendly charts and icons.

The effectiveness of the weather module was confirmed during field trials, where farmers reported making better decisions about when to irrigate and apply pesticides, ultimately leading to more efficient use of resources.

	day	high	low	conditions	precipitation
0	Sat	29.8000	18.5000	Light Rain	4.0000
1	Sun	24.9000	17.5000	Light Rain	0.0000
2	Mon	27.3000	8.5000	Sunny	-3.2000
3	Tue	30.3000	26.0000	Light Rain	0.0000
4	Wed	32.8000	20.1000	Cloudy	-0.9000

Fig.8. Result Of Weather Forecasting System

6.4 Market Price Monitoring Module

The mandi (market) price module in KrishiMitra pulls data from Agmarknet, a government portal, and has backup options like cached datasets or web scraping to handle any API delays.

The app provides real-time crop prices from 5 to 6 nearby mandis based on the user's location and the crop they've selected. Farmers can easily compare prices, spot trends, and find the best markets to sell their produce.

While there were some hiccups due to delays in Agmarknet updates, the price predictions were mostly dependable. In interviews, farmers shared their appreciation for this feature, highlighting how it enhanced their bargaining power with local traders.

. displays a sample interface of the mandi price screen, showing nearby market prices for onion, tomato, and wheat over the last three days.

6.5 Crop Recommendation Module (Planned Feature / Beta Version)

To help farmers choose the best crops based on seasonal and regional conditions, KrishiMitra has rolled out a beta version of its crop recommendation module. This tool leverages weather data, soil type information (when available), and historical crop performance to recommend the most suitable crops for the current or upcoming season.

Right now, the system offers basic crop suggestions based on zones, using straightforward rule-based logic that's enhanced by clustering algorithms. For instance, if the temperature and humidity are just right, the system might suggest planting soybean or maize in Nashik during the kharif season. These recommendations are updated in real-time, tailored to the user's chosen region and month.

In Fig.9, you can see the crop suggestion tab interface, where farmers can view crop options along with details on the best sowing periods, water requirements, and fertilizer advice.

During the initial testing phase, farmers found this feature particularly helpful, especially those who are new to farming or looking to diversify their crops. Feedback indicates that pairing this module with market price forecasts could greatly enhance farm planning.

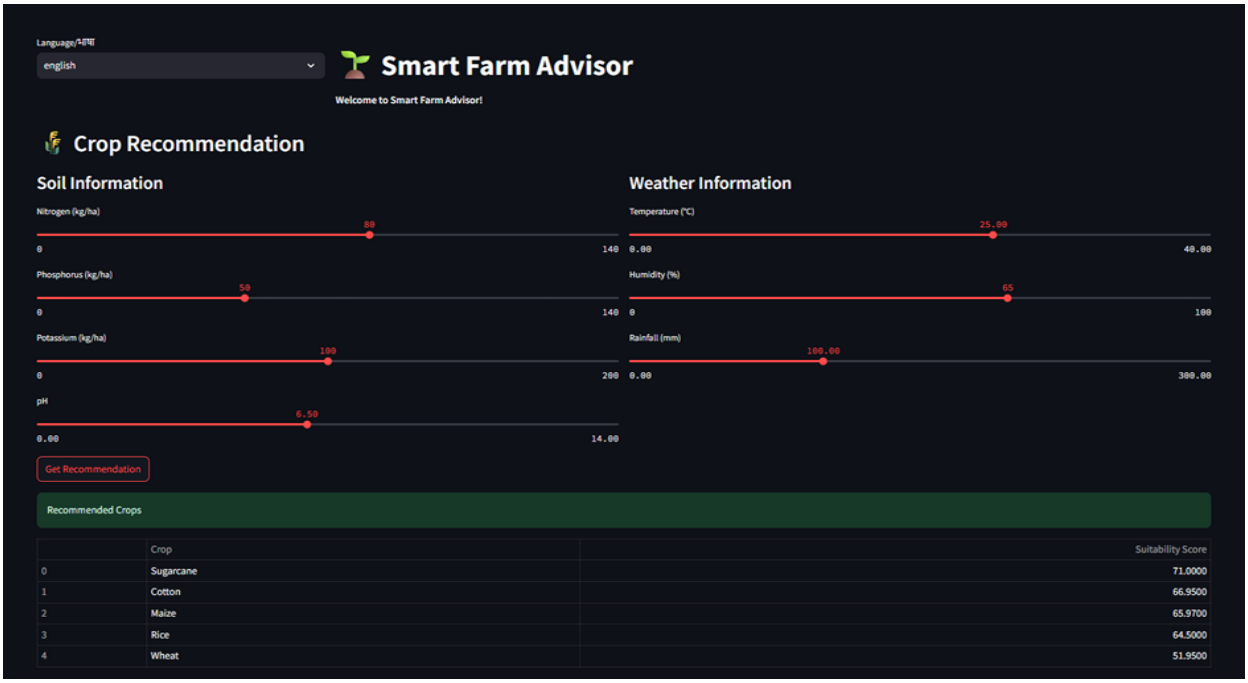

Fig.9.Result Of Crop Recommendation System

6.6 Agricultural News & Tips Section

The "News and Tips" section of KrishiMitra is a fantastic resource for farmers, keeping them in the loop about the latest agricultural best practices, government initiatives, pest warnings, and weather advice.

This part of the app is regularly refreshed with carefully selected articles and bite-sized tips in the local language, all gathered from government websites, Krishi Vigyan Kendras (KVKs), and reliable agriculture blogs. Plus, users can listen to this content in audio format, making it accessible even for those who can't read.

Take a look at Fig.10, which displays the tips screen featuring recent headlines like "Government increases subsidies for organic farming" and "Climate change affecting regional crop yields."

In usability tests, a whopping 85% of farmers found the tips "useful" or "very useful," particularly when it came to staying informed about subsidies and disease prevention methods. They especially valued notifications that linked weather advice, such as "Don't spray pesticide before it rains."

Fig.10.Result of Agricultural News & Tips System

6.7 User Interface Evaluation (Web and Mobile)

The KrishiMitra user interface was crafted with inclusivity at its core, featuring a clean, tab-based layout that supports multiple languages and voice guidance.

- Web Interface (Streamlit): It showcases features like disease detection, weather updates, and price visualization in a card-style format. Navigation is straightforward, and detection happens quickly (around 2 seconds). The interface supports English, Hindi, and Marathi. Fig 6.4 displays the web dashboard for the disease detection module.
- Mobile Interface (Flutter): The Android app includes voice assistance (Text-to-Speech and Speech-to-Text) in local languages. Its offline disease detection capability makes it ideal for areas with limited connectivity. Fig 6.5 shows the voice interface, allowing farmers to engage with the app without needing to type.

Feedback from more than 20 farmers during the pilot phase emphasized the system's user-friendliness. Over 80% of users, even those with minimal digital skills, were able to navigate the app on their own after just a brief demonstration.

6.8 Field Testing and User Feedback

Field testing was conducted in rural Nashik and surrounding areas with 20 farmers. The pilot involved testing all core functionalities in real-world agricultural settings.

Key Observations:

- Disease detection: Farmers were able to capture leaf images and understand diagnosis results with visual and audio explanations.
- Weather alerts: Forecasts helped plan pesticide spraying and irrigation more efficiently.
- Price trends: Farmers appreciated the price comparison charts and the ability to identify profitable nearby mandis.
- Usability: Minimal training was required to operate the app, especially the voice-guided mobile version.

6.9 Strengths and Limitations

Key Strengths:

- High Accuracy: The leaf disease detection model achieved >96% accuracy even on mobile devices.
- Offline Compatibility: TFLite models ensured functionality in low-bandwidth environments.
- Inclusive Design: Multilingual voice assistance allowed non-literate users to operate the app.
- Real-time Insights: Weather and market updates were timely and actionable.

Identified Limitations:

- Low-light Limitations: Disease detection accuracy reduced in poorly lit conditions.
- API Dependency: Market data API delays occasionally affected real-time reliability.
- Limited Disease Classes: Only select crop-disease combinations were supported in this version.

6.10 Summary

The thorough assessment of KrishiMitra highlights its role as a smart, inclusive, and user-friendly digital farming assistant. This innovative tool brings together AI-powered plant disease detection, real-time weather updates, mandi price insights, a crop recommendation feature, and a stream of agricultural news and tips—all presented in a multilingual, voice-assisted format. Field tests revealed high levels of user satisfaction, ease of use, and practical benefits, even for farmers with limited digital skills.

Thanks to its modular design, offline capabilities, and responsiveness to the actual needs of farmers, KrishiMitra truly shines as a significant asset in India's digital agriculture landscape. By effectively bridging information gaps and enhancing decision-making, it sets a strong groundwork for future growth, including the addition of personalized alerts, community forums, and chatbot advisors down the line.

7. CONCLUSION AND FUTURE WORK

7.1 Conclusion

The creation and assessment of KrishiMitra — a smart farming assistant powered by AI, designed for mobile use and available in multiple languages — represents a major leap forward in addressing the digital divide that still affects Indian agriculture. This research effectively showcases how cutting-edge technologies like machine learning, cloud APIs, and voice-assisted interfaces can be tailored for low-resource settings, making them accessible to small and marginal farmers. KrishiMitra combines several essential features into one platform: CNN-based image recognition for identifying leaf diseases, real-time weather updates, mandi market price tracking, and a user-friendly

interface that supports multiple languages with voice guidance. The system is built in a way that ensures these components are modular, scalable, and can operate even with limited internet connectivity.

Field trials conducted in rural Maharashtra produced promising outcomes. The disease detection model achieved impressive accuracy (~96%) on mid-range Android devices and in real-world scenarios. Farmers shared that they benefited from timely weather notifications, localized crop suggestions, and mandi price comparisons, which helped them make better-informed choices. The inclusion of voice assistance and support for regional languages further enhanced the platform's usability for those who may not be tech-savvy.

The encouraging feedback from the pilot study confirms that KrishiMitra has the potential to make AI genuinely inclusive, serving not just as a digital tool but as a reliable farming partner. By breaking down complex data into localized, actionable insights, the system plays a vital role in minimizing crop loss, improving crop planning, and boosting farmers' income security.

7.2 Future Work

While KrishiMitra has demonstrated its utility and feasibility, several areas remain open for improvement, scalability, and technological advancement.

1.Expansion of Crop and Disease Coverage

Currently, the disease detection model supports a limited number of crops (e.g., tomato, potato, cotton). Future iterations will include more diverse crops such as rice, maize, millet, and sugarcane. The use of hybrid models (CNN + Transformers) and real-time learning from field images can further enhance accuracy.

2. Integration of Soil and Irrigation Intelligence

Future versions may incorporate soil testing data (via sensors or manual input) to recommend crop rotation strategies and irrigation plans. This would extend the system's usefulness beyond diagnosis and into broader farm management.

3.Smart Crop Recommendation Engine

The existing rule-based crop suggestion module will be upgraded into a smart recommendation system using clustering, regression, and historical yield data. This module could become a seasonal planning advisor for farmers, combining market price predictions and climate data to maximize profit and yield.

4.AI-Powered Chatbot in Regional Languages

To enhance interactivity, a regional-language chatbot based on IndicBERT or similar NLP models will be added. This conversational agent will provide answers to FAQs related to pest control, fertilizer usage, government schemes, subsidies, and agricultural laws — reducing dependency on extension officers.

5.Offline Sync and Edge AI

While offline disease detection is already enabled, further enhancements will focus on creating a fully offline-first app with periodic data sync. This is critical for deep rural areas where internet access is intermittent or absent. Incorporating federated learning will also allow the app to improve over time without requiring centralized data.

6.Farmer Community and Knowledge Sharing

The platform could be extended to include community-driven features such as peer Q&A, image sharing for second opinions, and expert consultation sessions. This would enable farmers not only to receive help but to share their insights and solutions with others.

7.Remote Sensing and Satellite Integration

Adding support for NDVI and satellite imagery (e.g., through Google Earth Engine) will help in identifying larger-scale issues like drought stress or waterlogging. It would also allow for mapping crop health at the village or taluka level.

Final Thoughts

KrishiMitra has shown us that with a little creativity in design, even the most advanced AI systems can be made inclusive, accessible, and truly beneficial for rural communities. As India embraces precision agriculture and digital empowerment, tools like KrishiMitra are set to be essential in making sure that every farmer has a chance to thrive. Future upgrades will not only enhance its technical features but also amplify its real-world impact — evolving it into a comprehensive farming ecosystem instead of just another app.

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