AI-Driven Solutions for Crop Marketplace and Disease Management: AgriLink

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Abstract

AgriLink is an AI-powered mobile application that is supposed to help farmers in the early detection of crop diseases, thereby helping them improve yield through better management. Advanced CNN models such as ResNet and MobileNet can be used for analyzing images of crops for early disease detection, recommending advanced treatments and their prevention. AI models also provide insights related to the best planting schedule and market time, which is focused on maximum yields and profits. AgriLink is driven by an intuitive voice assistant and multilanguage support to enable farmers of any level of literacy to navigate it easily. It also integrates with a farmer-to-farmer LMS, where users teach others and learn best practices. AgriLink combines data analytics and continuous learning from user inputs, modernizing farming practices and enabling sustainable agriculture.

Keywords: AgriLink, AI in Agriculture, Crop Disease Detection, Convolutional Neural Networks (CNN), ResNet, MobileNet, Sustainable Agriculture, Farmer-to-Farmer LMS, Voice-Assisted Navigation, Multi Language Support, Data Analytics in Farming, Precision Agriculture, Early Disease Detection, Agricultural Marketplace, Smart Farming Practices.

I. Introduction

India, a country where agriculture forms the backbone of its economy, is home to over **120 million farmers**, with nearly **58% of the population** dependent on farming for their livelihood. Despite the sector's immense contribution to the nation's GDP and food security, the reality for most farmers is far from prosperous. The vast majority of Indian farmers are smallholders, with

more than **85% of them owning less than two hectares of land**. This fragmentation limits their ability to invest in mechanization of modern agricultural inputs that could boost productivity. Compounding these challenges are increasingly unpredictable weather patterns due to climate change, which disrupts traditional growing cycles and increases the frequency of crop failures. For a large number of farmers who rely on rain-fed agriculture, a delayed monsoon can be the difference between a good harvest and a season of debt and despair.

Beyond the fields, farmers face significant hurdles in the post-harvest phase, which further diminishes their income. India's agricultural markets are characterized by inefficiencies, with poor infrastructure, limited access to storage facilities, and a lack of transparent pricing mechanisms. Farmers often find themselves at the mercy of middlemen who control access to wholesale markets, taking a substantial cut of the profits that should rightfully belong to those who have labored to grow the crops. This market distortion leads to a situation where, despite bumper harvests, farmers are unable to get fair prices, leaving them vulnerable to financial instability. The lack of timely access to market data, combined with inadequate transport and storage solutions, forces many to sell their produce quickly at lower prices, often unable to store it for better rates in the future. As a result, even during periods of high demand, the benefits rarely trickle down to the farmers themselves.

Addressing these deeply ingrained issues requires more than just incremental changes; it calls for a transformative approach powered by technology and innovation. By leveraging AI-powered solutions, mobile applications, and data analytics, there is significant potential to bridge the knowledge gap and empower farmers with real-time insights. For example, tools that use AI to analyze satellite imagery, soil conditions, and weather forecasts can help farmers optimize planting schedules and detect crop diseases early, reducing losses. Additionally, platforms that connect farmers directly to markets and buyers can eliminate middlemen, ensuring fairer prices and better profit margins. Mobile apps with voice assistance in regional languages can democratize access to agricultural advice, ensuring that even farmers with limited literacy can benefit. These innovations not only promise to enhance productivity and profitability but also pave the way for a more resilient and sustainable agricultural sector, ensuring that farming in India is not just a way of life but a viable path to prosperity.

II. Background Study

The integration of mobile technology into agriculture has the potential to transform the way farmers access information, sell produce, and manage farm operations. Several studies have explored the use of mobile-based applications in Indian agriculture, focusing on overcoming barriers such as low adoption of Information and Communication Technology (ICT), reliance on middlemen, and inefficiencies in the agricultural supply chain.

1. Mobile-Based Agricultural Apps for Farmers' Welfare in India (Manobharathi K, 2021)

Manobharathi K (2021) discusses the challenges of low ICT adoption in rural India, primarily attributed to limited digital literacy among farmers. The study emphasizes the role of mobile apps in overcoming these barriers by offering user-friendly interfaces that provide real-time market information, weather updates, and expert advisory services. The research highlights the necessity of developing mobile-based solutions that cater specifically to the needs of farmers, promoting accessibility and improving decision-making processes through timely and relevant information. Such initiatives aim to reduce dependency on intermediaries and enhance farmers' welfare by increasing their market access and knowledge base.

2. A Study of E-Marketing Apps for Agricultural Products (Kajal V. Khandagale, 2022)

Khandagale (2022) identifies inefficiencies and price manipulation as major challenges within traditional agricultural markets, largely due to the involvement of multiple intermediaries. The study advocates for the adoption of digital platforms that provide greater transparency, reduce marketing costs, and offer real-time data to both farmers and consumers. By eliminating middlemen, these platforms can ensure that farmers receive fair prices for their produce while allowing consumers to access agricultural products at competitive rates. Khandagale suggests that e-marketing apps can be an effective tool for bridging the gap between producers and consumers, promoting direct trade and reducing the price inflation caused by intermediaries.

3. Android App for Farmers to Sell Their Crops (Vamsidhar Reddy et al., 2023)

Reddy et al. (2023) explore the issue of intermediary involvement in the sale of crops and propose a direct platform for farmers to sell their produce via an Android app. The app allows farmers to connect directly with buyers, eliminating middlemen and potentially increasing farmers' profits. In addition to facilitating crop sales, the app includes features like weather data,

soil health information, and agricultural advisory services. This multi-functional approach helps farmers make informed decisions about their crops, ensuring better yields and healthier produce. The study highlights the potential for such platforms to empower farmers economically and reduce the dependency on external agents in the agricultural supply chain.

4. Developing a Crop Disease Detection System Using Deep Learning (Rahul Papalkar, Abhishek Mane, 2023)

Papalkar and Mane (2023) focus on the need for real-time crop disease detection, which remains a significant challenge in modern agriculture. Their study proposes a deep learning-based solution for detecting crop diseases using images captured by mobile devices. The integration of this technology into mobile apps could provide farmers with timely alerts on potential disease outbreaks, allowing them to take preventive measures. By providing real-time monitoring of crop health, these apps can reduce crop losses and increase agricultural productivity. The research underlines the importance of incorporating advanced technologies like deep learning into mobile-based applications to support sustainable farming practices.

III. System Design/ Proposed Methodology

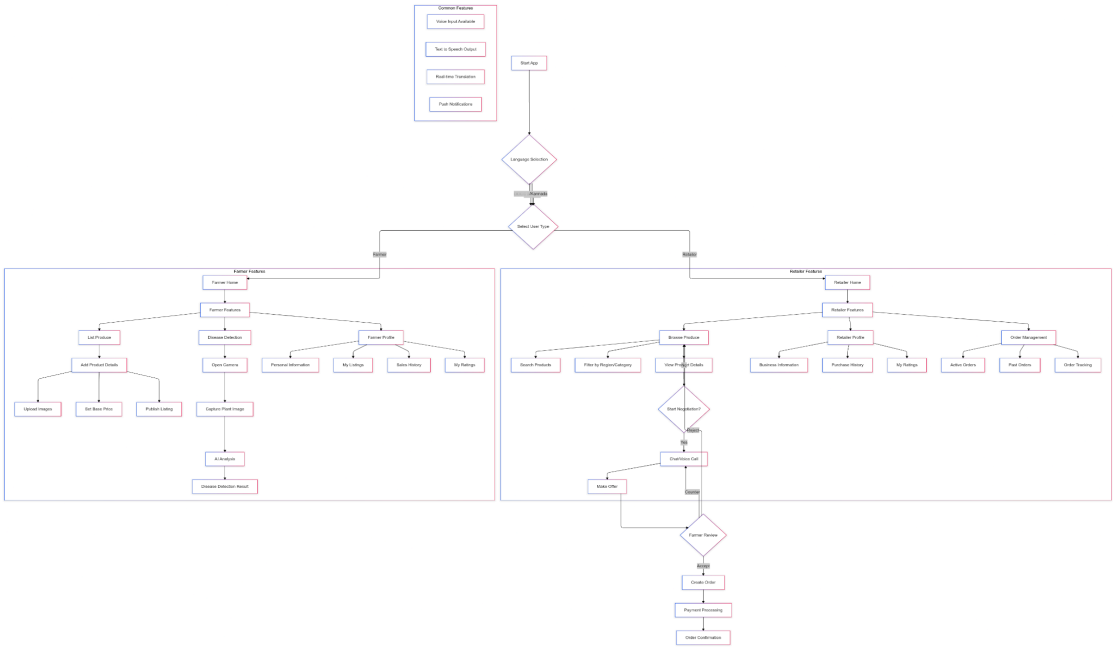

Figure 1. Architecture Diagram

The "AgriLink" application is designed to bring farmers and retailers together efficiently through a structured architecture system. Developed using Flutter, it ensures a cross-platform mobile experience with intuitive features available on both Android and iOS. Upon launch, users can select their language, enabling real-time translation and voice input/output via the Google Speech and Translate APIs. The app mainly supports farmers and retailers, each with tailored functionalities. Farmers can list their produce, manage profiles, and utilize a disease detection tool using TensorFlow Lite to identify crop diseases from uploaded images. In contrast, retailers can browse available produce, filter listings by category or region, and negotiate prices with farmers using an integrated chat and voice call system. After negotiations, orders can be placed, followed by automated order processing and real-time tracking.

The backend is designed with Node.js and Express.js to handle business logic efficiently and ensure smooth API interactions. MongoDB serves as the database, storing user profiles, product listings, disease analysis results, and transaction records. Secure user authentication is handled through JWT tokens, safeguarding access to app features. Notifications for updates, order confirmations, and listing alerts are managed via Firebase Cloud Messaging.

A key feature is its AI-based disease detection, leveraging a Convolutional Neural Network optimized for mobile devices using TensorFlow Lite. This provides instant feedback on crop health, enabling timely interventions. The database design includes collections for users, products, orders, disease diagnostics, and notifications for streamlined data storage and retrieval.

Deployment is managed using AWS cloud services, with a CI/CD pipeline through GitHub Actions to ensure continuous integration and smooth updates. Docker containers are used to maintain a consistent development environment. The app emphasizes security through data encryption, input validation, and access control, protecting sensitive information. In essence, AgriLink is built to be scalable, user-friendly, bridging the gap between farmers and retailers while supporting the agricultural ecosystem with AI-driven insights and seamless transactions.

IV. Implementation

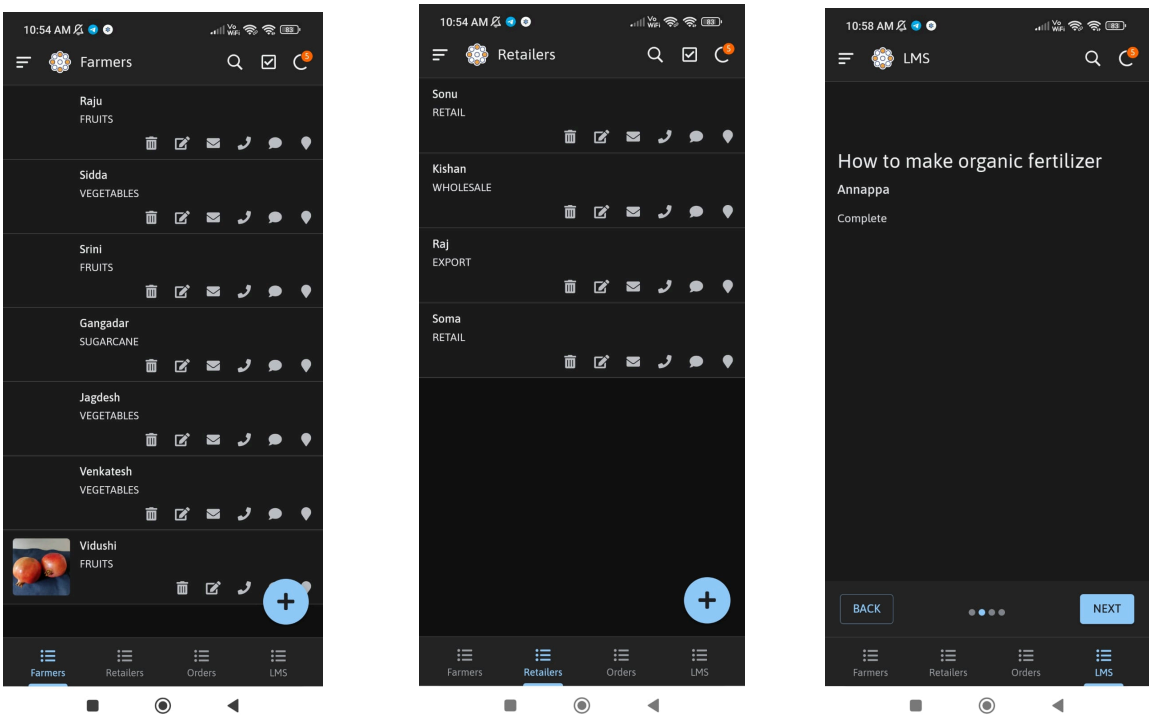

Figure 2. APP Design

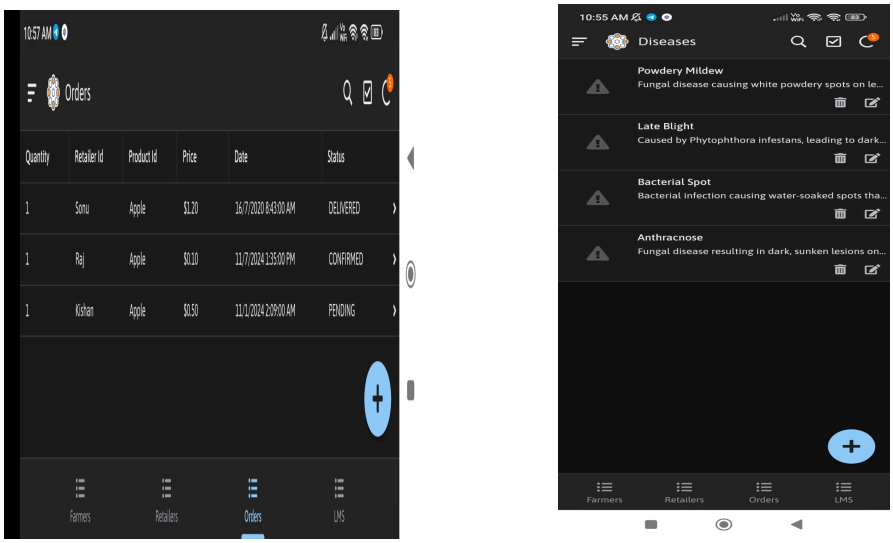

Figure 2.1. APP Design

1. User Interface Design

The UI was developed with simplicity and user-friendliness in mind for farmers. Using XML layouts, navigation buttons, image upload sections, and product listings were developed in a clean and intuitive flow. Multilingual support was incorporated to handle farmers from various regions.

2. Backend Development

Firebase has been used for user authentication, data storage, and real-time updates. It is designed to store data of farmers' profiles, crop listing, and detection of diseases. APIs are implemented to fetch the real-time market price and weather updates.

3. Disease Detection Module

The module was implemented for disease detection functionality using TensorFlow Lite. The pre-trained MobileNet model was fine-tuned to diagnose the crops uploaded by the farmers. This gave immediate diagnosis and prescription for treatment.

4. Marketplace Integration

A direct marketplace module was developed, which allowed farmers to list their produce with images, descriptions, and prices. Buyers could view listings, negotiate prices, and order directly through the app.

5. Learning Management System (LMS)

An LMS feature has been added, which gives access to video tutorials and guides on best farming practices for farmers. The content dynamically fetches and displays them in their preferred language.

6. Testing and Optimization

The app was rigorously tested on Android devices for compatibility with different screen sizes and resolutions. Performance optimization focused on the reduction of loading times and smooth navigation, even in areas with limited internet connectivity.

V. Results & Analysis

AgriLink has implemented practical and transformative solutions to face the most critical challenges that affect agriculture. The application has managed to bridge the gap between farmers and buyers, with the ability to make transactions directly between them without going through any intermediary. Through direct market access, the income of farmers has improved while also ensuring fair pricing. The impact of AI-powered disease detection has been especially high because it allows farmers to upload crop images and get accurate diagnoses. It has helped reduce crop losses through early detection but also led farmers to appropriate treatments, thus improving overall productivity. Real-time market price updates and weather-based crop recommendations also empower farmers with actionable insights, enabling them to optimize planting schedules, manage risks, and make informed decisions. AgriLink is designed to be user-friendly, as it is multilingual and supports voice navigation, making it easier for farmers with different literacy levels to use.

The above features have made it easy to perform complex agricultural activities, thus making the app useful in rural areas. But when implemented, there are always some areas that need improvement, such as logistics tracking and advanced pest control alerts, which would make the app more functional. Despite these gaps, the scalable architecture of the app's backend has shown good performance in testing, supporting real-time operations and concurrent access by users without disruption. AgriLink's success highlights its potential to modernize farming practices, promoting sustainable agriculture while improving the livelihoods of farmers. The app stands as a comprehensive and innovative solution to some of the most persistent challenges in the agricultural sector.

VI. Conclusion

In conclusion, the "AgriLink" application represents a significant advancement in leveraging technology to optimize the agricultural supply chain. By integrating AI-driven disease detection, seamless communication tools, and secure transaction management, the platform addresses key challenges faced by farmers and retailers, facilitating more efficient and transparent interactions. The use of a robust architecture with scalable cloud-based deployment ensures that the system can adapt to growing user needs while maintaining performance and security. This research

demonstrates that digital platforms like AgriLink have the potential to enhance agricultural productivity, streamline market access, and ultimately contribute to sustainable agricultural practices and economic growth.

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