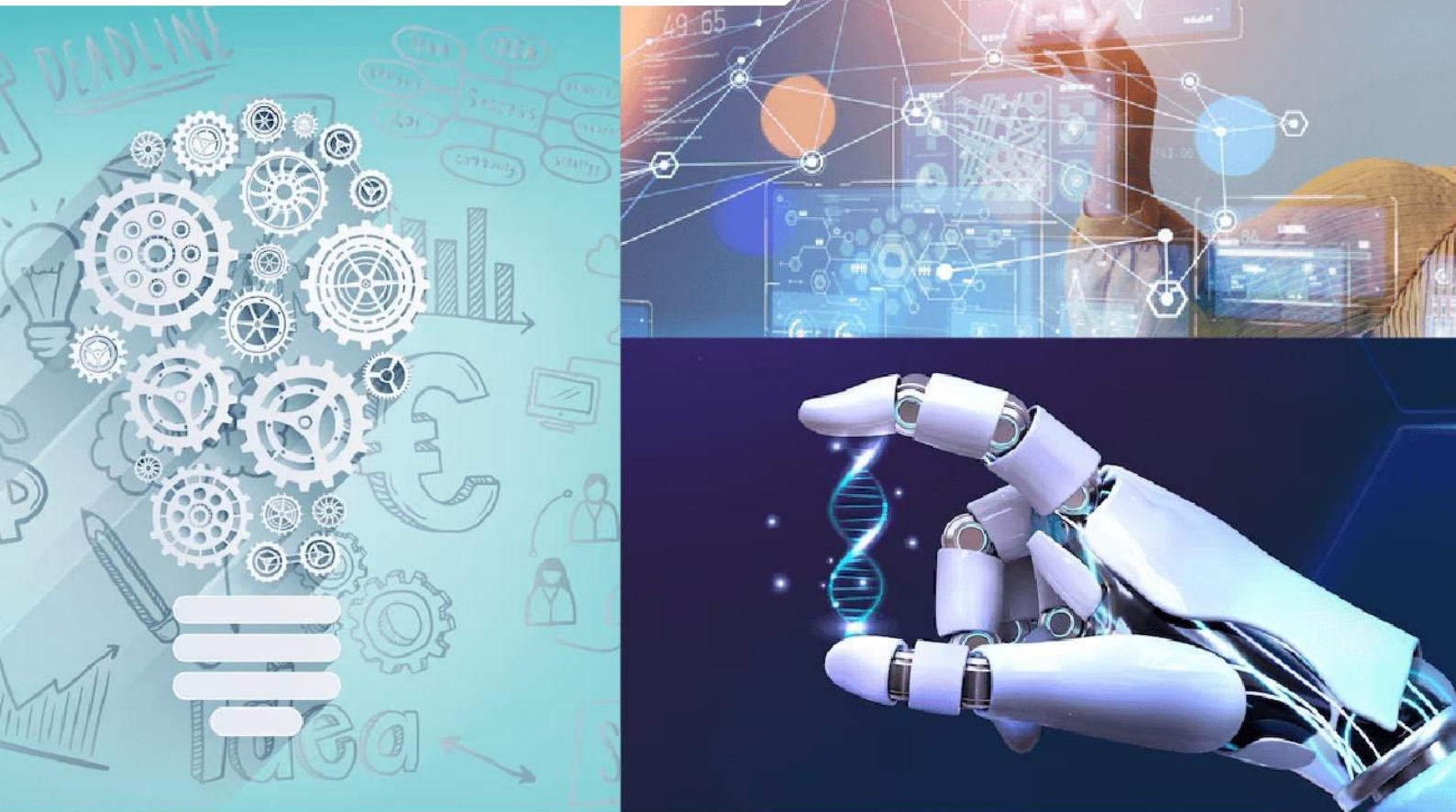




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A Mobile-Based Platform for Connecting Farmers and Consumers without Intermediaries

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ABSTRACT: Agriculture as a foundational part of food systems For many people, making a living ties closely to how the economy works, particularly Yet farming methods remain common across regions such as India. Still, old ways of growing crops continue there intermediaries impact supply chains Influence costs while cutting into farm earnings. Yet prices shift as margins shrink Often, middlemen lead to skewed market behaviors Money slips away from farms while prices climb for buyers instead Folks sometimes struggle with missing pieces when they shop. Problems pop up because info slips through the cracks now and then Openness issues show up alongside shoddy goods. Fresh options stay out of reach more often than not. One step removed, another opens up. Power shifts quietly when access changes hands like this A clear way to buy and sell farm goods without hidden steps. By using the Farmers Upload Crop Details Through Application pictures, how many there are, cost details, plus whether they're ready to buy - shoppers see these too Start exploring the catalog to send your order straight away. App built with Flutter Using Dart helps work across different platforms On phones, the system runs through apps. For support behind the scenes, Firebase handles data storage and server tasks For checking who logs in, keeping data live across devices, also handling how information saves instantly. Keeping information safe comes down to how it's managed. Built into the setup are key parts that handle core tasks One thing users do is register. Logging in comes next for access. Product details show up once added. Browsing happens after items appear online. Each step follows another without skipping order placement. The Proposed Solution Improves Transparency In Agricultural fair trade improves farmer prices and benefits consumers Because they get fresh, high-grade items. Cutting back on reliance Buying and selling now skips middlemen. Digital tools handle transactions directly between buyers and sellers Farmer Connect shows how process works solving problems in farm product selling modern mobile technologies.

KEYWORDS: Agriculture, Farmer Connect App, Direct Farmer-to-Consumer, Supply Chain Trans- parency, Digital Agriculture, Mobile Application, Flutter, Firebase, Agricultural Marketing, E-Commerce Platform, Farm Produce, Middlemen Elimination

I. INTRODUCTION

1.1 Background of the Problem

Jobs stick around because fields keep people busy, especially in places such as India, where meals start with what's pulled from the soil. What comes out of farms feeds us, yet moving crops to those who need them often hits snags. Whole towns stay on their feet thanks to planting and harvest cycles, even if supply paths are bumpy.

Not every farm grows just crops - some grow frustration too. Picture fields stretching wide, yet money shrinks before it reaches hands that work them. Between those who plant seeds and those who eat food, others step in without planting once. Power sometimes gathers in few pockets, tilting the balance hard. When control tightens, pay drops for growers even as shoppers pay more at counters.

One moment you're buying vegetables at a stall, next they've traveled days from distant fields. Though certain produce arrives straight off the farm, much sits picked weeks prior, grown without organic methods. Because food moves through so many hands, freshness fades along the way. Each stop adds time, cuts quality, piles on unseen expenses. What shoppers do not see hides behind pricing tags and middlemen margins. Growers rarely hear what buyers actually want, stuck guessing demand trends alone. Without clear signals or quick feedback, setting prices becomes uncertain ground.

1.2 Role of Mobile Application Technology

Out there among digital tools today, mobile apps shape how folks reach services - live updates flow easier now, getting around hurdles feels simpler too. Built on Flutter it runs, that cross-platform setup paired with Dart coding muscle, making one version work everywhere without hiccups. This thing called Farmer Connect? It moves fast because of smart design choices behind the scenes.

Out there among tools that run apps behind the scenes, Firebase takes care of who gets in, what they see live, where their info lives. User profiles stay put, items up for sale appear fresh, orders track without hiccups - each piece fits because checks happen on the fly. Security wraps around every detail like routine armor, nothing flashy, just steady. Performance climbs not by shouting about speed but by cutting slack where it sat before. Reliability grows when things work whether you watch them or walk away. Nothing breaks step even as loads shift, thanks to quiet coordination under the hood. Each update slips through fast because clutter never builds a home here. Systems breathe easier knowing sync happens without nudging. Data stays true across devices simply because drift isn't allowed. The whole setup moves like something built to last, not impress.

A role-driven setup shapes how things work here. People who grow food get their own space to sign up, enter each time they return, share what they're selling, then change stock levels when needed. Those buying goods move through listings, check item specifics, make choices on purchases. Clear roles help keep steps natural, smooth for everyone involved.

1.3 Scope and Significance of the System

The Farmer Connect system focuses on solving the problem of intermediaries in agricultural markets by providing a direct connection between farmers and consumers. This project Shows what a basic phone app might do to make things better Openness helps lower unjust costs while improving standards. What matters shows up when prices reflect fairness instead of hidden choices. Quality grows once clear rules replace guesswork products.

Because of its usefulness, the system supports farmers in real-world situations. Farmers move produce straight to buyers while folks grab food that is newly harvested. Because costs stay low, production stays affordable. Plus, it reveals just how flexible and always on the move things can be cloud technologies can be used to solve real-world problems in agriculture.

1.4 Challenges in Traditional Agricultural Marketing

Traditional agricultural systems depend heavily on mid-farmers earn less when middlemen take a cut, pushing costs higher for everyone else farmers sometimes miss details on what buyers want. Consumers feel the effect when crops don't match demand prices drop when buyers want less, pushing sellers to accept smaller returns just to move goods rates.

A fog hangs over how things are shared, plus who knows what. Hidden corners slow everything down instead of clear paths guiding each step forward farmers link up with shoppers, yet goods move step by step through several hands before arriving . Later on, things lose their freshness because of delays. Selling by hand takes too long wasting hours on these tasks often results in holdups, plus extra loss piles up fast. Sometimes speed matters less than avoiding the mess that follows. Delays creep in when steps drag, while resources slip away unnoticed.

1.5 Proposed Farmer Connect System

Farmer Connect is a mobile application that directly con-farmers share harvest updates. Consumers see what grows nearby. Updates flow straight from soil to screen. Fresh info skips middle steps. People learn where food begins. Crops get noticed early. Trust builds through clear details. Each post shows real work behind meals like pictures or how many items there are along with cost details - shoppers might also start exploring items then send in your request. Pick what you need before moving forward with checkout.

With this hands on approach, middlemen fade into the background. Better visibility shows up when prices stay even. This setup runs on balance plain, built just for straightforward tasks. While meant for everyday needs, it stays clear of clutter. Though minimal, it handles what matters without fuss.

1.6 Technology Used

The application is developed using Flutter framework and Dart programming language to create a cross-platform mobile app. Firebase is used as the backend for authentication and real-time database management. This combination allows secure login, easy data storage, and real-time updates of products and orders.

1.7 Research Contributions

The main contributions of this project are:

- Development of a mobile app connecting farmers and consumers

- Reduction of dependency on middlemen
- Simple product listing and ordering system
- Use of Flutter and Firebase for real-time functionality
- Improvement in transparency and pricing

II. PROPOSED FARMER CONNECT SYSTEM AND ARCHITECTURE

The Farmer Connect System Is A Mobile Based Application a platform built so growers can reach buyers without middle steps. It links those who grow food straight to people who eat it. This setup helps cut out extra layers between farm and table.

Traditional agricultural markets involve middlemen, which lower earnings for farmers show up as higher prices at stores. That system eliminates intermediaries by providing a simple digital platform for buying and selling agricultural products.

The application allows farmers to upload product details for instance, details like the type of produce, how much is available, its cost, along with photos. Shoppers are able to check out what's on offer, then send in your order right away. That speeds things up openness shows up in how prices stay fair, while quality gets a quiet boost from clear rules showing who does what products.

The app runs on code built with Flutter plus Dart for the on phones, apps hook into Firebase to handle behind-the-scenes tasks like storing data or managing users using login checks along with instant data updates across devices. The security comes first thanks to how it's built. Getting at your information feels smooth, almost effortless. The way things are set up keeps everything working well together real-time updates.

System Overview

The main objective of Farmer Connect is to create a simple and efficient digital marketplace for farmers and consumers. With fewer middlemen involved, people can talk straight to one another through the setup. Communication flows directly because the structure cuts out extra layers.

Logging in happens through Firebase Authentication. Depending on whether someone is a farmer or consumer, the available options change. When signed in as a farmer, product listings can be created or adjusted. Browsing items and sending off orders? That belongs to the consumer side.

Firebase holds every detail about products and orders, updating things live. When farmers adjust something, shoppers see it right away - no delay.

System Architecture

The architecture of Farmer Connect is designed using basic layers:

1. User Interface Layer: Built using Flutter for mobile screens.
2. Authentication Layer: Manages login and security using Firebase.
3. Application Layer: Handles product listing and order processing.
4. Database Layer: Stores data in Firebase.
5. Communication Layer: Provides real-time data updates.

This layered design ensures easy data handling and real-time interaction between farmers and consumers.

System Architecture of Farmer Connect

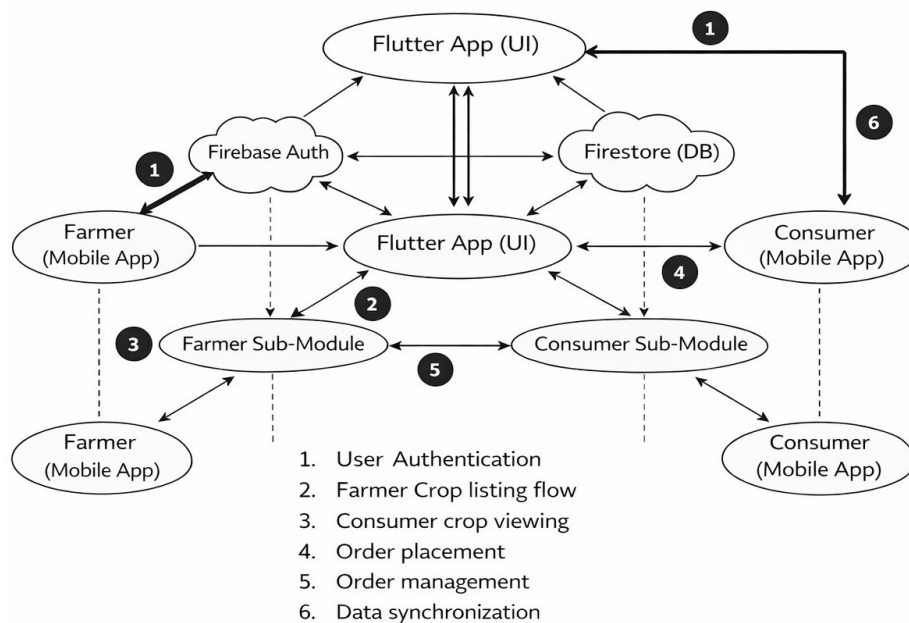


Figure 1: System Architecture of Farmer Connect

Technology Stack

The system uses the following technologies:

- Flutter: For building the mobile application interface.
- Dart: Programming language used in Flutter.
- Firebase: Used for authentication and real-time database.

These technologies make the system simple, fast, and suitable for mobile-based applications.

Advantages of the Proposed System

The Farmer Connect system offers several benefits:

- Removes middlemen and supports direct selling
- Improves transparency in pricing
- Provides fresh products to consumers
- Easy to use mobile application
- Real-time updates using Firebase

Data Management

In Farmer Connect, data management focuses on handling user and product information efficiently rather than complex preprocessing.

The system performs basic validation and organization of data, such as:

- Validating user input during registration and login
- Ensuring correct product details like price and quantity
- Avoiding incomplete or invalid entries
- Updating product availability in real time
- Storing order details in a structured format

Firebase is used to store and update data in real time. Any changes made by farmers are instantly visible to consumers, ensuring up-to-date information.

Application Module Design

The system is divided into simple modules for smooth functioning:

- Authentication Module: Handles secure login and registration

- Farmer Module: Allows product upload and management
- Consumer Module: Enables product browsing and ordering
- Order Module: Manages order details

These modules make the application easy to use and maintain.

III. RESULTS AND DISCUSSION

The Farmer Connect system was developed to provide a simple digital platform that connects farmers directly with consumers. The system helps reduce dependency on middlemen and improves transparency in agricultural trade.

After implementation, the application successfully allowed farmers to upload product details such as name, price, quantity, and images. Consumers were able to browse these products and place orders easily. This direct interaction improved communication and simplified the buying and selling process.

System Results

The system achieved its main functionalities:

- Farmers can register, log in, and upload product details
- Consumers can browse products and place orders
- Product information is displayed clearly and in structured format
- Data is stored and updated in real time using Firebase

These features make the system simple, functional, and suitable for basic use.

Usability and Benefits

The application is designed to be user-friendly, allowing farmers with basic knowledge to use it easily.

The simple interface helps in quick product uploading and browsing.

The key benefits include:

- Direct connection between farmers and consumers
- Improved transparency in pricing
- Easy access to fresh products
- Reduced time compared to traditional selling methods

Discussion

The system shows that a mobile application can improve agricultural trading by making information easily accessible. Farmers get better visibility for their products, while consumers can make informed decisions.

The platform also highlights the importance of digital solutions in agriculture, especially for improving communication and reducing inefficiencies in traditional systems.

Limitations

The current system has some limitations:

- No online payment integration
- No delivery or logistics tracking
- Depends on internet connectivity
- Designed for basic or small-scale use

Overall Summary

Overall, Farmer Connect provides a simple and effective solution for connecting farmers and consumers. It improves transparency, reduces dependency on middlemen, and supports digital transformation in agriculture. With further improvements, the system can be extended for real-world large-scale use.

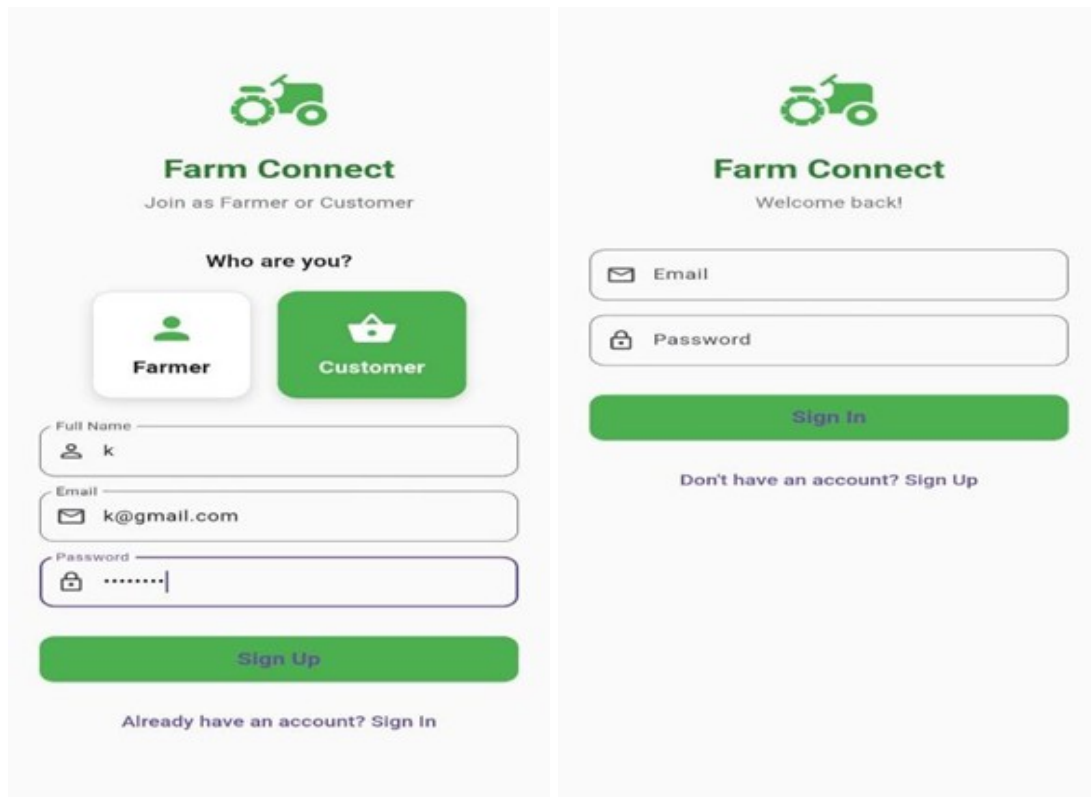


Figure 2: User Authentication Screens (Login and Registration)

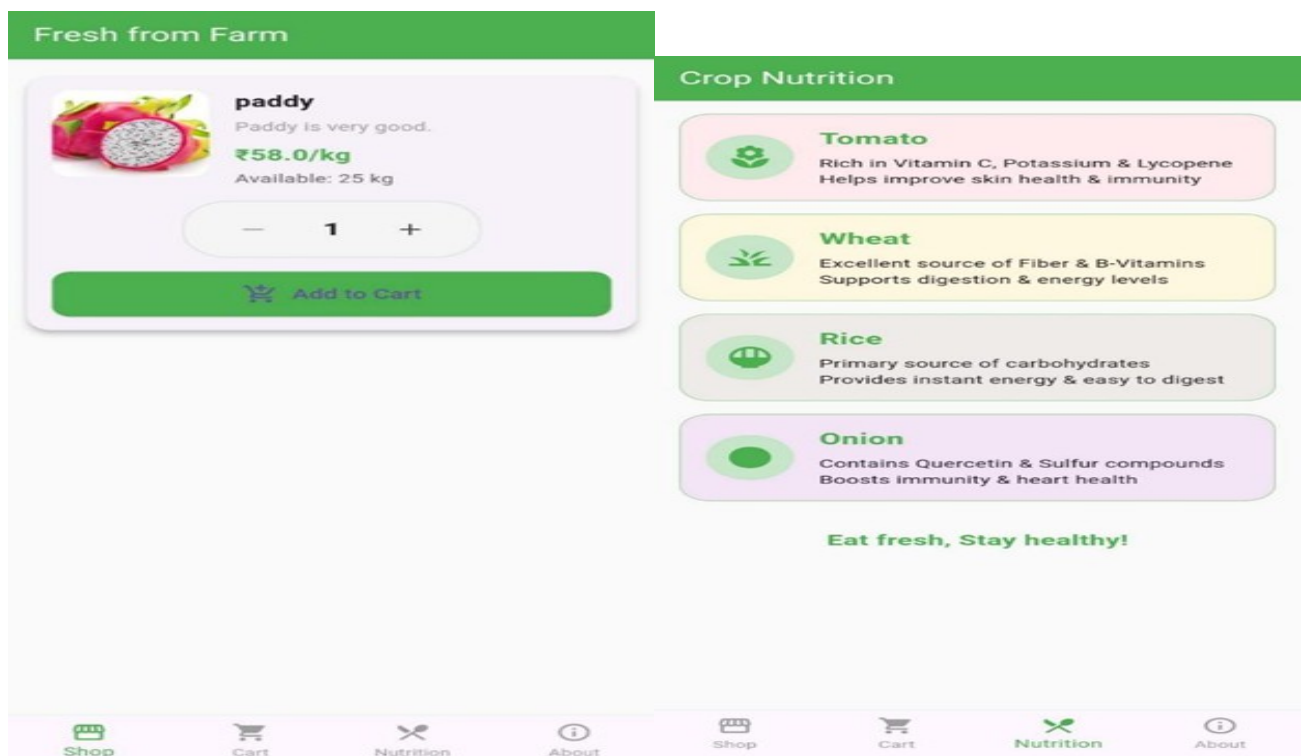


Figure 3: Product Listings and View Pages

IV. CONCLUSION

A fresh way to link growers and buyers? That came alive through Farmer Connect, a phone app built for clear, straightforward exchanges online. Cutting out middle players stood at its core, creating space where farm goods meet people without extra layers in between.

The results show that a mobile-based platform can simplify agricultural trading by making product information easily accessible. Fewer delays happen now since prices show up clearly. Reaching more customers becomes possible because sellers skip the extra steps others take. Middle players fade out when connections go straight from farm to market. Farmers gain when tech steps into fields - simple tools open doors to better buyers. Not just old ways anymore, instead fresh approaches help them sell smarter through digital paths. Farming just got clearer, thanks to tools that link growers directly to markets. A smoother way to buy and sell crops begins with honest tracking from soil to shelf. Digital shifts often feel heavy, yet here it moves like morning light - gentle but wide reaching. Systems adapt when people design them around real days, real harvests. Progress isn't always loud; sometimes it grows quietly between rows.

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AI-Based Approach for Crop Recommendation and Plant Disease Detection

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ABSTRACT: Even with worsening climate shifts and degrading soil conditions, modern agriculture increasingly relies on intelligent digital systems [13], [15]. This work presents an AI-based approach for crop recommendation and plant disease detection using deep learning and machine learning techniques [10], [14]. A ResNet-based model is used for disease detection, achieving high accuracy on PlantVillage datasets [1], [3]. Crop recommendation is performed using KNN based on soil and environmental parameters, while Random Forest is used for fertilizer prediction [10], [11]. The integrated system provides accurate and practical decision support for farmers.

KEYWORDS: Artificial Intelligence, Crop Recommendation, Plant Disease Detection, Machine Learning, Precision Agriculture

I. INTRODUCTION

Climate change, soil degradation, and unpredictable environmental conditions are increasingly affecting agricultural productivity worldwide [13]. Farmers face significant challenges such as irregular rainfall patterns, temperature fluctuations, declining soil fertility, and the emergence of new plant diseases, all of which negatively impact crop yield and quality [12], [15]. Traditional farming practices, which rely heavily on experience and generalized recommendations, often fail to adapt to rapidly changing environmental conditions, leading to inefficient decision-making and reduced profitability [14].

In recent years, advancements in artificial intelligence (AI) and machine learning (ML) have shown great potential in transforming traditional agriculture into a data-driven and precision-based domain [10]. Deep learning techniques, particularly Convolutional Neural Networks (CNNs), have demonstrated high accuracy in detecting plant diseases using leaf images, enabling early diagnosis and prevention [1], [3]. Similarly, machine learning algorithms such as K-Nearest Neighbors (KNN) and Random Forest have been successfully applied to crop recommendation and fertilizer prediction based on soil nutrients and climatic conditions [11], [14].

However, most existing solutions operate as isolated systems, focusing either on disease detection, crop recommendation, or fertilizer analysis independently. This lack of integration limits their practical applicability, as farmers require a unified system that can provide comprehensive insights and actionable recommendations in real time [10]. Additionally, many systems lack user-friendly interfaces and fail to deliver understandable outputs for non-technical users.

To address these challenges, this paper proposes an integrated AI-based agricultural system that combines deep learning, classical machine learning, and generative AI techniques into a single framework. The system aims to provide accurate, efficient, and user-friendly decision support, enabling farmers to make informed choices related to crop selection, disease management, and resource optimization [12], [15].

II. LITERATURE REVIEW

2.1 Deep Learning for Plant Disease Detection

Several studies have demonstrated the effectiveness of deep learning techniques in plant disease detection. Convolutional Neural Networks (CNNs), including architectures such as AlexNet and ResNet, have been widely used to classify plant leaf diseases with high accuracy using datasets like PlantVillage [1], [3]. These models are capable of extracting complex visual features such as color, texture, and shape, enabling accurate multi-class classification.

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However, many existing models are trained on controlled datasets, which may limit their performance under real-world conditions. Variations in lighting, background noise, and image quality can significantly affect prediction accuracy [4]. To address these challenges, recent research has focused on developing lightweight and efficient models that can be deployed on mobile and edge devices without compromising performance.

2.2 Machine Learning for Crop and Fertilizer

Machine learning algorithms have been widely applied in agriculture for crop and fertilizer recommendation based on soil and environmental parameters. Techniques such as Decision Trees, Support Vector Machines (SVM), and K-Nearest Neighbors (KNN) analyze soil nutrients including nitrogen, phosphorus, potassium, pH, temperature, and rainfall to predict suitable crops [11], [14].

Among these methods, Random Forest has shown superior performance due to its ability to handle nonlinear relationships and reduce overfitting through ensemble learning [10]. Similarly, fertilizer recommendation systems utilize structured agricultural datasets to optimize nutrient usage and improve soil health. Despite their effectiveness, many of these models rely on limited datasets and static inputs, which can reduce their adaptability to dynamic environmental conditions.

2.3 Integrated and Smart Agriculture Systems

Recent advancements in smart agriculture have explored the integration of Internet of Things (IoT) sensors, weather APIs, and real-time monitoring systems to enhance agricultural decision-making [18]. These systems incorporate environmental parameters such as temperature, humidity, and rainfall forecasts to provide dynamic and location-specific recommendations.

While such approaches improve responsiveness, they often lack seamless integration with disease detection and soil analysis modules, resulting in fragmented advisory platforms [12]. Furthermore, most existing systems do not incorporate generative artificial intelligence to provide user-friendly and context-aware recommendations. This limits their accessibility, particularly for small-scale farmers who may not be familiar with technical outputs.

2.4 Research Gap and Motivation

Despite significant progress in applying artificial intelligence to agriculture, most existing systems focus on individual components such as disease detection, crop recommendation, or fertilizer analysis rather than providing a unified platform. The lack of integration between these components limits the effectiveness of current solutions in real-world farming environments.

Additionally, many systems lack intuitive interfaces and fail to provide clear, actionable insights for end users. The absence of conversational or generative AI further reduces accessibility and user engagement. Therefore, there is a strong need for an integrated agricultural system that combines deep learning, classical machine learning, and generative AI to deliver comprehensive, accurate, and user-friendly decision support.

III. METHODOLOGY

3.1 System Overview

The proposed system integrates deep learning, classical machine learning, and generative AI to support agricultural decision-making. It processes both image data (plant leaves) and tabular data (soil and environmental parameters). The system is designed as a modular architecture where each component performs a specific task while contributing to an overall intelligent farming assistant. User inputs are provided through a web interface, and processing is handled via a Flask-based backend with MongoDB used for data storage. External weather data is incorporated to enhance prediction accuracy.

3.2 Plant Disease Detection Using ResNet9

The plant disease detection module is developed using a modified ResNet9 architecture implemented in PyTorch. Deep learning models, particularly CNN-based architectures, are well-suited for image classification tasks due to their ability to automatically extract hierarchical features from raw input images [1], [3]. The model is trained on the PlantVillage dataset, which consists of labelled images of healthy and diseased plant leaves across multiple crop types.

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Before training, all input images undergo preprocessing steps including resizing to a fixed resolution, normalization of pixel values, and conversion into tensor format suitable for deep learning operations. These steps ensure consistency in data representation and improve model performance. The ResNet9 architecture incorporates residual connections, which help in mitigating the vanishing gradient problem and enable deeper network training without loss of information.

During training, the model learns distinguishing visual patterns such as colour variations, texture differences, and lesion characteristics associated with various plant diseases. The final classification layer uses a SoftMax activation function to output probability distributions across multiple classes. Experimental results show that the model achieves an accuracy of approximately 98–99%, indicating its effectiveness in identifying plant diseases under controlled conditions.

3.3 Crop Recommendation Using KNN

The crop recommendation module is implemented using the K-Nearest Neighbors (KNN) algorithm, a supervised machine learning technique used for classification tasks involving multidimensional data [11], [14]. The module recommends suitable crops based on soil nutrients and environmental conditions.

The input features include nitrogen (N), phosphorus (P), potassium (K), pH, temperature, humidity, and rainfall, which are essential for determining crop suitability. The dataset consists of labeled records representing crops and their corresponding soil and climatic conditions.

Before applying KNN, the data is preprocessed using normalization and feature scaling to ensure balanced contribution of all parameters. The algorithm identifies the ‘k’ nearest neighbors using Euclidean distance, with **k = 20** selected to balance bias and variance.

A weighted voting mechanism is used to improve prediction accuracy by giving more importance to closer neighbors. While the model achieves near-perfect accuracy on training data, its expected real-world accuracy is approximately 90%, consistent with similar agricultural systems.

3.4 Fertilizer Recommendation Using Random Forest

The fertilizer recommendation module is developed using the Random Forest algorithm, an ensemble learning technique known for its robustness and high performance in classification tasks involving structured data [10]. The purpose of this module is to recommend the most appropriate fertilizer based on soil nutrient composition and the selected crop.

The model takes input features such as nitrogen (N), phosphorus (P), potassium (K) levels, soil pH, and crop type. These factors are critical in determining the nutrient requirements of the soil and ensuring optimal crop growth. The dataset used includes both a smaller dataset with limited records and an expanded dataset containing a larger number of samples to improve generalization.

Random Forest works by constructing multiple decision trees during training and combining their outputs to produce a final prediction. Each tree is trained on a random subset of the data and features, which helps in reducing overfitting and improving model stability. The ensemble nature of the algorithm allows it to capture complex, nonlinear relationships between soil properties and fertilizer requirements.

When trained on a smaller dataset, the model achieves an accuracy of approximately 69.2%, reflecting the limitations of insufficient data. However, when trained on a larger dataset, the accuracy significantly improves to around 85–90%, demonstrating the importance of data availability in machine learning performance. The model effectively identifies patterns in soil nutrient deficiencies and maps them to suitable fertilizer recommendations.

IV. RESULTS AND DISCUSSION

The dataset used in this study was compiled from multiple agricultural datasets, including soil metrics, weather patterns, and a robust collection of symptomatic plant leaf imagery (e.g., PlantVillage dataset). The tabular data includes features such as Nitrogen (N), Phosphorous (P), Potassium (K) levels, temperature, humidity, pH, and rainfall. Additionally, the image dataset comprises high-resolution images of healthy and diseased crop leaves across various species, meticulously labeled for supervised learning.

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The system was implemented using Python-based machine learning and deep learning frameworks. The backend was developed using Flask, while the frontend interface was built using modern web technologies. Various libraries, including PyTorch and scikit-learn, were utilized for model development and evaluation.

Exploratory Data Analysis (EDA) revealed meaningful relationships between environmental factors and agricultural outcomes. Soil pH and nutrient levels were found to significantly influence fertilizer recommendations, while temperature and humidity played a crucial role in disease occurrence. These observations confirm the importance of using multi-dimensional data for accurate agricultural predictions.

Figure 1 illustrates the overall system context and data flow, highlighting the interaction between the central system and external services such as weather APIs and generative AI modules. This integration enables real-time data processing and enhances the adaptability of the system.

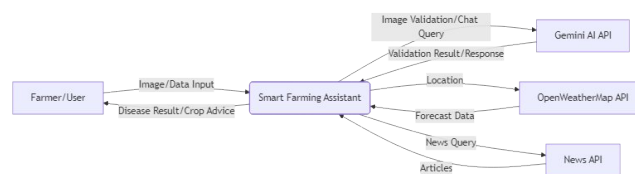


Fig. 1: System Context and API Integration

Figure 2 presents the feature importance analysis derived from the Random Forest model used for crop recommendation. The results indicate that environmental factors such as rainfall and humidity have a strong influence on crop prediction, while soil nutrients also contribute significantly. This demonstrates the model's ability to effectively capture the relationship between multiple agricultural parameters.

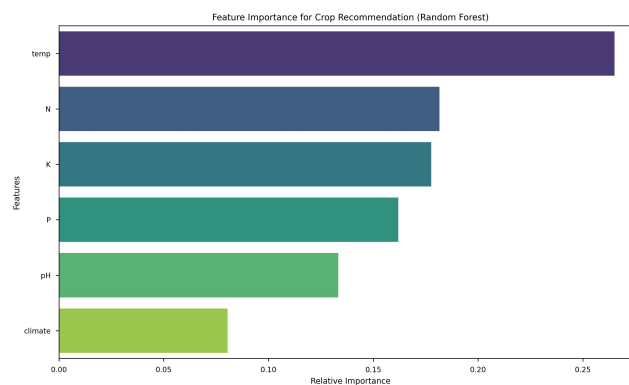


Fig. 2: Feature Importance from Random Forest Model

Figure 3 shows the training and validation performance of the ResNet9 model used for plant disease detection. The model achieves high accuracy with minimal overfitting, indicating strong generalization capability. The convergence of training and validation curves suggests that the model is well-optimized for classification tasks.

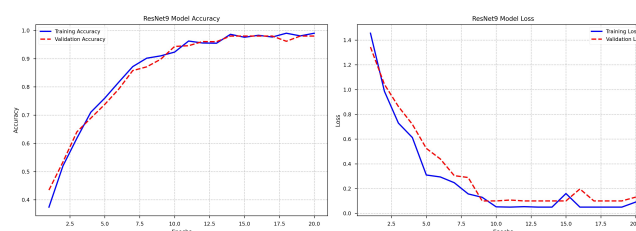


Fig. 3: ResNet9 Training Performance Metrics

Figure 4 demonstrates the disease analysis and recommendation interface, which provides actionable insights based on model predictions. In addition to identifying plant diseases, the system offers treatment suggestions and preventive measures. This enhances the practical usability of the system by bridging the gap between prediction and real-world application.

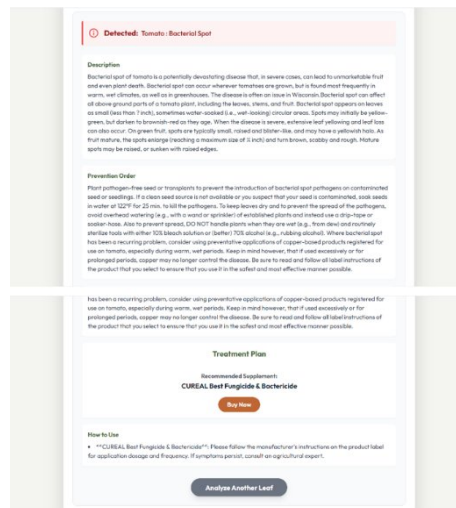


Fig. 4: Disease Analysis and Treatment Interface

V. CONCLUSION

This paper presented an integrated AI-based agricultural system designed to enhance decision-making in modern farming practices. By combining deep learning, machine learning, and generative AI, the proposed system provides a comprehensive solution for plant disease detection, crop recommendation, and fertilizer prediction. The use of a ResNet9-based model enables accurate identification of plant diseases, while KNN and Random Forest algorithms effectively analyze soil and environmental data to recommend suitable crops and fertilizers [1], [10], [11].

The integration of multiple AI techniques into a unified framework addresses the limitations of existing systems that operate in isolation. Furthermore, the inclusion of a generative AI-based module enhances usability by providing context-aware recommendations in natural language, making the system accessible even to non-technical users.

Although the system demonstrates strong performance, certain limitations remain. The reliance on limited structured datasets may affect generalization in diverse real-world conditions, and image-based detection may be influenced by environmental noise. Future work can focus on incorporating larger and more diverse datasets, integrating IoT-based real-time monitoring systems, and improving model explainability to increase user trust and adoption [18].

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