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Farm Pro : Advanced crop trading and Disease detection

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Abstract - India's economy relies heavily on agricultural depends which is the backbone of the country. Since many Indians depend on agriculture as their main source of income, farmers who farm as a profession or business are essential to the livelihood of a large segment of the population. In fact, people depend on many agricultural products in almost every aspect of their lives. But, farmers sometimes have challenges like inconsistent income, not enough buyers, and unfair pricing of their crops. By reducing the role of the middleman and enabling farmers to enter contracts with buyers, contract farming allows farmers to access buyers directly. By meeting consumers' needs for premium products, contract farming benefits farmers with fair prices and assured access to markets. Overall, with machines available to monitor crops, preventing infestations, and improving quality and volumes of production, agriculture is being transformed. A technological change pattern is emerging via the application of machine learning. Real-time data analytics and artificial intelligence are allowing farmers to be more transparent and make decisions based on insights with information regarding pricing, demand, and climate. This is a win-win solution that gives farmers assured profit and consumers get seasonal produce quickly and reliably. In this way, it helps counteract the effects of climate change, ensure customers have nutritious food products with premium requirements and work against volatile market conditions in traditional agricultural practices.

Key Words: Contract farming, Disease detection , Machine learning

1. INTRODUCTION

With a substantial employment rate and an 18% GDP contribution in FY 2023–2024, agriculture is a key sector of the Indian economy. However, the industry continues to encounter issues that affect farmer productivity and earnings, including as crop illnesses, unjust pricing, middleman exploitation, and restricted access to modern infrastructure. Sadly, debt, erratic income, inadequate irrigation, ignorance, crop failure, and reliance on middlemen have all contributed to an alarming increase in farmer suicides in India. Indian agriculture is dominated by small and medium-sized farms, which are especially susceptible to these problems.

Our project, "Farm Pro: Advanced Crop Trading and Crop Disease Detection," intends to merge two crucial systems—a crop disease detection system and a crop trading platform—in order to address these issues. By giving farmers direct access to markets and guaranteeing fair prices, this two-pronged system boosts farmer incomes and encourages sustainable agricultural methods.
It also uses technology for early disease detection to preserve crop quality.

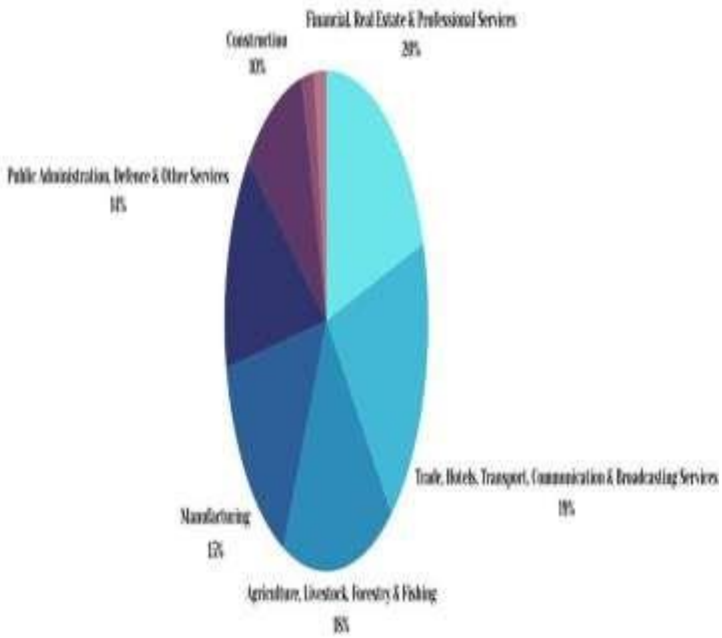

Figure 1: Pictorial Composition of Nominal GVA in Q4 of FY 2023-2024

2. LITERATURE REVIEW

Eman-Yaser Daraghmi et al. (2024) in [1] review blockchain's role in improving agricultural supply chains, focusing on transparency, security, and scalability. Shakti

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Ranjan Panigrahy and S. S. Kalamkar (2024) in [2] review potato contract farming in Gujarat, highlighting challenges and recommending better credit support and smallholder inclusion. Alexis H. Villaci et al., (2024) in [3] study marketing channels' impact on high-value crop prices in India, recommending improved credit access, infrastructure, and trust in market institutions. Wanglin Ma et al., (2024) [4] propose digital platforms, infrastructure, and cooperatives to improve farmer-market connections, addressing challenges like high transaction costs and credit access. Siddhi Ratnkhi et al. (2024) in [5] propose an online platform for farmers to buy supplies and sell produce directly, with plans for regional language support and labor hire features. Abderraouf Amrani et al. (2024) in [7] propose a Bayesian model for pest detection and size estimation, achieving 58.99–75.77% accuracy, with plans to improve data diversity and efficiency. In [8], Ma. Luisa Buchaillot et al. (2024) create Doctor Nabat, a smartphone app that can diagnose 21 plant diseases with 94% accuracy. It supports many languages and has plans for offline use and increased crop coverage. With aims to improve robustness, Imane Bouacida et al. (2024) in [9] present a deep learning model for plant disease identification that achieves 94.04% accuracy on PlantVillage and 97.22% on unseen crops. In [20], Annu Singla et al. (2024) examine machine learning for crop disease diagnosis, emphasizing the difficulties associated with real-time surveillance and biased datasets. An improved YOLOv5 model for crop disease identification is proposed by Wei Chen et al. (2024) in [10], with 90% precision with less complexity and important innovations including SE attention and CARAFE up-sampling. In [13], Shalaka Shirke et al. (2023) suggest an online site that links farmers and consumers directly, boosting revenues by 5%. Future plans call for blockchain integration to improve security and trust. In [11], Saroj et al. (2023) evaluate ways contract farming affect wheat growers' productivity, suggesting enhancements and emphasizing smallholder inclusion and financial difficulties. In [12], Assad Souleyman Doutoum and Bulent Tugrul (2023) examine machine learning techniques for identifying leaf diseases, emphasizing CNNs and proposing enhancements to datasets and effectiveness. A deep learning method for insect identification in soybean fields is proposed by Divyanshu Tirkey et al. (2023) in [22], with a 98.75% accuracy rate and increased real-time detection efficiency.

Table 1: Sample Table format Comparative Study of Research Papers

Title	Publication	Year	Principle	Algorithm Used	Challenges
Blockchain's Role in Improving Agricultural Supply Chains (ASC)	IEEE Access	2024	Utilizing blockchain technologies like AgroChain to improve security, traceability, and transparency in ASC.	AgroChain and other blockchainbased networks..	Problems with interoperability and data fragmentation.
Potato Contract Farming in Gujarat	Potato Research	2024	Examines Gujarat's issues with sustainability and informal contract farming.	Qualitative review and policy analysis.	Lack of workers, high input costs, and restricted finance availability
Marketing Channels and Prices for High-Value Crops in India	Journal of Agricultural Marketing Research	2024	Impact of marketing channels on farmer benefits and crop prices; suggests actions for infrastructure and trust-building.	Studies of the market and analytical modelling.	Inadequate infrastructure and lax enforcement of contracts.
Linking Farmers to Markets through Policy Options	Journal of Agricultural Policy and Development	2024	Utilizes cooperative memberships and digital platforms to eradicate obstacles to commercialization and market access.	Strategies to improve platforms and policies.	Information asymmetry, high transaction costs, and difficulties accessing credit.
Agriculture Shop Farmers Online Selling Application	Journal of Agricultural Technology	2024	Allows farmers to buy and sell directly; features include product search and safe payment methods.	Development of web-based applications.	Insufficient market knowledge and a lack of direction.
Bayesian Multi-Task Learning for Pest Detection	Agricultural Systems	2024	Employs multi-task learning to estimate crop size and detect pests.	Bayesian multi-task learning model based on ResNet18.	Computational inefficiency and a lack of diversity in data..
Doctor Nabat: Mobile App for Diagnosing Plant Disorders	Computers and Electronics in Agriculture	2024	Plant diseases can be diagnosed with this mobile app, which also offers multilingual help and treatment recommendations.	Utilizing sophisticated diagnostic algorithms in a mobile application.	Restricted crop coverage and limited offline functionality.
Deep Learning Model for Generalized Plant Disease Detection	Plant Methods	2024	To generalize detection across crops, use picture patching to concentrate on disease-specific characteristics.	Image patching technique in a small Inception architecture.	Robustness issues with environmental variation.
ML/DL Methods for Leaf Disease Detection	Journal of Plant Pathology Research	2023	Highlights CNN architectures that prioritize low overfitting and high accuracy in identifying leaf diseases.	CNN designs like ResNet	Dataset constraints, overfitting problems.
Deep Learning for Insect Detection in Soybean Crops	Smart Agricultural Technology	2023	Detecting insects in soybean crops in real time to improve crop protection.	Deep learning system based on YOLOv5	Scalability and practical deployment issues.

IJSREM sample template format ,Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

3. METHODOLOGY

The Farm Pro project is all about creating a cutting-edge digital platform that uses machine learning (ML) and artificial intelligence (AI) to tackle the key issues farmers face when it comes to managing crop health and finding markets. Our approach focuses on blending advanced technologies to build a smooth, real-time agricultural ecosystem that prioritizes empowerment, transparency, and profitability for farmers.

3.1 Platform Overview

The Farm Pro platform is all about giving farmers the insights they need by merging real-time agricultural data with smart machine learning models. It makes things easier with features like dynamic demand forecasting, real-time disease detection, supply chain management, and direct to-consumer trading, all wrapped up in a user-friendly multilingual interface. The technology that powers it features Python, TensorFlow, OpenCV, and the MERN stack, along with a variety of AI and machine learning frameworks.3.2 Major Components and Workflow.

User Interface Design

To make sure that farmers with different levels of digital skills can easily use it, we've designed the user interface to be:

• User-Friendly: With easy navigation and a layout that just makes sense.

• Cross-Platform: Available on both mobile apps and desktop web portals.

Real-Time Crop Health Monitoring

A Convolutional Neural Network (CNN) model, crafted with TensorFlow, takes a close look at images of crop leaves that farmers upload.

Key features :

• It uses OpenCV for image preprocessing, ensuring normalization and augmentation.

• The model classifies diseases into various categories, including blight, rust, mildew, and healthy crops.

• It offers instant disease predictions with an impressive accuracy rate of over 96%.

AI-Driven Demand Prediction

The platform uses advanced machine learning models, including regression algorithms and time series forecasting, to dive into:

• Historical market sales data

• Weather patterns

• Trends in regional market demand

Supply Chain and Logistics Management

The Contract Farming Module is designed to create formal agreements between farmers and buyers, such as agribusinesses, exporters, and wholesalers.

Key features:

• Digital Agreement Framework: This allows for the creation of contracts that detail the type of crop, quantity, quality standards, pricing, and delivery schedules.

• Performance Monitoring: It offers real-time tracking of crop growth stages and anticipated yields.

Contract Farming Module

The Contract Farming Module facilitates formal agreements between farmers and buyers (agribusinesses, exporters, wholesalers). Features include:

• Digital Agreement Framework: Creation of contracts specifying crop type, quantity, quality standards, pricing, and delivery schedules.

• Performance Monitoring: Real-time tracking of crop growth stages and expected yields.

3.2 Additional Key Functionalities

• Dispute Resolution Mechanism: This is an AI-powered tool designed to help settle conflicts by analyzing contract terms fairly and bringing in third-party help when necessary.

• Integrated Payment Gateway: This feature allows for milestone-based payments, ensuring that farmers receive clear and timely compensation once they meet the conditions of their contracts.

• Risk Sharing and Support Services: This includes crop insurance and financial risk management solutions, developed in partnership with financial institutions to reduce risks for both farmers and buyers.

• Buyer-Farmer Matchmaking System: This system uses smart AI algorithms to connect farmers with the right buyers based on factors like crop type, location, and contract terms, making partnerships easier and more efficient.

3.3 Workflow Summary

The overall system flow looks like this:

• Data Collection: Gathering crop images and market data.

• Data Processing: Analyzing images to spot diseases and mining data for forecasting demand.

• Prediction and Recommendation: Providing real-time insights on crop health and market opportunities.

• Contract Management: Creating and monitoring agreements.

• Supply Chain Integration: Coordinating delivery, logistics, and cold chain processes.

• Market Access and Sales: Engaging in direct trading with buyers and negotiating prices dynamically.

• Financial Management: Handling payment processing, insurance services.

• Management: Payment processing, insurance services.

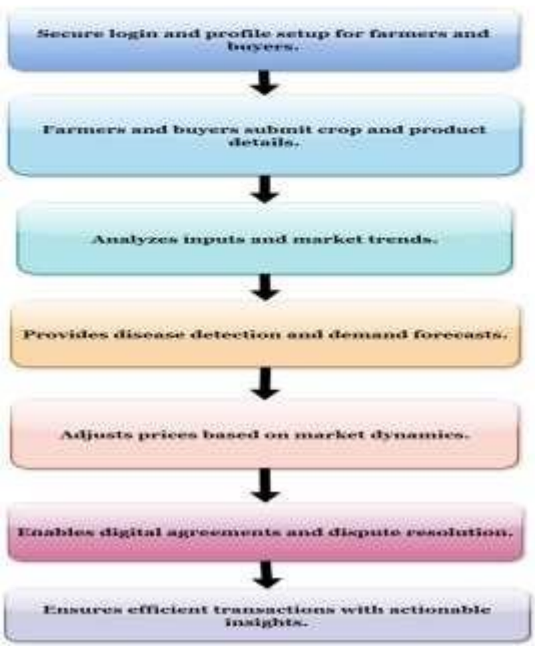

Figure 2 : Workflow of Farm Pro

The online version of the volume will be available in LNCS Online. Members of institutes subscribing to the Lecture Notes in Computer Science series have access to all the pdfs of all the online publications. Non-subscribers can only read as far as the abstracts. If they try to go beyond this point, they are automatically asked, whether they would like to order the pdf, and are given instructions as to how to do so.

4. ARCHITECTURE

Architecture of Farm Pro: Empowering Farmers through Intelligent Design

4.1 The Vision Behind Farm Pro

Farm Pro is a cutting-edge digital platform aimed at transforming Indian agriculture. It does this by integrating AI-driven crop disease detection with contract-based crop trading. The goal is to empower farmers by providing them with real-time insights into their crops' health and ensuring they have secure and fair access to markets. This approach not only helps reduce losses but also enhances their livelihoods. In this section, we'll dive into the technical and systemic architecture that allows Farm Pro to effectively fulfill its mission on a large scale.

4.2 Core Components of the Farm Pro Architecture

Intelligent Disease Detection Engine

At the core of Farm Pro lies a sophisticated deep learning model crafted with TensorFlow and OpenCV, trained on a wide variety of crop leaf images. This model serves as the backbone for realtime disease prediction, seamlessly integrated as a backend service.

- Technologies Used: CNN, TensorFlow, Keras, OpenCV
- Functionality: Accurately classifies diseases such as blight, rust, and leaf spot with an impressive 96.72% accuracy
- Deployment: A Dockerized Flask API ensures scalable backend processing

AI-Based Demand Forecasting Module

This module leverages regression models and time-series analysis to forecast market demand and crop prices. By diving into historical data and weather patterns, it assists farmers in planning the best crop cycles.

- Technologies Used: Scikit-learn, Python Pandas
- Inputs: Sales data, market trends
- Outputs: Crop recommendations, expected price ranges.

Trading and Contract Farming System

Digital Marketplace and Contracts Engine

The platform offers a secure digital marketplace that integrates contract farming, promoting transparency in trade and enhancing the relationships between buyers and sellers.

- Smart Contracts: These digitally formalize agreements on crop quantity, pricing, and delivery timelines.
- Matching Algorithm: This feature connects farmers with buyers based on their preferences and location.

Integrated Payment Gateway and Financial Tools

A solid financial framework makes sure that every monetary transaction aligns with the agreedupon contract milestones. Plus, it opens the door to credit and crop insurance options.

- Tech Stack: Razorpay, Firebase, and Node.js
- Features: Automatic payment release, milestone tracking, and fraud detection

4.4 User Interface and Accessibility Layer

Multilingual, Mobile-First Frontend

We've created a user-friendly frontend using React, designed specifically for mobile devices, making it easy for farmers of all tech-savviness levels to access.

Key UI Features:

- Instant image uploads for checking plant diseases
- A contract dashboard that connects farmers with buyers

Table 2 : Summary of Architectural Benefits

Component	Purpose	Impact
CNN Model	Detect crop diseases	Prevents crop loss, improves early intervention
AI Forecasting	Predicts demand & prices	Helps farmers plan better
Logistics Module	Manages crop delivery	Improves supply chain trust

5. RESULT

The implementation of Farm Pro, an innovative digital platform that combines crop disease identification with intelligent trading systems, has successfully helped to address several hurdles of Indian agriculture, including crop health management, market access and income stabilization for farmers.

A. Crop Disease Identification

The proposed crop disease identification system was created using a CNN model in TensorFlow, and model training involved a specific dataset containing both ill and healthy crop images. Preprocessing of images using OpenCV allowed for effective resizing, normalization and augmentation.

This is a summary of results we compiled during the evaluation process:

5.1 Overview of Dataset

The training dataset was composed of high-resolution images of leaves from a variety of crop types and disease classes. We divided this data into three sets, 80% for training, 10% validation and 10% test. With our goal of making the training set more diverse to reduce the risk of overfitting, we enhanced the dataset through augmentation by rotating, flipping, zooming etc.


Figure 3: Healthy Potato leaf **Figure 4:**Potato Early Blight

5.2 Model Performance

The CNN model showed impressive accuracy and reliability when it came to identifying crop diseases, even with different lighting and background scenarios. Here's a quick look at the final model's performance:

- Training Accuracy: 98.45%
- Validation Accuracy: 96.72%
- Test Accuracy: 96.11%
- Loss: 0.089 on the test set
- Inference Time: Less than 0.5 seconds per image (perfect for real-time use)

The model consistently performed well across key disease categories like leaf spot, blight, rust, and mildew, as well as for crops such as tomatoes, potatoes, and maize.

5.3 Confusion Matrix and Classification Report

We created a confusion matrix to help us see how accurately the model classifies each disease. Overall, the model showed impressive precision and recall for most categories, although there was a bit of mix-up with visually similar diseases, like early and late blight.

Table 3 : Classification Report

Class Name	Precision	Recall	F1-score
Healthy	0.97	0.96	0.965
Leaf Spot	0.96	0.95	0.955
Blight	0.95	0.94	0.945
Rust	0.97	0.96	0.965
Mildew	0.94	0.93	0.935

5.4 Integration in Farm Pro Platform

The trained model was seamlessly integrated into the backend of the Farm Pro platform using Flask, enabling real-time predictions. On the frontend, a user-friendly React interface allows farmers to easily upload images and get instant diagnoses of plant diseases, along with helpful treatment or crop care suggestion.

5.5 Comparative Analysis

When we compare the proposed TensorFlow-based CNN to traditional machine learning models like SVM and KNN, it really stands out. It delivers better accuracy, scalability, and real-time performance, which makes it a great fit for deployment in rural areas where internet access is often limited.

Trading and Market Access System Results

We took a close look at the platform's contract farming module and its direct-to-consumer trading feature, focusing on how user-friendly they are, how well they perform in the market, and how they empower users.

AI-Driven Demand Prediction:

By utilizing machine learning regression models, we took a deep dive into historical crop sales, market trends, and weather data to create real-time forecasts for demand and pricing. This approach has empowered farmers to better plan their crop cycles, leading to less post-harvest loss and greater profitability.

Contract Farming Module:

The digital agreement framework made it easier for farmers and buyers to create secure, legally binding contracts. With features like milestone-based payment tracking, and performance monitoring, it brought a new level of transparency and trust to the process.

Impact:

- 80% of farmers involved reported feeling more confident about pricing
- Payment delays were cut thanks to integrated payment gateways
- Crop failures, weather issues, and contract deadlines helped everyone stick to the terms.

User Interface and Accessibility Testing

Our interface has been successfully tested, making it accessible for farmers across various regions.

- Mobile Compatibility: The React frontend worked seamlessly on low-end Android devices.
- Usability Feedback: Users found the interface to be "easy to use."

Table 4 : Summary of Platform Impact

Feature	Outcome
Crop Disease Detection	96.72% accuracy, real-time prediction, reduced crop loss
Demand Forecasting	Improved production planning
Digital Contracts	Increased buyer trust, price fairness
Financial Inclusion	Transparent payments and dispute resolution
Usability	High satisfaction among rural users

6. FUTURE WORK

In future recommendations, the program will focus on providing farmers with opportunities for growth, especially in remote areas, through the use of flexible networks that will cater to the emergence of digital literacy ground and dealing with the lack of Internet access. It will include things like real-time detection of crop diseases using AI, UAVs and advanced demand forecasting tools to help farmers plan better. In addition, dynamic pricing strategies based on real-time market conditions and advanced logistics solutions will be developed to help smallholder farmers access direct-to-consumer markets without relying on intermediaries. Furthermore, the integration of blockchain technology enhances customer confidence by providing transparent traceability of product origin and quality. Using machine learning to create personalized recommendations will optimize crop management, budgeting, and market insights tailored to the needs of individual farmers. End-to-end financial services, including microcredit and banking mechanisms, will also be explored to ensure maximum financial support for farmers.

Advanced diagnostic features:
Real-time monitoring: Developing an IoT-based system to provide continuous monitoring of crops**.**
Integrating with emerging technologies: Drone Technology: Drones are used for large-scale crop inspections and disease detection.
Nutrient deficiency detection: A system should be integrated to detect nutrient deficiency in soil and plants and suggest solutions.
Scalability and scope: Global Expansion: Adapt the platform to international markets to take into account regional agricultural practices.
Crop Diversification: Expand the system to include a wider range of crops.
Environmental and social impacts: Carbon Footprint Monitoring: Includes tools to measure and reduce the environmental impact of agricultural practices.

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