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AgroSmart: An Intelligent Agricultural Assistant for Farmers Using SaaS-Based AI/ML Architecture

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Abstract

The project AgroSmart (or Krushi Care Hub) is designed as a multimodal digital platform designed to help farmers relocate to the data-driven agriculture. The system integrates several computing tools into one interface, such as the leaf-disease detection module with images and the crop recommendation engine with an assessment of the soil properties and the climate conditions of a specific region. The primary contribution that is made in this work is the hybrid decision making framework of the platform which validates the predictions made by the algorithm by referring to real-time weather and already approved agricultural principles that guarantee field-coded advice. In order to improve transparency and confidence among users, the platform uses explainable AI methods to show the factors which are behind each recommendation including rainfall, temperature changes and nutrient availability. The combination of sophisticated analytics, real-time data and interpretable outputs will help AgroSmart to provide reliable and easily accessible decision-support technology to farmers interested in applying smart farming.

In addition to the discipline, AgroSmart assists farmers with the business aspect of farming. It entails a marketplace where goods are sold to buyers bypassing the middle man and a price predictor which assists farmers to make the most when selling their goods. It can be the AI chatbot or the live weather notifications, but the platform is created to assist farmers in reducing their expenses, increasing the yield, and gaining more income by means of a friendly, user-friendly mobile platform.

Keywords: Smart Farming Toolkit; Digital Agriculture System; AI-Powered Crop Advisor; AI Farming Chatbot; Precision Agriculture; Internet of Things.

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Introduction

Agriculture is now in a paradox, its weather is becoming unpredictable, and its market systems are becoming very intricate in such a way that farmers are left behind. AgroSmart (or the Krushi Care Hub) is an online solution that aims to transform that by directly bringing high-tech solutions to people that grow our food. It is an all-in-one assistant made on the contemporary MERN stack which assists farmers make smarter and data-driven decisions.

The overall objective of this project is to minimize the uncertainty which farmers are usually exposed to in their day-to-day decision making. AgroSmart can be viewed as a 24-hour agricultural consultant that operates on artificial intelligence. When a farmer notices any form of abnormalities or discoloration on a leaf, all one needs is to take a photo quickly and leave the system to work on the image, determine the probable disease, and propose the necessary measures to contain the situation. The platform goes ahead to suggest crops that would have the best chances to thrive in the prevailing conditions based on the nutrient content of soil, the weather pattern of the location and other environmental variables [1]

AgroSmart has a unique feature namely a hybrid decision framework. This extra layer makes sure that the advice that has been given is safe and practically applicable. In order to establish transparency, the system also justifies the basis of its outputs- why one factor like humidity patterns or recent rains could have promoted a certain recommendation.

In addition to crop management, AgroSmart is also geared to assist the overall economic welfare of the farmers. The platform will come with an integrated marketplace where producers will be able to interface with the buyers without necessarily having to use the intermediaries who usually take a large chunk of the profit. Other functionalities like market price prediction and built-in AI-powered support system also enhance the platform, and it forms a complete ecosystem to assist farmers to save on costs, increase production, and transition to a more stable financial environment in a shifting agricultural environment [2]

Fig. 1. *Krishi Doctor – AI Pest & Disease Diagnosis*

Literature Review

AgroSmart represents a wider pattern in the agricultural research community of the world, where technologies are moving towards digital, data-centric agriculture systems. In 2024 and 2025, research papers point out that using Artificial Intelligence (AI) and Internet of Things (IoT) technologies have become a necessity in both small and large farming operations, as opposed to an optional advanced tool.[3]

High-tech Crop Health and Disease Surveillance

Recent research demonstrates that computer vision technology or, to provide a machine with the ability to read and process the visual data, has finally attained the degree of precision that signifies a major turning point in its evolution.

- High-Precision Diagnostics: According to research published in 2024, the most advanced deep-learning frameworks, such as CNNs or ResNet50, now have the ability to detect crop diseases in leaf images with an accuracy ranging from 95 to 99% (with some exceptions).
- Multimodal Detection: This is an essential trend of 2024, which involves a combination of pictures and environmental

statistics (temperature, humidity). Studies indicate that this context enhances the level of accuracy of diagnosis by approximately 2.5% relative to the use of images alone.

The Move towards Hybrid Decision Support Systems (DSS)

Differentiation between simple prediction and decision intelligence is now available in literature.

- Beyond Basic Algorithms: Although the old-fashions of machine learning (such as Random Forest or KNN) are still widespread, research in 2025 is about Digital twins and hybrid solutions that combine these models with up-to-date satellite and sensor measurements.
- Measurable Impact: According to system reviews, the implementation of Decision Support Systems would be able to grow crop production by 15 per cent and save water usage by 20 per cent due to more accurate resource allocation.

Explainable Artificial Intelligence (XAI) and User Confidence

In 2024-2025 research, one of the present priorities is the so-called trust gap.

- The Black Box Proposal: When farmers do not know the reasons behind the suggestion, they tend to be reluctant to employ AI.
- Transparency as a Solution: New models in Explainable AI (XAI) are being created to give understandable explanations of AI predictions to make farmers and agronomists comfortable in acting upon the information.

Digital Ecosystems to Revolutionize Markets

Digital marketplace research is a challenge to the traditional agricultural supply chain.

- Direct-to-Consumer (D2C) Impact: 2025 directs a project that at least 60 percent of farmers in such places as India will have access to digital marketplaces to avoid middlemen.
- Economic Benefits: According to studies, FY 2024-25 demonstrate that the farmers who use these platforms experience higher incomes by 10-12 percent and a significantly quicker payment settlement (usually within 3-4 days).
- Market Transparency: Real time price discovery markets have been found to enhance the bargaining power of the farmer since he or she will not be so dependent on the local intermediaries.[4]

Problem Statement: The Struggle of Modern Farming

Even though agriculture is the fundamental element of the economy, most of the farmers are in a dilemma of being stuck between the traditional ways of doing things and the rapidly changing new world where they are not yet ready to handle. Their problems are not only due to the physical burden of agricultural work but mostly due to an extensive information gap that enhances uncertainty and leads to the decrease in the profitability of their labor in many cases [5]

Some of the core issues that have been addressed in this project include:

- The Guesswork in Farming: The majority of farmers use historical experience or gut feeling to determine what to plant or even the amount of fertilizer to apply. In the absence of data-driven insights, they usually have poor yields as the quality of the soil or the weather that will occur does not coincide with their decisions.
- Slow Response to Disease: A farmer can fail to realize that a crop is diseased until it has spread. Agricultural professionals are usually difficult and costly to access resulting in avoidable crop losses.
- The "Middleman" Problem: There is a complete absence of direct sales to the actual end consumers of the agricultural products in the market today. They are forced to pass through various middlemen who receive massive percentage of the profit so that the farmer receives low wages as consumers spend high prices.
- Unpredictable Markets: Farmers usually get their goods ready around the same time as everybody and the prices go down. They have no means of forecasting market conditions or price fluctuations and therefore are unable to plan their sales in such a way to achieve a reasonable profit on their investment.
- The Black Box of Technology: The technological tools are too complex or do not clarify the reason they are providing some pieces of advice. This makes farmers distrustful of any digital solutions, which might benefit them also generates a lack of trust in farmers.[6]

Proposed System

High Order Decision Support System

- Multi-Algorithm Recommendations: Multi-algorithm recommendations based on the system are based on multi-machine learning models that include Random Forest, K-NearestNeighbors (KNN), and Decision Trees that help propose the most appropriate crops in a particular field.
- Data-Driven Inputs: Recommendations are created as a result of the analysis of soil nutrients (Nitrogen, Phosphorus,

Potassium), pH, and climatic conditions such as rainfall and temperature.

- Hybrid Intelligence: To be safe, the system compares AI predictions with up-to-date weather information and agricultural limitations based on rules and ignores the recommendations in case conditions are not safe.
- Explainable AI (XAI): The platform restores confidence by demonstrating to farmers how specific elements of their environment resulted in a particular suggestion [7]

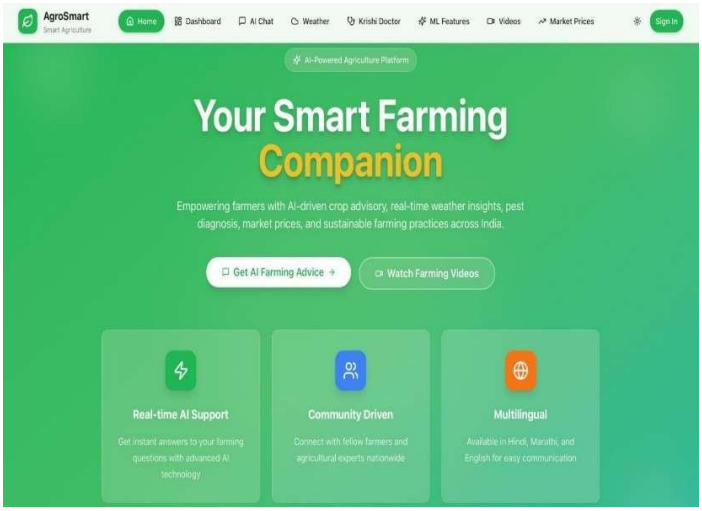

Fig. 2. *Smart Farming Companion*

Crops: Health/Diagnostics

- Image-Based Diagnosis: The farmers are able to send photos of plant leaves to be analyzed instantly to determine the presence of pests or diseases.[8]
- Treatment Protocols: After an illness has been identified, the app gives remedies and video instructions to treat the illness effectively.

Fig. 3. Educational Video Library Interface for Farmer Training on AgroSmart

- AI Farming Assistant: It is a chatbot that can reply to natural language enquiries regarding irrigation, fertilizing, and general management of farms 24/7.

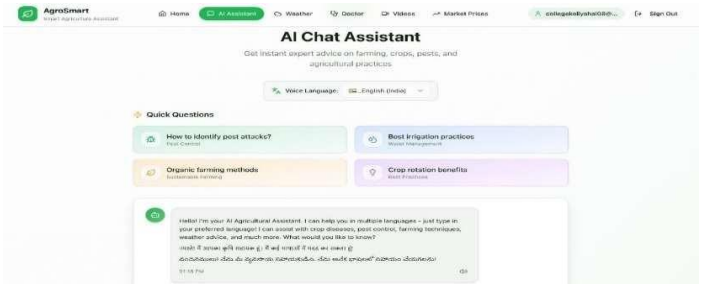

Fig. 4. *AI Chat Assistant*

Marketplace Characteristics and Economic

- Direct Marketplace: The service is a platform that helps to connect the farmers with the consumer and bulk purchasers bypassing middlemen that usually reduce the profit of farmers [9]
- Market Price Forecast: The system aids in predicting crop prices in the future based on the trends in the market to enable farmers to know when to harvest their crops when the market price is at its best.

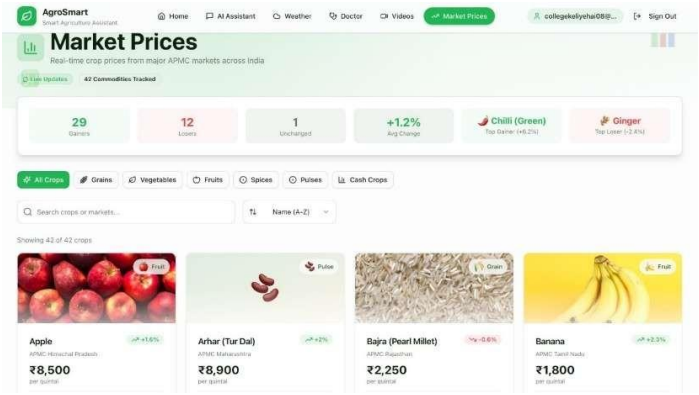

Fig. 5. *Market Price Monitoring Interface Showing Real-Time Crop Rates on AgroSmart*

- Supply Chain Transparency: Direct to consumer strategy means that the system would ensure farmers get fair prices as well as making the product affordable to the final consumer.

Technical Architecture

Contemporary Tech Stack: It is built on the MERN stack, consisting of MongoDB, Express.js, React, and Node.js, and Supabase to add real-time backend support.

Research-Ready Design: The system has such features as Ablation Studies to check the extent to which live weather data enhances prediction accuracy as compared to conventional ML.

Scalability: The modular code is made to be able to later be extended to IoT sensors, drones, or satellite imagery.[10]

Impact on Farmers

Improved Productivity: With the availability of accurate data, farmers can manage resources more effectively which translates to an improved crop yield at the end.

Reduction in Costs: Early disease identification and accurate recommendations of fertilizers assist in the reduction of wastage and avoidance of unnecessary chemical application [11]

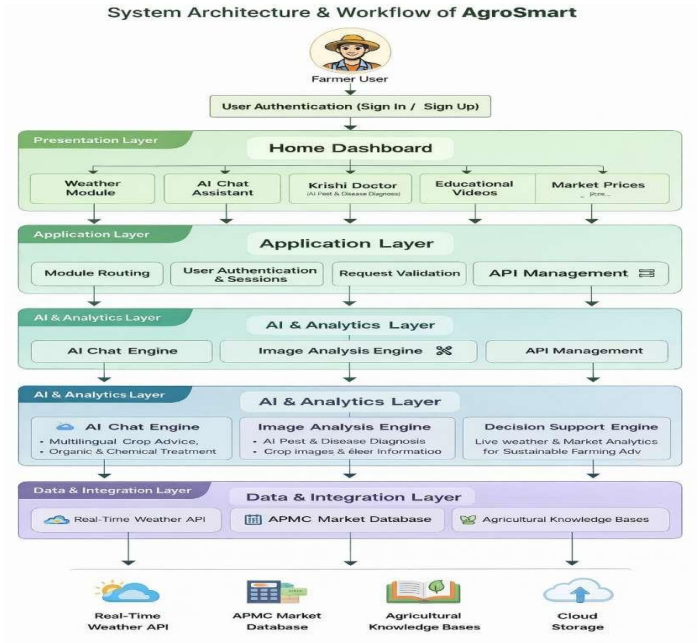

Fig. 6. *System Architecture and Functional Workflow of the AgroSmart Platform*

Project Results: What We Have So Far Achieved

The implementation of AI technology and online markets into the farming supply chain is already showing specific and quantifiable benefits on farming performance:

- Increased Yields: By using precision farming equipment, crop yields can increase by up to 20 percent by providing a crop with the amount of what it requires.
- High-Cost Savings: The farmers can reduce their operational expenses by approximately 10-15 percent and in some cases may realize up to 31 percent by utilizing their input resources, which are expensive like the use of seeds, fertilizers and irrigation water, more efficiently.
- Quickly Control Diseases: Image analysis systems powered by AI can now detect pests and crop-related diseases with up to an over 90 percent to almost 99 percent accurately and can detect the disease prior to its manifestation in farmers.
- Resource Efficiency: Smart systems rely on saving water and pesticide waste by approximately 20-40 that safeguard not only the farmer but also the local environment too [12]

Table 1. *Market Price Training Data*

Crop	Month	Year	Avg_Price_Per_Quintal
Barley	1	2023	2147
Millet	4	2022	1461
Wheat	1	2021	2486
Rice	7	2023	1878
Barley	4	2023	1202
Millet	11	2024	3030
Maize	4	2022	2321
Maize	8	2024	3293
Millet	11	2021	1579

Table 2. *Model Evaluation Data*

Model_Name	Accuracy	Precision	Recall
Price Prediction	0.92	0.86	0.85
Weather Advisory	0.83	0.8	0.88
Crop Recommendation	0.91	0.79	0.92
Disease Detection	0.83	0.81	0.88
Crop Recommendation	0.8	0.87	0.86
Price Prediction	0.86	0.9	0.81
Disease Detection	0.87	0.91	0.95
Price Prediction	0.81	0.82	0.84
Price Prediction	0.85	0.94	0.9
Price Prediction	0.94	0.93	0.95

Table 3. *Weather Advisory Data*

Temperature	Humidity	Rainfall	Advisory
38.1	85	169	Avoid fertilizer
33.4	39	194	Avoid fertilizer
14.5	60	35	Normal irrigation
22.8	68	121	Reduce irrigation
22.9	55	227	Ideal farming condition

14.7	71	117	Reduce irrigation
21	35	103	Normal irrigation
32.5	64	287	Ideal farming condition
25.6	77	348	Drain excess water
42	88	217	Drain excess water

Future Scope: Where The Project Is Headed (2026 And beyond)

By the year 2026, the project will be ready to expand beyond its existing web-based platform and become a fully integrated and intelligent farming ecosystem:

- IoT + Satellite Integration: Like a camera, the platform will be integrated with satellite imaging and ground sensors to scan whole fields in space to automatically detect dry spots or nutrient-deficient soil [13]
- Safe Trading with Blockchain: The idea is to use blockchain technology to create the ability to fully trace agricultural products- food, from farm to fork. This will enable the consumers to be certain of the source of their produce as farmers get to earn safe and instant payments.
- Autonomous Farming (Drones and Robots): Future developments will add support to agricultural drones, as well as miniature autonomous robots that can carry out specific tasks, including spraying just the infected plants, or weeding them, not to be controlled directly.
- Climate-Smart Prediction: AI will be further personalized, which predicts extreme weather, such as droughts or floods, and allows farmers to shift their planting times weeks before disaster occurs [14]
- Hyper-Localized Edge Devices: We are equally looking into deploying solar powered brain boxes that can be deployed directly in the fields to run AI computation in those fields. This would enable the system to work even in the remote areas that have limited or no internet connectivity [15]

Conclusion: The Path Toward Sustainable Agriculture

AgroSmart (Krushi Care Hub) is a giant leap towards a combination of the traditional farming experience with the new digital smartness. By not necessarily depending on the common methods of making guesses but instead choosing a Hybrid Decision Support System the project demonstrates how technology can help agriculture to be more predictive, minimize the losses that do not have to be made, and help farmers to enjoy much higher profits.

The site also addresses some of the most pressing issues of the current agricultural environment such as:

- Informed Decision Making: It is also informed decision making whereby farmers, thanks to Explainable AI, do not follow a black box but they are studying the science behind crop selection and soil health.
- Immediate Intervention: Image-based Crop Diagnosis tool guarantees the ultimate result of disease detected early enough hence crops are saved that would have been lost due to not being diagnosed in time.
- Economic Independence: The economic independence approach enables farmers to take control of their economic performance by providing a direct marketplace, which guarantees fair compensation to their efforts by mitigating the reliance of intermediaries.

In the future, AgroSmart is not only hoped to be understood as a single application, but it is a scalable system of the next generation of Smart Agriculture. Its open-source design enables the easy addition of IoT sensors, satellite-based monitoring units, and autonomous drones so that the platform can keep being expanded as the agricultural technologies improve. Essentially, the project shows that through timely and accurate information on the farmers, the resilience will be enhanced, sustainability will be promoted, and the communities across the globe will have a brighter and more secure agricultural future.[16]

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