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Farmingo: A Multi-Module AI-Based Farmer's Assistant Application Using CNN for Crop Health Monitoring, Market Forecasting, and Smart Agricultural Management

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Abstract: *The agriculture sector has been the backbone of the Indian economy for many decades. Besides, it also employs a great number of people. Nonetheless, the farming community is still facing several challenges. Farmers face challenges such as illiteracy, lack of awareness of crop prices, erratic climate conditions, sporadic rainfall, and uncertain crop yields. In order to counter these problems, this paper proposes Farmingo. It is a comprehensive platform that offers digital services for farmers. It is a combination of machine learning concepts as well as data analysis. Using Farmingo, users can predict crop disease, crop price, climate conditions, communicate with experts, access the marketplace and demand and supply trading platform. The system includes an integrated communication module that enables messaging. Through this module, farmers can share their experiences with experts. In addition, the farmers can talk to each other. This module promotes knowledge sharing and timely information exchange. Experts' dialogue and response are archived for future reference. Common diseases can be identified and analyzed through these interactions. The system facilitates easy and efficient two-way communication between experts and farmers.*

Keywords: AI in Agriculture, Crop Disease Prediction, Crop Price Prediction, Marketplace Platform, Weather Forecasting, Demand and Supply Trading.

I. INTRODUCTION

Farmingo is an app that brings together artificial intelligence and data analytics to make decision-taking easy for the farmers. The system adopts a common approach hosting several modules via which the farmers can manage cropping data. Besides this, it also helps the farmers to sell their products. Farmers can also contact specialists and get their questions answered in their own language. This enables the farmers to converse with each other about their issue. The farming activity gets authentic agricultural information from the farmers with the help of expert advice and one expert can share his farming experience with another expert. Through the web and mobile interface, the real-time weather forecasting is made possible by the forecasting of the weather module.

Through a machine learning method, crop images are used to identify diseases. To sum up, together these modules will develop a digital ecosystem that makes the farmers knowledgeable, predictive, verified market access and more productive and profitable.

II. LITERATURE SURVEY

The document entitled "Farmer connect" – a step towards enabling machine learning based agriculture 4.0 efficiently [5] by Jesal Desai and Mohammed Husain Bohara represents such a hybrid that serves the purpose of connecting the

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whole agricultural value chain through a digital platform with the aid of machine learning. The researcher uses this development to bring a revolution in the agriculture sector by bringing the farmers and dealer retailers and company on a platform so that they can easily together and at affordable prices without middlemen. Experts also use machine learning for forecasting the prices of commodities for the upcoming days which helps the farmer decide whether they should hold on and sell it later or sell now. Cold storage and transport are integrated into logistics which assist the farmer in this.

The paper titled CropAI: Crop Disease Prediction and Growth Tracking Using AI [13] propose an AI-based system for early crop disease detection to reduce losses and improve productivity. This intelligent crop disease prediction helps the user to get the prediction. Thus, any disease will be detected in the early stage. It will reduce the loss of crops and increases the yield in the grown crops for better productivity of the crops. The prediction model was created using deep learning methods namely, CNN, VGG16, VGG19 and Resnet50 on the 10101 Plant Village images. - The Resnet50 model attains the highest accuracy of 98.17% among all models.

Weather forecasting has become one of the most important research and development this far which has evolved with technology over the years. The paper is entitled "Precision Agriculture Through Weather Forecasting" [2] by Arif Bramantoro, Wida Susanty Suhaili, and Nor Zainah Siau helps in precision agriculture using weather prediction. Farmers can effectively manage their resources by using rainfall, humidity and temperature forecasting. There has been a recent development of an intelligent agriculture system to aid economic management of crop cost and maximum crop yield. Weather prediction for every crop relies on its minimum and maximum temperature limit. In addition, graphical evaluation is applied for maximum and minimum humidity limits.

The study Rural-Based Agricultural E-commerce Platform [8] by Samkeliso S. Dube et al. describes the development of an e-commerce platform for rural farmers in Zimbabwe to overcome challenges like limited market access, unfair pricing, and logistical barriers. Using a user centered design and stakeholder collaboration, the platform connects farmers directly with consumers and broader markets. Key features include an intuitive interface, logistics coordination, digital payments, and training modules to improve digital literacy. The results show improved market reach, better pricing, and reduced reliance on intermediaries. The study highlights the potential of rural-focused e-commerce to enhance agricultural sustainability, economic empowerment, and rural development.

The paper "An Innovative Deep Learning Based Approach for Accurate Agricultural Crop Price Prediction" [4] by Mayank Ratan Bhardwaj et al. presents a framework using deep learning-based approach to forecast crop prices. The proposed model will generate accurate priced forecast through innovative use of mixed deep learning architecture. This framework employs various climate situations, types of soil, locations for the high propagation of prices through market nodes. The model designed utilizes GNN for depicting the geo-spatial dependence, and also uses CNN to design a feature map from historical priced – T. Additionally, at the end LSTM is applied to combine the node features and forecast accurate future prices through cooperative training. The experimental verification of this, the model depicts looking at the Indian market data of potato and tomato prices.

III. PROPOSED SYSTEM

The proposed system, Farmingo, is an AI-based application designed to support farmers by integrating multiple agricultural services into a single platform. It addresses key challenges such as crop diseases, price fluctuations, unpredictable weather, and limited market access. The system combines intelligent prediction models with user-friendly tools to assist farmers in making informed decisions.

The Crop Disease Prediction module uses Convolutional Neural Networks (CNN) to detect plant diseases from images at an early stage. The Crop Price Prediction module applies machine learning to forecast market trends, helping farmers

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decide the right time to sell. The Weather Forecasting module provides real-time climate updates to support better farm planning. In addition, the platform offers an E-commerce Marketplace for purchasing agricultural inputs and a Demand–Supply Trading module that connects farmers directly with buyers. A communication feature enables interaction with experts and other farmers. Together, these modules create an integrated and data-driven solution to improve productivity and profitability.

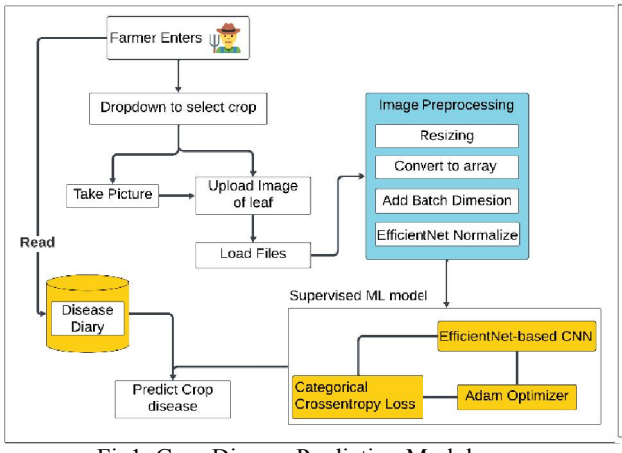

Fig1. Crop Disease Prediction Module

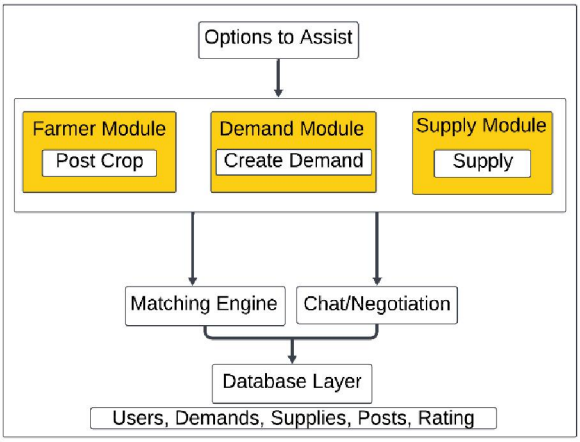

Fig2. Demand and Supply Module

1.Crop Disease Prediction Module

Users can upload the image of the crop and through image processing and learning algorithms, diseases of the plant can be detected. Additionally, farmers receive little professional advice on time as there is a lack of awareness of agricultural information and field experts have restricted access to rural areas. The trained CNN models can process the image uploaded by the user. The model aids in recognizing recurring plant diseases and their repeated patterns and visual traits. The warnings give first signal of the diseases. The alert includes prevention and recommended treatment protocols.

2. Demand and Supply Trading Module

Farmers sell their harvested produce at their desired price. Interested buyers may express interest through the platform. The buyer can communicate with the farmer and place an order from the platform as per the required quantity. The involved parties coordinate delivery and logistics directly, by eliminating intermediary involvement. This module ensures that farmers earn their fair price while other users benefit.

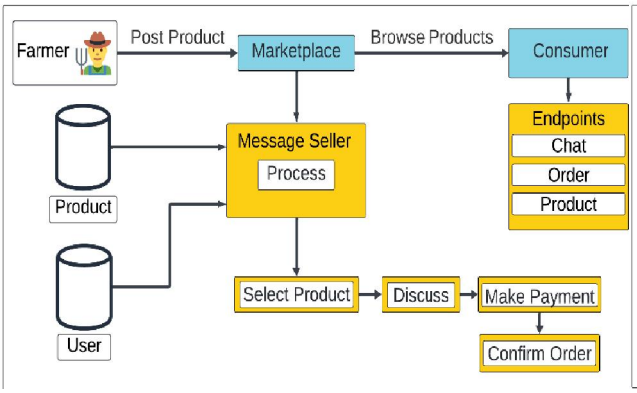

Fig3. E-Commerce Module

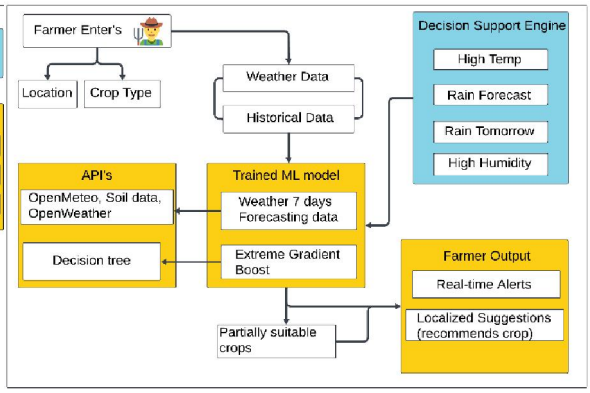

Fig4. Weather Forecast Module

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3. E-Commerce Marketplace Module

Farmers can buy seeds, fertilizers, pesticides, tools, and other agricultural inputs from the E-commerce marketplace module. It addresses the issue of limited access to quality agricultural inputs. Farmers can examine multiple options and compare various products like fertilizers, pesticides, seeds, and tools based on price, quality, and specifications. This enables them to make an informed purchasing decision. Detailed product specifications are provided. The platform ensures seller verification and promotes transparency to enhance trust and authenticity in transactions.

4. Weather Forecasting Module

The weather forecast module provides farmers with live weather reports and accurate short term and long-term forecasts. Drastic climate change causes seasonal crop losses. With the help of live weather reports, farmers can take preventive actions. In addition, it facilitates the scheduling of irrigation, fertilization, spraying, sowing, and harvesting. The module integrates reliable weather APIs to improve forecast accuracy. It aids in understanding the probability of rain, temperature changes, and climate risk. This tool allows farmers to make safer and more informed decisions.

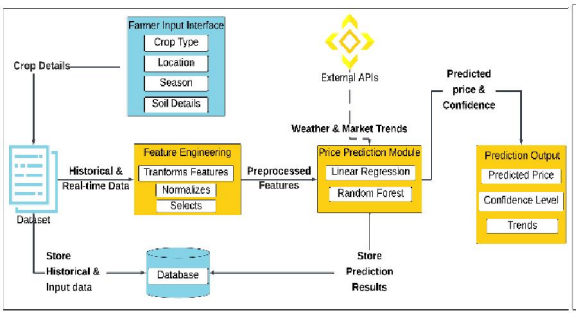

Fig5. Crop Price Prediction Module

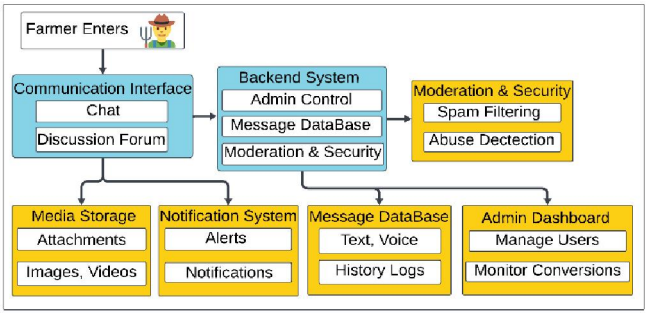

Fig6. Communication Module

5. Crop Price Prediction Module

The Crop Price Forecasting and Analysis module predicts Crop Prices in the future and analyses it. This will enable the farmer to mitigate the risks connected to changes in market prices. Our system extracts data from multiple sources and feeds it into the machine learning model. It can provide a complete analysis of the historical data regarding the crop price fluctuations, government price reports, seasonal trends, etc. of a certain particular crop. Using this analysis the farmer can gain insights to take intelligent decisions regarding short-term price trends. By using price forecasting and analysis module, using machine learning, the farmer can prevent selling his product at loss or delaying the selling beyond optimum insights with the use of agriculture machine learning.

6. Communication Platform Module

The communication platform module provides an interactive platform that enables farmers to connect with other farmers and Agri-professionals. Farmers generally have limited opportunities to share their knowledge on cropping problems, techniques and local issues in the villages. It assists farmers to engage in discussions with other farmers, seniors, and professionals. Farmers can address any queries and seek solutions. In addition, they also get the chance to learn from others' practical experiences. The platform helps reduce the spread of misinformation by enabling expert moderation and verified responses. Lastly, it boosts community mobilization and quick resolution of problems.

IV. IMPLEMENTATION DETAILS

A. Technology Stack

Farmingo is an app that brings together artificial intelligence and data analytics to make decision-taking easy for the farmers. The system adopts a common approach hosting several modules via which the farmers can manage cropping data. Besides this, it also helps the farmers to sell their products. Farmers can also contact specialists and get their

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questions answered in their own language. This enables the farmers to converse with each other about their issue. The farming activity gets authentic agricultural information from the farmers with the help of expert advice and one expert can share his farming experience with another expert. Through the web and mobile interface, the real-time weather forecasting is made possible by the forecasting of the weather module.

The proposed system employs Next.js (App Router framework), as the front-end framework to build a Dependable system along with security, and maintainability. Next.js also improves web apps with server-side rendering, optimized routing, and more performance features. We use Firebase for backend and database service. Firebase Authentication allows us to log in securely and access based on role. Cloud Firestore can be defined as a scalable database that we use to store the data securely and syncing in real-time across all clients. With Cloud Firestore, you can also retrieve data quickly. In order to include generative AI capability and intelligent processing in the app, Google's Gemini models are integrated through Genkit. We've implemented ShadCN UI components in our user interface for consistency and accessibility across the user experience. The responsive and customizable website was styled using Tailwind CSS.

B.Core System Functionalities

The proposed system provides data-driven intelligent support to farmers through the integration of multiple modules.

The system incorporates a user registration and authentication mechanism. Users must register and log in to access the platform. Role-based authentication is implemented to provide controlled access for three categories of users: farmers, buyers, and experts. Access to modules and data is restricted based on user roles to ensure system security and data integrity. It is a Demand–Supply Trading Platform that helps farmers directly connect to buyers of their produce and also facilitates listing of produce, negotiation on prices, order management without involvement of any intermediary. The communication module enables structured interaction between farmers and agricultural experts for query resolution and knowledge exchange.

A system will be developed for notification. The system provides the notifications in real-time regarding weather hazards, disease detection, price updates and buyer interest updates. This system's user credentials are kept safely with the help of encrypted authentication and role-based access.

The system takes into account that many farmers in the rural area have a language barrier. The solution provides multi-language support throughout the interface and modules to ensure people can use the system easily and understand it better. The messaging facility of the community communication platform allows farmers, experts and buyers to communicate in their own language in more than six languages. This ensures better accessibility and understanding so that people can participate without hesitation and share knowledge more efficiently.

The system provides limited offline functionality to support users in low-connectivity rural areas. The crop disease prediction module can operate in offline mode, allowing farmers to upload crop images and receive predictions without continuous internet access. Additionally, previously loaded community messages and posts remain accessible offline, enabling users to view information from their last online session.

V. RESULTS

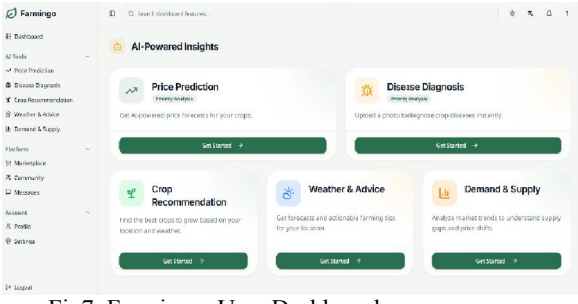

Fig7. Farmingo: User Dashboard

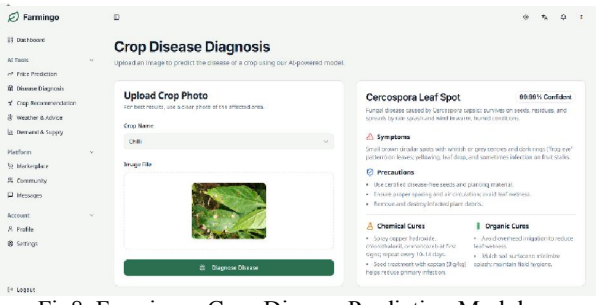

Fig8. Farmingo: Crop Disease Prediction Module

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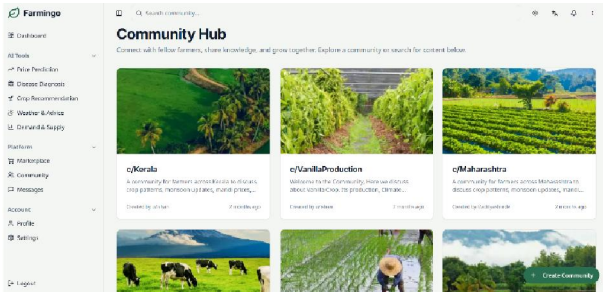

Fig9. Farmingo: Communication platform Module

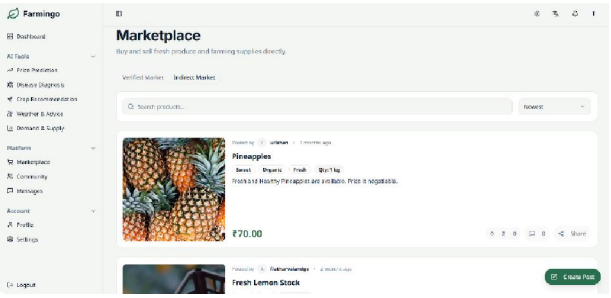

Fig10. Farmingo: E-Commerce Marketplace Module

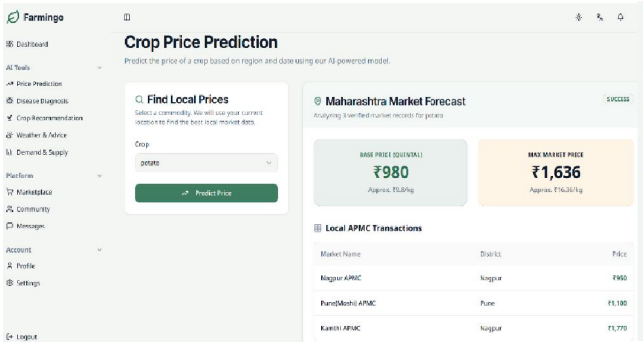

Fig11. Farmingo: Crop Price Prediction Module

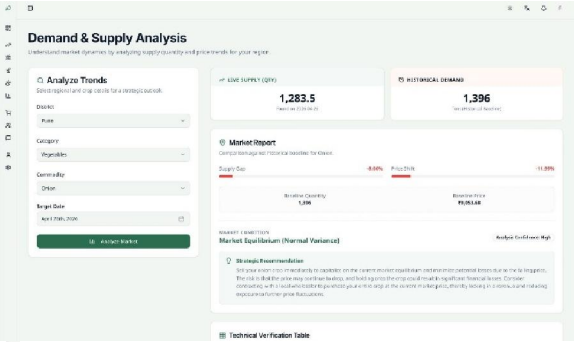

Fig12. Farmingo: Demand & Supply Module

VI. CHALLENGES AND LIMITATIONS

The heading of the Acknowledgment section and the References section must not be numbered. Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template.

While creating, constructing, and ultimately testing our technology a variety of technical, user and operational challenges emerged that had significant implications for design and implementation. The issues we had while testing the platform are important lessons learned that can impact the scalability and uptake of our platform in future social–technical situations.

A. Technical Implementation Challenges

Proper working of such multi-module agricultural platforms requires various technologies. For example, artificial intelligence (AI), machine learning (ML), cloud services, and web APIs facilitate real- time data access and intelligent decision-making processes. To accurately predict the weather, weeds, biotic stress, a pest's presence, and market prices, a good-quality and properly structured set of data is required. Additionally, another problem is that the rural area may lack high-quality datasets for making accurate predictions. In contrast, if the data is of low quality, a considerable decline in accuracy takes place. In rural areas, slow internet connection is causing serious infrastructure damage to the system. Devices not matching compatibility is yet another big issue. The system works well on all user-side devices and is providing a good installation experience on all devices with easy deployment.

B. User Adoption and Behavioural Challenges

One of the primary hurdles is encouraging farmers to adopt digital platforms and agricultural technologies. Having relied on traditional farming practices for many years, many farmers may find it difficult to be convinced of the benefits of a digital system. Low levels of digital literacy, lack of trust in technology, and difficulty navigating complex user interfaces may result in lower user engagement, lack of trust in technological systems and inability to navigate

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complex user interfaces may result in lower engagement. These factors collectively create behavioral barriers to technology adoption. Language barriers represent another significant challenge to user adoption. The user interface must support regional languages to ensure ease of use and accessibility. A further challenge is ensuring continuous technical support and platform maintenance.

C. Operational and Scalability Challenges

The operation planning and ongoing monitoring of platforms with numerous integrated modules present significant challenges. There will be extensive inter-module communication, including high-volume data processing, required for 24/7 operations that serve thousands of simultaneous users. Real-time backend updates with accurate and synchronized data will impose a substantial burden on infrastructure. Payment integration features, transaction validation, fraud prevention, will be required by future models like the Marketplace and Demand and supply management. As the future scales, we will need to effectively manage cloud resources and plan capacity. It must ensure high system availability and uptime. The governing module will require system coordination, performance monitoring and enforcement of policies.

VII. FUTURE SCOPE

The integrated agricultural platform that was discussed can embed features that can help farmers make intelligent decisions. In the future, the platform may introduce systems that allow for the submission of plans designed by agricultural scientists using an AI-based recommendation system. This system will recommend plans that have been validated previously. In the future, we can further enhance things and integrate IoT-based devices like soil moisture sensors and automated weather stations for intelligent farm monitoring and whatnot. Implementing voice assistance in regional languages can help the farmers, especially those who are illiterate.

Satellite imageries and remote sensing data can facilitate large-scale monitoring of fields and timely cautioning of pest incidence. Throughout the entire supply chain, the blockchain has the potential to enhance price transparency and fairness. The participation of wholesaler exporters, logistics service providers, and other stakeholders can help create a more comprehensive digital ecosystem of the marketplace module. When you partner with various governmental agencies you can receive automatic updates for schemes, subsidies, insurance claim etc. In the long run, the ecosystem has the potential to develop into a sustainable and data-driven profitable entity.

VI. CONCLUSION

The farmer's decision-making ability in everyday farming process is enhanced when multiple agricultural businesses operate on a single platform. This platform provides a mix of services that include weather forecasting, crop prices forecasting, disease detection service, messaging service, and market service allowing the farmers for smart agricultural management. In addition, the platforms with various services come together to work for themselves, then such a system serves one of the two purposes either helping in real-time solution seeking or strategic decision making for the long term. This way, it will help the farmer in making reliable and complete decisions from a single source of truth as against multiple disintegrated systems. Moreover, predictive analytics helps farmers to optimize their agricultural processes and manage potential risks to enhance productivity and returns.

Additionally, crops incur losses due to the undetected diseases or delayed information. Due to the infeasibility of constant human surveillance of the crop, disease detection & advisory module notifies timely status of the crops present in the field. Another important feature of this platform is that helps to establish direct linkages between the farmers and the buyers. Consequently, the system provides farmers with valuable information on time to make informed decisions. Farmers often suffer from major challenges like unpredictable weather, market price volatility and unavailable expert advice. Moreover, technology-enabled and sustainable farming can prevent all these hurdles.

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