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A Smart Agricultural Assistant for Crop Recommendation using Machine Learning: A Review

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ABSTRACT : This project presents a Smart Agricultural Assistant that assists farmers in making informed decisions based on data by utilizing computer vision, artificial intelligence, and machine learning. In addition to recommending the best crops, the system also suggests the right fertilizers and pesticides depending on environmental factors, weather, and soil nutrients. Using algorithms like Random Forest and XGBoost, it collects and analyzes data from government databases, rainfall records, and soil maps to produce precise forecasts. A computer vision module assesses crop quality and identifies agricultural illnesses, while a price forecasting tool helps farmers choose profitable crops and the best times to sell. The web-based platform, which promotes data-driven and intelligent agriculture methods for Indian farmers, boosts production, profitability, and sustainability.

KEYWORDS: Computer vision, image analysis, machine learning, artificial intelligence, crop recommendation, data analytics, and precision agriculture.

I. INTRODUCTION

One of the most important industries supporting both human survival and global economic expansion is agriculture. In India, it provides about half of the population with their main source of income and makes a substantial contribution to the GDP of the nation. Despite its significance, the agricultural industry faces a number of difficulties, including dwindling soil fertility, erratic weather patterns, a shortage of water, and rising population needs. Modern, data-driven agriculture methods are crucial because of the tremendous pressure these variables have put on farmers to produce more with fewer resources. The efficiency and sustainability demanded in the modern day cannot be achieved with traditional farming methods that depend on experience and intuition. Thus, a revolutionary method for enhancing crop yield and decision-making is offered by the integration of technology, particularly artificial intelligence and machine learning.

The creation of smart farming and precision agriculture systems has been made possible in recent years by developments in machine learning, artificial intelligence, the Internet of Things (IoT), and big data analytics. In order to suggest the best crops, fertilizers, and pesticides, these technologies enable the analysis of intricate agricultural statistics, including soil composition, rainfall, humidity, and temperature. By spotting patterns and correlations in agricultural data that human observation might overlook, machine learning models can provide accurate recommendations that lower waste, save money, and boost crop output. Furthermore, computer vision systems provide real-time insights that boost overall productivity by monitoring plant development, identifying crop diseases, and assessing the quality of produce.

The Smart Agricultural Assistant proposed by the research aims to bridge the gap between traditional farming methods and state-of-the-art technological developments. Its objective is to provide farmers with a comprehensive, data-driven platform that combines crop guidance, fertilizer forecasts, and price forecasting into a single system. By looking at environmental and soil conditions, the assistant suggests the best crops to grow in a certain area. It also predicts market trends to help farmers plan more strategically for their sales and produce. The incorporation of photo analysis also enables farmers to assess crop health and detect diseases early. Farmers may boost output, make educated choices, and support sustainable agricultural practices that support both economic prosperity and environmental balance with the aid of this all-encompassing approach.

Motivation

- Rather than using data-driven insights, farmers frequently make decisions based on traditional, experience-based criteria.
- Poor crop choices and ineffective fertilizer use lead to crop failures and low yield.
- Farming is financially uncertain due to weather volatility and market price swings.
- To increase rural agriculture's sustainability and profitability, low-cost, AI-driven systems are required .

Objectives

1. To create and deploy a smart assistant that uses meteorological and soil data to make precise crop suggestions.
2. To create a pesticide and fertilizer recommendation module that is tailored to the local environment.
3. To analyze crop quality and identify diseases using computer vision.
4. To incorporate price forecasts in order to assist farmers in making lucrative sales choices.
5. To assess the accuracy and usability of the suggested methodology in comparison to conventional farming practices.

II. LITERATURE SURVEY

Senthil Kumar Swami Durai[1] , Farming is defined as the process of tilling the land, growing crops, and raising livestock. An essential component of a nation's economic growth is agriculture. Farming accounts for around 58% of a nation's main source of income. Farmers have used traditional farming methods up to this point. These methods took a lot of time and decreased production because they were imprecise. By accurately identifying the procedures that must be followed at the appropriate time, precise farming contributes to increased output.

BenedettaFasciolo [2] ,To maintain food security in the face of population growth, agricultural output must rise significantly. However, the adverse effects of open-field agricultural practices and environmental crises limit the potential for further growth in such output. Aeroponics and other vertical farming methods can be used to maximize resource utilization.The approach for creating intelligent aeroponic systems based on IoT and AI algorithms is presented in this research. The parameters influencing plant growth and their relationships to the plant performance metrics are determined using the suggested methodology.

RushaBegnaWakweya [3] ,Reviewing the obstacles and opportunities of implementing climate-smart agricultural methods and technologies, as well as the consequences for sub-Saharan Africa's food security, is the goal of this article. An integrative literature evaluation based on inclusion and exclusion criteria was employed in the study. The review's findings showed that the primary obstacles to the adoption of CSA technologies and practices were a lack of suitable policies and political commitment, smallholder farmers' ignorance of these technologies, institutional limitations, and financial limitations. On the other hand, policymakers, advisors, and farmers had opportunities due to the availability of resources in the form of projects, programs, technologies, practices, and other applications.

PremRajak [4] ,In such a situation, combining cutting-edge technologies like sophisticated sensors with the Internet of Things (IoT) could increase agricultural output while reducing financial loss. Research has been done all around the world that has adequately shown how integrated IoT-smart sensors may be used to monitor environmental parameters that are crucial for crop growth, including temperature, humidity, moisture, and soil composition. Automated sensors are also used to measure greenhouse gases like carbon dioxide, methane, etc. Additionally, smart farming makes it possible to measure the quantity of nitrogen in the soil, which aids farmers in deciding how much fertilizer to apply to their fields. Unmanned aerial vehicles and some IoT-enabled devices are helpful for precise monitoring of insect attacks and related diseases in agricultural vegetation.

EvageliaKoutridi [5] ,Eco-friendly management of agricultural systems is a component of sustainable rural development, and research on smart farming technologies (SFT) is moving in that direction. Networking is essential for knowledge accumulation and system integration because emerging technologies like smart farming lack feedback and network interactions. As a result, it integrates research and development, improves marketing strategies, embeds interaction between various elements, and strengthens feedback loops between them. This strategy was used because successful rural development necessitates the insights of multiple established disciplines and must be linked to politics.

Furthermore, if sustainability is the aim, the multidisciplinary nature of the participating scientists ought to support policy choices and be beneficial for rural strategic planning.

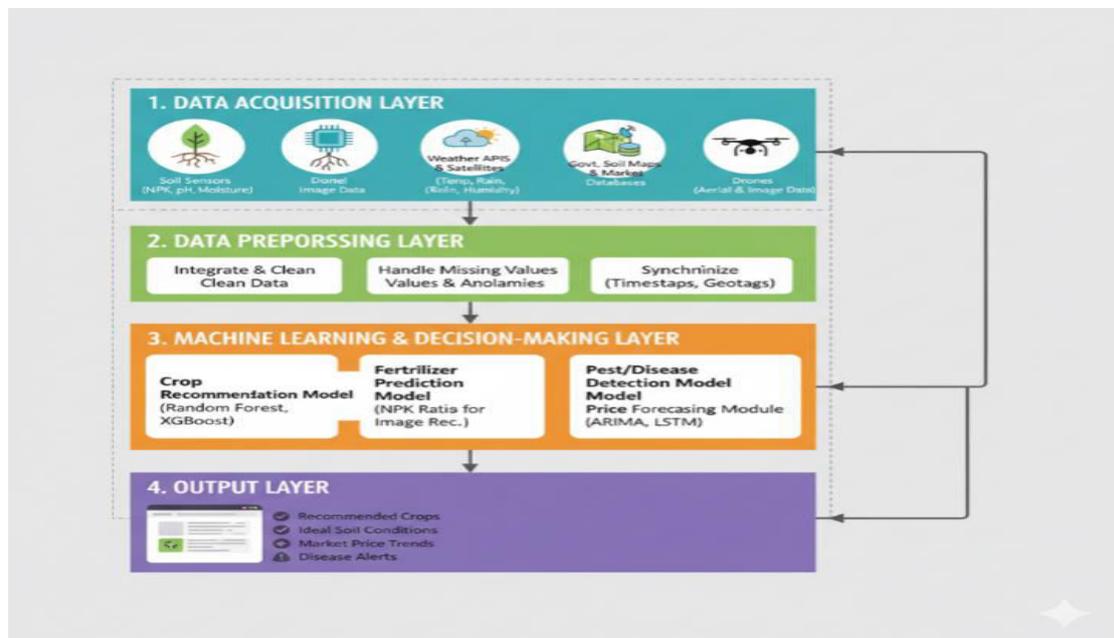
Acharya Balkrishna [6] ,Through real-time improvements in crop productivity, pest control, soil health, etc., this revolution is empowering farmers in terms of farm management. We have presented a detailed account of the major ICT initiatives implemented, followed by a redundancy analysis, and we have carefully examined the digital adoption in terms of insights into the Indian agriculture sector. We have also examined the impact of these initiatives on the sector. Unfortunately, while being a major agrarian nation, India is still in the early stages of adopting digital solutions, as shown by a careful examination of crucial FMIS and essential elements of globally recognized systems. After identifying 28 FMIS solutions that are currently in use worldwide, we generated a list of 29 local (Indian) applications spanning 23 distinct agricultural sub-domains. Theresa McMenemy [7] , Agricultural automation can play an important role towards achieving the Sustainable Development Goals (SDGs), not least SDG 1 (No Poverty) and SDG 2 (Zero Hunger) and those relating to environmental sustainability and climate change, by building resilience, raising productivity and resource-use efficiency, and improving food quality and safety.

Viveksharma [8] ,Due to its great potential to help farmers, this integration has increased agricultural output. The drive for technical development has brought back traditional farming practices and produced farming that is efficient, sustainable, and environmentally friendly. With the help of contemporary technologies like big data, machine learning, deep learning, swarm intelligence, the internet of things, blockchain, robotics and autonomous systems, cloud-fog-edge computing, cyber physical systems, and generative adversarial networks (GAN), smart farming has undergone a revolution. In order to address this, this report presents a thorough analysis of ten smart farming hotspots.

Existing System

When it comes to crop selection, irrigation, and fertilizer use, farmers in the current agricultural system mostly rely on conventional techniques and their own experiences. These practices frequently result in low crop yields, degraded soil, and monetary losses because they lack scientific research. The smart agricultural solutions that are now on the market are either pricy, complicated, or restricted to particular features like irrigation control or weather prediction. Furthermore, many systems are less able to adjust to local conditions since they do not take into account regional differences in soil, climate, and rainfall. Inefficiency arises when market predictions, fertilizer management, and crop advice are not integrated. Therefore, a comprehensive, data-driven, and reasonably priced system that works for small and medium-sized farmers is required.

III. SYSTEM ARCHITECTURE



IV. PROPOSED SYSTEM

To increase agricultural output, the suggested Smart Agricultural Assistant offers a clever, comprehensive solution that combines artificial intelligence and machine learning. In order to suggest the best crops and fertilizers, it gathers soil, weather, and market data from dependable sources. The system uses algorithms like XGBoost and Random Forest to accurately anticipate crops based on rainfall, temperature, humidity, and soil nutrients. Additionally, a price forecasting module helps farmers maximize income by predicting market movements, and computer vision is utilized to detect crop illnesses through image analysis. The online platform is accessible, easy to use, and tailored for Indian farmers. By using data-driven agricultural processes, it guarantees better decision-making, increased output, and sustainable resource management.

V. CONCLUSION

The Smart Agricultural Assistant effectively illustrates how computer vision, AI, and ML can transform agriculture. It enables farmers to make well-informed decisions by offering precise crop recommendations and forecasted pricing insights.

The system improves sustainability, profitability, and resource use. Future efforts will focus on expanding language localization for wider use, enhancing data access, and creating low-cost hardware integration. In order to bridge the digital divide and guarantee that all farmers benefit from technology, cooperation between researchers, developers, and agricultural specialists is essential.

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