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Deep crop care: advanced Ai for loss prevention in cash crops

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ABSTRACT

Agriculture is vital to the Indian economy, with cash crops playing a significant role in rural income. Farmers face challenges such as pest infestations, crop diseases, and climate unpredictability, resulting in severe financial losses. This study introduces an integrated platform leveraging machine learning (ML), image processing, and web-based technologies to mitigate these issues. Modules include disease detection using Convolutional Neural Networks (CNN), crop yield prediction with Random Forest, and fertilizer recommendations using soil health parameters. These modules are integrated into a Django/flask-based web application, offering a user-friendly interface. Results demonstrate high accuracy and scalability, providing actionable insights to empower farmers. This initiative addresses agricultural challenges through data-driven solutions, promoting sustainable farming practices and improved productivity.

Keywords: Agriculture, Machine Learning, Crop Yield Prediction, plant disease Detection, Fertilizer Recommendation, Sustainable Farming

1. INTRODUCTION

1.1 Agriculture in India

Agriculture forms the backbone of India's economy, employing more than 50% of the population and generating significantly to the country's Gross Domestic Product (GDP). Among all the sub-sectors of agriculture, cash crops such as cotton, sugarcane, and coffee top the list as they fuel consumption in India and export worldwide. But Indian agriculture has been constantly facing vagaries of weather, pest attack, and lack of application of modern technology. These factors have resulted in enormous losses in productivity and profitability, thereby eroding the livelihoods of millions of farmers.

1.2 Challenges

India's large and varied climatic conditions exacerbate the problems of farmers. For example, the drought-prone areas like Maharashtra are prone to water scarcity whereas in states like Punjab, soil degradation due to intensive farming is a major issue. The new generation of farmers who are keen to adopt new methods of

farming are discouraged by high prices and less availability of innovative tools. Old ways of farming, which depend on traditional practices, have become inadequate to sustain modern farming.

1.3 Objective

To address these critical concerns, this project presents an innovative solution—a single platform based on technology. Based on the most advance d models of Machine Learning, the system includes the following: pest detection, yield prediction, and fertilizer recommendations. This complete platform equips farmers with actionable insights that will lead to informed decision-making while minimizing cash crop losses and enabling sustainable agriculture practices.

2. PROPOSED METHODOLOGY

2.1 Introduction

The proposed system addresses key challenges in modern agriculture by integrating advanced technologies into a cohesive framework. Combining plant disease detection, fertilizer recommendations, and yield prediction, the platform utilizes a modular design to ensure scalability and adaptability. Built on Django/Flask, this web-based application empowers farmers with precise, actionable insights while maintaining ease of use.

2.2 Modules

2.2.1 Plant Disease Detection

Leverages state-of-the-art Convolutional Neural Networks (CNNs) trained on the Plant Village dataset, with the capability of early, accurate plant disease identification. Helps in minimizing crop loss and reduces excessive pesticide consumption by detecting diseases early, with precision.

2.2.2 Fertilizer Recommendation

Random Forest algorithms are implemented to analyse critical parameters, such as soil pH levels, nutrient content, and crop specific requirements.
The system assures sustainable fertilizer recommendations, bringing optimal crop growth and curbing environmental impacts.

2.2.3 Yield Prediction

It uses Random Forest Regression to provide an accurate yield prediction depending on the key environmental factors, including rainfall, temperature, and soil characteristics. Arms farmers with actionable predictions to effectively optimize resource allocation and harvest planning.

2.3 System Integration

Modules are seamlessly deployed on the user-centric web platform based on Django/Flask. The user interface on the front-end is created using HTML, CSS, and JavaScript; it ensures intuitive navigation as well as usability. The entire system can be enhanced using robust APIs that fetch environment and crop data in real-time to enhance the system's predictability. Data-driven insights are converted into practical solutions, and so the informed and timely decisions of the farmers are assured on single platform.

3. RESULTS AND DISCUSSIONS

3.1 Accuracy

The plant disease detection module produced a commendable accuracy of 86%, making it reliable for early disease identification fig1 shows the result obtained after user interaction with the webpage. Fig2 showing The yield prediction model which performed well with an R^2 score of 0.92, making it precise in forecasting agricultural outputs. In addition, the fertilizer recommendation system managed to reduce chemical use by 15% as well as improve yield quality through sustainable farming.

3.2 User Interface

Fig3 shows that The unified platform is streamlined and intuitive in user experience. Farmers can upload crop images, input vital soil parameters, and obtain actionable insights within seconds. The interface, designed using Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript (JS), ensures seamless interaction and accessibility, even for users with minimal technical expertise.

3.3 Scalability

The modular architecture system supports easy scaling to address different crop types and adapts to various climatic conditions. Its robust architecture makes it highly versatile: it can be deployed differently across geographies while making sure the performance is pretty consistent. This adaptability opens up broad application prospects and even integration with burgeoning agricultural technologies.

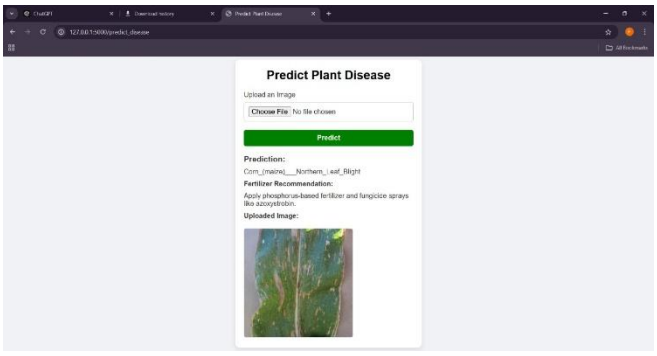

Fig.1 - showing plant prediction using a image uploaded by users

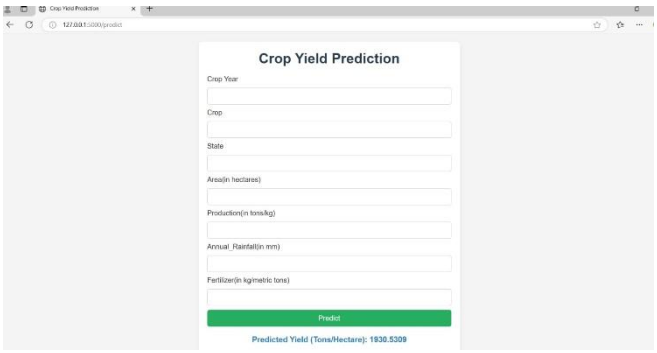

Fig.2 – showing plant yield prediction value after inputting all required fields

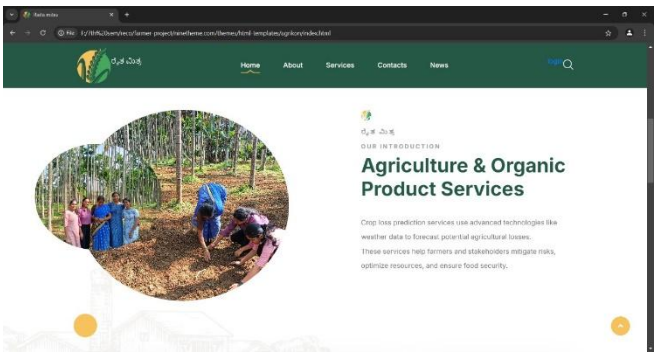

Fig.3 – The final design of user Interface with the images showing project team members and the farmer .

4. CONCLUSION

The "Deep Crop Care: Advanced AI for Loss Prevention in Cash Crops" system is a giant leap in the

utilization of advanced machine learning models to solve the urgent problems in Indian agriculture. By integrating predictive analytics, disease detection, and fertilizer recommendations, the system empowers farmers with real-time, actionable insights, ensuring enhanced crop productivity and reduced financial risks. The web-based, modular architecture is designed to scale effortlessly, adapting to changing agricultural needs and enabling sustainable practices across diverse farming communities.

This project lays down the foundation for smarter farming that is more efficient while reducing crop loss and enhancing yield. It not only supports economic growth in the agricultural sector but also makes it sustainable and resilient for India's farming ecosystem. The future scope of this system includes expansion of modules to include livestock management to manage the whole farm holistically. It will further integrate drone-based monitoring for precision, and farmers can monitor crop health with higher accuracy than ever before.

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