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Intelligent Crop Yield Forecasting Using Meteorological And Pesticide Data

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Abstract: Agriculture is the main pillar of economy in our country. Most of the families rely on Agriculture. Country's Gross Development predominantly lean on Agriculture. 60%of the land is utilized for Agriculture to adequate the requirements of the Country's population. To meet the requirements, modernization in Agricultural practices is required. Thus, heading towards the growth in Farmers' and Country's economy. This Project is an Attempt to minimize the losses occurs in Agricultural field. The majority of experimenter's work on agribusiness focuses on biological mechanisms to identify crop growth, improve yields, price prediction and plant disease classsification, hence presentation of agribusiness is influenced by several weather aspects.Additionally, the system incorporates crop prediction capabilities to forecast suitable crops based on environmental conditions and historical data. Furthermore, the fertilizer recommendation model suggests optimal fertilizers based on soil composition, crop type, and nutrient requirements. This multifaceted approach facilitates precision agriculture by enabling farmers to make informed decisions regarding crop health management, crop selection, and fertilization practices. The developed crop price prediction and forecasting system helps farmers to predict price of the commodity. The system gives detailed forecast up to next 12 month. The methodology we use in the system is decision tree regression and Random forest which is machine learning regression technique. The integration of these models provides a holistic solution for enhancing agricultural productivity, optimizing resource utilization, and promoting sustainable farming practices.

Keywords: RFA Random Forest Algorithm, Back Propagation, Price prediction, Crop Growth, Improve Yield,Price,Plant Disease Classification

I. INTRODUCTION

Agribusiness is a considerable significant sector of the Indian Economizing. The Indian agribusiness sector accounts for 18 percent of India's GDP and employs 50% of the country's work area. But most notable experimentations have documented a successive reduction in the offering made by agribusiness to the Indian economy and may also be a conception of the money needed for industrial growth to the dimensions although it is demographically the most comprehensive financial sector and plays a momentous functionin the overall socio-economic material of India.

Correct and convenient monitoring of farming crop requirements and evaluating possible harvest products are fundamental techniques for functioning programs Crop outcome forecasting, which supplies knowledge for decision Makers. Because of the effectiveness of predicting crop, crop price and yield is the definition of this study and to apply several Algorithm procedures for contemplating crop yield computations in various locations. For estimating the yields of various crops in specific states using aggregate physical production functions.

A newly developed weather index and various technological factors are used as inputs. To make a respectable assessment among our real result, that is known as target, and prediction model, that is a pleasant interface for farmers and offers the evaluation of rice manufacturing primarilybased totally on to be had data, regression and coefficient of dedication evaluation, in addition to the Average Error rate, have been carried out. Because of the effectiveness of predicting crop price and yield is the definition of this study and to apply several forecasting procedures for contemplating crop yield computations in various locations. With the price In the market at periodic time of modal price of the crop in certain season and year based with the name of crop. This prediction will help the farmers. To choose appropriate crops for their farm according to the soil type, temperature, humidity, water level, spacing depth, soil PH, season, fertilizer and months. And based on their price prediction the farmers can change the crop based on prfit or loss before cultivation to get more profits.

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II. PROPOSED SYSTEM

The AI-Based Crop Analyzer addresses these gaps by offering a comprehensive solution that leverages machine learning and data analytics to provide tailored recommendations for farmers. This system recommends the most suitable crops for specific regions using classification techniques that analyze soil properties, climate conditions, and historical data, enhancing productivity and resource utilization. It delivers precise fertilizer recommendations by analyzing soil nutrient levels and crop requirements, promoting sustainable farming practices. The solution also incorporates crop yield prediction, using regression models to estimate yields based on current and historical data, enabling farmers to plan better and maximize output. Additionally, it includes market price prediction to forecast crop prices, helping farmers make informed decisions on what to grow and when to sell for better profitability. The system also features plant disease detection, leveraging image recognition and diagnostic models to identify diseases early and provide effective treatment recommendations, minimizing crop loss and safeguarding productivity. A user- friendly interface ensures farmers can easily input data and receive actionable, personalized insights.

III. METHODOLOGY

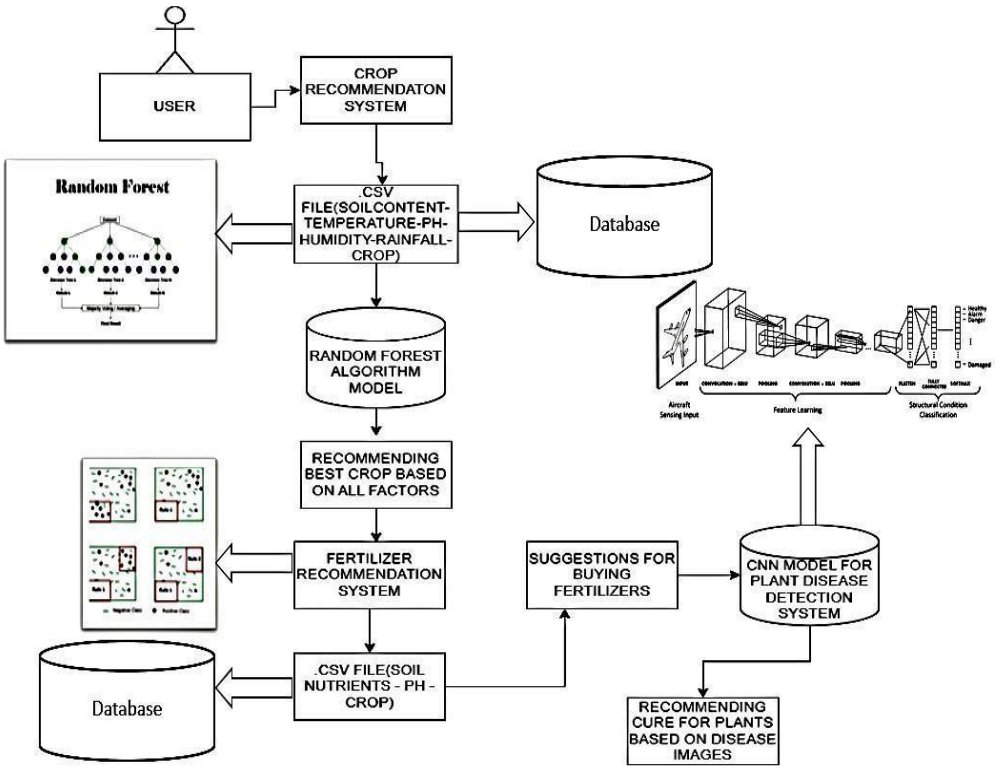

Fig.1.Illustrates the Block Diagram of the Proposed System.

The diagram illustrates a comprehensive methodology designed to assist users in agricultural decision-making. It begins with the user providing essential input data, including soil content, temperature, pH, humidity, and rainfall, which are stored in a database for processing. This data is then analyzed using a Random Forest model, which evaluates multiple parameters to recommend the most suitable crop for cultivation. Simultaneously, the system incorporates a fertilizer recommendation module that examines soil nutrient data and suggests the best fertilizers, complete with purchasing guidance to simplify decision-making for the user.

In addition to crop and fertilizer recommendations, the methodology integrates an advanced plant disease detection system. This component leverages a Convolutional Neural Network (CNN) model to analyze plant images, diagnose diseases, and recommend appropriate cures. The system also applies data preprocessing techniques, such as cleaning, normalization, and standardization, to ensure accurate and reliable results. By combining these modules, the methodology delivers end-to-end support, empowering users to make informed decisions to optimize agricultural productivity and address challenges effectively.

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IV. IMPLEMENTATION

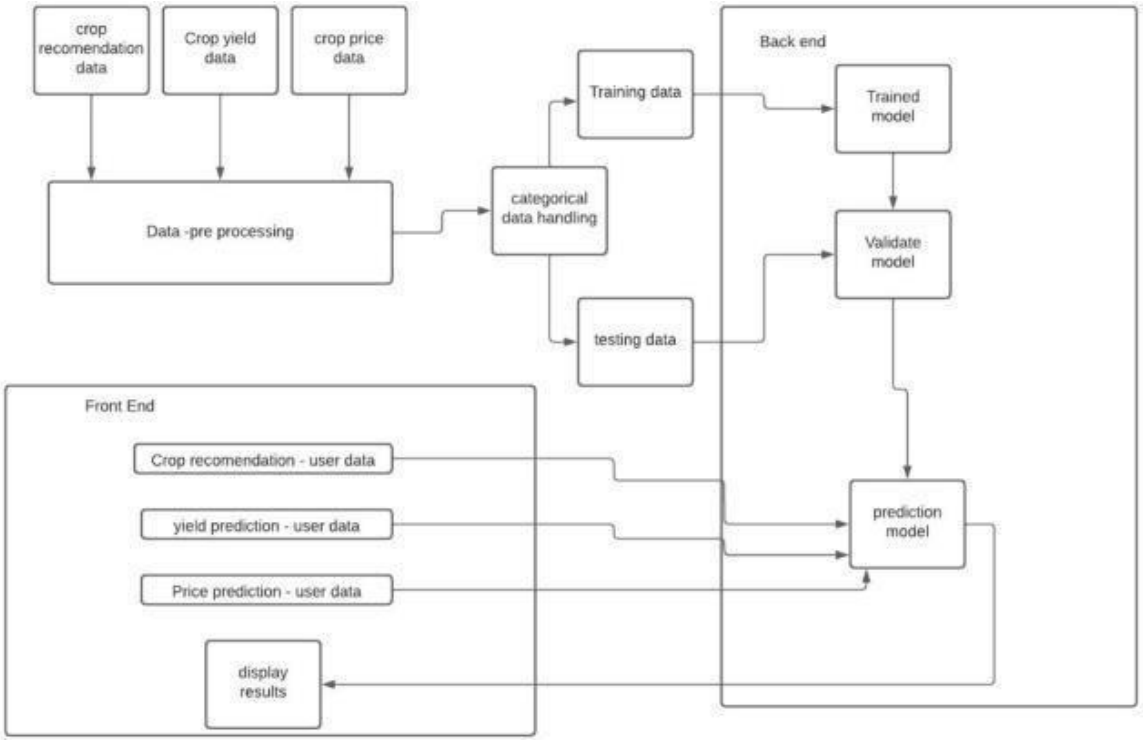

Fig 2. System Architecture

Crop recommendation, yield, and price data are gathered and pre-processed independently, after pre- processing, data sets are divided into train and test data. Data trained with ML algorithms and trained models are saved. Algorithms for a particular dataset are selected based on the result obtained from the comparison of all the different types of ML algo- rithms.

The web interface is developed using flask, the front end is developed using HTML and CSS. Flask is a web framework that provides libraries to build lightweight web applications in python. It is classified as a microframework because it does not require particular tools or libraries. It has no database abstrac- tion layer, form validation, or any other components where pre- existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself.

Users were able to enter the postal code and other Inputs from the front end. Location and weather API is used to fetch weather data which is used as the input to the prediction model.Prediction models which deployed in back end makes prediction as per the inputs and returns values in the front end.

List of Modules

1. **Flask Module:** A web framework used for building the user interface and handling HTTP requests.

2. **NumPy and Pandas Module:** Libraries for numerical computing and data manipulation, respectively. They are used for processing and analyzing data.

3. **PyTorch Module:** A deep learning framework used for building and training neural networks. In this case, it's used for loading and running the ResNet9 model for disease prediction.

4. **Requests Module:** A library used for making HTTP requests to fetch weather data from an external API. It's used to retrieve temperature and humidity data based on the user's input city.

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Module Description

Flask framework:

- Model Integration: Flask integrates the trained ResNet-9 model into the web application, enabling real-time inference on user-uploaded images.
- Flask is employed to develop a web application where users can interact with the trained model through a user- friendly interface.
- Flask renders HTML templates to create the user interface, displaying input forms for image uploads and presenting the model's predictions in an organized manner.
- It provides tools and libraries for building web applications.
- Flask is lightweight, easy to use, and allows for rapid development of web applications.

NumPy:

- Library for numerical computing, providing support for arrays and matrices.
- It provides support for large, multi-dimensional arrays and matrices.
- NumPy offers a wide range of mathematical functions for array manipulation and operations.

Pandas:

- Library for data manipulation and analysis, offering data structures like DataFrame.
- It provides data structures like DataFrame and Series, which are efficient for handling structured data.
- Pandas offers functionalities for reading, writing, and processing data from various sources such as CSV files, databases, and Excel sheets.

PyTorch:

- Deep learning framework for building and training neural networks.
- It provides support for building and training deep neural networks.
- PyTorch is known for its dynamic computation graph, allowing for flexible and efficient model development.

Requests:

- HTTP library for making requests and handling responses.
- It simplifies the process of sending HTTP requests and handling responses.
- Requests supports various HTTP methods like GET, POST, PUT, DELETE, etc., and provides functionalities for handling cookies, sessions, and authentication.

PIL (Python Imaging Library):

- Library for opening, manipulating, and saving many different image file formats.
- It provides support for opening, manipulating, and saving many different image file formats.
- PIL offers functionalities for basic image processing tasks like resizing, cropping, rotating, and applying filters to images.

TorchVision:

- Package consisting of popular datasets, model architectures, and image transformations for PyTorch.
- It provides datasets, models, and utilities for common computer vision tasks.
- TorchVision includes pre-trained models, data loaders, and transformation functions for tasks like image classification, object detection, and semantic segmentation.

Pickle:

- Serialization library for serializing and deserializing Python objects.
- It allows objects to be converted into a byte stream for storage or transmission and then reconstructed later.

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V. RESULTS AND DISCUSSION

1. Crop Prediction Model:

The model performance of various algorithms for crop recommendation was evaluated using accuracy scores and classification reports. Decision Tree achieved an accuracy of 84%, showing promising performance with limited depth. Naive Bayes demonstrated an accuracy of 72%, indicating decent classification ability. Support Vector Machine (SVM) achieved an accuracy of 92% after normalization, showcasing robust performance with polynomial kernel. Logistic Regression showed an accuracy of 88%, indicating good predictive ability with linear decision boundaries. Random Forest attained an accuracy of 96%, highlighting strong ensemble learning capabilities. XGBoost exhibited the highest accuracy of 98%, emphasizing its superior performance in boosting weak learners. Overall, Random Forest and XGBoost outperformed other algorithms, demonstrating their effectiveness in crop recommendation. These results were consistent with cross-validation scores, indicating the models' generalizability. The bar plot visualization further illustrated the comparative accuracy of different algorithms, providing insights into their relative performance. balance between quality and speed suitable for real-time applications on mobile devices.

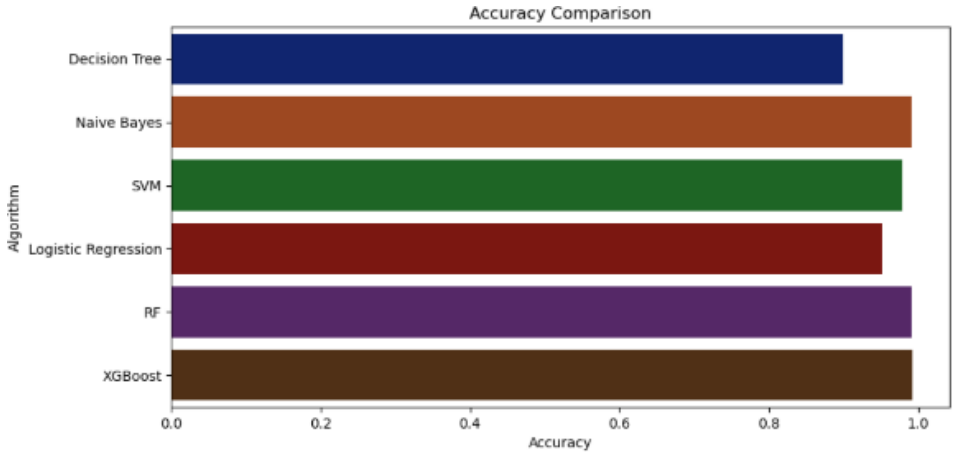

Fig 3. Performance of Crop Prediction Model with different Datasets

Figure 3.shows the performance of the model when it was trained with different datasets such as synthetic, real world and mixed dataset. It is clearly inferred from the image that the performance of the XG boost model is much better when the combination of the datasets were used.

2. Crop Recommendation:

Using machine learning classification techniques to analyze soil, climate, and historical data, the system recommends the most suitable crops for specific regions, enhancing productivity and resource use.

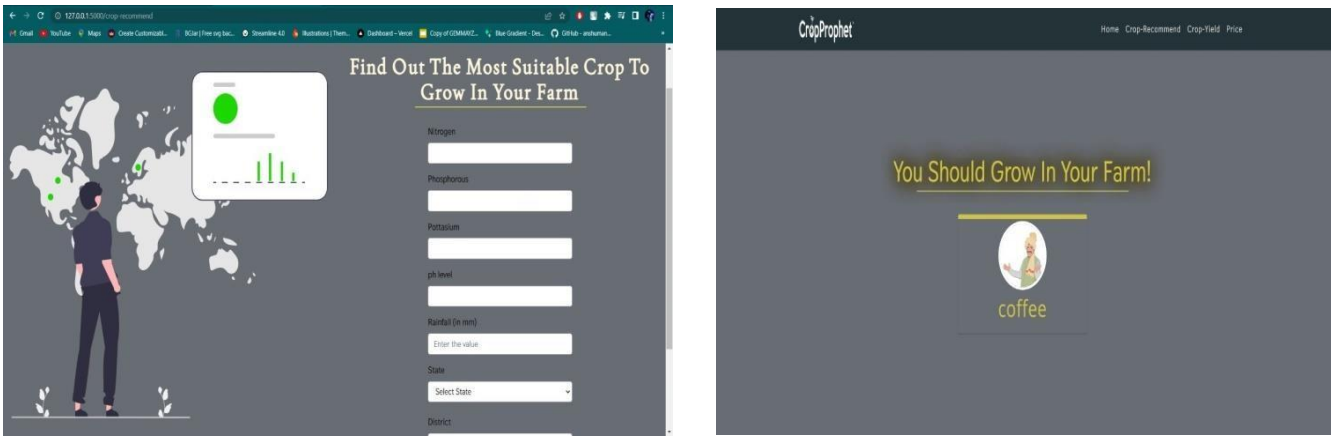

Fig 4. Crop Recommendation Page

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3. Crop Yield Prediction:

Implementing regression models to predict crop yields based on current and historical data, allowing farmers to plan and allocate resources effectively, reducing waste and maximizing output.

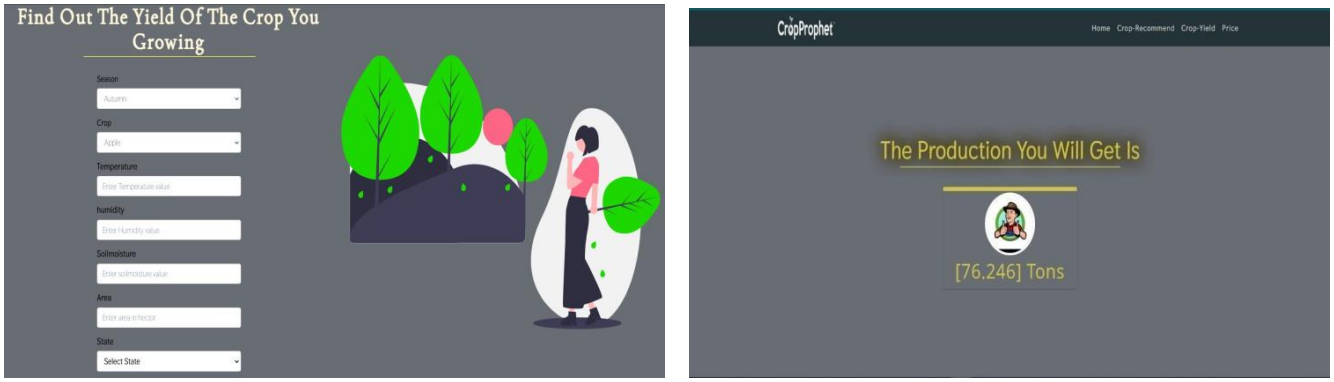

Fig 5. CropYield Prediction Page

4. Fertilizer Prediction:

Analyzing soil nutrient levels and crop requirements to deliver precise fertilizer recommendations, promoting healthy soil and sustainable farming practices.

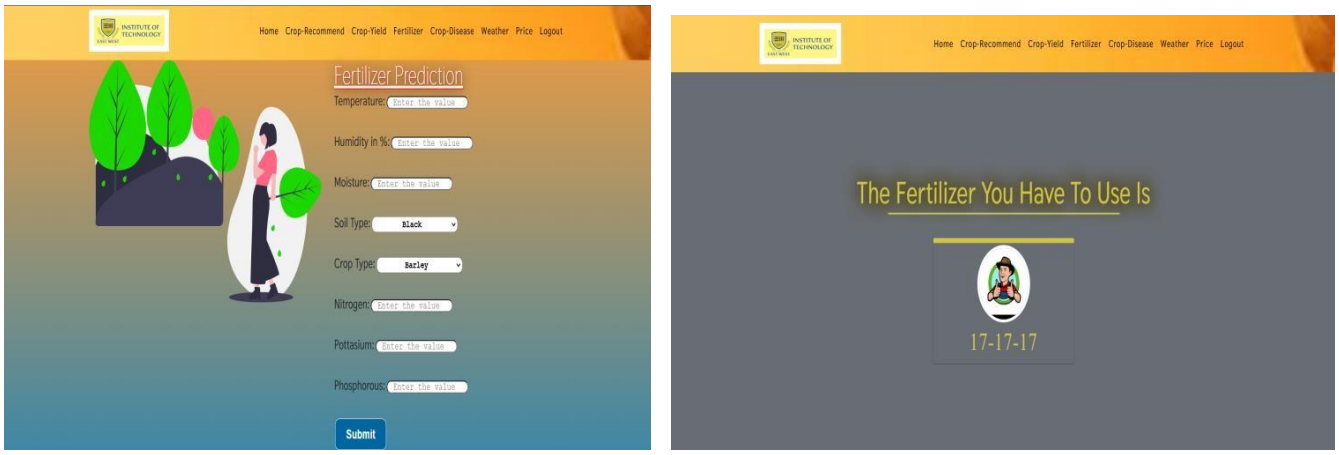

Fig 6. Fertilizer Prediction Page

5. Disease Prediction:

The plant disease classification module utilizes a Convolutional Neural Network (CNN) to analyze images of plants and accurately identify diseases. Based on the classification, the system provides recommendations for appropriate treatments or remedies to address the detected issues.

Fig 7. Crop Disease Prediction Page

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6. Market Price Prediction:

This component uses historical and real-time data to predict market prices for crops based on various factors, helping farmers, traders make informed decisions about when to sell or store produce for optimal profit.

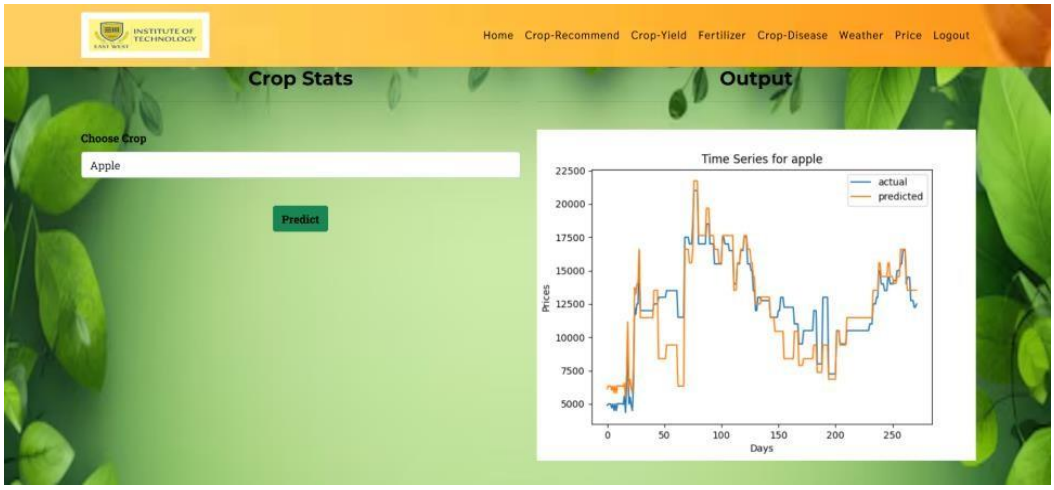

Fig 8. Crop Disease Prediction Page

VI. CONCLUSION

We have proposed an approach for predicting crop type, crop yield, and crop price using the Random Forest Algorithm (RFA) and the Back Propagation Algorithm. This approach aims to improve agribusiness by reducing farmers' losses and enhancing crop yields. In the current phase of the project, we reviewed literature on price and crop-yield prediction, which provided insights into the challenges in price datasets and helped identify obstacles to accurate predictions. Experimental results from the reviewed literature demonstrated that Random Forest and Back Propagation algorithms effectively address these challenges and outperform other methods in terms of accuracy. By integrating this solution with initiatives like sericulture and village-level development programs, farmers gain a deeper understanding of agricultural ecosystems, fostering sustainable and profitable farming practices.

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