Farmer's Tech Toolbox-Crop Recommendation and Disease Detection

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Abstract - *Agriculture farming is an important sector for each country's growth. Many technologies like ML and DL are being implemented for farmers for the growth of crops. This research paper presents a novel approach to address this challenge by integrating crop recommendation with plant disease detection. Leveraging machine learning and image processing techniques, our system aims to provide farmers with intelligent decision support for crop selection and disease management. The methodology involves the collection of extensive datasets comprising crop information, soil conditions, climate data, and images of plant diseases. Deep learning models like RESNET models are employed for accurate disease detection from these images, while decision support algorithms analyze multiple factors to recommend suitable crops based on local conditions and disease prevalence. The results of our study demonstrate promising accuracy in disease detection and effectiveness in crop recommendation, thus offering a practical solution to enhance agricultural productivity and sustainability. This research contributes to the advancement of precision agriculture and underscores the potential of technology-driven approaches to address critical challenges in food security and agricultural sustainability.*

***Key Words*: Deep Learning, Random Forest, Logistic Regression, Feature Extraction, Accuracy.**

1.INTRODUCTION

Agriculture is the foundation of global food security, but it faces significant difficulties such as changing environmental conditions and the ongoing danger of plant diseases. In recent years, the use of technology into agricultural methods has shown considerable promise for tackling these difficulties. One such novel strategy is the combination of crop recommendation systems and plant disease detection methods. Using machine learning, image processing, and data analytics, this study aims to create a holistic system that provides farmers with intelligent decision support tools for crop selection and disease control. Traditionally, agricultural practices rely on subjective assessments and historical knowledge, which may not always be accurate or take more time to detect the emerging threats like plant diseases. In Crop Recommendation, various factors such as temperature, soil nutrient levels (nitrogen, phosphorus, potassium), humidity, and pH are considered to assist farmers in selecting suitable crops for specific land plots. Utilizing advanced recommendation tools, farmers can anticipate the most appropriate crops to cultivate based on these environmental parameters. In Plant Disease Detection, farmers can upload images of their plants to identify potential diseases and monitor their plant health. This method enables farmers to promptly diagnose plant diseases and track the types of diseases affecting their crops. Furthermore, the scalability and adaptability of the proposed system hold the potential to drive sustainable agricultural practices and enhance food security on a global scale.

2. RELATED WORK

In,"Crop Recommender System Using Machine Learning Approach", it includes 76-90% accuracy in assessing weather impacts on crops in Madhya Pradesh. Another system compared supervised and unsupervised learning methods to predict yields and recommend fertilizers based on soil quality. Decision tree classifiers and random forest models have also been explored, alongside clustering techniques for improved accuracy. The current paper builds on these previous systems to advance crop yield prediction further [1]. In "Improving Crop Productivity Through A Crop Recommendation System Using Ensembling Technique" (Kulkarni et al., 2018), an ensemble model is developed to recommend optimal crops based on soil data. By combining multiple models, such as Random Forest and Naive Bayes, the system achieves 99.91% accuracy in classifying crops for Kharif versus Rabi growing seasons. This approach aims to boost agricultural productivity by offering tailored guidance to farmers regarding suitable crops for their soil conditions. Further advancements in predictive farming systems hold promise for benefiting farmers and the wider economy [2]. In "Prediction of Crop Yield and Fertilizer Recommendation Using Machine Learning Algorithms" (Bondre &

Mahagaonkar, 2019), Soil nutrient data is utilized by Random Forest and Support Vector Machine (SVM) algorithms to categorize soils and estimate yields for crops like rice, wheat, and soybeans. The SVM model achieves 99.47% accuracy for yield forecasting, surpassing Random Forest. Moreover, the system offers location-based weather data and suggests optimal fertilizers for selected crops [3]. In Using Deep Learning for Image-Based Plant Disease Detection, it demonstrates the use of deep convolution networks to accurately identify plant diseases from images. It uses PlantVillage dataset of over 54,000 labeled images containing 14 crop species and 26 disease models that were trained to classify crop-disease pairs. The best model achieved 99.35% accuracy on the test data, However, the performance dropped on real-world images taken under variable conditions [4]. In "Plant Disease and Classification by Deep Learning," deep learning methods are employed to accurately identify leaf diseases. The dataset comprises a substantial collection of images depicting various diseases. To enhance accuracy, the study utilizes techniques such as data augmentation, visualization, and transfer learning. Furthermore, the significance of hyper-spectral imaging for plant disease detection is discussed [5]. In the paper titled "Krisha Rakshan - A Machine Learning Based New Recommendation System for Farmers," a novel machine learning-based recommendation system named KrishaRakshan is introduced, aimed at enhancing farmers' productivity. The system employs the XGBoost algorithm to predict suitable crops based on soil nutrients and rainfall, while utilizing Random Forest for fertilizer recommendation. Additionally, MobileNet is utilized for detecting plant diseases from leaf images. Moreover, the system contributes to soil fertility improvement. Notably, the model achieves high accuracy rates of 99% for crop prediction, 95.7% for fertilizer recommendation, and 92% for disease detection. By providing personalized recommendations, the system aids farmers in enhancing yields sustainably, steering clear of excessive fertilizer use that can lead to soil degradation. The proposed system surpasses existing methods and offers a user-friendly tool for farmers to enhance productivity [6]. In the research on "Deep Learning-based Plant Leaf Disease Detection," CNN, VGG16, and VGG19 models are examined for their efficacy in identifying plant leaf diseases. The dataset comprises 9,000 images representing 8 types of diseases. CNN emerges as the top performer, achieving an accuracy and recall rate of 97%. Its architecture enables effective learning of relevant features from the images. Among the architectures evaluated, VGG16 demonstrates the highest precision and score. The study underscores the capability of deep learning techniques to automate disease identification from leaf images accurately, offering a potential means to enhance crop health and yields [7]. In the paper, Crop and Fertilizer Recommendation to Improve Crop Yield using Deep Learning, the system's development stages include data collection, pre-processing, model generation, and user interface development. These phases necessitate considerable investments in infrastructure and data collecting, as well as skill in deep learning model development and training. The system's successful implementation, which resulted in higher yields, increased nutrient utilization rates, and lower fertilizer costs for suggested crops, demonstrates its effectiveness in increasing agricultural productivity, mitigating environmental damage, and improving agricultural economic sustainability [8].

3. METHODOLOGY

3.1 DATA COLLECTION

The crop recommendation dataset is collected from Kaggle which consists of 7 data fields or attributes which are N - ratio of Nitrogen content in soil, P - ratio of Phosphorus content in soil, K - ratio of Potassium content in soil, temperature in degree Celsius, relative humidity in %, ph value of the soil, rainfall in mm. Each attribute is measured using suitable instruments or methodologies to ensure data accuracy and consistency throughout the dataset. By combining information on soil nutrients, climate, and rainfall, the dataset provides a robust foundation for developing predictive models that can assist farmers in making strategic decisions about crop selection and agricultural practices. The dataset's focus on the Indian agricultural context enhances its applicability to regional farming scenarios, contributing to the broader landscape of precision agriculture research and application. An extensive dataset of crop images was amassed, featuring both healthy specimens and those afflicted by various diseases. The aim was to create a large and varied collection, covering various types of crops and issues. The images were procured from Kaggle, a renowned platform for datasets and machine learning resources. Post data acquisition, rigorous efforts were undertaken to preprocess the images, ensuring uniformity in terms of size, color, and brightness for enhanced model comprehension. Additionally, we added labels to inform the model about the crop type and the presence of diseases in each picture. This approach enables our model to learn effectively from the dataset, contributing to a better understanding of crop health and diseases in our research.

3.2 DATA PROCESSING

Following the preparation of our dataset, the subsequent phase involves the judicious selection of an appropriate deep learning model for training with the curated dataset. In the context of image classification tasks relevant to our disease prediction and crop recommendation project, several distinguished deep learning models, such as Convolutional Neural Networks (CNNs), ResNet, and VGGNet, are available, each renowned for its unique strengths. In our specific pursuit of disease prediction, we have opted for the utilization of ResNet. This architectural selection is informed by ResNet's established efficacy in capturing intricate features within images, particularly advantageous for discerning nuanced patterns associated with crop diseases.

Likewise, for the crop recommendation facet of our project, we employed a tailored model specifically crafted to address the intricacies of crop-specific recommendations. The training process is systematic, involving the provision of pre-processed images along with their corresponding labels to the selected model. Through this iterative training process, the model undergoes a learning phase, wherein it acquires the ability to discriminate between various crop species and detect the presence of diseases within each image. This training phase is pivotal, as it empowers the model with the requisite insights to make precise predictions and recommendations. By implementing ResNet for disease prediction and employing a specialized model for crop recommendation, our research endeavors to leverage the distinctive strengths of these architectures to achieve optimal performance in the dual tasks of identifying crop diseases and recommending suitable crops. This strategic approach aligns with the overarching objective of advancing agricultural practices through the integration of sophisticated deep learning methodologies.

3.3 FEATURE EXTRACTION

In ResNet, feature extraction happens through a process akin to pattern recognition. Imagine you're looking at a complex image, like a scene with various objects. At the start of the ResNet, there are layers that serve as filters. These filters act like different lenses, each looking for specific patterns or features within the image, such as edges, textures, or shapes.As the image passes through these layers, the filters detect increasingly complex patterns. Early layers might detect simple features like lines or colors, while deeper layers detect more abstract features like shapes or textures of objects.The magic of ResNet lies in its ability to learn and adapt. It doesn't just passively analyze the image; it actively adjusts its filters based on what it learns. This learning process is facilitated by what are called "residual connections." These connections allow the network to skip over certain layers if needed, making the learning process more efficient and enabling the network to delve deeper into understanding the image. Additionally, there are pooling layers interspersed throughout the network. These layers serve to condense the information gathered from the previous layers, making it more manageable while retaining the most essential featuresBy the time the image has traversed through all the layers of the ResNet, it has been broken down into a set of highly abstract features that capture the essence of what the image contains. These features can then be used for various tasks like image classification, object detection, or image generation. Overall, feature extraction in ResNet is a complex yet elegant process that mimics how our brains interpret visual information, breaking down images into meaningful components that can be used to understand and interpret the world around us.

3.4 MODEL EVALUATION

We assessed the performance of six chosen models on the testing set, examining metrics like model accuracy for Crop Recommendation. We also utilized visualization tools, such as bar graphs to gain insights into model performance and identify potential areas for improvement. So as Table I. shows the algorithm Random Forest having a high accuracy of 0.99 was used to create the model for crop recommendation.

Table-1: This table shows the evaluated results of performance factors of the algorithm(s).

Name	**Accuracy**
Naïve Bayes	0. 990909090909091
SVM	0.10681818181818181
Decision Tree	0.9
XGBoost	0.990909090909091
Random Forest	0.990909090909091
Logistic Regression	0.9522727272727273

For Plant Disease Detection, we utilized the ResNet algorithm as we had an image dataset to model. ResNet, short for Residual Network, is a type of artificial neural network architecture designed primarily for image recognition tasks, known for its deep structure with the use of residual blocks. We trained the model for 20 epochs, and the accuracy obtained after using this algorithm was 0.9479. Additionally, we employed visualization tools such as bar graphs and line graphs to gain insights into the model's performance.

3.5 DATA VISUALISATION

In the realm, the focus is on presenting complex agricultural data in a visually intuitive and comprehensible manner. Utilizing various techniques such as charts, graphs, and maps, the relationships between different factors influencing crop growth and yield can be effectively conveyed. Visual representations of soil nutrient levels, weather patterns, and crop health indicators allow stakeholders to identify trends, patterns, and correlations that may not be immediately apparent from raw data alone. Furthermore, interactive visualization tools enable users to explore and analyze the data dynamically, fostering deeper insights and informed decision-making in agricultural practices. Through thoughtful and informative data visualization, the systems can empower farmers and agricultural professionals to optimize crop selection, improve productivity, and enhance sustainability in farming practices.

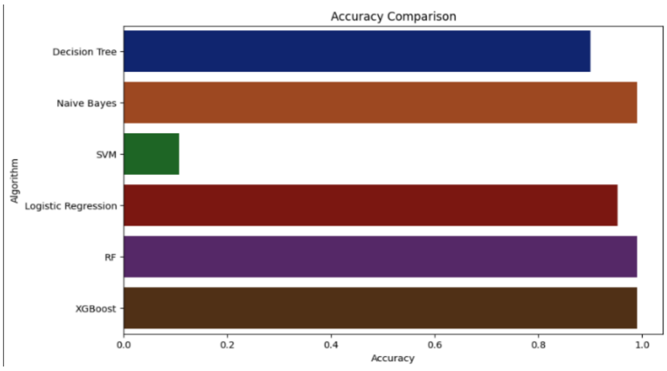

Chart -1: Accuracy for Crop Recommendation models

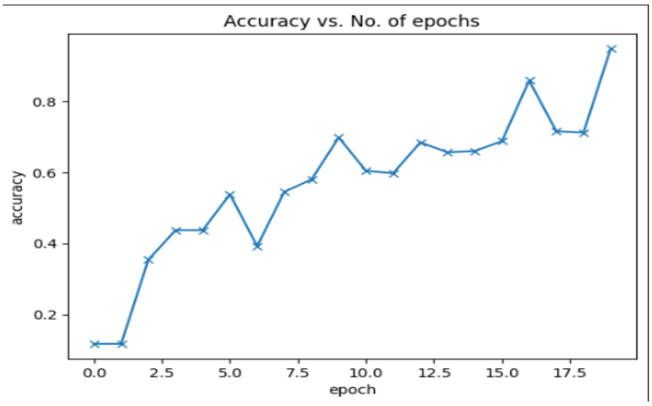

Chart -2: Line chart for accuracy gained at different epochs for Plant Disease Detection model

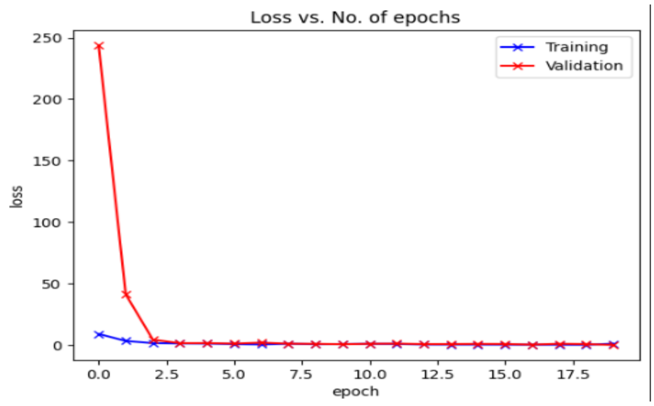

Chart -3: Loss caused at different epochs for Plant Disease Detection model

4. DISCUSSION

This study showcases the effectiveness of machine learning (ML) algorithms in crop recommendation and disease detection in agriculture. Naive Bayes, XGBoost, and Random Forest models offer high accuracies, providing valuable insights for farmers. The integration of a specialized RESNET model for disease detection underscores the importance of tailored approaches. However, the lower accuracy of the Support Vector Machine (SVM) model suggests the need for further investigation. Overall, this research highlights the transformative potential of ML in agriculture, emphasizing collaboration between agricultural experts and data scientists for optimal results

5. CONCLUSION

This study looks at the efficacy of machine learning algorithms for crop recommendation and disease detection in agriculture. ML algorithms like Naive Bayes, XGBoost, Random Forest, Logistic Regression, and Decision Tree were tested. Additionally, for disease diagnosis, a RESNET model was used. The accuracy rates were as follows: Naive Bayes, XGBoost, and Random Forest achieved the greatest 99% accuracy, followed by Logistic Regression at 95%. Decision Tree had an accuracy of 90%, while SVM had the lowest accuracy at 10%.

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