REST Journal on Data Analytics and Artificial Intelligence
Vol: 4(1), March 2025
REST Publisher; ISSN: 2583-5564
Website: http://restpublisher.com/journals/jdaai/
DOI: https://doi.org/10.46632/jdaai/4/1/87

Smart Farming Crop Recommendations Fertilizer Advice and Diseases Detection

P. Sai Kiran, B. Jashwanth, N. Shiva Prasad, K. Chandhram, Rajesh Myakala
Anurag University, Hyderabad, Telangana, India.
**Corresponding Author Email: 21eg107b28@anurag.edu.in*

Abstract: *Leveraging advanced technologies such as Machine Learning and Deep Learning, this research aims to transform agriculture. A machine learning recommendation model is proposed to assist farmers in selecting optimal crops and fertilizer strategies based on soil and weather conditions. By integrating location-specific data from third-party APIs, including weather and soil nutrient content, decision-making accuracy is enhanced. Additionally, a data-driven mathematical model for plant disease detection using deep learning techniques is proposed, achieving high precision and efficiency. This research provides farmers with tools to enhance crop yields, profitability, and land sustainability.*

Key words: *Agriculture, Machine Learning, Crop Recommendation, Deep Learning.*

1. INTRODUCTION

Agriculture stands as a vital pillar of our nation's economy, employing approximately 58 percent of the workforce and serving as a primary revenue source. Despite India's position as the world's second-largest producer of fruits and vegetables, crop losses remain a significant concern for farmers, as highlighted in the Ministry of Agriculture's annual report. To address these challenges and enhance productivity, modern agricultural techniques leveraging deep learning, machine learning, and data mining are being increasingly adopted. Central to agricultural productivity is soil health, which directly impacts crop yields. Informed crop selection based on soil analysis is essential to bolster agricultural output and improve farmers' economic stability. Fertilizer mismanagement also incurs substantial financial losses for farmers. Moreover, factors such as seasonal variations, environmental unpredictability, and soil fertility parameters further complicate crop selection decisions for farmers [1-5]. This research paper aims to propose a user-friendly recommender system tailored to assist farmers in making informed crop selection decisions based on soil characteristics and external environmental factors. By leveraging machine learning prediction models like Decision Trees and XG Boost Algorithm, the proposed system aims to optimize crop selection and fertilizer usage, thereby enhancing agricultural productivity to meet the growing food demand of the nation. Additionally, advancements in plant disease detection technologies are explored to aid farmers in diagnosing and mitigating crop illnesses effectively. Through this study, we seek to contribute to the enhancement of agricultural practices by leveraging innovative technologies and data-driven approaches for improved crop management and productivity [6-9].

2. BACKGROUND

Precision Agriculture: Precision agriculture refers to the use of technology and data analytics to optimize agricultural practices. Smart sensors, drones, and IoT devices enable real-time data collection, which is critical for decision-making in crop management and resource allocation [10]. Role of Deep Learning in Agriculture: Deep Learning models, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), are widely used in image recognition and time-series data analysis, making them suitable for agricultural applications [11-13].
For example:

- **Crop Selection:** DL models analyze soil quality, weather patterns, and market demand to recommend crops with the highest yield potential.
- **Fertilizer Recommendation:** Algorithms process soil nutrient data to suggest optimal fertilizer types and quantities, minimizing waste and environmental impact.
- **Disease Detection:** CNNs detect plant diseases by analyzing leaf images, enabling early intervention and reducing crop losses.

3. LITERATURE REVIEW

In the work" Crop Recommendation System and Plant Disease Classification using Machine Learning," [14] Chaudhary and colleagues present a brand-new method of agricultural management that makes use of machine learning approaches. The study suggests an integrated system that suggests appropriate crops based on soil properties and environmental factors, addressing the significant challenges farmers face in crop selection and disease diagnosis. The authors also investigate the application of machine learning algorithms for precise plant disease classification, with the goal of helping farmers detect and efficiently manage crop diseases. The study offers a thorough framework for maximizing agricultural practices and raising productivity by combining cutting-edge technologies. The researchers offer a novel method of crop recommendation using machine learning technologies in their paper," Smart Crop Recommendation System Using Machine Learning," [15] which was written by CH. RAJESH et al. This paper discusses the difficulties farmers face when choosing which crops are best suited for cultivation. In order to provide farmers with crop recommendations that are ideal, the suggested system makes use of machine learning algorithms to assess a variety of variables, including soil type, climate, and historical crop data. The goal of the research is to increase agricultural productivity by incorporating cutting-edge machine learning techniques and help farmers choose crops with confidence. The integrated system presented in the paper" Crop and Fertilizer Recommendation and Disease Diagnosis System Using Machine Learning," authored by TARANJEET SINGH et al. [16-18], uses machine learning to address important issues in agriculture. The system makes recommendations for crop choice and fertilizer use based on a number of variables, including nutrient levels, soil type, and climate. Furthermore, the system offers a mechanism for early detection and treatment of plant diseases through the use of machine learning techniques. The research seeks to improve agricultural productivity and reduce crop losses due to diseases and subpar practices by using this all-encompassing approach. The paper titled" Soil Analysis and Crop Recommendation Using Machine Learning," authored by Aditya Motswana et al. [19], introduces an innovative approach to agricultural decision-making. By leveraging machine learning techniques, the system performs soil analysis to assess key soil parameters. Based on the soil analysis results, the system recommends suitable crops for cultivation, taking into account factors such as soil type, moisture levels, and nutrient composition. This integrated solution aims to optimize crop selection processes, enhance agricultural productivity, and contribute to sustainable farming practices. In the paper" Efficient Crop Yield Recommendation System Using Machine Learning for Digital Farming," [20] Suresh and colleagues introduce a new method for crop yield optimization within the framework of digital farming. The authors offer a recommendation system based on machine learning that is intended to help farmers choose crops with knowledge. Through the examination of diverse agricultural factors like soil composition, weather patterns, and past crop production records, the system produces customized crop suggestions for individual farming situations. In the age of digital agriculture, this creative solution seeks to increase agricultural productivity, reduce risks, and support sustainable farming methods by integrating cutting-edge machine learning techniques. In the paper" Crop Recommendation using Machine Learning Approach," Pande et al. [7] present a framework based on machine learning for suggesting appropriate crops to farmers. The system makes customized crop recommendations by analyzing various agricultural factors like soil characteristics, climate, and geographic location. It does this by utilizing sophisticated algorithms and data analysis techniques. The strategy uses machine learning models to maximize agricultural productivity, help farmers make decisions, and promote sustainable farming methods. This study advances precision agriculture by providing a data-driven method to improve yield outcomes and crop selection. Priyadharshini et al.'s research paper," Intelligent Crop Recommendation System using Machine Learning," [8] presents a sophisticated method of crop recommendation that makes use of machine learning techniques. The system uses artificial intelligence to provide intelligent recommendations that are suited to particular agricultural contexts. It considers variables like soil composition, climate, and past crop performance data. The proposed system aims to provide farmers with actionable insights to optimize crop selection and increase overall agricultural productivity through the integration of advanced algorithms and data analysis. The present study advances the field of precision farming by providing a resilient and flexible crop recommendation system for a range of agricultural environments. Aryamol, Raji, and Sam Benjamin's survey paper,"

A Survey Paper on Crop Prediction Using Machine Learning," [10] offers a thorough summary of the use of machine learning methods in crop prediction. This paper investigates different approaches, algorithms, and datasets used in crop prediction research by a thorough review of the literature. The goal of the survey paper is to identify trends, obstacles, and opportunities in this field by combining insights from several studies. Additionally, it talks about how crop prediction powered by machine learning may affect farming methods, output, and sustainability. For researchers, practitioners, and policymakers interested in using machine learning for crop prediction and agricultural decision-making, this survey paper is a useful resource overall.

4. METHODOLOGY

In order to create a comprehensive dataset with crucial parameters like pH value, humidity, NPK levels, rainfall, and geographic state—all of which are crucial for crop and fertilizer recommendations—we aggregate data from various sources using our methodology. In order to prepare this data for analysis, the next step, known as data pre-processing, entails eliminating unnecessary attributes and handling missing values. In order to improve the performance of the machine learning model, feature engineering further improves this dataset by extracting meaningful features using domain knowledge. Our method uses an unlabeled testing set to assess the model's predictive power in addition to a labeled training set for model development. Accurate predictions depend heavily on the machine learning algorithms used, such as Gradient Boosting, XG Boost, and Decision Trees. These algorithms make recommendations for crops based on the properties of the soil, figure out the best fertilizer combination for the crop that has been identified, and identify plant diseases from pictures of leaves. Performance analysis is then used to evaluate the model's efficacy, with an emphasis on improving prediction accuracy and decision-making.

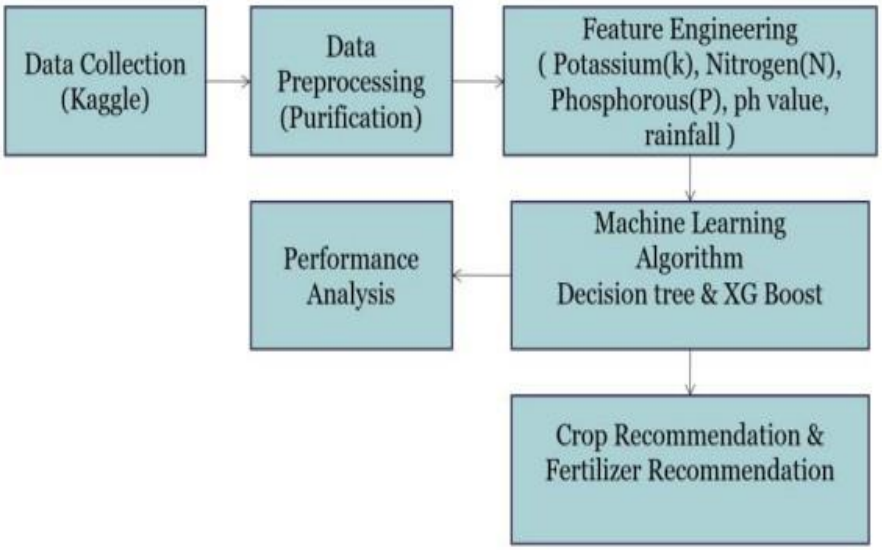

FIGURE 1. Data Flow Diagram for Crop & Fertilizer Recommendation

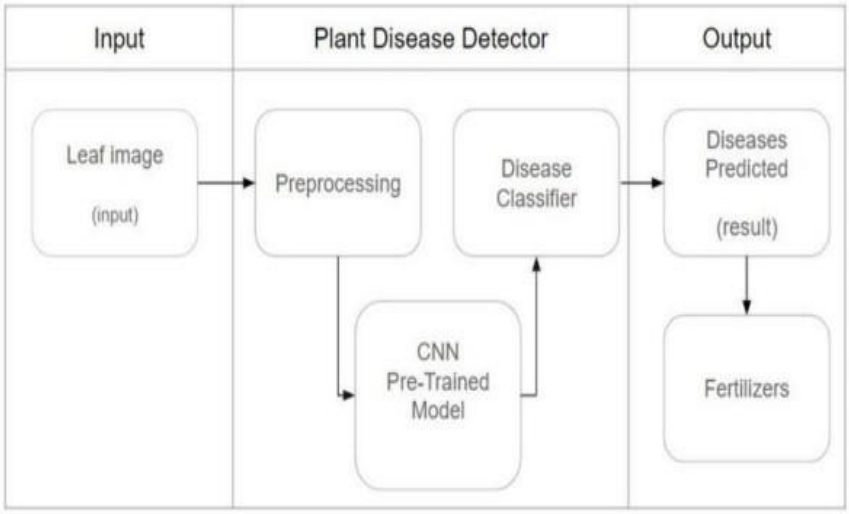

FIGURE 2. Data Flow Diagram for plant disease

The proposed model involves Crop Recommendation using Random Forest, Fertilizer Recommendation using Decision Tree and Plant Disease Detection using Convolutional Neural Network. A. Crop Recommendation The crop recommendation process begins with input parameters like soil contents (N, P, K), pH value, and rainfall, utilizing external datasets. After pre-processing this data, a Random Forest classifier is employed for model training. Various factors, including temperature, humidity, soil pH, and predicted rainfall, are considered for accurate crop prediction. These inputs can be manually entered or sourced from sensors.
Data fields

- N – ratio of Nitrogen content in soil
- P – ratio of Phosphorus content in soil
- K – ratio of Potassium content in soil
- PH – PH value of the soil
- Rainfall – Rainfall in mm

Random Forest: This supervised learning algorithm constructs a" forest" of decision trees via the" bagging" method, improving prediction accuracy through model ensemble. It achieves an accuracy of 89.09%.

Fertilizer Recommendation: Fertilizer data, along with crop and location specifics, are the basis for fertilizer recommendations. For real-time weather, temperature, humidity, atmospheric pressure, and other environmental data, this module makes use of third-party applications.
Decision Tree: Uses basic decision rules and training data to predict the class or value of the target variable. The 90% accuracy rate of this supervised learning algorithm is demonstrated.
Plant Disease Detection: Seasonal variations can affect crop profitability by exposing crops to diseases. Using photos of leaves, our model categorizes illnesses and recommends the right fertilizers for treatment.
Convolutional Neural Networks (CNNs): Designed specifically for image processing, CNNs automate the learning of hierarchical features from unprocessed images, and they achieve a comparative 74% accuracy rate in diagnosing diseases.

5. RESULT

The study presents a comprehensive framework integrating various machine learning algorithms for crop recommendation, fertilizer recommendation, and plant disease detection in agriculture. Through data collection, pre-processing, and feature engineering, models utilizing Decision Tree, XG Boost, Gradient Boosting, and Convolutional Neural Network techniques were developed. These models effectively recommended suitable crops based on soil characteristics, predicted fertilizer requirements, and identified plant diseases from leaf images with promising accuracies. The system architecture facilitated seamless integration of these components, providing farmers with user-

friendly recommendations to optimize crop yield and mitigate risks. Overall, the study demonstrates the potential of machine learning in enhancing agricultural decision-making and improving farm productivity.

6. FUTURE DIRECTION

The potential for innovation in smart farming remains vast. Future research should focus on:

- Developing lightweight DL models for resource-constrained environments.
- Enhancing dataset quality by integrating IoT data and crowdsourced inputs.
- Exploring explainable AI (XAI) techniques to make DL models more interpretable for end-users.
- Implementing real-time decision-support systems for adaptive farming practices.

By addressing these areas, researchers can further empower farmers and foster sustainable agriculture.

7. CONCLUSION

This study emphasizes how important technology breakthroughs are to transforming agriculture and giving farmers more power. Our proposed approach provides a comprehensive solution for crop selection and yield prediction by addressing the shortcomings of current systems. Farmers can maximize productivity and profitability by making well-informed decisions about crop cultivation and fertilizer application through the integration of machine learning algorithms and predictive analytics. The intuitive web application makes communication easy and gives farmers—experienced and inexperienced—the tools they need to maximize their farming methods. It is essential that these systems be improved and refined going forward in order to satisfy the changing demands of the agriculture industry. We can improve the lives of farmers all around the country, boost the Indian economy, and promote sustainable growth by wisely utilizing technology.

REFERENCES

[1]. Samir Sadok, Simon Leglaive, Renaud Séguier. "A Vector Quantized Masked Autoencoder for Speech Emotion Recognition." CentraleSupélec, IETR UMR CNRS 6164, France, 2023. [arXiv:2304.11117v1]

[2]. Chandrasekhara Reddy, T., Sirisha, G., Reddy, A.M. Smart Healthcare Analysis and Therapy for Voice Disorder using Cloud and Edge Computing, Proceedings of the 4th International Conference on Applied and Theoretical Computing and Communication Technology, iCATccT 2018, 2018, pp. 103–106, 9001280

[3]. Chandrasekhara Reddy, T., Srivani, V., Mallikarjuna Reddy, A., Vishnu Murthy, G. Test case optimization and prioritization using improved cuckoo search and particle swarm optimization algorithm, International Journal of Engineering and Technology(UAE), 2018, 7(4.6 Special Issue 6), pp. 275–278

[4]. Dayaker, P., Chandrasekhara Reddy, T., Honey Diana, P., Mallikarjun Reddy, A. Recent trends in security and privacy of sensitive data in cloud computing, International Journal of Engineering and Technology(UAE), 2018, 7(4.6 Special Issue 6), pp. 241–245

[5]. Mallikarjuna Reddy, A., Venkata Krishna, V., Sumalatha, L. Face recognition approaches: A survey, International Journal of Engineering and Technology(UAE), 2018, 7(4.6 Special Issue 6), pp. 117–121

[6]. Obulesh, A., Vamshi Krishna, P., Mallikarjuna Reddy, A. Classification of lung patterns based on transition neighborhood pattern (TNP), Journal of Advanced Research in Dynamical and Control Systems, 2018, 10(15), pp. 35–41

[7]. Manoranjan Dash, N.D. Londhe, S. Ghosh, et al., "Hybrid Seeker Optimization Algorithm-based Accurate Image Clustering for Automatic Psoriasis Lesion Detection", Artificial Intelligence for Healthcare (Taylor & Francis), 2022, ISBN: 9781003241409

[8]. Manoranjan Dash, Design of Finite Impulse Response Filters Using Evolutionary Techniques - An Efficient Computation, ICTACT Journal on Communication Technology, March 2020, Volume: 11, Issue: 01

[9]. Manoranjan Dash, "Modified VGG-16 model for COVID-19 chest X-ray images: optimal binary severity assessment," International Journal of Data Mining and Bioinformatics, vol. 1, no. 1, Jan. 2025, doi: 10.1504/ijdmb.2025.10065665.

[10]. Manoranjan Dash et al.," Effective Automated Medical Image Segmentation Using Hybrid Computational Intelligence Technique", Blockchain and IoT Based Smart Healthcare Systems, Bentham Science Publishers, Pp. 174-182,2024

[11]. Manoranjan Dash et al.," Detection of Psychological Stability Status Using Machine Learning Algorithms", International Conference on Intelligent Systems and Machine Learning, Springer Nature Switzerland, Pp.44-51, 2022.

[12]. Samriya, J. K., Chakraborty, C., Sharma, A., Kumar, M., & Ramakuri, S. K. (2023). Adversarial ML-based secured cloud architecture for consumer Internet of Things of smart healthcare. IEEE Transactions on Consumer Electronics, 70(1), 2058-2065.

[13]. Ramakuri, S. K., Prasad, M., Sathiyanarayanan, M., Harika, K., Rohit, K., & Jaina, G. (2025). 6 Smart Paralysis. Smart Devices for Medical 4.0 Technologies, 112.

[14]. Kumar, R.S., Nalamachu, A., Burhan, S.W., Reddy, V.S. (2024). A Considerative Analysis of the Current Classification and Application Trends of Brain–Computer Interface. In: Kumar Jain, P., Nath Singh, Y., Gollapalli, R.P., Singh, S.P. (eds) Advances in Signal Processing and Communication Engineering. ICASPACE 2023. Lecture Notes in Electrical Engineering, vol 1157. Springer, Singapore. https://doi.org/10.1007/978-981-97-0562-7_46.

[15]. R. S. Kumar, K. K. Srinivas, A. Peddi and P. A. H. Vardhini, "Artificial Intelligence based Human Attention Detection through Brain Computer Interface for Health Care Monitoring," *2021 IEEE International Conference on Biomedical Engineering, Computer and Information Technology for Health (BECITHCON)*, Dhaka, Bangladesh, 2021, pp. 42-45, doi: 10.1109/BECITHCON54710.2021.9893646.

[16]. Vytla, V., Ramakuri, S. K., Peddi, A., Srinivas, K. K., & Ragav, N. N. (2021, February). Mathematical models for predicting COVID-19 pandemic: a review. In Journal of Physics: Conference Series (Vol. 1797, No. 1, p. 012009). IOP Publishing.

[17]. S. K. Ramakuri, C. Chakraborty, S. Ghosh and B. Gupta, "Performance analysis of eye-state charecterization through single electrode EEG device for medical application," *2017 Global Wireless Summit (GWS)*, Cape Town, South Africa, 2017, pp. 1-6, doi:10.1109/GWS.2017.8300494.

[18]. Gogu S, Sathe S (2022) autofpr: an efficient automatic approach for facial paralysis recognition using facial features. Int J Artif Intell Tools. https://doi.org/10.1142/S0218213023400055

[19]. Rao, N.K., and G. S. Reddy. "Discovery of Preliminary Centroids Using Improved K-Means Clustering Algorithm", International Journal of Computer Science and Information Technologies, Vol. 3 (3), 2012, 4558-4561.

[20]. Gogu, S. R., & Sathe, S. R. (2024). Ensemble stacking for grading facial paralysis through statistical analysis of facial features.