OPEN ACCESS

Volume: 13

Special Issue: 2

Month: January

Year: 2026

E-ISSN: 2582-0397

P-ISSN: 2321-788X

Citation:
Priyadharshini, R., and M. Srisankar. "AgroGuardian: An Intelligent Web-Based System for Crop Recommendation and Plant Disease Detection Using Machine Learning and CNN." *Shanlax International Journal of Arts, Science and Humanities*, vol. 13, no. 2, 2026, pp. 169–75.

DOI:
https://doi.org/10.34293/sijash.v13iS2-Jan.10599

AgroGuardian: An Intelligent Web-Based System for Crop Recommendation and Plant Disease Detection Using Machine Learning and CNN

Ms. R. Priyadharshini
Assistant Professor, Department of Computer Science (AI & DS)
KG College of Arts and Science, Coimbatore, Tamil Nadu, India

Dr. M. Srisankar
Assistant Professor, Department of Computer Science (Cyber Security)
KG College of Arts and Science, Coimbatore, Tamil Nadu, India

Abstract
Agriculture plays a crucial role in the development of many countries, particularly India, where it provides employment to millions of people. However, farmers continue to face challenges such as unpredictable climate conditions, soil degradation, and crop diseases. To address these problems, this paper presents AgroGuardian, an intelligent web-based system designed to assist farmers with real-time crop recommendations and plant disease detection. The system uses multiple environmental parameters such as soil nutrients (N, P, K), pH, temperature, humidity, and rainfall to recommend suitable crops for cultivation. Several machine learning models—Decision Tree, Naïve Bayes, Support Vector Machine (SVM), Logistic Regression, Random Forest, XG Boost, and K-Nearest Neighbors (KNN)—were trained and evaluated. Among these, the Random Forest model achieved the highest accuracy, making it the most suitable for crop prediction. In addition, a Convolutional Neural Network (CNN) model was developed for automatic plant disease detection from leaf images. This feature enables early identification and prevention of crop losses. The integration of both modules within a single Streamlit web application provides a user-friendly interface for farmers. By combining AI-based crop recommendation and disease detection, AgroGuardian contributes to sustainable farming, better decision-making, and improved agricultural productivity.
Keywords: Machine Learning, Crop Recommendation, Convolutional Neural Network, Weather Forecasting, Plant Disease Detection

Introduction

The agricultural sector has benefited significantly due to the substantial progress made in ML and AI technology. Efficient tools designed for agricultural professionals were developed through integrating statistical analysis techniques with forecasting algorithms. Recognising plant ailments and suggesting advanced crop varieties now play crucial roles in enhancing agricultural productivity. By analysing soil properties, weather information, and ecological conditions through ML algorithms, agricultural systems assist growers in choosing optimal plant varieties for current cultivation practices.

The research objectives regarding crop recommendation, weather prediction, and plant disease detection are as follows. The crop recommendation system seeks to select the best crops for particular areas by using nutrient data, weather patterns, and soil characteristics, guaranteeing increased yield, economical resource use, and sustainable farming methods. The weather prediction model relies on sophisticated machine learning algorithms to evaluate past climatic and environmental data, providing precise real-time forecasts that help farmers with crop planning, irrigation scheduling, and risk management. The plant disease detection system uses artificial intelligence and image processing techniques to detect early indications of crop diseases, allowing for prompt treatment, reducing losses, and enhancing overall agricultural quality and productivity.

This research focuses on the creation and implementation of AgroGuardian, a Python-based web platform that employs a CNN-based image classifier to identify plant diseases and a range of machine learning classification methods to recommend crops. The system collects inputs such as temperature, humidity, rainfall, pH level, and the makeup of soil nutrients (N, P, and K) in order to recommend the best crops. A separate feature allows users to enter crop-leaf photographs to assist farmers in taking action before major losses occur. These pictures are used by the CNN model to identify the type and existence of illness. The web interface was made with Streamlit, which ensures that even non-technical people can use it easily and that it is responsive. The paper is organised as follows: Section II covers relevant literature; Section III outlines the suggested methodology; Section IV presents findings; Section V outlines applications; Section VI discusses limitations and challenges; and Section VII concludes with the AgroGuardian framework's future direction.

Literature Survey

Our attitude to agriculture has radically changed because of the development of smart farming technologies. These developments provide new ways to increase crop yields, improve utilisation of resources, and successfully combat plant illnesses. By preventing the spread of illness and reducing crop losses, early diagnosis enables farmers to take prompt action [11]. Pudumalar et al. suggested that, for crop recommendations, precision agriculture increases production through an ensemble model that is highly accurate and efficient [6].

A. Machine Learning Algorithms

Agriculture has seen a true transformation with the introduction of machine learning, which provides cutting-edge crop management and prediction tools. This section examines the different machine learning technologies that have been effectively applied to forecast crop yields and identify the best crops to grow, increasing agricultural sustainability and production [1][10].

Decision Trees

A fundamental class of machine learning algorithms, decision trees are well-known for their efficiency in problems involving regression and classification [3]. Decision trees are useful tools in crop prediction because they can represent the relationship between many environmental and soil parameters and the potential yield of various crops. Decision trees simplify the comprehension and presentation of the decision-making process by dividing the data into subsets according to input features such as temperature, moisture content, and soil pH. They are quite helpful for farmers and agronomists looking for practical insights because of their simplicity.

Convolutional Neural Networks (CNN)

The structure of the human brain's visual cortex serves as the model for Convolutional Neural Networks (CNNs), a particular type of neural network designed to analyse organised grid data, such as photographs, by working with pixels. According to Pathania, Nahita, et al., CNNs are widely used to detect plant diseases in the agriculture sector and may be trained to recognise patterns in crop images that indicate a variety of illnesses, enabling quick and accurate diagnosis. CNNs are very helpful for this since they can automatically extract relevant information from pictures. They are therefore perfect for evaluating plant photos taken in the field or using remote sensing equipment [2].

Random Forest

Random forests use an ensemble learning technique by mixing several decision trees, building on the ideas of decision trees. By combining the predictions of many trees, this technique improves predictive accuracy and reduces overfitting. Random forests are excellent at managing big datasets with lots of input variables, which are typical in agricultural datasets that include a range of variables affecting crop health and growth. Random forests greatly improve crop yield estimates by producing more accurate and dependable predictions by lowering model variance [1]. K. Muthusannan along with associates classified leaves based on diseased leaf classification algorithms using machine learning techniques to identify leaf spot diseases. Plant leaves with disease were recognised by utilising FFNN (Feed Forward Neural Network), RBFN (Radial Basis Function Networks), and LVQ (Learning Vector Quantization) to analyse the shape and texture info obtained from the affected leaf picture. The simulation proved that the recommended system works well [9].

System Architecture

In the realm of web-based smart crop recommendation systems, optimising the performance and user experience of these platforms is paramount for their effective utilisation by farmers and agricultural stakeholders [18]. This optimisation involves several key strategies. Ensuring responsive design is crucial to enable seamless access to the application across various devices, including desktop computers, tablets, and smartphones. Additionally, prioritising fast loading times enhances user engagement and satisfaction, particularly for farmers in remote areas with limited internet connectivity. Lastly, integrating external data sources, such as weather forecasts, enriches the system with comprehensive and up-to-date information to support informed decision-making.

User Input: The system accepts three types of user input: Soil Details Input, City Input for Climate, and Disease Image Input. For soil details, users provide information about the soil including its pH, moisture content, and amounts of potassium, phosphate, and nitrogen—these specifics aid in determining the ideal crop match and soil fertility. For climate, real-time weather data is retrieved via APIs when the user inputs the name of the city or region, guaranteeing that forecasts consider regional climate variances. For disease detection, crop photos illustrating possible disease symptoms are uploaded by the user, and the illness detection module analyses these photos to find diseases and suggest protection.

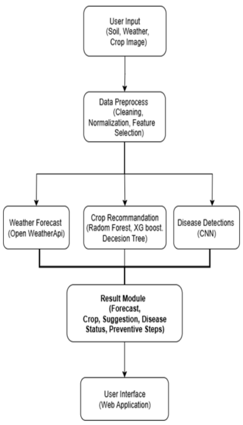

Figure 1 System Architecture

Data Processing: The data preparation module cleans and converts the gathered information into formats that can be used for analysis. It guarantees consistency and accuracy for the models that follow. Cleaning involves removing missing or unnecessary data values to preserve dataset quality. Normalisation scales the data into a standard range, increasing the accuracy and efficiency of the model. Feature selection enhances model performance and lowers computational costs by selecting the most pertinent features, such as temperature or soil nutrients, that have a significant impact on prediction results.

A. Main Pipeline

The main pipeline of the project consists of three components: Weather Forecast, Crop Recommendation, and Disease Detection.

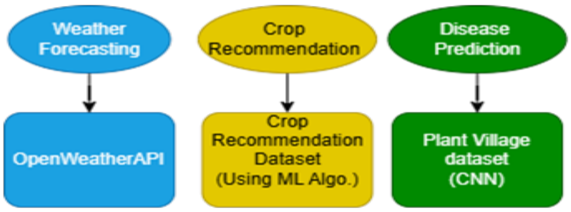

Figure 2 Main Pipeline of Architecture

Weather Forecast: To give precise and up-to-date weather forecasts, the weather forecast module incorporates information from the OpenWeather API. According to Dewi C. et al., it aids farmers in scheduling harvesting, fertiliser application, and irrigation [8]. This module makes sure that the suggested measures are in line with the current and future climatic circumstances by using meteorological data like temperature, humidity, and rainfall likelihood, thereby lowering risk and improving crop health.

Crop Recommendation: The crop suggestion module uses machine learning methods such as Random Forest, XGBoost, and Decision Tree to forecast the optimum crop for a given soil and weather scenario. These algorithms analyse multidimensional input data, identify hidden trends, and select crops that maximise profitability and yield. The collective method ensures that suggestions are highly accurate and reliable by integrating the strengths of numerous models [1].

Disease Detection: Convolutional Neural Networks (CNN) are used in this module to identify plant illnesses in crop photos that have been uploaded. CNN models automatically extract characteristics from leaves, such as colour, texture, and form patterns, to identify the type of illness. By enabling farmers to take prompt preventive or curative measures, the module reduces crop loss and improves quality by detecting illnesses like rust or blight early [1][2].

Analysis

India’s agriculture confronts several difficulties because of the country’s erratic climate, which has a negative influence on crop quality and productivity. Farmers now face financial instability because of the disruption of the traditional farming cycle caused by sudden temperature fluctuations, unpredictable rainfall, droughts, and floods [7][9]. Numerous crop diseases, including Bacterial Blight, Late Blight, Stem Rust, and Blast Disease, can quickly decimate substantial areas of crops due to the unpredictability of these weather patterns. Researchers have found that delayed disease identification and poor crop management result from a lack of real-time data on rainfall, humidity, and soil conditions [15][20][21].

K. Raghuvanshi et al. openly discussed the three major issues with Indian agriculture: inadequate disease monitoring systems in rural areas, low awareness of contemporary agricultural technologies, and restricted access to weather forecasting tools [20].

Using AI-based models, sophisticated mobile and web applications are being created to address these issues by offering early illness prediction, soil health monitoring, and weather notifications. According to Gupta, Nitika, et al., in order to provide fertilisers, irrigation schedules, and preventive actions, these programs examine soil factors, climatic data, and images of sick plants. Such technological integration provides farmers and researchers with an easy-to-use digital solution while reducing losses, increasing production, and promoting sustainable farming practices [16][17][23].

Major FindingsTable 1 Segment Categories

After examining a number of agricultural studies and recent study reports, the main problems and obstacles that India's agricultural industry is currently facing as a result of crop diseases and unpredictable weather were determined [2][4]. The results highlight the urgent need for sophisticated technology that assists farmers with weather forecasting, crop monitoring, and disease outbreak prevention. The primary findings are as follows.**Table 1 Segment Categories**

- **Unpredictable Weather Patterns:** Abrupt changes in the climate, such as droughts, floods, and erratic rainfall, have a significant impact on crop productivity [20]. Farmers' frequent incapacity to create precise short- and long-term weather forecasts leads to poor crop management and resource loss [21].
- **Crop Disease Outbreaks:** Under ideal climatic circumstances, diseases like bacterial spot, black rot, stem rust, and scab—which are widespread on fruit leaves like apples and grapes—have been shown to spread quickly, destroying significant crops and costing farmers money [24][23].
- **Soil Degradation and Nutrient Imbalance:** Due to continuous cropping without a sufficient evaluation of the soil's health, fertility levels have dropped [22]. Nutrient imbalances and a lack of real-time soil analysis lead to lower yields and sick crops.
- **Limited Access to Information:** Many farmers, especially those in remote areas, find it difficult to obtain timely information about pest infestations, weather alerts, and soil conditions. It is more difficult to make timely decisions about crop protection and planning when one lacks knowledge [16].
- **Lack of Disease Prediction Mechanisms:** Conventional farming methods mainly rely on experience rather than insights from data. Ineffective treatment approaches and delayed reactions result from the lack of early disease detection technologies [19].
- **Research Gaps in Localised Forecasting:** The majority of prediction models now in use do not account for regional climate changes [1][13]. This makes them less reliable for region-specific agricultural practices.

The study highlights that a data-driven mobile or web-based system can act as a vital bridge between farmers and technology. Such an application could provide real-time weather forecasting, soil condition updates, and disease identification assistance, ultimately reducing uncertainty, minimising losses, and ensuring better productivity across diverse agricultural regions of India [7][9][15][20][23].

Conclusion

The study concludes that the main factors restricting India's agricultural output are still crop diseases and unpredictable weather patterns. Frequent temperature fluctuations, unpredictable rainfall, droughts, and floods not only reduce output but also encourage the spread of disease outbreaks that damage crops and negatively impact farmer livelihoods. These issues are made worse in the absence of accurate weather forecasts, information on soil quality, and early disease detection methods.

Researchers stress the value of using contemporary analytical and digital tools to give farmers data-driven, real-time advice. By providing crop disease alerts, weather forecasts, and soil monitoring, intelligent mobile and web-based solutions can assist farmers in making informed decisions. Through the integration of technology and conventional farming methods, these systems encourage sustainability, minimise losses, and boost output. In summary, using data analytics and predictive modelling to address agricultural difficulties is an essential first step in guaranteeing food security and assisting India's farming community in the face of environmental instability.

References

1. Diwakar, R., et al. Smart crop recommendation system with plant disease identification. In 2024 International Conference on Electrical Electronics and Computing Technologies (ICEECT), 1. IEEE, 2024.
2. Pathania, N., et al. Advancing crop disease detection: Harnessing deep convolutional neural networks and transfer learning. (November 27, 2024).
3. Kar, A., Nath, N., Kemprai, U., & Aman. Performance analysis of support vector machine (SVM) on challenging datasets for forest fire detection. International Journal of Communications, Network and System Sciences, 17(2), 11–29, Feb. 2024.
4. Shripathi Rao, M., Singh, A., Subba Reddy, N. V., & Acharya, D. U. Crop prediction using machine learning. Journal of Physics: Conference Series, 2161(1), p. 012033, Jan. 2022.
5. Kamatchi, S., Bangaru, B., & Parvathi, R. Improvement of crop production using recommender system by weather forecasts. Procedia Computer Science, 165 (2019): 724–732.
6. Pudumalar, S., Ramanujam, E., Rajashree, R. H., Kavya, C., Kiruthika, T., & Nisha, J. Crop recommendation system for precision agriculture. In 2016 Eighth International Conference on Advanced Computing (ICoAC) (pp. 32–36). IEEE, 2017.
7. Gosai, D., et al. Crop recommendation system using machine learning. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 7.3 (2021): 558–569.
8. Dewi, C., & Chen, R. C. Integrating real-time weather forecasts data using OpenWeatherMap and Twitter. International Journal of Information Technology and Business, 1.2 (2019): 48–52.
9. Muthusannan, K., Latha, P., Pon Selvi, R., & Nisha, P. Diseased plant leaves using neural network algorithms. ARPN Journal of Engineering and Applied Sciences, 10(4), March 2015.
10. Pande, S. M., Ramesh, P. K., Anmol, A., Aishwarya, B. R., Rohilla, K., & Shaurya, K. Crop recommender system using machine learning approach. In 2021 5th International Conference on Computing Methodologies and Communication (ICCMC), Apr. 2021.
11. Raju, C., Adv., & Adi P. B. V. CropCast: Harvesting the future with interfused machine learning and advanced stacking ensemble for precise crop prediction. Kuwait Journal of Science, p. 100160, Dec. 2023.
12. Chauhan, P., Mandoria, H. L., Negi, A., & Rajput, R. S. Plant diseases concept in smart agriculture using deep learning. Advances in Environmental Engineering and Green Technologies, pp. 139–153, Oct. 2020.
13. Medar, R., Rajpurohit, V. S., & Shweta, S. Crop yield prediction using machine learning techniques. In 2019 IEEE 5th International Conference for Convergence in Technology (I2CT), pp. 1–5. IEEE, 2019.
14. Garanayak, M., Sahu, G., Mohanty, S. N., & Jagadev, A. K. Agricultural recommendation system for crops using different machine learning regression methods. International Journal of Agricultural and Environmental Information Systems (IJAEIS), 12(1) (2021): 1–20.
15. Chaube, H. S., & Pundhir, V. S. Crop diseases and their management. PHI Learning Pvt. Ltd., 2005.
16. Gandhi, P. B., & Parejiya, A. The power of AI in addressing the challenges faced by Indian farmers in the agriculture sector: An analysis. Journal of Northeastern University, 43.1 (2022): 14–48.
17. Kumar, R., et al. Artificial intelligence: New technology to improve Indian agriculture. International Journal of Chemical Studies, 8.2 (2020): 2999–3005.
18. Sine, M., Theo-Paul, H., & Emeric, E. API-AGRO: An open data and open API platform to promote interoperability standards for Farm Services and Ag Web Applications. Journal of Agricultural Informatics, 6.4 (2015).

19. De Wolf, E. D., & Isard, S. A. Disease cycle approach to plant disease prediction. Annual Review of Phytopathology, 45.1 (2007): 203–220.
20. Raghuvanshi, K. The problems of agriculture in the Indian context. International Journal of Computer Science & Management Studies, 14.3 (2014).
21. Krishna Kumar, K., Kumar, R. K., Ashrit, R. G., Deshpande, N. R., & Hansen, J. W. Climate impacts on Indian agriculture. International Journal of Climatology, 24(11) (2004): 1375–1393.
22. Tahat, M. M., et al. Soil health and sustainable agriculture. Sustainability, 12.12 (2020): 4859.
23. Gupta, N., et al. Role of nutrients in controlling the plant diseases in sustainable agriculture. In Agriculturally Important Microbes for Sustainable Agriculture: Volume 2. Springer Singapore, 2017: 217–262.
24. Miller, P. R., & O'Brien, M. J. Prediction of plant disease epidemics. Annual Reviews in Microbiology, 11.1 (1957): 77–110.