INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ORIGINAL ARTICLE

An Intelligent Information System for Plant Disease Detection using Machine Learning and Image Processing

Asim Seedahmed Ali Osman[1]*, **Syeda Hijjab Zahra**[2], **Aeshah Alotaibi**[1]

1 College of Computer Science & Engineering, University of Hafr Al Batin, Saudi Arabia
2 Department of Computer Science and IT, The University of Lahore, Lahore, 54000, Pakistan
3 Department of Computer Science, College of Computer and Information Sciences, Jouf University, Sakakah 72311, Saudi Arabia

OPEN ACCESS

Received: 30/10/2025

Accepted: 17/11/2025

Published: 07/12/2025

Citation: Osman ASA, Zahra SH, Alotaibi A (2025) An Intelligent Information System for Plant Disease Detection using Machine Learning and Image Processing. Indian Journal of Science and Technology 18(45): 3582-3594. https://doi.org/10.17485/IJST/v18i45.1777

* **Corresponding author**.

aalageed@uhb.edu.sa; dr.asimalageed@gmail.com

Funding: None

Competing Interests: None

Published By Indian Society for Education and Environment (iSee)

ISSN
Print: 0974-6846
Electronic: 0974-5645

Abstract

Objectives: This article focuses on designing and developing an AI-based plant disease identification system using machine learning and image processing techniques to identify crop diseases and health from images of the leaf. The main objectives include developing a real-time automated investigation tool reachable to farmers, creating datasets of both healthy and disease plant images, designing an easy-to-use interface of the application comparing existing solutions. Methods: This study observed mixed-method approach as research methodology. The method merged with qualitative feedback and quantitative surveys. The data set contains images of healthy and infected plant leaves gathered from multiple crops to train the machine learning models for classification. The experiment used image preprocessing and feature extraction for better accuracy, and performance parameters like response time and usability were assessed. The model's performance was compared with present gold-standard Pashu Poshan, apps—Plantix and Leaf Doctor—aiming on localization, prediction capability and response time. The usability tests were applied to 80 stakeholders, consisting of farmers of both small and medium scale. Findings: Proposed system got an accuracy rate approximately 90% in plant disease detection, average response time of less than one minute, surpassing other available systems that required time of 20–60 seconds for some elementary or basic recognition. The user assessment provides a usability score of 4.5 out of 5, where nearly 87% of participants valued the software as easy to use. As most rural areas face limited internet connection, the system's offline feature offered significant advantages. Novelty: Unlike other systems with general disease identification and poor interfaces, the proposed system, integrated with voice commands, disseminates real-time localized treatment guidance projecting prediction based on weather circumstances. It also joins NGOs and local agricultural teams giving extended support such as funding and crop insurance. This wide-ranging integration of intelligent automation, approachability and user adaptation makes Plant Guard a valuable and novel solution for technology enabled agriculture.

Keywords: Machine Learning; Plant disease detection; Image processing; Smart agriculture; Crop disease identification

1 Introduction

Agriculture is the primary source of income for rural people. It is one of the most important economic sectors in emerging nations. Majority of Gross Domestic Product (GDP) in several emerging nations comes from agriculture[1]. However, the contribution of agricultural goods is greatly impacted by losses brought by pests and crop diseases. From a financial point of view, plant diseases have an annual impact on the global economy of about US$220 billion. The agricultural research report shows that pests and diseases cause majority of agricultural output to be harmed each year[2]. Thus, an alarming increase in the number of pests and illnesses threatens food security. Accurate plant disease detection is still a crucial process for agricultural sector[3]. Preventing these diseases is fundamental in agricultural growth, but most solo farmers and small-to-medium scale farmers do not have the luxuries where they can afford to hire several experts to gain consultation or focus on manual inspection, being costly and time-consuming. Delaying advice leads to widespread crop devastation and a larger financial disadvantage for the farmer.

AI and machine learning have risen to the top in recent years because they have improved the efficiency of various industries, including agriculture. According to AI's strong integration with modern planting systems, automated plant disease detection systems may now address several long-standing challenges in crop health management. Such technologies can quickly and easily diagnose diseases by using cameras to take pictures of sick leaves. Farmers with limited resources do not need advanced technologies; these steps are perfect.

This paper seeks to design and implement an automated plant disease detection system that uses AI and image processing techniques to detect the plant and recommends the solution for the observed disease. The intended purpose of the system is to solve the challenges that farmers face in agriculture and boost the efficiency of agriculture by ensuring that time is not wasted.

This study has specific objectives that include determining optimal solutions using machine learning algorithms in the field of the target disease detection, creating a balanced plant image dataset, and creating an appropriate interface for the target users, farmers. Addressing gaps in existing solutions, this research aims to affirmatively answer the question of where the gap between technology and agriculture is and how it is possible to develop a more efficient and sustainable agricultural system.

Agriculture continues to be one of the main sectors for global food security, but it is faced with perennial threats of crop diseases which in turn lowers production levels, and income for farmers. Throughout the years, numerous applications for detection of various agricultural diseases have been created. They all have advantages and disadvantages, which makes the overall potential of these applications for different farming communities very limited.

There exist several applications or solutions, but they have some limitations. Table 1 shows a comparison and highlights the limitations as well.

Plantix[4] was launched in 2015 and can perform only basic disease recognition, lacking other features such as multilingual interface and disease prediction planning. Its interface is static with no adjustment settings, while the treatment plan for agriculture is generic and not specific to the area, making it less useful to farmers in different agricultural zones. Furthermore, it requires a persistent online connection which makes it less useful for customers in rural areas with limited network accessibility.

The agricultural app[5] started in 2017, which allows for partial multilingual support and includes some features as well, however, as for the time it takes to respond it is too long when one is making life influencing decisions in agriculture. It indeed is an offline application and offers basic treatment principles, but the recommendations made are only partially available, in the sense that they do not fully pertain to the local agricultural practices. It does not provide real-time forecasts for the disease and has no connection with the existing local agricultural networks like in the case of Plantix.

The Leaf doctor app[6], which was launched in 2015, brings in some level of value by providing response times between 25 to 60 seconds with some setting options at a more reasonable time. However, use of this app is mostly only useful to farmers who speak English. Like most other apps, treatments are not recommended, and the app has no such feature which would allow the farmers to forecast a disease before it occurs or use voice commands to search for information within the app.

Plant Guard[7] contains features that increase its effectiveness and use. It has a displayed disease forecast based on weather patterns, a completely changeable user interface with themes, and multilingual compatibility. It also connects to regional banks, non-governmental organizations, and agricultural networks. ensure that farmers will have access to resources like cash, crop insurance, or farming materials. Plant Guard seeks to serve as a one-stop resource for disease management and diagnosis by bridging the gap between the available choices. Table 1 provides comparison of market competitors. There are more studies related to the plant disease detection and their importance for community[8],[9],[10],[11],[12],[13] and use of AI in different domains[14],[15],[16].

Numerous mobile-based applications have been implemented for plant disease detection, including **Leaf Doctor and Plantix**, **Pashu Poshan**, yet each have some notable limitations that control their effectiveness in the agricultural contexts. The **Pashu Poshan app** offered in 2017 provides partial bilingual support but faces generic treatment recommendations, long response times and no integration with local agricultural organizations. It also limits its decision-making utility for small-

Table 1. Comparison of Existing Work

Sr	Features	Plantix App [4]	Pashu Poshan App [5]	Leaf Doctor [6]	Plant Guard [7]
1.	Introduced	2015	2017	2015	2024
2.	Customization	Static interfaces with no personalization options	Offer some degree of customizable options	Static interfaces with no personalization options	Offers themes and customizable settings
3.	Response Time	20 to 50 seconds	Too long	25 to 60 seconds	10 to 15 seconds
4.	Multilingual Support	Limited language options	Supports multiple languages	Primarily supports English	Supports multiple languages
5.	Treatment Recommendation	Recommendations not tailored to local conditions	Recommendations not tailored to local conditions	No treatment recommendation	Custom recommendations based on local data
6.	Real-Time Disease Forecasting	No	No	No	Predictive forecasting based on weather patterns
7.	Integration with Local Agricultural Networks	No	No	No	Integrated NGOs and banks, offering additional resources such as funding for disease management, crop insurance, or access to agricultural supplies
8.	Offline function	Requires constant internet			Allows offline use
9.	Voice Command	None of these applications natively support voice commands			Allows voice command

scale farmers. The **Plantix app**, launched in 2015, makes only very basic level disease identification and absence of important features like localized handling recommendations, predictive disease forecasting, and bilingual interfaces making it less useful for farmers working in varied linguistic. Moreover, it's it required continues internet that is not available in rural areas. Similarly, **Leaf Doctor**, though useful in evaluating disease severity, is fundamentally tailored for English-speaking users and absences any form of treatment advisory, remarkably narrowing its usability. Together, these systems emphasis on single-function disease detection rather than supporting comprehensive decision-support frameworks that deliver the practical needs of farmers. On the other hand, the proposed **Plant Guard** system deals with these limitations through an AI-based, image-processing-based framework accomplished of real-time diagnosis, context-aware handling recommendations, voice-command and multilingual support, and prognostic disease forecasting integrated with weather data. Furthermore, its integration with local agricultural systems, NGOs, banks and offline operability make it a more accessible, inclusive and scalable solution for enhancing crop health management and linking the persistent gap between innovative technology and grassroots agriculture.

2 Methodology

This study used mixed method approach [17]. Objective of this study was to develop a finalized version of GUI for automated plant disease detectors. We made a questionnaire. Questionnaire consists of three sections, these sections are demographics, fixed questions, and open-ended questions. The responses from 80 respondents were collected. This quantitative and qualitative paradigm is integrated by taking insights from farmers' feedback, which is used to assess the performance of. machine learning models. For instance, qualitative analysis includes stakeholders' surveys to evaluate usability of the system in practicality and design specifications. All these together provide an end-to-end solution that is efficient and ergonomic. Figure 1 shows the adopted workflow.

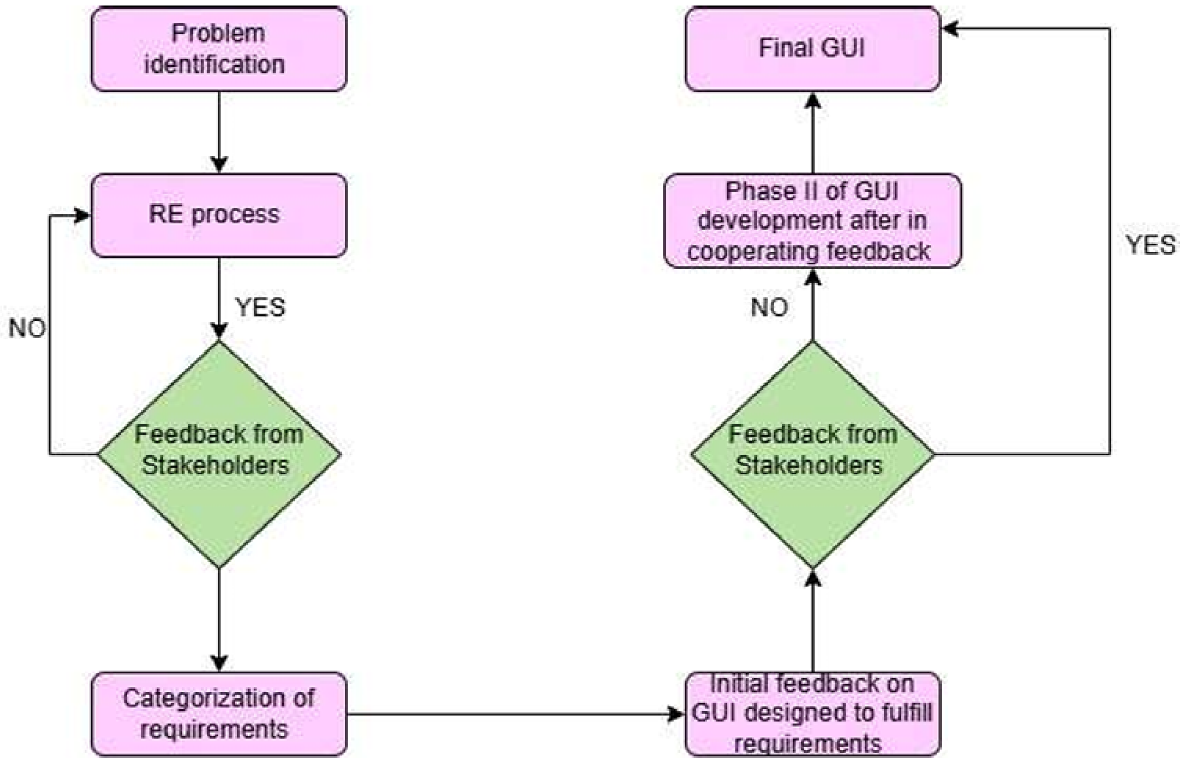

Fig 1. Methodology

3 Result and discussion

Usability tests were conducted with 80 stakeholders, which gave a rating of 4.5 out of 5. It offers offline capabilities making it suitable for use in areas without a reliable internet connection and features voice commands for hands free use. Nonetheless, the narrow spectrum of the training database limits the efficiency and metric applicability to all crop varieties and atmosphere situations. Future work will include the extension of the data set, implementation of IoT for real-time data collection, and an increase in scalability to include more crops and environmental factors.

Table 2 shows the details like Demographic Survey and Age group. Table 3 gives the details about survey questions.

Table 4 shows the open-ended questions. It shows that majority questions were related to design improvement.

When users enter their details and hit the Sign-Up button, they are registered. Figure 2 illustrates the app's Sign-up Screen, which is the main hub for users. Figure 3 for Home Screen.

The top features an Information Bar for instant details about crops. Farmers can use this feature to search for information about different crops for growing tips, pest species, and diseases. The Diagnosis Feature enables farmers to capture images of their plants from the home screen. This functionality assesses the image and gives instant suggestions to cure any detected diseases or pests. Additionally, the home screen includes a Settings button, which lets users access the app's settings to adjust notifications, or other app features. Figure 4 presents the app's Diagnosis Page that shows the results after users take a photo of the plant.

By simply seeing the name and description of the spotted disease, it's easier for farmers to detect the disease harming the crops. Underneath the diagnosis, the application displays what the treatment is, clarifying solutions or ways to treat the identified disease. The page also features a voice command, to improve accessibility, allowing users to hear rather than read the information.

Figure 5 represents the added screen, where users can select their category or role to proceed with the app's services. Figure 6 demonstrates the sign-up screen, it was enhanced based on survey feedback, where farmers can give data about their email/phone number, password, farm size, and location.

This design enhancement ensures a more customized registration experience, letting farmers to speedily sign up and access the app's features altered to their needs.

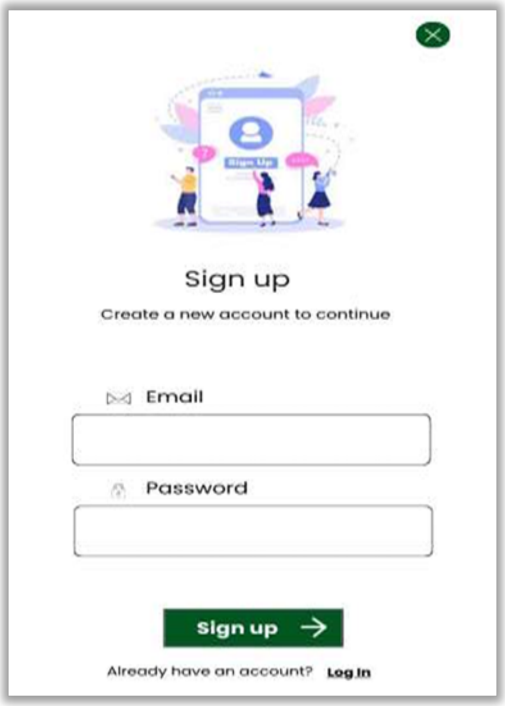

Fig 2. Sign up form

Fig 3. Home screen

Fig 4. Diagnosis page

Fig 5. Role selection screen

Fig 6. Updated Sign-up form

Table 2. Demographic Information

Age Group		80
Under 20	5	
21–30	20	
31–40	25	
41–50	15	
51+	15	
Farm Location		80
Rural	60	
Urban	10	
Suburban	10	
Farming Experience		80
Less than 1 year	10	
1–5 years	25	
6–10 years	30	
More than 10 years	15	
Farming Type		80
Crop farming	50	
Livestock farming	15	
Mixed farming	15	
Farm Size		80
Small-scale (<2 hectares)	25	
Medium-scale (2–10 hectares)	40	
Large-scale (>10 hectares)	15	
Internet Access		80
Yes	70	
No	10	
Device Type		80
Smartphone	60	
Feature phone	10	
Computer/Laptop	5	
Other	5	
Comfort with Apps		80
Very comfortable	25	
Somewhat comfortable	45	
Not comfortable	10	
Digital Tools Usage		80
Yes	65	
No	15	

Figure 7 shows the updated (after user feedback) Home Screen, encompassing new features recommended by stakeholders. The updated design let the users access detailed cultivation tips, information on diseases and pests, and fertilizer commendations tailored to their crops. The farmers can view live weather updates. The enhanced Home Screen also includes an easy navigation option to move to the Settings page, where users / farmers can adjust their favorites and app settings.

Figure 8 demonstrates the Customization Screen, this unique feature in the application that allows users / farmers to personalize their experience. On this screen, farmers can select from diverse languages to make the application more approachable to a diverse audience. The font size can be changed to accommodate farmers with diverse visual preferences, confirming greater readability. To interact with more users, the application also has voice command functionality.

Fig 7. Updated Home screen

Fig 8. Customization Screen

Table 3. Survey Question

GUI Survey Fixed Questions	**Navigation Ease**		80
	Very easy	15	
	Easy	40	
	Neutral	15	
	Difficult	5	
	Very difficult	5	
	Icon Intuitiveness		80
	Very intuitive	10	
	Intuitive	45	
	Neutral	15	
	Confusing	5	
	Very confusing	5	
	Information Clarity		80
	Very clear	15	
	Clear	50	
	Neutral	10	
	Unclear	5	
	Very unclear	0	
	Difficulties Encountered		80
	Yes	20	
	No	60	

Table 4. Open-ended questions

Type	**Frequency**
Navigation issues	12%
Design improvements	50%
Missing features	15%
General satisfaction	23%

The usability testing of the **Plant Guard** system offered improvements over existing tools like **Plantix**, **Leaf Doctor and Pashu Poshan**. Whereas comparing applications had slower response times (20–60 seconds), needed nonstop internet access, limited localized approvals, **Plant Guard** attained a usability score of 4.5/5, with 87% of users observing it easy to use and a response time under one minute. Its voice-command feature, offline access and predictive forecasting based on weather data made it more useful for rural area farmers. Though limited by a smaller dataset, its incorporation with local agricultural organizations and NGOs provides extended support unavailable in previous systems, establishing Plant Guard as a more accessible, intelligent, and farmer-oriented solution

4 Conclusion

Plant Guard helps farmers, especially from the rural and underdeveloped areas. It gives practical applications for real-time decisions, and it can provide disease diagnosis and recommendations in under one minute. Its offline functionality allows the system to operate effectively in rural regions with low Internet access. Usability studies scored it 4.5 out of 5 based on how easy and relevant it is to its audience, which further proves its user- friendliness.

Plant Guard is a working solution that can significantly assist small- and medium-scale farmers with identifying plant diseases that tries to ensure they will be able to produce a better yield. Future and ongoing improvements to increase the dataset, integrate IoT data, and scale the solution's capabilities will strengthen its durability and make it a vital tool for farmers around the world, resulting in better crop health, reduced losses, and more environmentally friendly farming practices.

The **Plant Guard system** offered novel AI-enabled software for real-time plant disease detection with a 4.5/5 usability score, over 90% accuracy, and response time under one minute. Its voice-command feature, offline use, and localized commendations make it more useful for rural area farmers. Even though limited by dataset diversity, future improvements encompassing IoT integration and data extension can improve performance. Overall, **Plant Guard** offers intelligent, and a sustainable approach to modern agriculture

References

1) Nwankwo CU, Ikehi ME, Ejiofor TE, Ifeanyieze FO. Successive national agricultural policies/programmes, growth of gross domestic product (GDP) and expansion of agribusinesses in Nigeria. *PLOS One*. 2024;19(2):e0291999. https://doi.org/10.1371/journal.pone.0291999.
2) Junaid MD, Gokce AF. Global agricultural losses and their causes. *Bulletin of Biological and Allied Sciences Research*. 2024;(1):66. https://doi.org/10.54112/bbasr.v2024i1.66.
3) Upadhyay A, Chandel NS, Singh KP, Chakraborty SK, Nandede BM, Kumar M, et al. Deep learning and computer vision in plant disease detection: a comprehensive review of techniques, models, and trends in precision agriculture. *Artificial Intelligence Review*. 2025 Jan;58(3):92. https://doi.org/10.1007/s10462-024-11100-x.
4) Samal I, Bhoi TK, Pradhan AK, Mahanta DK. Plantix app: A success story of artificial intelligence in plant protection. *Van Sangyan*. 2023;10:24–44. Available from: https://www.researchgate.net/publication/370650382_Plantix_app_A_Success_story_of_artificial_intelligence_in_plant_protection.
5) Sivakumar S, Bijoshkumar G, Rajasekharan A, Panicker V, Paramasivam S, Manivasagam VS, et al. Evaluating the expediency of smartphone applications for Indian farmers and other stakeholders. *AgriEngineering*. 2022;4(3):656–673. https://doi.org/10.3390/agriengineering4030042.
6) Alheeti AAM, Farhan MA, Al-Saad LA, Theer RM. Evaluation of the performance of imagej, leaf doctor applications, and visual assessments in measuring severity of two leaf spot diseases. vol. 761. IOP Publishing. 2021;p. 012030. https://doi.org/10.1088/1755-1315/761/1/012030.
7) Arulmurugan S, Bharathkumar V, Gokulachandru S, Yusuf MM. Plant guard: AI-enhanced plant diseases detection for sustainable agriculture. IEEE. 2024;p. 726–730. https://doi.org/10.1109/ICICT60155.2024.10544402.
8) Bhavyashree HD, Shakthivale R, Vinay M. Plant Leaf Disease Detection Using Image Processing and Machine Learning. *International Advanced Research Journal in Science, Engineering and Technology (IARJSET)*. 2025. https://doi.org/10.17148/IARJSET.2025.125370.
9) Shafay M, Hassan T, Owais M, et al. Recent advances in plant disease detection: challenges and opportunities. *Plant Methods*. 2025;21:140. https://doi.org/10.1186/s13007-025-01450-0.
10) Chai AYH, Jee KLZ, Lee SH, Tay FS, Vandeputte J, Goeau H, et al. Deep-Plant-Disease Dataset Is All You Need for Plant Disease Identification. New York, NY, USA. Association for Computing Machinery. 2025;p. 12578–12584. https://doi.org/10.1145/3746027.3758192.
11) Dolatabadian A, Neik TX, Danilevicz MF, Upadhyaya SR, Batley J, Edwards D. Image-based crop disease detection using machine learning. *Plant Pathology*. 2025;74:18–38. https://doi.org/10.1111/ppa.14006.
12) Balaji GN, Parthasarathy G, Kovendan AKP, Jha A. Using deep learning for plant disease detection and classification. *Nature Environment and Pollution Technology*. 2025;24(2):B4260. https://doi.org/10.46488/NEPT.2025.v24i02.B4260.
13) Kim D, Park SB, Jung C, et al. Large-scale direct sensing of pine trees for diagnosing pine wilt disease. *Biotechnology and Bioprocess Engineering*. 2025. https://doi.org/10.1007/s12257-025-00235-5.
14) Latif RMA, Iqbal T, Qader IA, Ikram A, Alsolai H, Alabdullah B, et al. Interpretable machine learning framework for predicting Urban air quality. *PLOS One*. 2025;20(11):e0336241. https://doi.org/10.1371/journal.pone.0336241.
15) Ikram A, Jalil MA, Ngah AB, Khan AS, Iqbal T. Critical success factors for client proposal selection: A vendor perspective in offshore software maintenance outsourcing. vol. 2484. AIP Publishing LLC. 2023;p. 060011. https://doi.org/10.1063/5.0110110.
16) Ikram A, Jalil MA, Ngah AB, Raza S, Khan AS, Mahmood Y, et al. Project Assessment in Offshore Software Maintenance Outsourcing Using Deep Extreme Learning Machines. *Computers, Materials & Continua*. 2023;74(1). https://doi.org/10.30534/ijatcse/2021/151012021.
17) McLaughlin JE, Kane-Gill SL, Snyder ME. Research and scholarly methods: Mixed methods studies. *Journal of the American College of Clinical Pharmacy*. 2025. https://doi.org/10.1002/jac5.70068.