

# User needs analysis for developing plant monitoring information system: enhancing agricultural efficiency and productivity

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Article Info	ABSTRACT
<p><b>Keywords:</b> User Needs Analysis, Plant Monitoring, Software Development, Agricultural</p>	<p>This research explores users' needs and barriers in developing a plant monitoring information system to enhance agricultural efficiency. Through a qualitative approach, the needs of farmers and agricultural managers and challenges in technology adoption are analyzed. The findings emphasize the importance of a user-friendly system relevant to its users. By gathering data through interviews, observations, and document studies, desired features for the plant monitoring information system are identified. As a result, solutions are recommended to improve crop management efficiency and support sustainable farming practices. This research contributes to understanding user needs in the context of agricultural technology development, hoping to enhance overall productivity and sustainability in the agricultural sector.</p>
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## INTRODUCTION

The agricultural sector is crucial in ensuring food security and economic stability worldwide. However, this sector faces various challenges, from unpredictable weather patterns to limited resources and labor shortages. In this context, the need for efficient plant monitoring becomes increasingly crucial. Monitoring plants' health, growth, and environmental conditions is essential to optimize agricultural productivity and sustainability. Traditional monitoring methods have limitations, emphasizing the importance of leveraging technology to develop more effective solutions (Badrzadeh et al., 2022; Daouti et al., 2022; Hinnou et al., 2022).

Recent technological advancements offer promising opportunities to revolutionize agriculture. Information systems dedicated to plant monitoring have emerged as powerful tools in modernizing farming practices. These systems enable real-time tracking of various parameters such as soil moisture levels, nutrient content, and pest infestations. Despite their potential significant benefits, adopting such systems in agriculture faces challenges, including limited access to technology and implementation complexity. Understanding the needs and preferences of users is critical to successfully developing and adopting plant monitoring information systems. Farmers, agricultural managers, and researchers alike

require user-friendly and customizable solutions that provide actionable insights to optimize crop management decisions (Ashraf & Jamil, 2022; Droppers et al., 2022; Williamson & Leonelli, 2022). This research aims to bridge the gap between technological innovation and practical application in agriculture by conducting in-depth user needs analysis. By addressing these needs, the proposed plant monitoring information system has the potential to enhance agricultural efficiency, productivity, and sustainability significantly (Lino et al., 1998).

Previous studies have highlighted the importance of user-centered approaches in agricultural technology development. However, targeted research on plant monitoring information systems is still explicitly needed. By building upon existing knowledge and addressing gaps in understanding, this research aims to provide valuable insights into designing and implementing effective agricultural information systems. Ultimately, by harnessing technology's power and meeting end users' needs, we can pave the way for a more resilient and sustainable agricultural future (1+ et al., 2007; Madeira et al., 2022; Pan et al., 2006; Williams, n.d.).

Traditional plant monitoring often faces significant challenges. Manual data collection processes are time-consuming and labour-intensive, with limitations in gathering information accurately and promptly. The ability to identify and prevent plant problems quickly is also limited, leaving the potential for significant crop loss risks (1+ et al., 2007; Barbón et al., 2023; Lino et al., 1998; Ompal et al., 2022; Shojaeimehr & Rahmani, 2022). On the other hand, adopting more advanced agricultural technology still faces constraints such as limited access to technology and infrastructure and lack of user awareness and skills. As a result, agricultural productivity may be disrupted, with the potential for negative impacts on overall agricultural efficiency and sustainability. To address these issues, this research has several primary objectives. Firstly, the research aims to identify users' needs and challenges in plant monitoring. This involves an in-depth analysis of the preferences and requirements of farmers, agricultural managers, and other stakeholders. Furthermore, the research objective is to develop an effective plant monitoring information system by designing features that can assist users in monitoring and analysing plant conditions more effectively. Research objectives also include raising awareness and user skills in adopting agricultural technology by providing necessary training and support.

Finally, by implementing effective information systems and increasing technology awareness (Al-Saqqa et al., 2020; Dingsøyr et al., 2012; Santos et al., n.d.; Serrador & Pinto, 2015; Shrivastava & Rathod, 2014), the research objective is to enhance agricultural productivity and sustainability by reducing crop loss risks, improving crop management efficiency, and promoting more sustainable and environmentally friendly farming practices. Thus, these objectives are expected to significantly contribute to improving farmer welfare and the overall sustainability of the agricultural sector. This research has several limitations that need to be considered. Firstly, in terms of geographic scope, the research will be focused on specific areas or regions, considering the differences in geographical and environmental conditions that may affect the implementation of the information system. Secondly, in terms of temporal scope, the research will be limited to a specific time range,

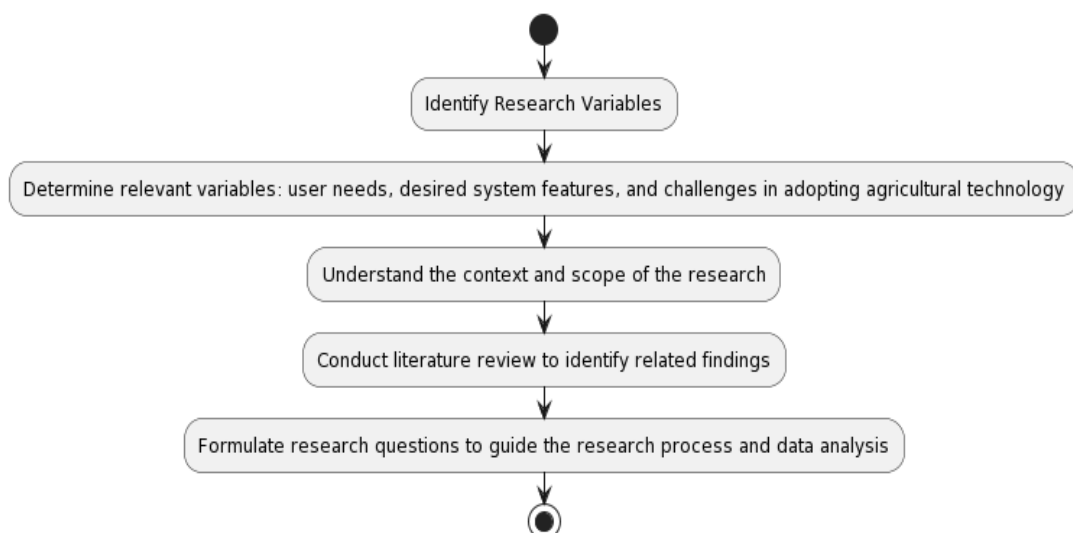
such as one growing season, to ensure that the research results reflect relevant and current conditions. Thirdly, regarding technological scope, the research will utilize available and affordable technology to develop the plant monitoring information system, considering the availability of infrastructure and existing resources. Fourthly, regarding user scope, the research will limit the users involved in analyzing user needs to farmers, agricultural managers, and other relevant stakeholders to ensure that the results are relevant and applicable in the actual agricultural context.

## METHODS

This research will employ a qualitative approach to understand user needs in developing a plant monitoring information system. The qualitative research method is chosen because it can provide comprehensive and contextual insights into users' preferences, challenges, and expectations regarding the system to be developed. This approach also allows researchers to explore various complex and unstructured aspects of users' issues in agricultural practices.

### Research Design

As depicted in Figure 1, the research design begins with identifying research variables such as user needs and challenges in adopting agricultural technology, then determines relevant variables and gains an in-depth understanding of the research context. A literature review follows this to gather necessary information and formulate research questions to guide the entire research process and data analysis. This stage aims to develop a robust and relevant conceptual framework, providing clear direction in conducting the research effectively.



. Figure 1. Research Design

### Research Question

How do we identify user needs, understand desired features, and address challenges in adopting agricultural technology to develop an effective and sustainable plant monitoring information system?

### Data Collection

During the data collection phase, various activities are undertaken to obtain the necessary information for the research. One of these activities is in-depth interviews, where researchers interact directly with respondents to gain deep insights into their perceptions and experiences related to the research topic. Additionally, field observations involve direct observation of activities or events in the field, such as farming practices and crop conditions. Documentation studies also play a crucial role, where researchers analyze documents or related records such as previous research reports or statistical data. Surveys are often conducted by collecting data from several respondents through questionnaires or survey forms. At the same time, focus group discussions facilitate the exchange of views and experiences in small groups of respondents led by a moderator. Furthermore, participatory observation is also carried out, where researchers are directly involved in activities in the research environment to gain a deeper understanding of the context. These activities aim to gather relevant and diverse data to support research analysis and findings.

### Analysis

During the analysis stage, several activities are carried out to process the data collected in the research. First, qualitative data such as interviews or focus group discussions are transcribed into text. Subsequently, the data are analyzed by identifying emerging patterns or themes, which are then interpreted to provide meaning within the research context. Additionally, comparisons and contrasts between various findings are conducted to gain a deeper understanding. Following this, conclusions or generalizations are drawn based on these findings, considering the research context and implications for theory and practice. This process also involves verifying and validating findings and data interpretation, as well as the preparation of a report or academic publication presenting the results of the analysis systematically and structured. This analysis stage is an essential part of the research process that allows researchers to understand the topic under investigation deeply.

## RESULTS AND DISCUSSION

Table 1 presents aspects of technology infrastructure availability and accessibility of information systems, highlighting the need for easy access for farmers to obtain essential information. Furthermore, understanding the desired information needs of farmers and the ease of application use emphasizes the importance of designing relevant and user-friendly systems. Moreover, technical support and training are vital to ensuring effective system utilization by farmers. However, limited internet access and low digital literacy levels can hinder technology adoption. Additionally, the implementation costs and alignment with local conditions need to be considered to ensure the system is well-received by farmers. Finally, farmers' belief in the benefits derived from technology will also influence their adoption rate of plant monitoring information systems. By considering these factors, system developers and researchers can design more relevant solutions tailored to the needs and challenges farmers face in agricultural practices.

**Table 1.** Agricultural Application Development Variables

Variabel	Description
User Needs	This variable encompasses various needs and preferences held by users regarding plant monitoring information systems. It may include the need for accurate and timely information about crop conditions, the ability to analyze data efficiently, or the need for specific features such as weather monitoring or early warning of plant diseases.
System Features	This variable refers to the features or functions desired by users in plant monitoring information systems. It may include the ability to track plant growth over time, interactive map features, or integration with agricultural sensors for more accurate measurements.
Challenges in Agricultural Technology Adoption	This variable encompasses various challenges or barriers faced by users in adopting agricultural technology, including plant monitoring information systems. It may include factors such as limited access to technology, lack of knowledge or skills in technology use, or concerns about the cost or complexity of implementation.

Effective plant monitoring information systems require features that can provide accurate and helpful information to users. These features include monitoring plant and environmental conditions, early warning notifications about potential threats to plants, efficient maintenance management, the ability to analyze collected data, monitoring the sustainability of farming practices, integration of sensors for more accurate measurements, as well as accessibility and interoperability that allow the system to be easily accessed and used by various users and can be integrated with existing systems or platforms. With these features, the system can assist users in managing their crops more effectively, increasing productivity, and supporting more sustainable farming practices. The research recommends the features presented in Table 2.

**Table 2.** Proposed Features

Feature Name	Description
Plant Condition Monitoring	This feature allows users to track the condition of plants over time, including growth, development, and plant health.
Environmental Monitoring	This feature provides information about the environmental conditions where plants grow, such as temperature, air humidity, sunlight, and rainfall.
Early Warning	This feature provides notifications or early warnings

User needs analysis for developing plant monitoring information system: enhancing agricultural efficiency and productivity– Denny Jean Cross Sihombing

Feature Name	Description
Maintenance Management	about potential threats to plants, such as pest infestations, plant diseases, or extreme weather. This feature assists users in planning and implementing plant maintenance activities, including fertilization, watering, and plant protection.
Data Analysis	This feature enables users to analyze data collected by the system, such as plant growth, productivity, and resource use efficiency.
Sustainability Monitoring	This feature helps users track and evaluate the sustainability of their farming practices, including the use of fertilizers and pesticides, as well as the environmental impacts of farming activities.
Sensor Integration	This feature allows users to integrate existing agricultural sensors for more accurate and timely measurements of plant and environmental conditions.
Accessibility and Interoperability	This feature ensures that the system is easily accessible and usable by various users, and can be integrated with existing systems or platforms.

### User Needs

The analysis of user needs highlights the importance of plant monitoring information systems that are user-friendly, customizable, and provide relevant and useful information to farmers and agricultural managers. In this context, the systems should be capable of providing real-time monitoring of plant and environmental conditions, issuing early warnings of potential threats, and providing in-depth data analysis to support decision-making.

### Challenges in Technology Adoption

Despite the significant potential for technology to enhance agricultural practices, there are still challenges to be overcome in adopting plant monitoring information systems. One of the main challenges is limited access to technology, particularly in rural areas or developing countries. Additionally, lack of awareness and digital skills also hinder the adoption of agricultural technology.

### Relevance of Technological Solutions

Proposed technological solutions, such as plant monitoring information systems, have great potential to improve agricultural efficiency and productivity. By providing accurate and timely information, these systems can assist farmers in making better decisions and increasing crop yields. However, the relevance of these solutions depends on how well the systems meet the needs and challenges faced by users.

### Research Limitations

This study has certain limitations that need to be considered, such as limitations in geographical, temporal, technological, and user scope. These limitations affect the generalization of research findings and the applicability of proposed solutions in various agricultural contexts.

### Proposed Solutions

Based on the analysis of user needs and challenges in technology adoption, several solutions can be proposed to enhance the effectiveness of plant monitoring information systems. One of them is to provide training and assistance for farmers in using agricultural technology. This can be done through local training programs or collaboration with agricultural education and research institutions. Additionally, efforts to improve accessibility to technology infrastructure, such as internet and electricity access, in rural areas also need to be enhanced. Furthermore, developing user-friendly information systems customized to local needs can accelerate technology adoption by farmers. These measures can address some key challenges in adopting plant monitoring information systems.

### Practical Implications

The findings of this research have several relevant practical implications:

1. Information system developers and stakeholders must carefully consider user needs and preferences when designing technological solutions.
2. Governments and non-governmental organizations can be crucial in providing financial support and infrastructure for farmers to adopt agricultural technology.
3. Cooperation among various stakeholders, including farmers, researchers, industry, and government, is needed to create a supportive environment for developing and adopting effective plant monitoring information systems.

In the context of agriculture, which is constantly changing and evolving, the use of technology has the potential to improve efficiency and productivity significantly. However, an in-depth analysis of user needs and challenges in technology adoption is necessary to optimize its benefits. By understanding and addressing these barriers, plant monitoring information systems can become valuable tools in supporting sustainable agriculture and improving farmer welfare.

## CONCLUSION

This research identifies user needs and challenges in developing plant monitoring information systems to enhance agricultural efficiency and productivity. Findings highlight the importance of systems that are user-friendly, customizable, and provide relevant information to users. Challenges in agricultural technology adoption, such as limited access to technology and lack of digital awareness, require efforts to improve technology infrastructure accessibility and provide technical training for farmers. The proposed features for plant monitoring information systems, such as plant condition monitoring, early warning notifications, and data analysis, can improve crop management efficiency and support sustainable farming practices. This research has practical implications in supporting the

development of technology solutions tailored to user needs and local challenges. Hopefully, this research can contribute to developing applications to enhance efficiency, productivity, and sustainability in the agricultural sector.

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