# UREA: A Case Study on Identifying Organic Fertilizer, Nutrients based on Color Characteristics Using Random Forest Algorithm for Small-scale Vegetable Farms

BAUTISTA, MARK JOHN B.[1], CRUZ, JERSHWIN MARC A.[2], PAGULAYAN, EUNICE VIELLE L.[3], TABOR, DENNIS JUSTIN[4], FUENTES, JUSTINE[5], SHEINN REYES[6], JOHANI BASAULA[7]
[1, 2, 3, 4, 5, 6, 7] *College of Computer Studies, Our Lady of Fatima University, Quezon City, Philippines*

***Abstract- Effective fertilizer management is critical to the productivity and sustainability of small-scale vegetable farms. However, identifying different types of fertilizers, especially organic and inorganic fertilizers, can only be possible with specialized tools. Using the Random Forest algorithm, this case study presents a new method to identify nutrients from organic fertilizers such as urea based on their color characteristics. We created a machine-learning show by collecting color-based information from different fertilizer tests. This show can precisely classify fertilizers based on their visual properties. This investigation points to supplying smallholder agriculturists with a cost-effective and open solution that permits them to form educated choices of supplements utilized without requiring costly research facility gear. Our conclusion illustrates that the Sporadic Forest calculation can accurately recognize urea and other normal fertilizers when arranged with a comprehensive dataset of color characteristics. This approach might make strides in fertilizer organization on small-scale vegetable farms, diminishing the danger of mishandling and making more viable agrarian sharpens. The study also recommends that the process be further analyzed for enhanced reliability and flexibility and suggestions on practical implementation in small-scale agricultural production. This research has added value to the field of precision agriculture, providing innovative solutions for resource-constrained rural environments by using machine learning.***

***Indexed Terms- Organic Fertilizer***

## I. INTRODUCTION

Within the world of cultivating, viable supplement administration is essential to guarantee edit efficiency and maintainability, especially on small-scale vegetable ranches. Fertilizers play a central part in giving fundamental supplements that plants require For sound development and improvement. However, destitute fertilizer distinguishing proof can lead to disgraceful fertilization, influencing edit well-being and abdicate, and possibly causing natural issues. This challenge is particularly solid for small-scale ranchers, who regularly depend on visual prompts to recognize fertilizer sorts due to constrained access to progressed innovation or research facility offices.

Urea, a well-known nitrogen-based fertilizer, is widely used in agriculture due to its high nitrogen content and affordability. It is especially important for small-scale farming operations, where maintaining soil fertility is crucial. However, recognizing the differences of organic fertilizers from other types of fertilizers with a similar appearance can be difficult. This need for differentiation can lead to incorrect application rates, resulting in reduced crop yields or negative environmental impacts.

To address this challenge, this case study investigates the use of the Random Forest algorithm, a machine learning technique, to identify organic fertilizers based on their color characteristics. Machine learning has gained popularity in agricultural applications, where Random Forest is recognized for its robustness and accuracy in classification tasks.

By leveraging this technology, we aim to create a viable and accessible method of fertilizer identification that allows smallholder farmers to make more informed nutrient management decisions. The most important objective of this case study is to determine whether the Random Forest algorithm can accurately classify urea and other fertilizers based on their color characteristics. We have collected and analyzed a large dataset of fertilizer samples and are working on creating a machine-learning model that can be used in real-world agricultural settings. This approach has the potential to reduce errors in fertilizer identification and improve fertilizer management among smallholder farmers, contributing to better and more sustainable agricultural practices.

Objectives: 1) To create a user-friendly interface that permits small-scale agriculturists to effectively input fertilizer tests for investigation utilizing the Irregular Forest-based distinguishing proof framework. 2) To conduct field tests to guarantee that the framework capacities are viable in differing agrarian situations, giving solid comes about over different conditions. 3) To provide training sessions for neighboring ranchers on how to use the framework to enhance fertilizer distinguishing proof and supplement abilities and expertise. 4) To give changes in rural efficiency and natural results over time, to assess the impact of the system on yield reduction and supportability.

## II. RELATED WORKS

This section discusses current research in the aforementioned area as well as similar strategies in several fields.

Gao et al.'s paper focuses on organic fertilizers that have gained attention for their role in enhancing tomato yield and quality while promoting sustainable agriculture. This study analyzed 769 data sets from 107 research papers to investigate the impact of organic fertilizers on tomatoes. Results show a significant increase in tomato yield and improvements in parameters like soluble solids, lycopene, and vitamin C with organic fertilizer application. The findings underscore the importance of soil health and organic fertilizer management for optimizing tomato production and quality, offering valuable insights for sustainable agriculture.

According to a study by Li, J., Zhao, X., Bailey, L. M., Kamat, M., & Basso, K. B. 2021, organic fertilizers sourced from diverse animal and plant-derived materials are extended and Employed as nutrient reservoirs for organic vegetable cultivation. In contrast to synthetic chemical fertilizers, organic alternatives typically possess reduced nutrient concentrations and exhibit compositional diversity contingent upon their constituent elements. Nonetheless, organic fertilizers frequently harbor advantageous microorganisms and are typically abundant in organic Carbon.

In agriculture, excessive use of liquid organic manures (LOM) is leading to environmental concerns such as the eutrophication of non-agricultural ecosystems and contamination of groundwater with nitrates. To address these issues, it is crucial to implement precise and tailored fertilization practices with LOM. However, achieving this necessitates understanding the nutrient content of LOM. Conventional chemical analysis techniques are frequently expensive, time-consuming, and dependent on obtaining representative samples (Horf, M., Gebbers, R., Olfs, H., & Vogel, S., 2024).

In South Asia, the use of nitrogen-based fertilizers has been largely introduced over the last three decades as a result of efforts to increase crop yield through GreenFAO Change 2021; Benbi 2017; Pingali 2012). This quick increase in inorganic fertilizer utilization, especially urea and diammonium phosphate, has been instrumental in overhauling rustic proficiency, enabling India to accomplish food-grain self-sufficiency (GoI 2020).

Agreeing with Tukey and Marczynski (1984), combined soil and foliar applications ought to be suggested to extend both plant efficiency and abdicate quality. Kuepper (2003) moreover emphasized that foliar application of fertilizers is becoming more predominant as a home in a rural trim generation since it is more straightforwardly focused on and possibly more inviting to the environment in differentiation to soil fertilization. Johnson et al. (2001) proposed that providing N to peach trees employing a combination of soil and foliar N fertilizers leads to ideal plant reactions and restricted natural contamination dangers. The study of Bondarenko, A.M., Kachanova, L.S., Baryshnikov, A.V., & Novikov, S.A. focuses on understanding and improving soil quality for organic farming. It suggests using methods like green manure, organic fertilizers, and precise crop rotations to restore soil health. The goal is to create new technologies for making and using organic fertilizers in agriculture, with a special focus on processing liquid manure to make high-quality fertilizers. The study also talks about designing machines for restoring soil quality and gives details about machines for making solid fertilizers and applying them to fields. By using these organic fertilizers carefully, farmers can improve soil and increase crop yields, which can offset the cost of making them.

The transformation of agriculture spurred by the "Green Revolution" has reshaped farming practices, emphasizing the adoption of modern technologies such as synthetic fertilizers to bolster productivity and meet increasing food demands. While these fertilizers have played a crucial role in enhancing yields, their indiscriminate use has resulted in soil and environmental degradation, necessitating a shift towards organic farming and integrated nutrient management. This transition offers numerous benefits, including improved soil health, reduced pollution, and higher-quality produce, highlighting the significance of organic fertilizers in sustainable soil and environmental management (Verma, B.C., Pramanik, P., Bhaduri, D., 2020).

The study from Frontiers in Soil Science (2023) investigates the impact of organic farming practices on soil health and microbial communities. Organic farming has gained attention as a sustainable agricultural approach that minimizes the use of synthetic inputs and promotes soil conservation (Smith et al., 2020).

The research delves into various organic management strategies and their effects on soil properties, nutrient cycling, and microbial diversity. This exploration is essential for understanding the long-term sustainability and productivity of agricultural systems (Jones & Brown, 2018).

By evaluating the relationship between organic farming practices and soil health, the study contributes valuable insights into sustainable agriculture and environmental conservation efforts (Garcia et al., 2021). Understanding how organic management influences soil microbial communities is particularly crucial for optimizing agricultural practices and maintaining ecosystem balance (Lee & Kim, 2019).

## III. METHODS

The Developer implemented the Agile Development Methodology to develop and design UREA. The diagram illustrates the steps of the process. The developer underwent seven (7) phases of development – plan, design, develop, test, release, and feedback.

Within the scope of our study, it is expected we developers will face obstacles in crafting a dynamic identification system for organic fertilizer. Consequently, our strategy revolves around developing a fundamental system that presents the overall nutrient composition of the fertilizer. This iterative process guarantees that UREA will meet its necessary functions while being equipped to address the challenges about the accuracy of the nutrient composition of the organic fertilizer.

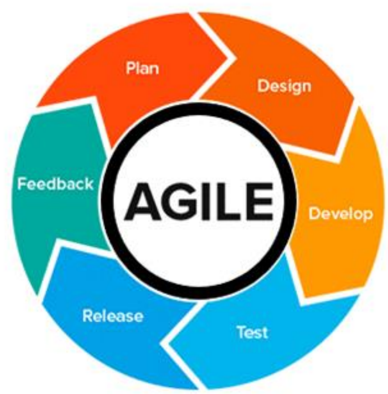



Figure 1. Visual Representation of Agile Development

### *A. Planning Phase*

Our mobile app project is in its initial phase, focusing on understanding the challenges and needs of small-scale vegetable farms. The project involves conducting focus group discussions, interviews, and surveys to understand current practices and challenges in nutrient management. A survey will be conducted to identify common problems faced by small-scale farms, and the researcher will also research the Random Forest Algorithm's applicability to the specific problem domain. The project targets small-scale vegetable farms, which contribute significantly to local food production. The goal is to enhance nutrient management practices to improve crop yield and sustainability. The project is expected to be completed before the end of the finals, with the mobile app developed for real-world testing and feedback collection.

*1) Project Framework:* As an outcome of careful deliberation, this study develops a project framework aimed at enhancing the efficiency and sustainability of small-scale vegetable farming through the development of UREA. The framework encompasses the following key components: 1) color characteristic analysis system; 2) machine learning system; 3) user interface system; 4) result visualization system; 5) integration system; and 6) image acquisition system.

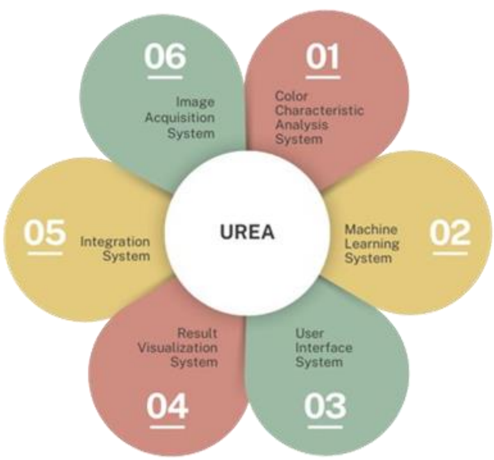



Fig. 2. Project Framework of UREA

*2) Architecture of an Office Automation System:* The overall flow of the UREA is represented in Figure 3. The input-process-output cycle is briefly illustrated as follows.

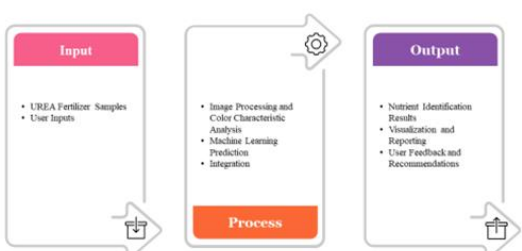



Fig. 3. Architecture of UREA

*Input.* This pertains to the inputs primarily in the form of images of organic fertilizer samples obtained from small-scale vegetable farms. Additionally, users interact with the system by providing inputs through the user interface. These inputs may include uploading images of fertilizer samples, configuring analysis settings such as model parameters, and making queries regarding nutrient identification.

*Process.* The system processes the input images through a series of steps. Firstly, image processing techniques are applied to extract color characteristics from the fertilizer samples. These techniques involve preprocessing steps such as contrast enhancement. Next, the color characteristic analysis algorithms analyze the extracted features, such as hue, saturation, and intensity, to characterize the color profile of each sample. Subsequently, the processed color characteristics are fed into the machine learning model, which applies the Random Forest Algorithm to predict the nutrient composition of the fertilizer samples. Throughout this process, the system manages and integrates data from various sources, including fertilizer sample images, color characteristics, and prediction results.

*Output.* The output of the system includes nutrient identification results for the input of organic fertilizer samples. These results typically consist of predicted nutrient composition along with confidence scores or probability estimates, which are provided to users through the user interface. Additionally, the system generates visualizations and reports to present the analysis results in a user-friendly format. These visualizations may include charts, graphs, or tables displaying nutrient content and related information. Users also receive feedback on the analysis results and recommendations for fertilizer management practices based on the identified nutrient composition. These recommendations may include optimal fertilizer application rates, timing, and distribution strategies tailored to specific crop needs and soil conditions.

*3) Use Case Modeling:* In this phase, the researcher used the use case diagram to demonstrate how the system works and how the user will interact with it. Figure 4 represents the user's interaction with the system. Figure 5 on the other hand, represents how the system responds to the user.

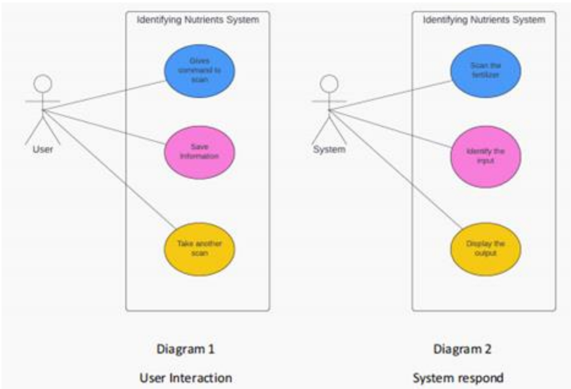



Figure 4. User Interaction Figure 5. System Respond

*B. Design Phase*

In this phase, the researcher addresses the "How" of the specified solution. The system used a user-friendly interface accessible via mobile application. The project aims to develop a system capable of identifying organic fertilizer nutrients based on color characteristics using the Random Forest algorithm and capturing images of fertilizer samples using device cameras.

Java was used for this project due to its versatility, robustness, and widespread use in enterprise and scientific applications. Java provides a solid foundation for implementing the design outlined above, enabling the development of a scalable, reliable, and user-friendly system for identifying organic fertilizers and nutrients-based on color characteristics using the Random Forest algorithm.

*C. Coding Phase*

In this phase, developers constructed the UREA Application using Android Studio with a Java Language. It is free, open-source, and cross platform where you can develop a mobile application. It supports development tasks such as debugging, drag and drop features which you can design easily using Extensible Markup Language (XML), task execution, and version control. Figure 6 is the real code of the system using the Java Language. While the Figure 7 is the drag and drop feature of the Android Studio using the XML.

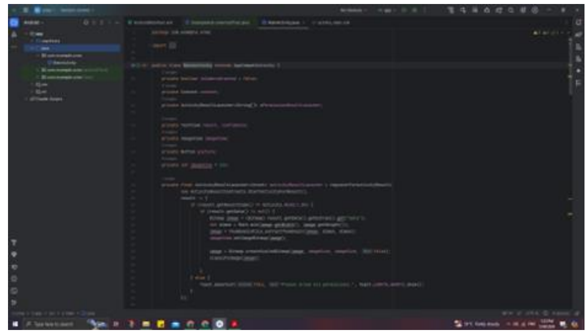


Figure 6. Java Code

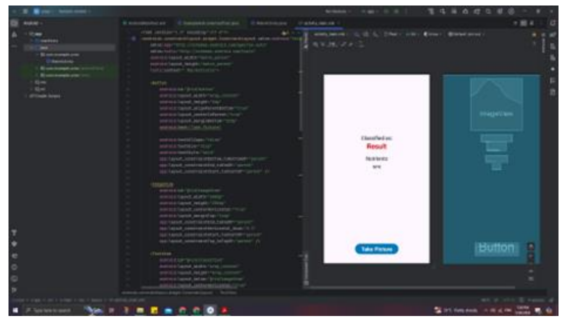
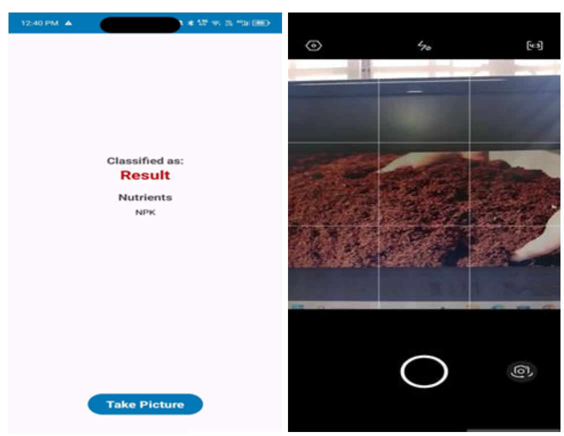
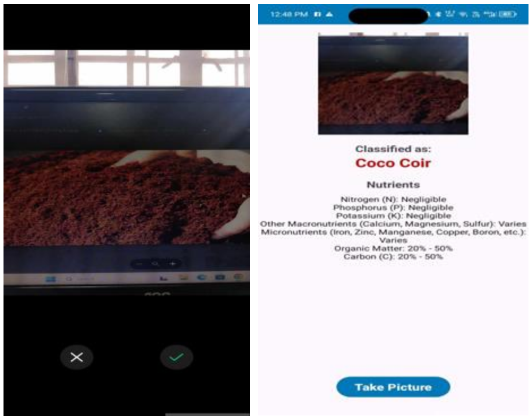


Figure 7. Drag & Drop with XML

*D. Testing Phase*

During this phase, the developers tested to scan (5) five organic fertilizers; such as Chicken Manure, Coco Coir, Compost, Rice Hull Ash and Vermicompost. On the other hand, the developers also scanned other forms of fertilizer such as soil and manures that would likely be found in the house to test the accuracy of the system. The system was evaluated to ensure the proper accuracy as well the input-output flow to improve the functionality.






*E. Release of the system*

In this phase, the developers compressed the code files into an archive format called zip file before deploying the application, which was then installed on several devices. Subsequently, the application was tested again on a sample of relatives who worked in farming and gardening. The purpose of the testing was to determine the application's usability and functionality. During that test, the system received positive feedback from the sample relatives.

## IV. PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

The results that were gathered are presented in this chapter. The developers used survey questionnaires to gather feedback from the respondents for the effectiveness of the UREA Application. After a series of validation and evaluation of results, the developers were able to come up with the results of the proposed system on the survey that was conducted.

The respondents consist of (2) two professional farmers, and (2) two gardeners for a total of (4) four respondents. The developers received four filled questionnaires as a turn-out and used it as a population.

*Instruction: The following scales are used in evaluating the effectiveness of UREA Application.*

| Scale | Weighted mean | Corresponding remarks |
|---|---|---|
| 4 | 3.50 – 4.00 | Strongly Agree |
| 3 | 2.50 – 3.49 | Agree |
| 2 | 1.50 – 2.49 | Disagree |
| 1 | 1.00 – 1.49 | Strongly Disagree |

*PROFESSIONAL FARMER'S EVALUATION*

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system perform all the system tasks and objectives. | 3.50 | Strongly Agree |
| 2. The system provide precise results according to the input provided. | 3.50 | Strongly Agree |
| 3. The system provide necessary features and functions to support tasks and objectives. | 3.50 | Strongly Agree |
| Total | 3.50 | Strongly Agree |

*Table 1: Functionality*

The table 1 shows the evaluation of (2) two professional farmers toward the system according to its Functionality which gained an overall of 3.50 which concludes that the functionality of the system is highly acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system display all requested data promptly. | 3.50 | Strongly Agree |
| 2. The system process the fertilizer | 3.50 | Strongly Agree |

| | | |
|---|---|---|
| nutrients in real-time. | | |
| Total | 3.50 | Strongly Agree |

*Table 1.1: Efficiency*

The table 1.1 shows the evaluation of (2) two professional farmers toward the system according to its efficiency which gained an overall of 3.50 which concludes that the efficiency of the system is highly acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system co-exist seamlessly with other installed applications on the same system. | 3.50 | Strongly Agree |
| 2. The system effectively adapt to various screen sizes and resolutions on different devices. | 3.50 | Strongly Agree |
| Total | 3.50 | Strongly Agree |

*Table 1.3: Compatibility*

The table 1.3 shows the evaluation of (2) two professional farmers toward the system according to its compatibility which gained an overall of 3.50 which concludes that the efficiency of the system is highly acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system look user-friendly. (text are visible; buttons and textboxes are exact of sizes. | 3.00 | Agree |
| 2. The system can be learnt by the user within a specified amount of time. | 3.00 | Agree |
| 3. The system function properly across different Android versions. | 3.00 | Agree |
| 4. The system prevent user against operation errors. | 3.50 | Strongly Agree |
| 5. The system have attributes that make it easy to operate and control. | 3.50 | Strongly Agree |
| Total | 3.20 | Agree |

*Table 1.4: Usability*

The table 1.4 shows the evaluation of (2) two professional farmers toward the system according to its usability which gained an overall of 3.20 which concludes that the efficiency of the system is somewhat acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system can be easily accessed when required for use. | 3.50 | Strongly Agree |
| 2. The system is free from errors. | 3.00 | Agree |
| Total | 3.25 | Agree |

*Table 1.5: Reliability*

The table 1.5 shows the evaluation of (2) two professional farmers toward the system according to its usability which gained an overall of 3.25 which concludes that the reliability of the system is somewhat acceptable.

*GARDENER'S EVALUATION*

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system perform all the system tasks and objectives. | 4.00 | Strongly Agree |
| 2. The system provide precise results according to the input provided. | 3.00 | Agree |
| 3. The system provide necessary features and functions to support tasks and objectives. | 2.50 | Agree |
| Total | 3.17 | Agree |

*Table 2: Functionality*

The table 2 shows the evaluation of (2) gardeners toward the system according to its Functionality which gained an overall of 3.17 which concludes that the functionality of the system is somewhat acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system display all requested data promptly. | 3.00 | Agree |
| 2. The system process the fertilizer nutrients in real-time. | 2.00 | Disagree |
| Total | 2.50 | Agree |

*Table 2.1: Efficiency*

The table 2.1 shows the evaluation of (2) gardeners toward the system according to its efficiency which gained an overall of 2.50 which concludes that the efficiency of the system is somewhat acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system co-exist seamlessly with other installed applications on the same system. | 2.00 | Disagree |
| 2. The system effectively adapt to various screen sizes and resolutions on different devices. | 2.00 | Disagree |
| Total | 2.00 | Disagree |

*Table 2.3: Compatibility*

The table 2.3 shows the evaluation of (2) gardeners toward the system according to its compatibility which gained an overall of 2.00 which concludes that the compatibility of the system is somewhat unacceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system look user-friendly. (text are visible; buttons and textboxes are exact of sizes) | 3.00 | Agree |
| 2. The system can be learnt by the user within a specified amount of time. | 3.00 | Agree |
| 3. The system function properly across different Android versions. | 2.50 | Agree |
| 4. The system prevent user against operation errors. | 3.00 | Agree |

| | | |
|---|---|---|
| 5. The system have attributes that make it easy to operate and control. | 3.00 | Agree |
| Total | 2.90 | Agree |

*Table 2.4: Usability*

The table 2.4 shows the evaluation of (2) gardeners toward the system according to its compatibility which gained an overall of 2.90 which concludes that the usability of the system is somewhat acceptable.

| Indicator | Weighted mean | Interpretation |
|---|---|---|
| 1. The system can be easily accessed when required for use. | 3.00 | Agree |
| 2. The system is free from errors. | 2.00 | Disagree |
| Total | 2.50 | Agree |

*Table 2.5: Reliability*

The table 2.5 shows the evaluation of (2) two professional farmers toward the system according to its usability which gained an overall of 2.50 which concludes that the efficiency of the system is somewhat acceptable

## CONCLUSION AND RECOMMENDATIONS

Professional farmers and gardeners' evaluation of the UREA Application revealed a wide range of perspectives regarding its use, compatibility, efficiency, and reliability. Professional farmers, for the most part, provided positive feedback on the system's functionality, efficiency, compatibility, and reliability across most evaluation criteria. But gardeners' assessments showed a range of opinions, especially when it came to effectiveness, suitability, and consistency; their assessments ranged from moderately acceptable to somewhat unsatisfactory.

To improve the performance and effectiveness of the UREA Application, for the future developers, there are some recommendations that can be implemented. Firstly, addressing concerns raised by gardeners regarding real-time processing of fertilizer nutrients is essential. The User experience and usefulness should be improved by guaranteeing smooth interaction with other apps and flexibility to fit different screen sizes and resolutions on different devices. Conducting user experience (UX) testing to identify areas for enhancement, such as user-friendly interfaces and error prevention mechanisms, will facilitate easier learning and operation. Lastly, addressing reliability concerns, particularly system errors identified by gardeners, is imperative. Implementing robust quality assurance measures to rectify potential software bugs or glitches will ensure stable and consistent performance.

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