# Android-Based Feed Calculator for *Oreochromis Niloticus* Farms

**Rudolf Ian S. Canlas [1], Deniel Marie V. Bachecha [1], Deniel Marie V. Bachecha [1], Reginald C. Canlas [1], Aerielle Kyla B. Dayto [1], Ana Marie R. Maribojo [1], Cyrus Dhel M. Razon [1], Jennifer Elizabeth Y. Buenviaje [1]**

[1]*College of Engineering and Architecture, Department of Electronics Engineering, Don Honorio Ventura State University, Bacolor, Pampanga, Philippines.*

*Corresponding Author: reginaldcanlas06@gmail.com*

**Abstract: -** The researchers created an Android-Based Feed Calculator for Oreochromis Niloticus Farms to address the challenges of providing a timely and adequate food supply in aquaculture. The MABSCI application underwent development using a comprehensive methodology that involved equation development, prototyping, and construction of a fish pen. The researchers developed the application's user interface design using images and an alarm feature that reminded fish owners about the timing and total amount of feed required for the Oreochromis Niloticus. The application equation was developed based on several variables: feeding rate, stocking density, average body weight, temperature, pH, and salinity. They used a t-test and ANOVA to evaluate the application's performance in three groups: estimation, BFAR, and MABSCI. Despite having the lowest daily feed ratio among the three groups, MABSCI maintained a comparable average body weight of 52.39 g, with estimation, and BFAR with 75.889 g and 65.728 g, respectively. This suggests that MABSCI achieved efficient growth with a lower amount of feed, indicating potential optimization of feeding practices. Moreover, the app may serve as a model for optimizing feeding practices in aquaculture operations by identifying strategies to optimize feed utilization, reduce feed costs, and minimize waste. The system can help improve farm performance by providing information on improving productivity while ensuring the fish get a healthy diet.

**Key Words: —** ***Android-based, Aquaculture, Feed calculator, Fish, Oreochromis niloticus, ph, Salinity, Temperature.***

## I. INTRODUCTION

Despite having the fewest registered fisher folk engaged in fishery activities, aquaculture is the leading contributor of fish products in 2020, according to the Bureau of Fisheries and Aquatic Resources. It recorded a total fish production of 52.79% or 2.32 million MT. It had the most significant share in total production value, with 41.82%, corresponding to 114.4 million pesos [1].

Fish farming is one of the fastest-growing food-producing sectors in the world [2]. This industry has grown significantly and promises to provide fish meat, increasing fish consumption in the year 2050 [2, 3].

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Fish live in water and rely entirely on it for all their requirements. Water temperature, salinity, and pH are all standard water quality metrics in the Oreochromis Niloticus aquaculture sector [5]. If these ideal parameters are unmet, fish will exhibit poor growth, irregular behavior, illness symptoms, or parasite infestations. Fish survival rate may cease in extreme circumstances or when unfavorable conditions persist for an extended time. Water quality in manufacturing systems may substantially impact an organism's health and the costs of bringing a product to market [5].

Each species has its optimum range, within which it operates best, within certain tolerance limitations. As a result, fish farmers must always ensure that the water's physical and chemical characteristics are as close as possible to the ideal range for the fish they are raising [5]. Among the fishes farmed in aquaculture, Oreochromis Niloticus ranked 2nd as the most consumed type of fish in the Philippines due to its high demand Philippine Statistics Authority, 2021). Oreochromis Niloticus farming is one of the primary sources of aquaculture. This sector generates much income as it meets the local Filipino needs for protein sources [6].

Temperature is a crucial environmental factor affecting fish physiology, development, and metabolism. Tilapia, for instance, is a thermophilic fish that grows between 20 and 35°C [5]. Exposure to temperatures above or below their optimal range can reduce their ability to respond to physiological stress and cause physiological abnormalities and stress [7]. Extreme temperature changes can lead to mass mortality of tilapia, while significant mortality occurs at 12°C [8]. Changes in aquatic thermal regimes could adversely affect fish populations, leading to declines in fisheries income and employment in most coastal nations, causing disruptions to the social-ecological systems of fisheries [9].

Water pH is an essential factor in the growth and survival of fish, with a pH range of 7-8 being optimal for Nile tilapia growth [10]. Ammonia toxicity is also influenced by pH, with higher pH leading to increased toxicity [11]. The study conducted in Uganda's Ibanda District evaluated the impact of water quality on aquaculture productivity [12]. To ensure the safety of aquaculture systems, daily pH variation should be kept within a range of 0.4, and the pH levels should be regularly monitored to prevent harmful effects on fish tissues, particularly the gills [13]. A study highlights the importance of salinity levels in fish growth, especially for tilapia. Salinity can affect the growth, survival, and food conversion ratio of fish. Salinity Additionally, pH levels can significantly influence Oreochromis Niloticus growth. Temperature also plays a crucial role in salinity tolerance and can affect the growth rate of young tilapia [10].

Additionally, pH levels can significantly influence Oreochromis Niloticus growth. Temperature also plays a crucial role in salinity tolerance and can affect the growth rate of young tilapia [10].

This research paper revolves around the issues fish owners face in optimizing feeding practices in aquaculture operations while reducing feed costs and minimizing waste. Neglecting the water temperature, salinity, and pH levels in fish ponds can decrease efficiency and feed costs [14]. Additionally, the current methods of calculating feed amounts based on the conditions of the water in the pond can lead to overfeeding or underfeeding of fish, further contributing to inefficient feeding practices [15]. Lastly, fish owners may need to remember to feed their fish on time, which can lead to suboptimal feeding practices and potentially negative impacts on fish health [16].

Aquaculture is an important industry that provides a significant amount of the world's seafood supply. The researchers designed an Android-based Feed Calculator for Oreochromis Niloticus farms to address these problems. The study aims to optimize feeding practices in aquaculture operations, reduce feed costs, and minimize waste.

Specifically, its objective is to implement an android-based application for Oreochromis Niloticus farms using measuring tools by comparing the average body weight of fish using three different feeding methods namely Estimated, BFAR and MABSCI App. The first two methods mentioned are the currently used techniques in feeding the fish. While the third method is the name of the Android-based Feed Calculator designed by the researchers.

Based on the research objectives, the hypothesis states that the there is no significant difference in average body weight between the three groups, regardless of the feeding ratio. Comparing the three methods, MABSCI may serve as a model for optimizing feeding practices in aquaculture operations. By analyzing the feeding practices and management techniques applied to MABSCI, aquaculture operations can potentially identify strategies to optimize feed utilization, reduce feed costs, and minimize waste. This may include fine-tuning the feeding schedule, adjusting the feed composition, or implementing feeding strategies based on the needs of the fish species being cultured.

## II. METHODOLOGY

Figure 1 shows the conceptual framework of the study. The following data’s are gathered which will serve as the input of the app. The three data’s namely temperature, pH and salinity are measured on a weekly. The average body weight is measured monthly, while the feed rate and stocking density will depend on the fish farmers. This processed data will be displayed in the app.

### *2.1 Research Design*

The researchers employed the quantitative method and used experimental design to implement an android-based feed calculator for Oreochromis Niloticus farms. This method requires gathering data on the pond water, such as temperature, pH, and salinity, weekly at different parts of the pond to achieve accuracy. The three parameters will be the basis for the equation used for the feed calculator, which helped calculate the right number of feeds.

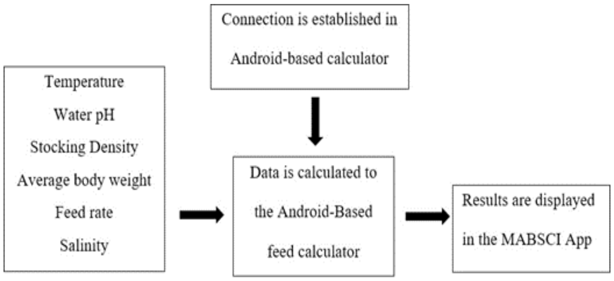

Fig.1. Conceptual Framework of Study

The results are compared to the number of feeds needed in terms of manual feeding or use of estimation, the amount of feed computed with the use of an equation from BFAR, and the amount of feed computed with the use of an equation from the MABSCI feed calculator and if there is any effect on the average body weight of the fish.

The respondents for this study are fish owners with experience in fish farming. The selected respondents know the essential water quality parameters such as temperature, salinity, and pH with the use of measuring tools. The study used convenience sampling to select six (6) fishermen or fish farm owners. The study also used cluster sampling to select water samples from fish farms.

### *2.2 Research Instrument and Data Collection*

In gathering the data, two testers were used, one for pH and

salinity and the other for temperature. Five designated spots were used in the pond for testing each parameter (pH, salinity, and temperature) to ensure data accuracy. The testers are dipped in the pond water to get the result, which will be calculated to get the mean for each of the five results for each parameter. This is done ones every week.

In getting the average body weight (ABW), the total weight will be divided to the total fish population. In getting the total weight, 2 to 3 tilapia fish are gathered from the pond and were weighed to determine the total weight of the fish. The gathered data's will be used in the MABSCI app.

The Evaluation with Fish Owners involves six (6) participants between 45 to 60 years old that will test the application, including various tools such as questionnaires to gather feedback on their experience with the feed calculator and identify areas for improvement.

### *2.3 Statistical Treatment of Data*

Several statistical treatments are used in analyzing data related to the Android-Based Feed Calculator project, depending on the research questions and data collected.

Descriptive statistics involves using mean, median, and standard deviation measures to summarize and describe the data collected. Descriptive statistics was used to describe the pond's temperature, salinity, and pH levels and the feed amounts calculated by the system.

T-test and ANOVA are used to compare the means of two or more groups. T- tests and ANOVA were used to compare the feed amounts calculated by the system for different temperatures, salinity, or pH levels in the pond.

### *2.4 Equation development*

*Eq.1. implemented daily feed ratio* $= F + G * L$

The equation implemented daily feed ratio = F+G * L, as seen from Equation 1, will be used to determine the amount of feed required to feed Nile tilapia daily based on the factors of feed conversion ratio [1], implemented feed conversion ratio (salinity) [17], and weight gain (pH) [18].

The feed conversion ratio (F) is the ratio of feed consumed by the fish to the weight gain of the fish and is dependent on feeding rate, stocking density, and average body weight. Salinity, temperature, and stocking density influence the implemented feed conversion ratio (G). Meanwhile, water temperature and pH influence weight gain.

Eq.2. F = feed conversion ratio = $(D/100)*E*C$

Equation F represents the feed conversion ratio (FCR), as seen in Equation 2, which measures the efficiency of feed utilization by the fish [1]. The amount of meal needed to create one unit of fish weight is used to determine the FCR where:

D = feeding rate (%)

E = stocking density

C = average body weight (g)

Eq.3. G = implemented feed conversion ratio (salinity)

$$= -0.1999 + 0.0476 * I + 0.0184 * K - 0.0027 * E - 0.003 * I * K - 0.0002 * I * E + 0.001 * K * E - 0.009 * I^\wedge 2 - 0.0009 * K^\wedge 2 - 0.0001 * E^\wedge 2$$

The equation for implemented feed conversion ratio (G) considers temperature, salinity, and stocking density and their interactions to calculate the ratio, as seen in Equation 3. The equation uses a combination of linear and quadratic terms for the variables.

The use of mathematical models to predict the dietary nutrient intake-growth response relationship in fish is essential due to the difficulty in measuring dietary digestion and absorption in the aquatic environment. This connection is widely understood and predicted using linear, exponential, and cubic formulae [19].

The model developed for FCR had a high determination coefficient (R2) of at least 98%, indicating that most of the variation in FCR could be explained by the three factors being tested rather than random noise [17].

Eq.4. L = weight gain (pH)

$$= 38.615 - 0.034 * 31 - 0.101 * 6.05 - 2.107 * I - 0.579 * J + 0.036 * (I\hat{}2)$$

Weight gain (L) in fish is based on temperature (I) and pH (J) using multiple regression analysis. Regression analysis is used to estimate the values of dependent variables based on the observed values of independent variables. A statistical model is used in regression analysis to simplify the connections between the dependent and independent factors [20].

The study found that increasing pH decreased feed conversion ratio (FCR) in one model tested, and stocking density had a significant positive effect on FCR in another model [18].

### 2.5 Prototype Development

Figure 2 shows the final output of the app. The group was able to resolve the issue regarding the alarm and having limitations of an input variable on parameters, temperature (- 2.6Â°C) to (58Â°C) pH (-3.6) to (14) salinity (0.5 ppt) to (37 ppt) feed rate (30%) to (2%) average body weight (5g) to (4535.92g). Then the group troubleshoots the issue regarding glitches and bugs in the Alarm feature. The group removed the notification. Instead, they add ringtones and label them to alert and remind the fish farmers.

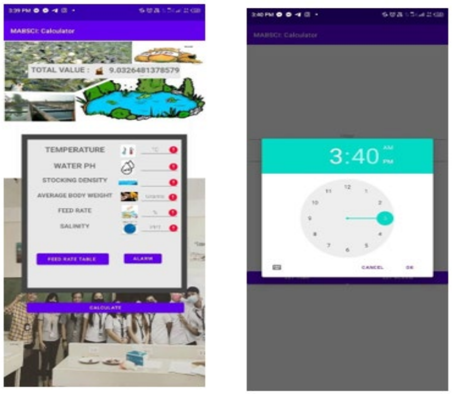

Fig.2. Final output of the app

## III. RESULTS AND DISCUSSION

### 3.1 Presentation of Statistical Tools

Table.1. Estimated feeding data from Week 1-4

| Variable | Week | Date | Daily feed ratio | Weight of fish |
|---|---|---|---|---|
| A1 | Week 1 | Mar 10-16 | 75.18 g | 58.073 g |
| A2 | Week 2 | Mar 17-23 | 75.774 g | 68.171 g |
| A3 | Week 3 | Mar 24-30 | 75.726 g | 74.531 g |
| A4 | Week 4 | Mar 31-onwards | 75.889 g | 79.833 g |

Table 1 presents data on the daily feed ratio and weight of fish for four weeks identified by the labels A1, A2, A3, and A4. The data investigate the effect of different feeding ratios on fish growth. Figure 3 shows that the daily feed ratio remained relatively constant across all weeks for each group, while the weight of the fish increased over time.

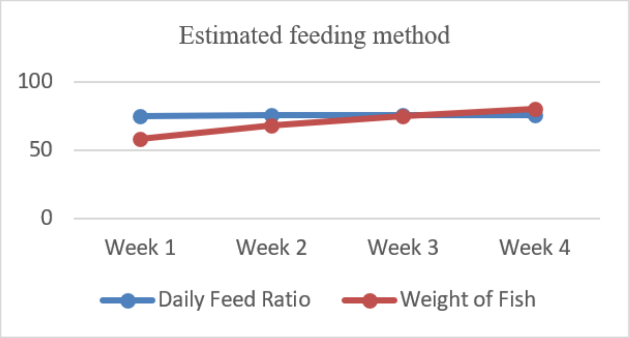

Fig.3. Estimated feeding method

Table.2. BFAR feeding data from Week 1-4

| Variable | Week | Date | Daily feed ratio | Weight of fish |
|---|---|---|---|---|
| B1 | Week 1 | Mar 10-16 | 57.1446 g | 63.494 g |
| B2 | Week 2 | Mar 17-23 | 61.8543 g | 68. 727 g |
| B3 | Week 3 | Mar 24-30 | 61.1496 g | 76.437 g |
| B4 | Week 4 | Mar 31-onwards | 65.728 g | 82.16 g |

Table 14 shows the result gathered from another pen that uses the method in accordance with BFAR as seen on Equation 2. It can be observed that the daily feed ratio for group B increased over time, while the weight of fish also increased identified by the labels B1, B2, B3, and B4. Figure 4 indicate that the increase in feed resulted in the increase in the weight of fish. The same goes for the remaining weeks.

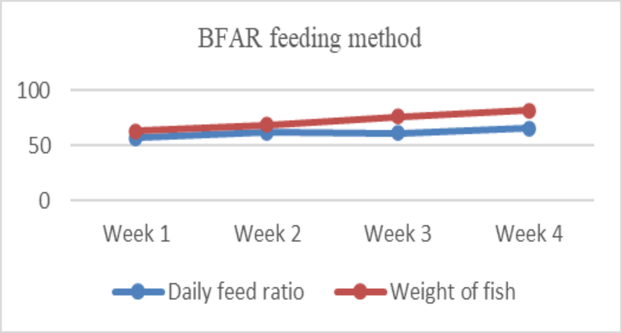

Fig.4. BFAR feeding method

Table.3. MABSCI feeding data from Week 1-4

| Variable | Week | Date | Daily feed ratio | Weight of fish |
|---|---|---|---|---|
| C1 | Week 1 | Mar 10-16 | 51.77548 g | 63.395 g |
| C2 | Week 2 | Mar 17-23 | 55.33296 g | 68.641 g |
| C3 | Week 3 | Mar 24-30 | 50.3153 g | 74.412 g |
| C4 | Week 4 | Mar 31-onwards | 52.39 g | 80.623 g |

Table 3 shows the result gathered from another pen that uses the method in accordance with MABSCI as seen on Equation 1. It can be observed that the daily feed ratio for group C increased over time, while the weight of fish also increased identified by the labels C1, C2, C3, and C4.

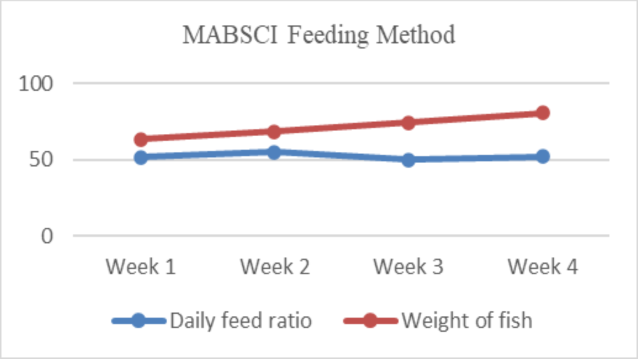

Fig.5. MABSCI feeding method

Figure 5 shows the graphical representation of the increase in weight of the fish from week 1 to week 4 using the MABSCI feeding method.

### 3.2 Analysis of Hypothesis

The group determined if there was a significant difference in the average body weight of fish between the three groups. The three groups were determined based on the method used to estimate their body weight: estimation, BFAR, and calculator. An ANOVA test was used to analyze the data and determine if there were any significant differences in the average body weight between the three groups. Table 16 shows the mean and standard deviation for each group.

Table.4. compares the means of three groups (A, B, and C) with respect to average body weight.

| Group 1 | Group 2 | Mean Difference | Standard Error | p-value | Significant ? |
|---|---|---|---|---|---|
| A | B | -11.35 | 3.41 | 0.015 | Yes |
| A | C | -15.63 | 3.41 | 0.001 | Yes |
| B | C | -4.28 | 3.41 | 0.543 | No |

Table.5. Pairwise comparison of the average body weight of fish for three different groups (A, B, and C)

| Week | A | B | C |
|---|---|---|---|
| Week 1 | 75.18 g | 57.1446 g | 51.77548 g |
| Week 2 | 75.774 g | 61.8543 g | 55.33296 g |
| Week 3 | 75.726 g | 61.1496 g | 50.3153 g |
| Week 4 | 75.889 g | 65.728 g | 52.39 g |

The results of the pairwise comparisons between Group A, Group B, and Group C indicate that there is a statistically significant difference in fish growth between Group A and Group B, as well as between Group A and Group C, based on the p-values (0.015 and 0.001 respectively) which are less than the significance level of 0.05. However, there is no statistically significant difference between Group B and Group C, as the p-value (0.543) is greater than the significance level of 0.05. These findings suggest that the feeding ratio may have a significant impact on average body weight between certain groups except BFAR and MABSCI equation.

### *3.3 Interpretation of Data for the Hypothesis*

Fig.6. shows the comparison of the daily feed ratio among the three groups (A, B, and C) over the four weeks of the study.

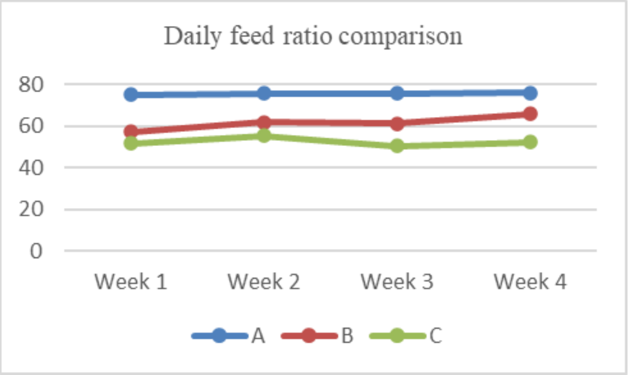

Fig.6. Daily Feed Ratio Comparison of 3 groups

- In Week 2, Group A still had the highest daily feed ratio at 75.774 g, followed by Group B at 61.8543 g, and Group C at 55.33296 g.
- In Week 1, Group A had the highest daily feed ratio at 75.18 g, followed by Group B at 57.1446 g, and Group C at 51.77548 g.
- In Week 3, Group A and Group B had similar daily feed ratios, with Group A at 75.726 g and Group B at 61.1496 g, while Group C had the lowest daily feed ratio at 50.3153 g.
- In Week 4, Group A had the highest daily feed ratio at 75.889 g, followed by Group B at 65.728 g, and Group C with the lowest daily feed ratio at 52.39 g.

Table 6 shows the comparison of the average body weight among the three groups (A, B, and C) over the four weeks of the study.

- In Week 1, Group B had the highest average body weight at 63.494 g, followed by Group C at 63.395 g, and Group A at 58.073 g.
- In Week 2, Group B still had the highest average body weight at 68.727 g, followed by Group C at 68.641 g, and Group A at 68.171 g.
- In Week 3, Group B had the highest average body weight at 76.437 g, followed by Group C at 74.412 g, and Group A at 74.531 g.
- In Week 4, Group B had the highest average body weight at 82.16 g, followed by Group C at 80.623 g, and Group A at 79.833 g.

It is important to note that Group C consistently had the lowest daily feed ratio among the three groups throughout the four weeks of the study, suggesting that Group C may have received a lower amount of feed compared to Group A and Group B during the study period as seen in Figure 18.

Table.6. Average Body Weight Comparison of 3 Groups

| Week | A | B | C |
|---|---|---|---|
| Week 1 | 58.073 g | 63.494 g | 63.395 g |
| Week 2 | 68.171 g | 68. 727 g | 68.641 g |
| Week 3 | 74.531 g | 76.437 g | 74.412 g |
| Week 4 | 79.833 g | 82.16 g | 80.623 g |

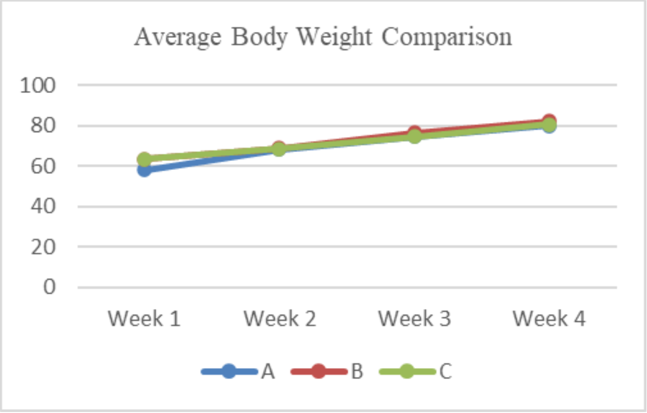

Fig.7. Average Body Weight Comparison

Group B consistently had the highest average body weight across all four weeks, followed by Group C, and then Group A. This suggests that Group B may have experienced slightly higher weight gain compared to the other two groups during the study period as seen in Figure 7.

## IV. CONCLUSIONS

Developing the Android-Based Feed Calculator for Oreochromis Niloticus Farmssignificantly contributes to aquaculture. The project's specific objectives were achieved by implementing an android-based application that measures the pond's temperature, salinity, and pH using measuring tools, provides a feed calculator for the conditions of the water, and notifies the farmer using an alarm for feeding time.

The study found that the participants found the app user-friendly, easy to navigate, and visually appealing. The app's purpose and features, including the alarm notifications and feed calculator, were also clear and easy to use. The app can potentially optimize feeding practices and reduce feed costs, minimizing waste and promoting ecological welfare. The notification feature is on time with the set alarm time. Overall, the Android-Based Feed Calculator for Oreochromis Niloticus Farms has significant technical benefits, industrial impact, and ecological welfare implications, making it a valuable tool for fish farmers and the aquaculture industry.

*RECOMMENDATIONS:*

Several recommendations can be implemented to improve the Android-Based Feed Calculator for Oreochromis Niloticus Farms. First, integrating Bluetooth technology into the system can help the farmer monitor the feed and water quality from a distance. Second, incorporating user feedback through surveys, interviews, or feedback forms can help make the application more suitable to non-technical person. Finally, expanding the features to include disease monitoring and water treatment can give the farmer a more comprehensive view of the farm's performance. These recommendations can help improve the system's effectiveness in improving farm performance, reducing production costs, and promoting ecological welfare. The researchers hope that this can serve as an instrument for future researchers.

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