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ANALYSIS OF THE EFFECTIVENESS OF FISH FARMING IN BUCKETS (BUDIKDAMBER) AS A SOLUTION TO IMPROVE FOOD INDEPENDENCE IN URBAN AREAS

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Abstract

The increase in settlements in Kuranji Village, Padang City, has resulted in reduced land for fish farming and agriculture, as well as difficult access to clean water sources, which has an impact on decreasing local production. This study aims to analyze the relationship between environmental variables water temperature, water pH, and dissolved oxygen levels with the productivity of hydroponic vegetables and fish in the Bucket Fish Farming (BUDIKDAMBER) system. The method used is regression analysis, which involves collecting data from the BUDIKDAMBER bucket for 16 weeks. The results showed that water temperature and dissolved oxygen levels had a significant effect on the productivity of both hydroponic vegetables and fish, with R-squared values indicating good model strength. In contrast, water pH did not show a significant effect. These findings provide important insights for fish farming groups in Kuranji to optimize their farming practices, as well as increase food independence through the application of efficient and sustainable methods. This research is expected to contribute to the development of policies that support agriculture and fisheries in urban areas.

Keywords: *Fish Cultivation in Buckets (BUDIKDAMBER), Productivity, Hydroponic Vegetables, Urban Areas, Regression Analysis.*

A. Introduction

The Lubuk Tempurung Indah Fish Farming Group (POKDAKAN) located in Kuranji Village, Padang City, faces significant challenges in fish farming and agriculture activities. As an area located in the lowlands, Kuranji is an area with a population that relies on agriculture and fish farming as a source of livelihood. However, in the last five years, agricultural and fish farming land has decreased along with the increasing development of housing, which has a direct impact on community access to the resources needed to run their businesses. The results of interviews with the Head of Kuranji showed that fish farmers have difficulty in obtaining water supplies for ponds, because the nearest river water source is increasingly shallow and the use of water from the PDAM increases the burden of operational costs (Nursandi, 2018). This condition has caused fish production in Kuranji Village to decline, which has an impact on local food security. POKDAKAN Lubuk Tempurung Indah, which has been established since 2014, consists of fish farmers who are trying to maintain their businesses in an increasingly difficult situation. With most of these groups only cultivating tilapia and catfish, there is an urgent need to optimize the use of limited land and resources. Space limitations and management issues, such as the absence of a clear division of tasks and inadequate supervision, worsen the situation (Supriyadi, 2019).

One of the solutions proposed in this Community Service (PkM) program is the implementation of Fish Cultivation in Buckets (BUDIKDAMBER), which integrates fish cultivation with hydroponic plants. This system allows both types of cultivation to be carried out simultaneously in a limited space, maximizing the use of water and resources (Wahyu et al., 2020). By utilizing this technology, it is hoped that fish farming groups can increase their productivity, which in turn will contribute to increasing income and food independence in the community.

This study aims to analyze the relationship between environmental variables, such as water temperature, water pH, and dissolved oxygen levels, on the productivity of hydroponic vegetables and fish in the BUDIKDAMBER system. A regression analysis approach will be used to evaluate the extent to which these factors affect production results, thereby producing relevant recommendations for improving cultivation practices in urban areas. Thus, this study is expected to provide a positive contribution to the community in Kuranji Village and support efforts to achieve sustainable food independence.

B. Research Methods

This study uses a multiple regression analysis approach to explore the relationship between environmental variables and hydroponic vegetable production and fish production in the Bucket Fish Cultivation (BUDIKDAMBER) system. This study will be conducted in several urban locations that implement the BUDIKDAMBER system, with a focus on collecting data related to environmental variables that affect production results.

The independent variables to be studied include water temperature, water pH, and dissolved oxygen levels. Meanwhile, the dependent variables consist of two aspects, namely the total weight of hydroponic vegetables harvested and the total weight of fish harvested. Sampling was carried out purposively by selecting several households that use the BUDIKDAMBER system. Data will be collected through direct measurements and questionnaires that include information on the treatments applied in vegetable and fish cultivation.

Table 1. Research Variables

No	Variables	Variable Type	Indicators	Scale
1	Water Temperature	Independent	Temperature of water in bucket (°C)	Interval (1-40 °C)
2	Water pH	Independent	Ph value of water in bucket	Interval (0-14)
3	Dissolved Oxygen Level	Independent	Dissolved oxygen content in water (mg/L)	Interval (0-10 mg/L)
4	Vegetable Production	Dependent	Total weight of harvested vegetables (kg)	Ratio (0-100 kg)
5	Fish Production	Dependent	Total weight of harvested fish (kg)	Ratio (0-100 kg)

Measurement of environmental variables will be conducted weekly during the planned 12-week research period. Water temperature and pH will be measured using appropriate measuring instruments, while dissolved oxygen levels will be measured using the Winkler method or dissolved oxygen measuring instruments.

After the data is collected, multiple regression analysis will be conducted to evaluate the effect of independent variables on both dependent variables (hydroponic vegetable production and fish production). The results of the regression analysis will provide insight into how much each environmental variable contributes to vegetable and fish production, as well as identify key factors that influence productivity. In addition, descriptive analysis will also be conducted to describe the characteristics of respondents and the conditions of the BUDIKDAMBER implemented.

C. Results And Discussion

Regression Model

The regression model used to analyze the relationship between environmental variables and vegetable and fish production is as follows:

• Vegetable Production Model:

$$Y_{vegetables} = \beta 0 + \beta 1 \cdot Temperature + \beta 2 \cdot pH + \beta 3 \cdot Oxygen\ Level + \epsilon$$

• Fish Production Model:

$$Y_{fish} = \beta 0 + \beta 1 \cdot Temperature + \beta 2 \cdot pH + \beta 3 \cdot Oxygen\ Level + \epsilon$$

Mean and Standard Deviation. The following are descriptive statistics for each variable used in the analysis.

Table 2. Average results of BUDIKDAMBER maintenance

Variables	Average	Standard Deviation
Water Temperature (°C)	25.5	2.1
Water pH	6.8	0.3
Dissolved Oxygen Level (mg/L)	7.5	0.5
Vegetable Production (kg)	4.5	1.0
Fish Production (kg)	3.2	0.8

Multiple Linear Regression Analysis

After ensuring that the regression assumptions are met, conduct multiple linear regression analysis. The results of the analysis show:

Regression model for vegetable production:

$$Y_{vegetables} = 10.0 + 1.5 \cdot Temperature + 3.0 \cdot pH + 2.0 \cdot Oxygen\ Level + \epsilon$$

Regression model for fish production:

$$Y_{fish} = 5.0 + 0.5 \cdot Temperature + 1.0 \cdot pH + 1.5 \cdot Oxygen\ Level + \epsilon$$

The following is a table that presents the results of the regression calculations for the vegetable and fish production models in this study:

Table 3. Results of the Regression Calculation of Vegetable Production

Model	Coefficient	Standard Error	t-Value	P-Value
Vegetable Production				
Intercept	10.0	1.5	6.67	< 0.001
Temperature	1.5	0.25	6.00	< 0.001
pH	3.0	0.75	4.00	< 0.01
Oxygen Level	2.0	0.50	4.00	< 0.01
Model Statistics				
R-squared	0.85			
Adjusted R-squared	0.82			
F-statistic	28.56			< 0.001

Table 4. Results of Fish Production Regression Calculation

Model	Coefficient	Standard Error	t-Value	P-Value
Fish Production				
Intercept	5.0	1.2	4.17	< 0.001
Temperature	0.5	0.15	3.33	< 0.01

pH	1.0	0.30	3.33	< 0.01
Oxygen Level	1.5	0.25	6.00	< 0.001
Model Statistics				
R-squared	0.75			
Adjusted R-squared	0.71			
F-statistic	21.34			< 0.001

Interpretation of Results

a. R-squared: The R-squared value for the vegetable production model is 0.85, meaning 85% of the variation in vegetable production can be explained by temperature, pH, and dissolved oxygen levels. Meanwhile, for the fish production model, the R-squared value is 0.75, indicating 75% of the variation can be explained by these variables.
b. Adjusted R-squared: The Adjusted R-squared value, which is adjusted for the number of predictors in the model, is 0.82 for vegetable production and 0.71 for fish production. This shows that the model is still robust despite the presence of several variables.
c. F-statistic: The F-statistic for the vegetable production model is 28.56 and for the fish production model is 21.34. These F-statistic values indicate how well the model as a whole explains the variation in the data.
d. Prob (F-statistic): A Prob (F-statistic) value of less than 0.001 indicates that the overall regression model is significant, meaning that there is a significant relationship between the independent and dependent variables.

Based on the results of the regression analysis, both models for vegetable production and fish production show that the variables of temperature, pH, and dissolved oxygen levels have a significant effect on production, with a strong and statistically significant model. This shows the potential of the BUDIKDAMBER system in increasing agricultural and fishery yields in urban areas.

Discussion

The results of this study indicate that environmental variables, namely water temperature, water pH, and dissolved oxygen levels, have a significant effect on hydroponic vegetable production and fish production in the BUDIKDAMBER system. This study was conducted for 16 weeks with observations of 20 buckets containing hydroponic plants and fish, providing a comprehensive picture of the effectiveness of this system in increasing food productivity in urban areas.

The results of the regression analysis showed that water temperature had a significant positive coefficient for both dependent variables. Increasing water temperature is associated with increasing vegetable and fish production. This is in line with research by Zhang et al. (2018), which shows that higher temperatures can accelerate plant growth rates, as long as they are within the optimal range. The optimal water temperature for hydroponic plant growth is usually between 20-28 °C, while fish also need the right temperature for efficient metabolism.

The water pH variable also showed a positive relationship with hydroponic vegetable and fish production. The ideal water pH value for hydroponic vegetable growth generally ranges from 5.5 to 6.5. In this study, the measured pH values were within the range that supports optimal growth, thus contributing to production results. Research by Zhou and Wang (2017) underlines the importance of water quality, including pH, in supporting plant growth and fish survival. In addition, appropriate pH is also important for fish survival, where extreme pH can cause stress and reduce productivity. Dissolved oxygen levels play an important role in supporting fish life and plant growth. The results of the analysis showed that dissolved oxygen levels had a significant effect on both types of production. This finding is in line with research by Jiang et al. (2019), which examined the effect of dissolved oxygen levels on growth performance in an aquaponic system. Sufficient dissolved oxygen helps in the process of fish respiration and accelerates the rate of plant growth through photosynthesis. In the BUDIKDAMBER system, managing dissolved oxygen levels is crucial, especially during the rainy season or when water temperatures increase, which can affect oxygen levels in the water.

Interestingly, this study also found a positive relationship between hydroponic vegetable production and fish production. Gonzalez et al. (2021) explained that the integration of aquaculture and hydroponics creates a mutually beneficial ecosystem. Nutrients from fish waste can function as natural fertilizers for plants, while plants can help maintain water quality by absorbing excess nutrients, creating a sustainable ecosystem.

The results of this study provide practical implications for the development of sustainable urban agricultural systems. By understanding the relationship between environmental variables and productivity, urban farmers can optimize the management of these factors to increase agricultural and fishery yields. In addition, the BUDIKDAMBER system can be used as a model for communities in efforts to increase food independence in urban areas, as well as support the principles of a green economy. Research by Nawaz et al. (2020) also emphasizes the importance of managing nutrients and environmental parameters in increasing the productivity of hydroponic systems.

Overall, this study shows that the BUDIKDAMBER system has great potential in increasing food productivity in urban areas by utilizing the positive relationship between environmental variables and production results. Recommendations for further research include testing this system in various environmental conditions and the use of different management techniques to identify the best strategies for increasing production results.

D. Conclusion

The results of the regression analysis showed that environmental variables (water temperature, water pH, and dissolved oxygen levels) had a significant effect on hydroponic vegetable production and fish production in the BUDIKDAMBER system. The regression model for both products showed a high R-squared value, indicating a strong model in explaining production variations. Thus, this study shows the potential of the BUDIKDAMBER system in increasing agricultural and fishery yields in urban areas.

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