# The Effect of pH and Water Level on Rice Productivity in Tidal Swamplands

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**Abstract:** The area of swamp land in Indonesia is spread across 5 (five) large islands, namely Sumatra, Java, Kalimantan, Sulawesi and Papua. The results of spatial analysis conducted by BBSDLP (2015) the area of swamp land in Indonesia is 34.12 million ha (17.92% of the total land area of Indonesia) consisting of tidal swamps of 8.92 million ha and lowland swamps of 25.21 million ha, spread across Sumatra 12.93 million ha, Kalimantan 10.02 million ha, Papua 9.87 million ha, Sulawesi 1.05 million ha, Maluku 0.16 million ha and Java 0.09 million ha. The aim of the research is to examine the formulation of the problem are analyzing the effect of water level and water pH on rice productivity at the research location. The F test shows that the variables of Water Level and Water pH together have a significant effect on rice productivity of 79.1%. The need for Operations and Maintenance Officers, the participation of both the Water Users Farmers Association (P3A) and the community as farmers to regulate the water level in rice fields so that it is in optimum condition so that it can increase rice productivity.

**Keywords:** pH; Rice Productivity; Tidal Swamplands; Water Level

## Introduction

Swampland areas have significant potential to be developed as agricultural land to support food security, particularly in regions with limited availability of dry land (Wignyosukarto et al., 2019). However, the utilization of swampland for agriculture requires appropriate management strategies due to its unique biophysical characteristics compared to non-swamp land (Koesrini et al,. 2017). One of the most critical factors in optimizing agricultural productivity in swampland areas is water management (Yulianto et al., 2020), as it directly affects soil conditions, nutrient availability, and crop growth (Herawati et al., 2020).

Water management in tidal swamplands must consider land hydrotopography as a fundamental aspect of planning irrigation systems (Bakri et al,. 2020). Hydrotopographic conditions serve as an initial consideration in determining appropriate water management strategies in tidal swamp areas (Suryadi et

al., 1986). Based on hydrotopographic characteristics, tidal swamplands are classified into flood types A, B, C, and D (Mawardi et al., 2020), each of which influences water level dynamics and soil chemical conditions differently (Kusnadi et al., 2022). Previous studies have shown that areas with certain hydrotopographic types (Putra et al., 2014), particularly downstream zones, tend to have higher iron (Fe) concentrations, which may adversely affect soil quality and crop growth (Mawardi et al., 2020). In addition, iron toxicity and soil acidity are common biophysical constraints encountered by farmers in lowland swamp agroecosystems (Annisa et al., 2021).

In practice, rice productivity in tidal swampland areas remains relatively low, including in South Kalimantan. One of the main contributing factors is the fluctuation of water levels, characterized by excessive inundation during the rainy season and insufficient water availability or drought during the dry season (Sukristiyonubowo et al., 2014). Such conditions trigger

the oxidation of iron compounds, leading to iron toxicity that disrupts rice plant growth (Alfarisy et al,. 2024). Pyrite, which is stable and harmless under saturated or anaerobic conditions, becomes reactive when groundwater levels decline below the pyrite layer, resulting in oxidation processes during the dry season (Hadi et al., 2018). These conditions highlight that improper water level management and unfavorable water pH significantly contribute to reduced rice productivity in tidal swampland areas (Lestari et al,. 2018), emphasizing the need for improved irrigation management to support sustainable agricultural production (Antralina et al,. 2022).

Previous studies have generally examined the effects of water level or soil and water acidity on rice productivity separately (Ariyanti et al., 2024). However, studies that simultaneously analyze the influence of water level and water pH based on field measurements over an extended period are still limited, particularly in tidal swampland areas of South Kalimantan. This study aims to analyze the effect of water level and water pH on rice productivity at the research location. Understanding the combined influence of these factors is crucial to support more effective water management strategies in tidal swamplands (Lestari et al,. 2019), which play an important role in increasing agricultural productivity and strengthening national food security (Blango et al,. 2019).

## Method

### Research Time and Location

This research was conducted over a period of six months, from November 2022 to April 2023. The research location was in the Terantang Swamp Irrigation Area, Barito Kuala Regency, South Kalimantan Province. The research objects included groundwater level (TMA), water pH, and rice productivity in tidal swamp areas. Data collection was carried out at 42 observation points representing the overall conditions of the irrigation area.

### Research Design

The research was conducted in several stages. The preparation stage included a literature review, hypothesis formulation, preliminary surveys, and planning of data collection. The research stage involved collecting primary and secondary data, including field measurements of water level and water pH, as well as rice productivity data (Hairani et al., 2023). The final stage consisted of data analysis, interpretation of results, and formulation of conclusions and recommendations.
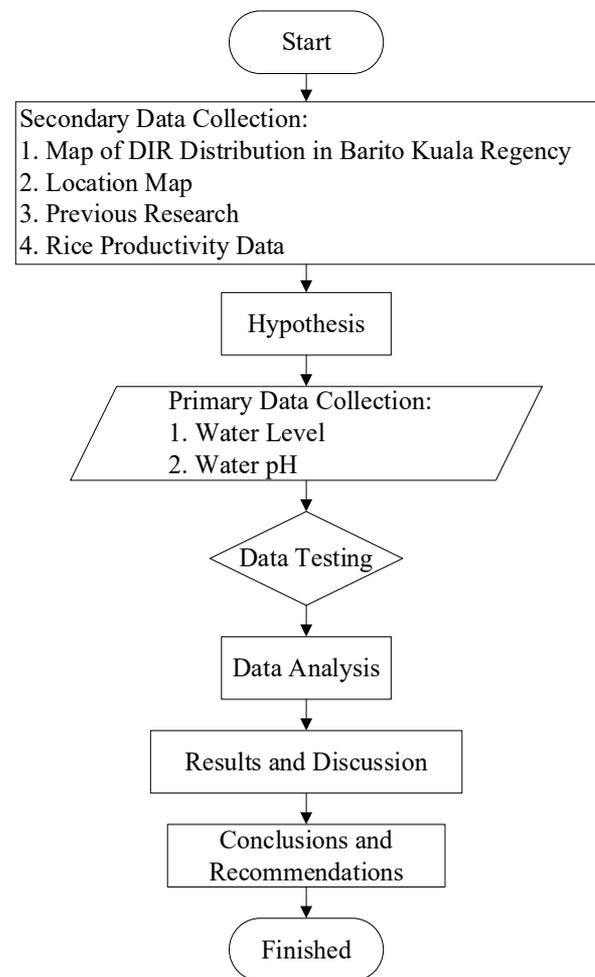


**Figure 1.** Research Flowchart

### Research Stage

The research was carried out in several stages. The preparation stage included literature study related to tidal land management (Mahdalena et al., 2025), determination of research hypotheses, preliminary surveys to identify field conditions and sampling points, and planning of data collection needs (Triadi et al., 2014). The research stage involved collecting primary and secondary data. Primary data consisted of direct measurements of water level and water pH in the field (Lestari et al., 2021), while secondary data included rice productivity (Mawardi et al., 2020) and supporting data obtained from relevant agencies (Alwi et al,. 2021). The final stage involved data processing, statistical analysis, interpretation of results, and formulation of conclusions and recommendations (Triana et al, 2021).

### Data Collection

The data used in this study consisted of primary and secondary data. Primary data included water level (TMA) and water pH obtained through direct field measurements. Water level data were measured using a piezometer made from a 4-inch PVC pipe, while water

pH was measured using a pH meter. Measurements were conducted every three days for six months, from November 2022 to April 2023, and each measurement was repeated three times with the average value used as representative data. Secondary data included rice productivity data for one planting season, land management data (Yudianto et al,. 2017), and supporting information obtained from the Agricultural Extension Center (BPP) of Belawang and Mandastana Districts, the Provincial Public Works Service, and the Kalimantan III River Basin Authority.

*Data Analysis*

Data analysis was conducted using statistical methods to evaluate the effect of water level and water pH on rice productivity (Erlianus et al,. 2021). The collected data were first tested for normality to ensure data distribution met statistical assumptions. Subsequently, simple linear regression analysis was used to analyze the individual effects of water level and water pH on rice productivity (Hidayanto et al., 2018). Multiple linear regression analysis was applied to examine the simultaneous influence of water level and water pH on rice productivity (Ruslan,. 2021). Hypothesis testing was performed using t-tests to evaluate partial effects and F-tests to assess simultaneous effects at a significance level of 5%. The coefficient of determination ($R^2$) was used to determine the proportion of rice productivity variation explained by the independent variables.

## Result and Discussion

*Data*

In the research on a analysis Influence Tall Water Face (TMA) and pH in Land Swamp Against Rice Productivity is carried out by collecting data on Water Level and pH directly in the field, while data on rice productivity is obtained from the Agricultural Extension Agency (BPP). Data collection on Water Level and pH in swampy areas was carried out for 6 months, namely from November 2022 to April 2023. And for rice productivity data used is during the Planting Period (MT) 1 month October 2022 to March 2023 in 42 locations according to the location of data collection on Water Level and pH. Water Level and pH data can be seen in the Appendix. Water Level and pH data are monitored every three days or three times a week, both data are then averaged monthly.

The Water Level and pH data for 6 months are averaged again, so that each location point becomes each TMA and pH only one data. The recap of the average data for 6 months can be seen in Table 1 for Water Level and Table 2 for water pH.

**Table 1.** Final Recapitulation Results of TMA Data

| Tertiary Salt | Point (Piezometer) | TMA (cm) |
|---|---|---|
| 09 Ki | 1 | 8.0 |
| | 2 | 7.0 |
| | 3 | 9.0 |
| 15 Ki | 4 | 5.0 |
| | 5 | 4.0 |
| | 6 | 18.0 |
| | 7 | 12.0 |
| 21 To | 8 | 14.0 |
| | 9 | 10.0 |
| | 10 | 13.0 |
| 27 To | 11 | 39.0 |
| | 12 | 23.0 |
| | 13 | 18.0 |
| 33 To | 14 | 10.0 |
| | 15 | 8.0 |
| | 16 | 14.0 |
| 39 To | 17 | 8.0 |
| | 18 | 10.0 |
| | 19 | 9.0 |
| 46 To | 20 | 6.0 |
| | 21 | 16.0 |
| | 22 | 7.0 |
| 10 Kn | 23 | 8.0 |
| | 24 | 8.0 |
| | 25 | 7.0 |
| 15 Kn | 26 | 11.0 |
| | 27 | 19.0 |
| | 28 | 12.0 |
| 21 Kn | 29 | 15.0 |
| | 30 | 20.0 |
| | 31 | 14.0 |
| 27 Kn | 32 | 5.0 |
| | 33 | 6.0 |
| | 34 | 0.00 |
| 33 Kn | 35 | 7.00 |
| | 36 | 4.0 |
| | 37 | 17.0 |
| 39 Kn | 38 | 5.0 |
| | 39 | 0.00 |
| | 40 | 17.0 |
| 46 Kn | 41 | 0.00 |
| | 42 | 0.00 |

Based on the averaged Water Level data for 6 months, there are 3 dry lands, namely the land on the Tertiary Ray 39 Kn channel, behind the land and Ray 46 Kn Middle and behind the land. There are 2 land locations with a Water Level of more than 20 cm, namely the Ray 27 Ki land in the middle and behind, while the others are more than zero and less than or equal to 20.

**Table 2.** Final Recap Results of Water pH

| Tertiary Salt | Point (Piezometer) | pH |
|---|---|---|
| 09 Ki | 1 | 5.83 |
| | 2 | 5.71 |
| | 3 | 5.67 |
| 15 Ki | 4 | 6.12 |
| | 5 | 5.93 |
| | 6 | 3.52 |
| 21 Ki | 7 | 6.36 |
| | 8 | 4.11 |
| | 9 | 3.88 |
| 27 Ki | 10 | 3.48 |
| | 11 | 3.46 |
| | 12 | 3.48 |
| 33 Ki | 13 | 3.01 |
| | 14 | 3.16 |
| | 15 | 3.39 |
| 39 Ki | 16 | 3.28 |
| | 17 | 3.04 |
| | 18 | 2.91 |
| 46 Ki | 19 | 3.89 |
| | 20 | 3.00 |
| | 21 | 2.97 |
| 10 Kn | 22 | 5.55 |
| | 23 | 5.47 |
| | 24 | 5.29 |
| 15 Kn | 25 | 5.27 |
| | 26 | 5.51 |
| | 27 | 5.51 |
| 21 Kn | 28 | 5.72 |
| | 29 | 4.47 |
| | 30 | 4.51 |
| 27 Kn | 31 | 5.49 |
| | 32 | 2.44 |
| | 33 | 2.00 |
| 33 Kn | 34 | 5.03 |
| | 35 | 2.72 |
| | 36 | 3.20 |
| 39 Kn | 37 | 5.15 |
| | 38 | 2.84 |
| | 39 | 0.00 |
| 46 Kn | 40 | 4.89 |
| | 41 | 0.00 |
| | 42 | 0.00 |

Based on the data of water pH results that have been averaged for 6 months, there are 3 fields that cannot be measured, namely Ray 39 Kn at the back and Ray 46 Kn in the middle and back. There are only 2 fields that have water pH ranging from 6 to 7, namely Ray 15 Ki and Ray 21 Ki in the front land. While the rest of the water pH is less than 6.

Finally, the rice productivity data obtained from the Agricultural Extension Agency in MT 1 for the period 2022 to 2023. Rice productivity data can be seen in Table 4. The rice productivity value ranges from 4.3 tons/ha to 5.9 tons/ha which is evenly distributed throughout the land. Meanwhile, at the Water pH Location where

productivity cannot be read, it is also not included or given a value of 0.

**Table 3.** Rice Productivity Results Data

| Tertiary Salt | Point (Piezometer) | Productivity (ton/ha) |
|---|---|---|
| 09 Ki | 1 | 5.8 |
| | 2 | 5.8 |
| | 3 | 5.6 |
| 15 Ki | 4 | 5.9 |
| | 5 | 5.5 |
| | 6 | 5.0 |
| 21 Ki | 7 | 5.9 |
| | 8 | 5.1 |
| | 9 | 5.5 |
| 27 Ki | 10 | 5.1 |
| | 11 | 4.7 |
| | 12 | 4.7 |
| 33 To | 13 | 4.9 |
| | 14 | 5.3 |
| | 15 | 5.5 |
| 39 To | 16 | 5.1 |
| | 17 | 5.3 |
| | 18 | 5.3 |
| 46 To | 19 | 5.5 |
| | 20 | 5.3 |
| | 21 | 4.9 |
| 10 Kn | 22 | 5.8 |
| | 23 | 5.8 |
| | 24 | 5.8 |
| 15 Kn | 25 | 5.8 |
| | 26 | 5.7 |
| | 27 | 5.3 |
| 21 Kn | 28 | 5.7 |
| | 29 | 5.2 |
| | 30 | 4.8 |
| 27 Kn | 31 | 5.3 |
| | 32 | 5.2 |
| | 33 | 5.1 |
| 33 Kn | 34 | 5.3 |
| | 35 | 5.2 |
| | 36 | 4.9 |
| 39 Kn | 37 | 5.3 |
| | 38 | 5.2 |
| | 39 | 0.00 |
| 46 Kn | 40 | 5.3 |
| | 41 | 0.00 |
| | 42 | 0.00 |

*Research Data Analysis*

This study examines three variables, namely the variables of Water Level, Water pH and Rice Productivity. Data analysis conducted is the Normality Test, T Test and F Test.

*Normality Test*

The distribution of points in the Normal QQ Plot Image of the Water Level Variable is relatively close to a

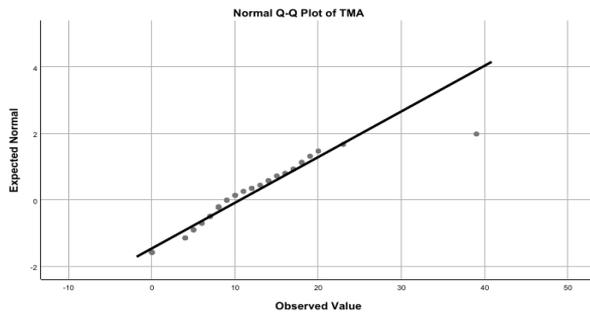straight line, so it can be concluded that the data is normally distributed.



**Figure 2.** Normal QQ Plot of Water Level Variable

The distribution of points in the Normal QQ Plot Image of the Water pH Variable is relatively close to a straight line, so it can be concluded that the data is normally distributed.
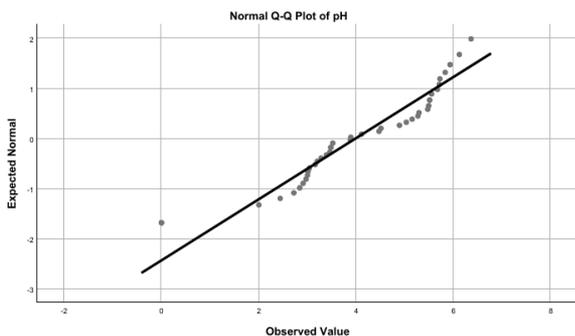


**Figure 3.** Normal QQ Plot of pH Variable of Water

The distribution of points in the Normal QQ Plot Figure of the Rice Productivity Variable is relatively close to a straight line, so it can be concluded that the data is normally distributed.
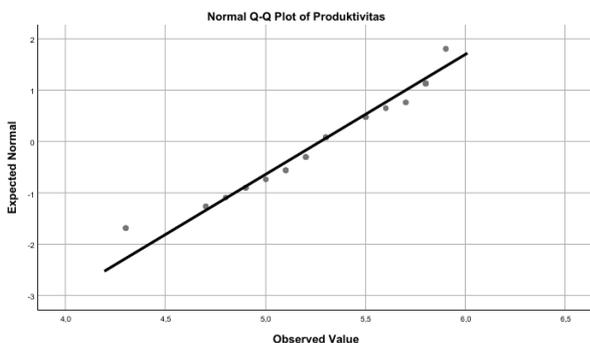


**Figure 4.** Normal QQ Plot of Rice Productivity Variables

In addition, the results of the normality test can be tabulated in Table 4. Data can be said to be normally distributed if the Significance value is more than the alpha value of 0.05. Based on the results of the Normality Test, the Significance value of the Water Level variable

is 0.096, the Significance value of the water pH variable is 0.140 and the Significance value of the Rice Productivity variable is 0.196. So, it can be concluded that the data in the three variables are normally distributed.

**Table 4.** Normality Test Results

| | Kolmogrov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| TMA | 0.125 | 42 | 0.096 | 0.897 | 42 | 0.001 |
| pH | 0.120 | 42 | 0.14 | 0.91 | 42 | 0.003 |
| Productivity | 0.114 | 42 | 0.196 | 0.937 | 42 | 0.022 |

*Simple Linear Regression*

The results of the Y = a +bx+ e simple linear regression analysis of the Water Level variable can be seen in Table 5 and the Water pH variable can be seen in Table 6.

**Table 5.** Simple Linear Regression Results for Water Level Variable

| Model | Unstandardized Coefficients | | Standardized Coeff. | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 5.346 | 0.118 | | 45.435 | 0.000 |
| TMA | -0.007 | 0.009 | -0.125 | -0.795 | 0.431 |

The results of this simple linear regression equation:
$\hat{Y} = 5.346 – 0.007 x + e$
Which means:
a. The constant value a = 5.346 means that if the Water Level variable is not included in the study, rice productivity will still increase by 5.346%.
b. The coefficient value b = -0.007 means that if the Water Level variable experiences an increase in water level, rice productivity will decrease by 0.007%.

**Table 6.** Simple Linear Regression Results of Water pH

| Model | Unstandardized Coefficients | | Standardized Coeff. | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 4.405 | 0.098 | | 44.719 | 0.000 |
| pH | 0.217 | 0.023 | 0.832 | 9.471 | 0.000 |

The results of this simple linear regression equation:
$\hat{Y} = 4.405 + 0.217 x + e$
Which means:
a. The constant value a = 4.405 means that if the water pH variable is not included in the study, rice productivity will still increase by 4.405%.

b. The coefficient value b = 0.217 means that if the pH variable experiences an increase in water pH, rice productivity will increase by 0.217%.

*Multiple Linear Regression*

The results of the multiple linear regression analysis can be seen in Table 7.

**Table 7.** Regression Coefficient

| Model | Unstandardized Coefficients | | Standardized Coeff. | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 4.531 | 0.087 | | 51.987 | 0.000 |
| TMA | -0.019 | 0.004 | -0.324 | -4.313 | 0.000 |
| pH | 0.236 | 0.02 | 0.903 | 12.037 | 0.000 |

The results of this multiple linear regression equation:

$\hat{Y} = 4.531 - 0.019\,X1 + 0.236\,X2 + e$

Which means:

a. The constant value a = 4.531 means that if the variables Water Level and Water pH are not included in the study, rice productivity will still increase by 4.531%.

b. The coefficient value $b_1 = -0.019$ means that if the Water Level variable experiences an increase in water level, rice productivity will decrease by 0.019% assuming the other independent variables are constant.

c. The coefficient value $b_2 = 0.236$ means that if the value of the water pH variable increases, rice productivity will increase by 0.236% assuming the other independent variables are constant.

*T-Test*

The t-test in multiple linear regression is intended to test whether the parameters (regression coefficients and constants) that are estimated to estimate the multiple linear regression equation/model are the right parameters or not. The meaning of right here is that the parameters are able to explain the behavior of the independent variables in influencing the dependent variables. The parameters estimated in linear regression include the intercept (constant) and slope (coefficient in the linear equation). In this section, the t-test is focused on the slope parameter (regression coefficient) only. So, the t-test in question is the regression coefficient test. The provisions used are if the probability value is less than 0.05 then H0 is rejected or the regression coefficient is significant, and if the probability value is greater than 0.05 then H0 is accepted or the regression coefficient is not significant.

Hypothesis:

- H 0 : b = 0, meaning that the Water Level variable has no real effect on Rice Productivity.
- H 1 : b ≠0, meaning the variable Water Level has a significant effect on Rice Productivity
  Hypothesis acceptance criteria:
- H 0 is accepted if the significance value is more than the alpha value of 0.05, meaning that water level has no real effect on rice productivity.
- H 1 is accepted if the significance value is less than the alpha value of 0.05, meaning that water level has a significant effect on rice productivity.

The significance value of the Water Level variable is 0.000, which is less than the alpha value of 0.05, it can be concluded that the Water Level variable has a significant effect on Rice Productivity or H0 is rejected and H1 is accepted.

The significance value for the water pH variable is also 0.000. Hypothesis:

- H 0 : b = 0, meaning that the pH variable of water has no real effect on rice productivity.
- H 1 :b 0, meaning the pH variable has a significant effect on rice productivity.
  Hypothesis acceptance criteria:
- H 0 is accepted if the significance value is more than the alpha value of 0.05, meaning that water pH has no real effect on rice productivity.
- H 1 is accepted if the significance value is less than the alpha value of 0.05, meaning that water pH has a real effect on rice productivity.

Where this value is also less than alpha 0.05 and it can be concluded that the water pH variable also has a significant effect on Rice Productivity or H0 is rejected and H1 is accepted. So that the results obtained based on the T Test of each variable Water Level and Water pH have an effect on Rice Productivity.

*F Test*

This test is intended to determine whether or not there is an influence of the independent variable together with the dependent variable. This test is also called the model feasibility test or more popularly known as the simultaneous model test. This test identifies whether the estimated regression model is feasible or not. Feasible here means that the estimated model is feasible to be used to explain the influence of the independent variables on the dependent variable.

**Table 8.** F Test Result

| Model | Sum if Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 5.926 | 2 | 2.963 | 73.894 | 0.000 |
| Residual | 1.564 | 39 | 0.040 | | |
| Total | 7.490 | 41 | | | |

Hypothesis:

- $H_0$: b = 0, meaning that the variables Water Level Height and Water pH have no significant effect on Rice Productivity.
- $H_1$:b 0, meaning that the variables Water Level and pH have a significant effect on Rice Productivity

Hypothesis acceptance criteria:

- $H_0$ is accepted if the significance value is more than the alpha value of 0.05, meaning that water level and water pH have no significant effect on rice productivity.
- $H_1$ is accepted if the significance value is less than the alpha value of 0.05, meaning that water level and water pH have a significant effect on rice productivity.

The results of the F test that can be seen in Figure 8 show that the significance value of the variables Water Level and Water pH together on Rice Productivity is 0.000 or less than the alpha value of 0.05. So, it can be concluded that together the variables Water Level and Water pH have a significant effect on the value of Rice Productivity or H0 is rejected and H1 is accepted.

*$R^2$ Test*

This test is intended to measure how far the independent variable influences the dependent variable. The R-Square value is 0.791, which shows that the proportion of the influence of the variables Water Level and Water pH on rice productivity is 79.1%. This means that rice productivity is 79.1% influenced by Water Level and Water pH, while 20.9% is influenced by other variables not listed in this linear regression modeling.

The effect of water level and water pH on rice productivity is quite large because it is close to 80%. Based on research data, the best water level for increasing rice productivity is around 5 cm to 10 cm and what should be avoided is a water level of more than 20 cm. While the best water pH value for increasing rice productivity is around 6 to 7, the lower the pH value, the lower the rice productivity. Together, the water level between 5 cm to 10 cm with a pH between 6 and 7 produces 5.9 tons/ha of rice or the highest productivity among lands that do not match the classification.

**Table 9.** $R^2$ Test Results

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | 0.889 | 0.791 | 0.781 | 0.200024 |

# Conclusion

After conducting the research and data analysis, it can be concluded that the t-test results show water table depth has a very limited effect on rice productivity, contributing only one point six percent, while water pH has a significant influence, accounting for sixty nine point two percent; meanwhile, the F-test indicates that water table depth and water pH simultaneously have a significant effect on rice productivity with a combined influence of seventy nine point one percent. Based on these findings and supported by previous studies, it is recommended that operation and maintenance officers, together with the active involvement of Water User Associations (P3A) and farmers, manage water levels in paddy fields to maintain optimal conditions and enhance rice productivity (Susilawati et al., 2016). Furthermore, the development of operation and maintenance manuals for regulating water table depth in tidal swamp areas is necessary (Saleh et al., 2023), and further research should be conducted to address the problem of low or acidic water pH in tidal swamp ecosystems.

**Conflicts of Interest**

The authors declare no conflict of interest.

# References

Alfarisy, D. A., Arif, C., & Purwanto, A. (2024). Pengembangan Model Identifikasi Air - Lingkungan - Tanaman untuk Budidaya Padi Sawah dengan Perlakuan Fine Bubble Technology. *Jurnal Teknik Sipil Dan Lingkungan*, *9*(2), 231–240. https://doi.org/10.29244/jsil.9.2.231-240

Alwi, M., Yusuf, W. A., & Fahmi, A. (2021). Improving productivity of rice yield on tidal swampland using soil amendment. *IOP Conference Series: Earth and Environmental Science*, *648*(1). https://doi.org/10.1088/1755-1315/648/1/012141

Annisa, Nugroho, Kurniasih, N. (2021). *Ilmu Pertanian ( Agricultural Science ) in lowland*. *9*(1), 51–56.

Antralina, M., Yuwariah, Y., & Simarmata, T. (2022). Effect of Water Level Management on Yield of Lowland Rice in Sobari System. *Ecodevelopment*, *2*(2), 59–62. https://doi.org/10.24198/ecodev.v2i2.39100

Bakri, B., Imanudin, M. S., & Chandra, W. L. (2020). Water Management and Soil Fertility Status at A Reclaimed Tidal Lowland of Telang Jaya Village, South Sumatra, Indonesia. *Journal of Wetlands Environmental Management*, *8*(2), 85. https://doi.org/10.20527/jwem.v8i2.228

Blango, M. M., Cooke, R. A. C., & Moiwo, J. P. (2019). Effect of soil and water management practices on crop productivity in tropical inland valley swamps. *Agricultural Water Management*, 222(May), 82–91. https://doi.org/10.1016/j.agwat.2019.05.036

Dwi Ariyanti, S., Nabila, U., Rahmawati, L., Syariah, M. E., Ampel, S., Pascasarjana, D., Syariah, E., & Surabaya, I. (2024). Pemenuhan Kebutuhan Produksi Beras Nasional Dalam Meningkatkan Kesejahteraan Masyarakat Menurut Perspektif Ekonomi Islam Fulfilling National Rice Production Needs in Improving Public Welfare According to an Islamic Economic Perspective. *Jurnal Ekonomi Syariah Dan Bisnis*, 7(1), 82–93. https://doi.org/10.31949/maro.v7i1.9121

Erlianus, Radian, & Ramadhan, T. H. (2021). Pengaruh Berbagai Varietas dan Tinggi Muka Air Terhadap Pertumbuhan dan Hasil Padi (Oryza sativa L.) Pada Tanah Alluvial. *Agriprima : Journal of Applied Agricultural Sciences*, 5(2), 138–149. https://doi.org/10.25047/agriprima.v5i2.402

Hadi, H., & Chalil, D. (2018). Effect of Irrigation on the Changes in Wetland Rice Productivity (Oryza Sativa L.) due to a Climate Change in North Sumatra Province. *Indonesian Journal of Agricultural Research*, 1(1), 51–57. https://doi.org/10.32734/injar.v1i1.183

Hairani, A., Alwi, M., Noor, M., Saleh, M., Khairullah, I., & Wakhid, N. (2023). Rice productivity on the swampland flooded tide: The case of Terusan Karya Village. *E3S Web of Conferences*, 444, 1–10. https://doi.org/10.1051/e3sconf/202344404013

Herawati, H., Yulianto, E., & Azmeri. (2020). Pengaruh Hidrotopografi dan Peruntukan Lahan Terhadap Saluran Tersier Daerah Rawa Pinang Dalam. *Jurnal Saintis*, 20(01), 1–10. https://doi.org/10.25299/saintis.2020.vol20(01).4698

Hidayanto, M., Noor, M., Fiana, Y., Witardoyo, D., & Darwin. (2018). *Pengkajian Budidaya Padi Melalui Pengelolaan Lahan dan Air di Lahan Rawa Pasang Surut*. 1–39.

Huda, N., Umyati, S., & Sulaksana, J. (2024). Pengaruh Pengelolaan Air Dan Bahan Organik Terhadap Produktivitas Air Dan Potensi Hasil Padi (Oryza sativa L). *Journal of Innovation and Research in Agriculture*, 3(1), 40–48. https://doi.org/10.56916/jira.v3i1.801

Koesrini, K., Saleh, M., & Nurzakiah, D. S. (2017). Adaptabilitas Varietas Inpara di Lahan Rawa Pasang Surut Tipe Luapan Air B pada Musim Kemarau. *Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy)*, 45(2), 117. https://doi.org/10.24831/jai.v45i2.13559

Kusnadi, H., Fauzi, E., Ishak, A., Firizon, J., Eka Putra, W., Riset dan Inovasi Nasional, B., & Pertanian Kabupaten Bengkulu Selatan, D. (2022). Produktivitas Padi Di Lahan Rawa Dengan Kapur Dolomit Rice Productivity in Swamp Land With Dolomit Lime. *Jurnal Pertanian*, 13, 47–53.

Lestari, G. A., Rahmadi, & Harahap, T. (2018). Kajian Kesesuaian Lahan Irigasi Rawa Pasang Surut Berdasarkan Pola Ruang Di Delta Telang II Kecamatan Tanjung Lago Kabupaten Banyuasin. *Seminar Nasional Hari Air …*, 2(1), 46–57.

Lestari, H. W., Putranto, D. D. A., & Sarino. (2019). The Influence of Operation and Maintenance Activities on Water Management of Tinondo Swamps Irrigation Area at East Kolaka Regency, Southeast Sulawesi Province, Indonesia. *Journal of Physics: Conference Series*, 1198(8). https://doi.org/10.1088/1742-6596/1198/8/082014

Lestari, S., Sumsanto, M., Anugerah, P., Sari, S. R., Bimon, P., Perikanan, I., Selatan, U. S., Perikanan, I., Selatan, U. S., Perairan, B., Asahan, U., Perikanan, I., & Selatan, U. S. (2021). *Jurnal Ilmu Perikanan Air Tawar ( Clarias ) Vol 2 No 2 , 13 Oktober Tahun 2021 e-issn : ISSN Online : 2774-244X Analisis pH Air pada Lahan Rawa Pasang Surut Sebagai Potensi MINAPADI di Desa Sungai Dua Analysis of pH Water in Tidal Swamp Land as a Potentia*. 2(2), 1–4.

Mahdalena, Z., & Aditya, M. R. (2025). Analysis of the Biophysical Conditions of Type A Tidal Swamp on Production Results and the Development of Siam Pandak Rice Farming in Barito Kuala Regency. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, 13(4), 1092–1112. https://doi.org/10.33394/j-ps.v13i4.17625

Mawardi, Hendro Sunarminto, B., Heru Purwanto, B., Sudira, P., & Gunawan, T. (2020). The Influence of Tidal on Fe Distribution at Tidal Swamp Rice-Farming in Barito River Area, South Kalimantan, Indonesia. *BIO Web of Conferences*, 20, 3–8. https://doi.org/10.1051/bioconf/20202002002

Putra, I. S., & Istianto, H. (2014). Dampak Perubahan Muka Air Laut pada Daerah Rawa dengan Irigasi Pasang Surut: Pemodelan Daerah Rawa Tabunganen. *Jurnal Tanah Dan Iklim*, Gambar 1, 43–49.

Ruslan, K. (2021). Produktivitas Tanaman Pangan dan Hortikultura Kadir Ruslan. *Jurnal Tanaman Pangan Hortikulrura*, 2(July), 7–12.

Sukristiyonubowo, Wibowo, H., Sosiawan, H., & Setyorini, D. (2014). Water productivity of newly developed lowland rice field. *Jurnal Tanah Dan Iklim*, 38(1), 63–68.

Suryadi. (1986). *Daftar pustaka. 1992*, 1229–1238.

Triadi, L. B., & Gifariyono, M. (2014). Dampak Kenaikan Muka Air Laut Terhadap Kesesuaian Lahan Rawa Pasang Surut Tabunganen Kalimantan Selatan. *Jurnal Sumber Daya Air*, *10*(2), 99–112.

Triana, N. A., Purnomo, H. R., & Khalid, F. (2021). 28888-Article Text-135896-1-10-20210511. *Jtep Jurnal Keteknikan Pertanian*, *9*, 9–16.

Wignyosukarto, B. S., & Santoso, H. (2019). Optimization of Spatial Planning of Tidal Swamp Area To Support the Community Evelopment of Buol Regency, Indonesia. *Icid.Org*, *September*, 1–7.

Yudianto, E. F., Andawayanti, U., & Prayogo, T. B. (2017). Penanganan Kebutuhan Air Dan Keracunan Pirit. *Jurnal Teknik Pengairan*, *8*, 89–99.