

## Channels Stability in Reclaimed Tidal Swamp Areas

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### Abstract

This study aimed to agricultural productivity in the area reclaimed tidal marsh. The location of research is reclaimed tidal delta region Telang I Primary 8 representing land typology A/B and the survey was conducted at 13 South Secondary scheme following tertiary in Telang I. To assess of the agricultural productivity, has surveyed farmers who are farming in the scheme of P8-13S Telang Karya Makmur District of Banyuasin. Each farmer respondents interviewed in person using a questionnaire. Based on the analysis of the survey data, successively presented the results of a study on the use of farm production factors, productivity, and the factors that influence the stability of the channel including the effect on productivity. The results study was a seed, fertilizer, and pesticide variables have a significant positive effect up to a 5% confidence level in increasing rice production, while labor and channel variables do not have a significant positive effect. The coefficient of determination  $R^2$  of 0.471 means that the rice production variable in the P8-13S scheme can be explained by the variables of seeds, fertilizers, pesticides, labor and canals by 47.10% while the remaining 52.91% is determined by other factors such as rainfall, tidal heights, manufacture of valve doors in ducts and duct maintenance. The value of Production Elasticity (VPE) is 1.177 (elastic). This means that in general rice production is still in a condition of increasing business scale (Increasing Returns to Scale).

**Keywords:** Channels stability, production factors, correlation variable

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Date of Submission: 05-02-2026

Date of acceptance: 16-02-2026

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### I. INTRODUCTION

Indonesia has the potential land for agriculture area of approximately 162.4 million ha, most of the potential land consists of swamp areas covering 33 393 million ha, divided into 20 097 million ha of tidal marsh and 13 296 million ha of lowland swamp scattered on the island of Sumatra, covering 9:37 million ha, Kalimantan area of 11.707 million hectares, an area of 1.793 million ha Sulawesi and Papua, an area of 10.522 million ha.

The Swampy area that has been reclaimed by the government has reached 1.8 million ha by the private and public sectors around 2.1 million hectares for a total of 3.9 million hectares, but land productivity achieved is still low at an average of 3 tons/ha.

This is due to a lack of attention to the Operations and Maintenance (O&M) where the activities carried out at this time are limited, namely, the maintenance carried out on the initiative of farmers in tertiary channels without building doors valve.

Study data inventory marsh area western region and the eastern region, we concluded that of the total area of reclaimed swampland that there are 1.8 million ha 0.8 million ha of swampland abandoned or unused land. The land is caused by many things, including the network of the existing water system is less than optimal, because the flow of the existing system is not appropriate. Besides, the channel conditions and waterworks also has not been rehabilitated plus-optimal channel maintenance both on a micro and macro water system.

Stability of channel has been conducted with various model scenarios Operation & Maintenance (O & M) produced a prototype in the stable channel tidal marsh area. Channel stability alleged impact on agricultural productivity. Therefore, according to the research objectives influence the stability of the channel on rice production, analysis is needed to prove whether the stability of the channel effect on agricultural productivity.

Criteria stable is no erosion and sedimentation in the channel with the channel condition of equilibrium. Although erosion and sedimentation, it is merely a momentary material on the channel does not affect the general condition of the channel.

To assess the effect of the channel on the productivity of agriculture has surveyed 50 farmers to farm in the P8-13S Telang scheme Karya Makmur District of Banyuasin. Each farmer respondents were interviewed in person using a questionnaire.

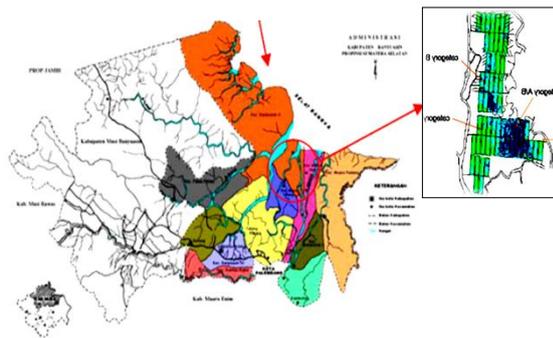
Based on the analysis of the survey data, successively presented the results of a study on the use of farm production factors, productivity, and the factors that influence the stability of the channel including the effect on productivity.

**II. MATERIAL AND METHODS**

This research was conducted in the Delta region Telang I, which is a swampy area in the province of South Sumatra, also reclaimed the second generation following the double-grid design layout (Rib System) along with Telang II, Delta Saleh and Air Sugihan [1].

The next design for an open channel system is prepared by the Institute of Technology Bandung (ITB). The system consists of the mainline (also used for navigation), secondary channels, and tertiary channels. Figure 1 (a) is the map of the research location.

Geographically, the region Telang I is located at 02° 29' to 02° 48' latitude and 104° 30' until 104° 52' east longitude. Generally Telang I is located in the north bordering the Strait of Bangka, south bordering the river, By contrast, the east with the river Musi and the west bordering the river Telang I.



**Figure 1: Research location**

**Table 2.** List of the tools used in the study

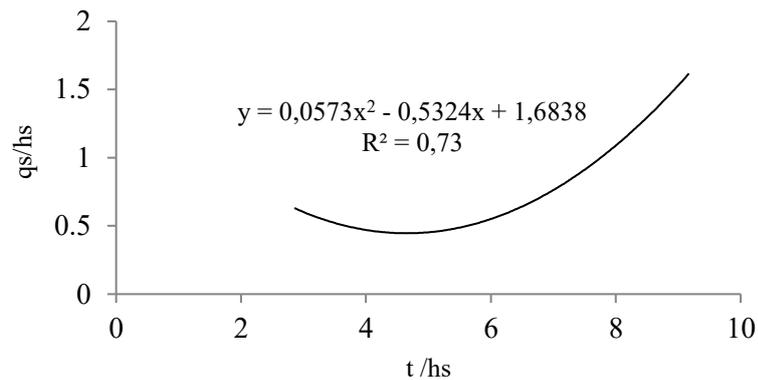
Channels	Infield		Model		Error percentage	
	Erosion (m <sup>3</sup> )	Sedimentation (m <sup>3</sup> )	Erosion (m <sup>3</sup> )	Sedimentation (m <sup>3</sup> )	Erosion	Sedimentation
Rural Channel	3,301,859	809,232	3,419,184	963,836,56	1.04	1.19
Main Drainage Channel	3,349,103	898,467	3,419,184	3,419,184.75	1.02	3.81

Dimension analysis of several parameters related to the effect of flow hydraulics on channel stability includes changes in water level at high tide and low tide, channel depth, and stability of the channel itself.

From the three parameters above, a parameter relationship can be made related to each other, namely:

- a. Fixed parameters, namely: qs
- b. Variable parameters, namely: t, hs, and Ks
- c. Other parameters, namely: land area and water management and distribution

From the three parameters above, a parameter relationship can be made related to each other, namely: (qs/hs); (t/hs) is proportional to the stability of the channel itself. More clearly can be seen in the comparison graph: St versus (qs/hs) and St versus (t/hs) in Fig. 2



**Figure 2.** The relationship between qs/hs vs t/hs

From Fig. 2, the  $R^2$  determinant value of 0.73 means that the hydraulic variable of the channel can be explained by discharge, depth, and tidal height changes in the channel by 85.44% while the remaining 14.56% is explained by other factors outside the model.

This means that if the increase in erosion and sedimentation of the channel is only influenced by the variables of discharge, depth and height change of the tidal water, the chance for a stable channel is 85.44%, while the remaining 14.56% is determined by other factors such as rainfall, production valve door in the channel and maintenance of the channel both regularly and routinely.

### 2.1. Impact of the Channel Stability

Some of the analysis in this study was carried out by surveying farmers in the P8-13S scheme. The survey method in this research is to see whether the influence of channel stability on agricultural production in this case rice production.

### 2.2. Population and sample

This study uses primary data collected from a survey conducted on the group of Water User Farmers (WUF) in the village of Telang Karya P8-13S Telang I as many as 50 farmers in each tertiary channel.

### 2.3. Data collection methods

Data for this study were collected and collected using data collection methods including:

- Documentation

The documentation method was carried out mainly to obtain data on input and output variables that were already available and this method was also carried out on publications, reports, literature books, journals, and papers to support this research.

- Observation

Observations made in this study are observations by observing and recording during observations, especially to get the variables in the study.

### 2.4. Technique of Analysis

In this study multiple regression analysis is used in the form of logarithms [2]. Besides, descriptive statistics are used to describe the general conditions of the study area [3]. The model used is the Cobb-Douglas production function, intended to analyze whether there is a relationship between rice production as a dependent variable with production inputs as the factors that influence it.

Analysis of the relationship between the parameters of channel stability in productivity was chosen in this study because it is directly related to environmental conditions that affect Operation and Maintenance activities. This is a simple case, where production directly influences various input parameters.

Therefore, the function of several variables including the purchase of seeds, fertilizers, pesticides, labor, and channel stability a dummy variable. Mathematically can be written as follows:

$$Y_s = f(X_s) \quad (1)$$

where:

$Y_s$  = Rice production

$X_i$  = Input variable (  $i = 1, 2, 3, 4, n$  )

Specifically, the function above can be formulated as follows:

$$Y_s = \beta_0 X \beta_{1i} + X \beta_{2i} + X \beta_{3i} + X\beta_{4i} + \beta_{5i} \quad (2)$$

Where:

$\beta_i$  = Estimated parameters;

$i = 1,2,3,4,\dots,\dots, n$ .

The production function can be described in various mathematical forms. For this reason, Cobb-Douglas function forms and translog functions are often used [4]. The Cobb-Douglas function form is a simple model of the production function. This model is a logarithmic transformation of variables that provides a simple straight line in estimating parameters to facilitate the interpretation of economic values [4]. However, this form of function has a limited scale assumption in the analysis. The Cobb-Douglas production function can be explained as follows:

$$\ln Y_s = \beta_0 + \beta_1 \ln S + \beta_2 \ln F + \beta_3 \ln Pst + \beta_4 \ln L + \beta_5 \ln D_{SS} \quad (3)$$

where:

$Y_s$  = Production

$S$  = Seed

$F$  = Fertilizer

$Pst$  = Pesticide

$L$  = Labor

$D_{SS}$  = Stable Channel(*Variabel Dummy*);

0 = without channel maintenance, and

1 = with cahnnel maintenance

The form of the translog function can interact between variables and parameters so that it can be estimated. This form of function is very suitable for multi-colinearity [3]. Translog production functions like the form below:

$$\ln Y_s = \alpha_0 + \sum_{i=1}^n \alpha_i \ln X_i + \sum_{i=1}^n \sum_{j=1}^n \beta_{ij} \ln X_j + \beta_3 \ln X_i \ln X_j + \varepsilon \quad (4)$$

where:

$Y_s$  = Production

$\alpha$  and  $\beta$  = Estimated parameters

$X_i$  and  $X_j$  = Input variable

In this study, the translog function above is included in the scope of production as in the formula (4)

$$\begin{aligned} \ln Y_s = & \alpha_0 + \alpha_1 \ln S + \alpha_2 \ln F + \alpha_3 \ln Pst + \alpha_4 L + \alpha_5 D_{SS} + \beta_1 (\ln B)^2 \\ & + \beta_2 (\ln F)^2 + \beta_3 (\ln Pst)^2 + \beta_4 (\ln L)^2 + \alpha_5 D_{SS} + \beta_6 \ln S \ln F \\ & + \beta_7 \ln S \ln Pst + \beta_8 \ln S \ln L + \beta_9 \ln F \ln Pst \\ & + \beta_{10} \ln F \ln Pst + \beta_{11} \ln F \ln L + \beta_{12} \ln Pst L \end{aligned} \quad (5)$$

The Cobb-Douglas production function and the Translog function are estimated using regression analysis [4,5]. In this case comparing the two estimation functions made to calculate the basic function of water distribution from several criteria such as goodness-of-fit of each estimate function, relative significant figures, and interpretation of estimated coefficients [4,5].

#### IV. RESULTS AND DISCUSSION

Research on channel stability that has been carried out under various scenarios has obtained a suitable pattern for channels in tidal swamp areas. Hydraulically stable lines will have an impact on agricultural productivity.

Therefore, following the objectives of the third phase of research, it is necessary to research how far the influence of stable channels on productivity.

The stable criterion is that there is no erosion or sedimentation in the channel with equilibrium channel conditions. Although erosion and sedimentation occur, it is only a momentary material transfer to the channel without affecting the condition of the channel in general.

To assess the effect of stable channels on productivity, an activity was conducted with a survey of farmer groups belonging to the P3A of Telang Karya village of 50 respondents where each farmer was interviewed and filled out questionnaires directly. Based on the survey, the results obtained are presented in the following section.

The use of factors Productivity from the factors of production can be reflected in marginal production. Marginal products are additional production obtained as a result of the addition of the number of production factors used. This model is a logarithmic transformation of variables that provides a simple straight line in estimating parameters to facilitate the interpretation of economic values [4]. However, this form of function has a limited scale assumption in the analysis.

The descriptive-analytic research approach and the model used is the Cobb-Douglas production function which is intended to analyze whether there is a relationship between rice production as a dependent variable with production inputs as the factors that influence it. The production function itself is influenced by several variables including Seed, fertilizer, pesticides, labor, and the channel itself.

In carrying out the approach as mentioned above, the authors describe the data collected by the method of direct interviews individually by collecting farmers in the form of Focus Group Discussion (FGD) and then analyzing interview data with respondents about the stable channel and factors of production in Intent as in table 2.

**Table 2.** Descriptive Statistics

	Mean	Std. Deviation	n
Production	27970800.00	1.258E7	50
Seed	608100.00	88850.310	50
Fertilizer	723600.00	257646.412	50
Pesticide	689580.00	219526.493	50
Labor	7222810.00	1119942.268	50
Channel	0.54	0.503	50

**Table 3.** Results of data analysis interviews with respondents

Variable	Units	Mean	Standard of Deviation
Land Area	ha	1.83	0.95
Production		2.79	0.57
Productivity	ton/ha	1.52	0.88
Income	Rp. 10 <sup>6</sup>	27.90	12.58
Seed	Rp. 10 <sup>6</sup>	1.11	0.08
Fertilizer	Rp. 10 <sup>6</sup>	1.32	0.25
Pesticide	Rp. 10 <sup>6</sup>	1.26	0.21
Labor	Rp. 10 <sup>6</sup>	7.22	1.11
Channel	-	0.54	0.50

#### 4.1. Classical Assumption Test

Before the data is interpreted, classical assumption testing is carried out to obtain an unbiased estimate. The classic assumption testing conducted in this study includes the multicollinearity, autocorrelation, and heteroscedasticity tests.

#### 4.2. Multicollinearity Test

Multicollinearity occurs if there is a perfect or certain relationship between several variables or all independent variables in the model. In the case of serious multicollinearity, the regression coefficient no longer shows the pure influence of the independent variables in the model. Multicollinearity means that there is a perfect or certain relationship between several variables or all variables that explain the regression model [5].

Multicollinearity testing is done by looking at the value of VIP (Variance Inflation Factor). If the VIP value of each variable is observed > 10, it is assumed that there is a relatively large multicollinearity problem [5].

**Table 4.** Collinearity Diagnostics

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions					
				(Constant)	Seed	Fertilizer	Pesticide	Labor	Channel
1	1	5.406	1.000	0.00	0.00	0.00	0.00	0.00	0.01
	2	0.408	3.639	0.00	0.00	0.01	0.01	0.00	0.83
	3	0.107	7.097	0.00	0.00	0.38	0.27	0.00	0.00
	4	0.061	9.426	0.02	0.12	0.14	0.42	0.00	0.04
	5	0.012	21.457	0.02	0.31	0.47	0.29	0.70	0.05
	6	0.006	29.295	0.97	0.56	0.00	0.01	0.30	0.07
a. Dependent Variable: Production									

Table 4 is the Collinearity Diagnostics from SPSS statistics analysis and the results of calculations using SPSS obtained values in Table 5.

**Table 5.** Multicollinearity Testing

No.	Variable	VIP value	Note
1	Seed (ln X <sub>1</sub> )	1.112	Multicollinearity free
2	Fertilizer	1.593	Multicollinearity free
3	Pesticide	1.232	Multicollinearity free
4	Labor	1.829	Multicollinearity free
5	Channel	1.185	Multicollinearity free

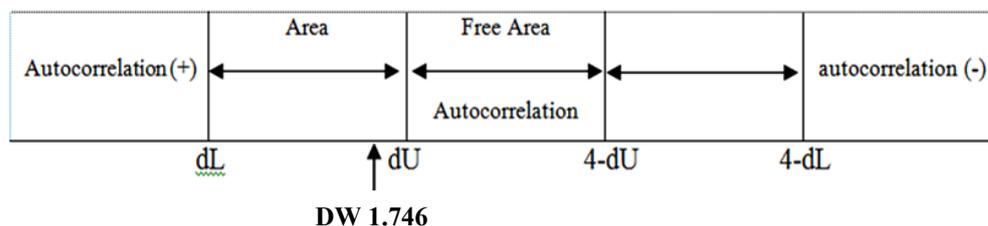
From Table 5 it can be seen that the VIP values of all multicollinearity independent variables with values are well below 10 so that it can be concluded that in the data there is no classic deviation of multicollinearity assumptions.

**4.3. Autocorrelation Test**

Autocorrelation is the relationship/correlation between members of the observation sorted by time (in time series) or space [5].

The consequence of autocorrelation is that the confidence interval becomes wide and the variation and standard error are estimated to be too low, the next result is that the tests using the t and F tests are invalid and if applied will give serious misleading conclusions about the statistical significance of the estimated regression coefficients. Testing the presence or absence of autocorrelation in this regression equation is done by looking at the state of the Durbin Watson value (DW test).

From the calculation results, the Durbin Watson (DW) mapping test obtained a DW number of 1.746. With the number of data (n) equal to 50 and the number of variables (k) equal to 5 and  $\alpha = 5\%$ , the number dL = 1.542 and dU = 1.776



**Figure 5.** Durbin Watson (DW) test results

Fig.5 be seen that the calculated DW value is located between  $dL < DW < dU$  or the area of hesitation approaching the autocorrelation free area, then the model can be said to contain little autocorrelation symptoms but can still be tolerated.

**4.4. Heteroscedasticity Test**

An important assumption of the classic linear regression model is that the disturbances (Disturbance Standard Error) that arise in the population regression function are homoscedasticity, ie all standard errors have the same variant.

Testing of heteroscedasticity uses the Park Test [5] by regressing the squared residual values (as the dependent variable) from the initial regression calculation with all the independent variables. If the statistical test of the regression results is not significant, it means that the model does not contain heteroscedasticity.

The regression results show insignificant results, which means the model is far from heteroscedasticity symptoms. Based on the analysis results obtained the following data:

**Table 6.** Park test results

Independent Variable	Significance	Note
Seed	0.608	Heteroscedasticity free
Fertilizer	0.199	Heteroscedasticity free
Pesticide	0.263	Heteroscedasticity free
Labor	0.107	Heteroscedasticity free
Channel	0.000	Heteroscedasticity free

From Table 6, it can be seen that almost all independent variables give significance probability values greater than 0.05, only channel variables that have values less than 0.05. Thus it can be concluded that all independent variables have no symptoms of heteroscedasticity.

#### 4.5. Regression Model

To analyze the factors that influence rice production due to the presence of stable channels, a regression model is used using natural logarithmic transformation data, with the following mathematical equations:

$$\ln Y_s = \beta_0 + \beta_1 \ln S + \beta_2 \ln F + \beta_3 \ln Pst + \beta_4 \ln L + \beta_5 \ln DSS \quad (6)$$

$$\ln Y_s = \beta_0 + \beta_1 \ln S + \beta_2 \ln F + \beta_3 \ln Pst + \beta_4 \ln L + \beta_5 \ln DSS = 0.608 \ln S + 0.199 \ln F + 0.263 \ln Pst + 0.107 \ln L \quad (7)$$

#### 4.6. F-test

The F-test is used to determine the effect of the independent variables together (simultaneously) on the dependent variable. Significant means the relationship that occurs can apply to the population. The F test results are seen in the ANOVA table.

By using a significance level of 5% (0.05), if the probability value <0.05, then it can be said that there is a significant influence together between the independent variables on the dependent variable. However, if the significance value > 0.05 then there is no significant effect together between the independent variables on the dependent variable.

For dk1 = 5 and dk2 = 44, the value F = 7.834 lies at the interval:

$$F1 = 2.43 \text{ with } \alpha = 0.05$$

$$F2 = 3.46 \text{ with } \alpha = 0.01$$

$$p\text{-v} = 0.05 - 0.04 (5.404 / -4.374) = 0.004$$

With a pv value <0.05, then Ho is accepted, meaning that it can be said that there is a significant influence together between the independent variables consisting of seeds, fertilizers, pesticides, labor and channels have a significant influence on the dependent variable, namely rice production in confidence level  $\alpha = 5\%$ . It can be seen that the significance value of F is 0.004 which is much smaller than 0.05.

#### 4.7. T-test

The t-test is to show how far the influence of one explanatory variable individually in influencing the dependent variable.

t-test results are seen in the table. By using a significance level of 5% (0.05), if the value of  $t_{count} > t_{table}$  at a 5% confidence level or a significance value of significantly less than 0.05 (5% significance level) then Ho is rejected in other words the independent variable has a significant effect concerning the dependent variable.

From Table 8 it can be concluded that there are independent variables  $t_{count} > 0.05$ . This means that the independent variables of seeds, fertilizers, and pesticides individually influence the dependent variable of rice production, but labor and individual channels do not affect the dependent variable of rice production

#### 4.8. Validity and Reliability Test

Hypothesis (H<sub>1</sub>), states that seeds have a positive effect on rice production. The  $t_{count}$  value of the seed variable has a significant probability of 0.608. Thus it can be said that the seed variable is significant, so the first hypothesis stating that seed has a positive and significant effect on rice production can be accepted.

Seed variables affect rice production which means that if the number of seeds is greater it will affect the amount of rice production obtained.

Hypothesis (H<sub>2</sub>) states that fertilizer has a positive effect on rice production. The  $t_{count}$  value of the fertilizer variable has a significant probability of 0.199. Thus it can be said that the fertilizer variable is significant, so the hypothesis which states the use of fertilizer has a positive and significant effect on rice production is acceptable.

The variable coefficient of fertilizer of 0.199 means that if there is an increase of fertilizer by 1%, then there is a tendency that rice production can be increased by 19.9%.

Hypothesis (H<sub>3</sub>) states that pesticides have a positive and significant effect on increasing rice production. The  $t$  value of the pesticide variable has a significant probability of 0.263. Thus it can be said that the pesticide variable is considered significant, so the hypothesis stating that pesticides have a positive effect on rice production can be accepted.

The pesticide variable influences rice production, which means that the more pesticide use relatively influences the increase in rice production.

Hypothesis (H<sub>4</sub>) states that labor has a positive and significant effect on rice production. The  $t$ -value of the labor variable has a significant probability of 0.107. Thus it can be said that the labor variable is insignificant, so the hypothesis which states that labor has a positive effect on rice production cannot be accepted. With a regression coefficient of 0.107. This means that if there is an increase in labor by 1%, then there is a tendency that rice production can be increased by 10.70%.

Hypothesis (H<sub>5</sub>) states that the channel has a positive and significant effect on rice production. The  $t$ -value of the channel variable has a significant probability of 0.653. Thus it can be said that the channel variable is insignificant, so the hypothesis stating that the channel has a positive and significant effect on rice production cannot be accepted.

The channel variable does not have a positive and significant effect on rice production which means that the better and the channel is stable, it does not increase the amount of rice production to be obtained. The coefficient of production input on the channel factor of 0.000. This means that if the canal is maintained regularly and it does not guarantee an increase in rice production.

The coefficient of determination ( $R^2$ ) essentially measures how far the model's ability to explain dependent variables. The coefficient of determination between zero and one ( $0 < R^2 < 1$ ). A small  $R^2$  value means that the ability of the independent variables to explain the dependent variable is very limited. Vice versa if the value of  $R^2$  is large or close to one, then the independent variables can explain the independent variables widely [5].

From Table 9 where  $R^2$  is 0.471, it means that variations in rice production variables in the P8-13S scheme can be explained by seed, fertilizer, pesticide, labor, and channel variables by 47.10% while the remaining 52.90% is explained by factors other outside the model. This means that if the increase in rice production is only done by increasing the use of the variables mentioned above, then there is only a chance of increasing rice production by 47.10% while the remaining 52.90% is determined by other factors such as rainfall, tides, valve door making in channels and other environmental conditions.

## V. CONCLUSIONS

Based on statistical analysis to see the effect of channel stability on increasing rice production, the following things are obtained:

- a. Seed, fertilizer, and pesticide variables have a significant positive effect up to a 5% confidence level in increasing rice production, while labor and channel variables do not have a significant positive effect.
- b. The coefficient of determination  $R^2$  of 0.471 means that the rice production variable in the P8-13S scheme can be explained by the variables of seeds, fertilizers, pesticides, labor and canals by 47.10% while the remaining 52.91% is determined by other factors such as rainfall, tidal heights, manufacture of valve doors in ducts and duct maintenance.
- c. The Value of Production Elasticity is 1.177 (elastic). This means that in general rice production is still in a condition of increasing business scale (Increasing Returns to Scale).

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