

## Correlation of Plantation Area and Palm Oil Production in Sumatra and Kalimantan Regions

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### ABSTRACT

This study aims to analyze the correlation between the area of oil palm plantations and oil palm production in Indonesia, especially in the Sumatra and Kalimantan regions which are the centers of oil palm plantation distribution. Data collection using secondary data from the Central Statistics Agency (BPS), this study aims to determine the relationship between the increase in land area and oil palm plantation production over the past 10 years. This study uses a quantitative method with a correlative approach. Data analysis was carried out using a bivariate correlation Pearson correlation test to determine the positive relationship between plantation area and oil palm production. The results of the analysis showed a significant positive relationship between the land area variable and oil palm production in both the Sumatra and Kalimantan regions, this is indicated by a positive number and a strong correlation of 0.852 for the Sumatra region and very strong, namely 0.996 for the Kalimantan region. In addition, the results of the interpretation of the correlation by looking at Sig. (2-tailed) also show that between the land area variable and production there is a significant correlation, namely 0.002 for the Sumatra region and a value of 0.000 for the Kalimantan region. Although the correlation between land area and production shows a positive value and has a very strong correlation, there are still other factors such as technology, climate, and management practices that also play a role in influencing palm oil production results.

**Keywords:** Oil palm area, Palm Oil Production, Correlation

### INTRODUCTION

The main commodity in Indonesia in the plantation sector that plays an important role in the national economy and has proven to be resistant to global pressures is palm oil. Extensification or land expansion is carried out due to the increase in global demand for palm oil, especially the expansion of areas in Sumatra and Kalimantan. Currently, the area of palm oil plantations in Indonesia is around 16 million hectares, divided into large private plantations, large state

plantations and independent farmers whose area reaches 40% of the total area of palm oil in Indonesia. Sumatra and Kalimantan are the centers of palm oil distribution in Indonesia, where the area of palm oil plantations in Sumatra is 2.9 million hectares with a total production of 10 million tons and the area of palm oil plantations in Kalimantan reaches 6.4 hectares and its total production reaches 21 million tons (BPS, 2023).

The continuous expansion of oil palm

plantations in Sumatra and Kalimantan also raises concerns when viewed from the context of sustainability because it can cause negative impacts on biodiversity and deforestation. Therefore, in land expansion, there needs to be an in-depth analysis of the impact on production and how to properly manage oil palm according to the concept of sustainability in optimizing production without damaging biodiversity. Satellite imagery (Gunarso et al., 2012) reveals that the origin of oil palm plantation land in Indonesia mostly comes from degraded land, conversion of agricultural land, and only 3.4% is converted from primary forest. This proves that the assumption that oil palm plantations are the main trigger for deforestation in Indonesia is incorrect. Good land management plays an important role in determining oil palm productivity because in some cases in the field, large areas of land cannot always produce high production

compared to relatively small areas of land but in terms of management and agricultural practices are more effective and efficient.

The production of oil palm plants, which is sometimes high and also low, is determined by the influence of production factors, where one of the production factors that plays a role in determining the level of oil palm production is land area (Feni & Marwan, 2023).

Based on the background above, it is necessary to conduct research that discusses the correlation between land area and palm oil production in Indonesia, especially in the regions of Sumatra and Kalimantan which are the centers of palm oil cultivation in Indonesia. The purpose of this study is to determine whether there is a correlation or relationship between the area of palm oil plantations and the resulting production so that the land that has been opened for palm oil is not wasted.

## MATERIALS AND METHODS

This study uses a quantitative method with a correlational approach. Correlation is a quantitative data analysis technique consisting of two or more variables. It is said to be correlated if changes in one variable are followed by changes in other variables regularly in the same direction (positive correlation) or opposite (negative correlation) (Aurana Zahro El Hasbi, Rima Damayanti, Dina Hermina, 2023). Positive correlation can be interpreted as the higher the value of a variable, the higher the value of the other variable or vice versa (Emzir, 2019).

The data used is secondary data for 10 years starting from 2014 to 2023 regarding the area of plantation land and palm oil production collected from official sources, namely from BPS (Central Statistics Agency). Samples were taken from the Sumatra region consisting of 3 large provinces of palm oil distribution and the Kalimantan region consisting of 5 provinces.

Data analysis was carried out using Bivariate Correlation to determine the relationship between

plantation area and palm oil production which began with a normality interpretation test to see whether the data used was normal or not (Ary, M. 2014). Bivariate Correlation is an analysis used to determine the effect of a land area (Land area = variable X) on palm oil production (Production = variable Y) which is known through the correlation equation ( $r$ ) (Ramdani et al., 2020).

Data testing is carried out in several stages, including:

### 1. Normality Test

The normality test is a test method used to assess the distribution of data or variables whether the data is normally distributed or not. The Normality Test is currently also increasingly developing, there are two types of tests currently known in SPSS 25, namely the Kolmogorov-Smirnov Test and the Shapiro-Wilk Test.

The Normality Test is carried out so that researchers can determine the type of statistics to be used, if the data processed comes from a normally distributed population, parametric

statistics can be used, but if the data is not normally distributed, non-parametric statistics can be used (Nasrum, 2018).

## 2. Plot Q-Q (Quantile-Quantile)

This method is a visual model in which sample data is plotted against a theoretical normal distribution. If the data follows a straight line, it is likely normally distributed.

## 3. Pearson Correlation Test

A statistical method used to measure the strength and direction of a linear relationship between two quantitative variables. This correlation produces a value called the Pearson correlation coefficient (r), which ranges from -1 to +1. Pearson correlation can be calculated using the following formula:

$$r_{xy} = \frac{n \sum x_i y_i - (\sum x_i)(\sum y_i)}{\sqrt{(n \sum x_i^2 - (\sum x_i)^2)(n \sum y_i^2 - (\sum y_i)^2)}}$$

Description:

$r_{xy}$  = Correlation between x and y

n = Number of samples

$X_i$  = Value of x-i

$Y_i$  = Value of y-i

Table 1. Level of Correlation Test Results

| Correlation Coefficient Interpretation Table |                         |
|----------------------------------------------|-------------------------|
| Correlation Coefficient Value                | Interpretation          |
| 0.00-0.10                                    | Very weak correlation   |
| 0.10-0.39                                    | Weak correlation        |
| 0.40-0.69                                    | Moderate correlation    |
| 0.70-0.89                                    | Strong correlation      |
| 0.90-1.00                                    | Very strong correlation |

Source: Jurnal Correlation Coefficients: Appropriate Use and Interpretation

# RESULTS AND DISCUSSION

The data used in this study is a collection of land area and production data from the Sumatra and Kalimantan regions for the last 10 years, namely from 2014 to 2023. The data analyzed in this study came from the Central Statistics Agency (BPS) in the form of secondary data, then data

normality testing was carried out and a Pearson correlation test was carried out to see whether there was a correlation between land area and production in the two regions.

## 1. Pearson Correlation Test for Data in the Sumatra Region

Table 7. Data on Oil Palm Plantation Area for 10 Years in Sumatra

| YEAR | LAND AREA DATA OF SUMATERA PROVINCES<br>(Thousand Hectares) |                 |               | TOTAL  |
|------|-------------------------------------------------------------|-----------------|---------------|--------|
|      | NORTH<br>SUMATRA                                            | WEST<br>SUMATRA | SOUTH SUMATRA |        |
|      |                                                             |                 |               |        |
| 2014 | 1396.3                                                      | 376.5           | 923           | 2695.8 |
| 2015 | 1427                                                        | 383.4           | 952.1         | 2762.5 |
| 2016 | 1342.6                                                      | 378.4           | 901.7         | 2622.7 |
| 2017 | 1461.2                                                      | 397.5           | 1032.8        | 2891.5 |
| 2018 | 1551.6                                                      | 379.6           | 1137.6        | 3068.8 |
| 2019 | 1373.3                                                      | 379.7           | 1191.4        | 2944.4 |
| 2020 | 1325.1                                                      | 393.3           | 1198          | 2916.4 |
| 2021 | 1285.8                                                      | 430.4           | 1058.6        | 2774.8 |
| 2022 | 1370.4                                                      | 439.9           | 1134.2        | 2944.5 |
| 2023 | 1371.9                                                      | 444.1           | 1162.7        | 2978.7 |

The table above shows the area of oil palm plantations in the Sumatra region for the last 10 years, namely from 2014-2023. The data is a combination of several provinces in the Sumatra

region, namely North Sumatra, West Sumatra and West Sumatra. The data above also shows an increase in land area, where in 2014 the area of oil palm plantations in Kalimantan was around 2.69

million hectares while in 2023 the area of oil palm plantations has reached 2.97 million hectares.

Table 8. Oil Palm Production Data for 10 Years in Sumatra

| YEAR | PRODUCTION DATA OF SUMATERA PROVINCES<br>(Thousand Tons) |                 |               | TOTAL   |
|------|----------------------------------------------------------|-----------------|---------------|---------|
|      | NORTH<br>SUMATRA                                         | WEST<br>SUMATRA | SOUTH SUMATRA |         |
| 2014 | 4870.2                                                   | 924.8           | 2791.8        | 8586.8  |
| 2015 | 5193.1                                                   | 926.6           | 2821.9        | 8941.6  |
| 2016 | 3983.7                                                   | 1183.1          | 2929.5        | 8096.3  |
| 2017 | 4852                                                     | 1209.2          | 2987          | 9048.2  |
| 2018 | 5737.3                                                   | 1248.3          | 3793.6        | 10779.2 |
| 2019 | 5647.3                                                   | 1253.4          | 4049.2        | 10949.9 |
| 2020 | 5776.8                                                   | 1312.3          | 4267          | 11356.1 |
| 2021 | 5310.9                                                   | 1352            | 3062.4        | 9725.3  |
| 2022 | 5051.5                                                   | 1411.6          | 4019          | 10482.1 |
| 2023 | 5017.4                                                   | 1420.9          | 4119.2        | 10557.5 |

The table above shows palm oil production in the Sumatra region for the last 10 years, namely from 2014-2023. The data is a combination of several provinces in the Sumatra region, namely North Sumatra, West Sumatra and West Sumatra. The

data above also shows an increase in production from palm oil commodities, where in 2014 the production obtained was around 8.58 million tons while in 2023 the production produced had reached 10.5 million tons.

Table 9. Data on Land Area and Palm Oil Production for 10 Years in Kalimantan

| YEAR | LAND AREA (HA) | PRODUCTION (TON) |
|------|----------------|------------------|
| 2014 | 2,695,800      | 8,586,800        |
| 2015 | 2,762,500      | 8,941,600        |
| 2016 | 2,622,700      | 8,096,300        |
| 2017 | 2,891,500      | 9,048,200        |
| 2018 | 3,068,800      | 10,779,200       |
| 2019 | 2,944,400      | 10,949,900       |
| 2020 | 2,916,400      | 11,356,100       |
| 2021 | 2,774,800      | 9,725,300        |
| 2022 | 2,944,500      | 10,482,100       |
| 2023 | 2,978,700      | 10,557,500       |

The table above shows data on land area and palm oil production in the Kalimantan region for the last 10 years, namely from 2014-2023. The data presented shows that the addition of land area affects the increase in palm oil production. The increase that occurred from 2014 to 2023 for land area reached 110.5% and the increase in production reached 122.9%. Below is a graph that illustrates the data in the table above and it can be seen that there has been a significant spike that has occurred over the last 10 years.

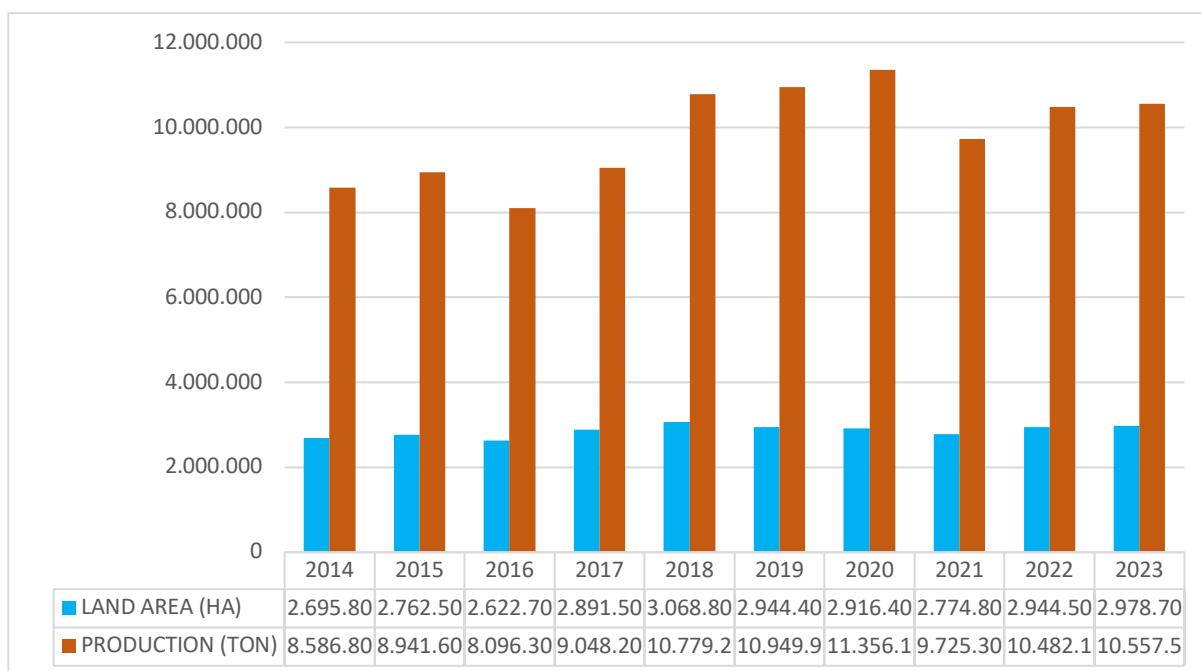


Figure 3. Graph of Land Area and Palm Oil Production for 10 Years in Sumatra (BPS, 2023)

Table 10. Results of Normality Test

| Tests of Normality |                                 |    |       |              |    |      |
|--------------------|---------------------------------|----|-------|--------------|----|------|
|                    | Kolmogorov-Smirnov <sup>a</sup> |    |       | Shapiro-Wilk |    |      |
|                    | Statistic                       | df | Sig.  | Statistic    | df | Sig. |
| Luas Lahan         | .189                            | 10 | .200* | .953         | 10 | .710 |
| Produksi           | .212                            | 10 | .200* | .931         | 10 | .457 |

\*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The results of the normality test show that Sig. Shapiro-Wilk for land area and production data shows a number  $> 0.05$ , namely for land area the Sig. value is 0.710 and production the Sig. value is

0.457, which means that the data for both variables are normal so that they can be continued to be analyzed with the Pearson correlation test bivariate correlation.

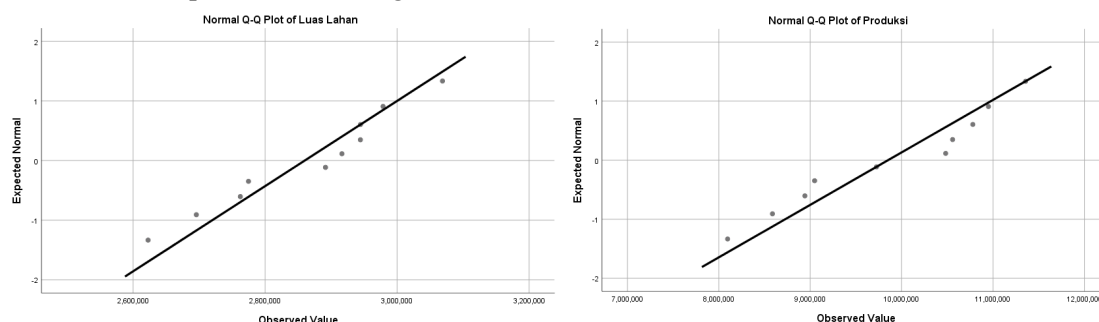


Figure 4. Q-Q Plot data distribution graph for land area and production

The image above shows that the data distribution for both land area and palm oil production is normally distributed, this is indicated by the data distribution which still follows the diagonal line.

Table 11. Pearson Correlation Test Results

### Correlations

|            |                     | Luas Lahan | Produksi |
|------------|---------------------|------------|----------|
| Luas Lahan | Pearson Correlation | 1          | .852**   |
|            | Sig. (2-tailed)     |            | .002     |
|            | N                   | 10         | 10       |
| Produksi   | Pearson Correlation | .852**     | 1        |
|            | Sig. (2-tailed)     | .002       |          |
|            | N                   | 10         | 10       |

\*\* . Correlation is significant at the 0.01 level (2-tailed).

From the results of the correlation analysis above, it can be concluded that there is a positive correlation between land area and palm oil production in Sumatra, this can be seen from the Pearson correlation value showing a positive number and a strong correlation of 0.852, meaning that the larger the area of palm oil land, the higher the production will be. The results of the

interpretation by looking at Sig. (2-tailed) also show that there is a significant correlation between the variables of land area and production, this can be seen from the Sig. (2-tailed) value of 0.002, which means that the value is less than 0.05.

### 2. Pearson Correlation Test for Data in the Kalimantan Region

Table 2. Area of Oil Palm Plantations Over 10 Years in Kalimantan

| LAND AREA DATA OF PROVINCES IN KALIMANTAN (Thousand Hectares) |                  |                     |                   |                  |                   |        |
|---------------------------------------------------------------|------------------|---------------------|-------------------|------------------|-------------------|--------|
| YEAR                                                          | WEST KALIMAN TAN | CENTRAL KALIMAN TAN | SOUTH KALIMAN TAN | EAST KALIMAN TAN | NORTH KALIMAN TAN | TOTAL  |
| 2014                                                          | 936.4            | 1115.9              | 512.9             | 733.4            | 153.3             | 3451.9 |
| 2015                                                          | 1144.2           | 1142                | 421.1             | 849.6            | 157.4             | 3714.3 |
| 2016                                                          | 1264.4           | 1288.1              | 553.1             | 1021.3           | 50.3              | 4177.2 |
| 2017                                                          | 1475.7           | 1339                | 508               | 1078.8           | 67.5              | 4469   |
| 2018                                                          | 1815.1           | 1640.9              | 542.4             | 1434.5           | 155.2             | 5588.1 |
| 2019                                                          | 2017.5           | 1922.1              | 471.3             | 1254.2           | 155.4             | 5820.5 |
| 2020                                                          | 2039.2           | 2018.7              | 497.3             | 1313.6           | 157.7             | 6026.5 |
| 2021                                                          | 2117.9           | 1815.6              | 479.3             | 1366.1           | 215.6             | 5994.5 |
| 2022                                                          | 2072.7           | 2205.8              | 516.1             | 1370.6           | 237               | 6402.2 |
| 2023                                                          | 2200.8           | 2196.3              | 516.7             | 1328.5           | 242.4             | 6484.7 |

The table above shows the area of oil palm plantations in Kalimantan for the last 10 years, namely from 2014-2023. The data is a combination of several provinces in Kalimantan, namely West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan and North

Kalimantan. The data above also shows a significant increase in land area, where in 2014 the area of oil palm plantations in Kalimantan was around 3.4 million hectares, while in 2023 the area of oil palm plantations has reached 6.4 million hectares.

Table 3. Palm Oil Production Data for 10 Years in Kalimantan

| YEAR | PRODUCTION DATA OF PROVINCES IN KALIMANTAN (Thousand Tons) |                    |                  |                 |                  | TOTAL   |
|------|------------------------------------------------------------|--------------------|------------------|-----------------|------------------|---------|
|      | WEST KALIMANTAN                                            | CENTRAL KALIMANTAN | SOUTH KALIMANTAN | EAST KALIMANTAN | NORTH KALIMANTAN |         |
| 2014 | 3451.9                                                     | 3158.2             | 1460.6           | 1407.3          | 255.7            | 9733.7  |
| 2015 | 3714.3                                                     | 3573               | 1049.5           | 1586.6          | 268.1            | 10191.5 |
| 2016 | 4177.2                                                     | 4260.1             | 1750.4           | 2358.4          | 167.7            | 12713.8 |
| 2017 | 4469                                                       | 5209.8             | 1560.1           | 2538.7          | 205.2            | 13982.8 |
| 2018 | 5588.1                                                     | 7230.1             | 1464.2           | 3786.5          | 305.1            | 18374   |
| 2019 | 5820.5                                                     | 7664.8             | 1665.4           | 3988.9          | 281.4            | 19421   |
| 2020 | 6026.5                                                     | 7685.8             | 1561.1           | 3823.2          | 301.6            | 19398.2 |
| 2021 | 5994.5                                                     | 8600.9             | 1212.8           | 3808.7          | 570              | 20186.9 |
| 2022 | 6402.2                                                     | 8363.8             | 1343             | 4100.9          | 574.4            | 20784.3 |
| 2023 | 6484.7                                                     | 8546.6             | 1331.5           | 4216            | 615.3            | 21194.1 |

The table above shows palm oil production in the Kalimantan region for the last 10 years, namely from 2014-2023. The data is a combination of several provinces in the Kalimantan region, namely West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan and North

Kalimantan. The data above also shows a significant increase in production from palm oil commodities, where in 2014 the production obtained was around 9.7 million tons while in 2023 the production produced had reached 21.1 million tons.

Table 4. Data on Land Area and Palm Oil Production for 10 Years in Kalimantan

| YEAR | LAND AREA (HA) | PRODUCTION (TON) |
|------|----------------|------------------|
| 2014 | 3,451,900      | 9,733,700        |
| 2015 | 3,714,300      | 10,191,500       |
| 2016 | 4,177,200      | 12,713,800       |
| 2017 | 4,469,000      | 13,982,800       |
| 2018 | 5,588,100      | 18,374,000       |
| 2019 | 5,820,500      | 19,421,000       |
| 2020 | 6,026,500      | 19,398,200       |
| 2021 | 5,994,500      | 20,186,900       |
| 2022 | 6,402,200      | 20,784,300       |
| 2023 | 6,484,700      | 21,194,100       |

The table above shows data on land area and palm oil production in the Kalimantan region for the last 10 years, namely from 2014-2023. The data presented shows that the addition of land area affects the increase in palm oil production. The increase that occurred from 2014 to 2023 for land

area reached 187.8% and the increase in production reached 217.7%. Below is a graph that illustrates the data in the table above and it can be seen that there has been a significant spike that has occurred over the last 10 years.

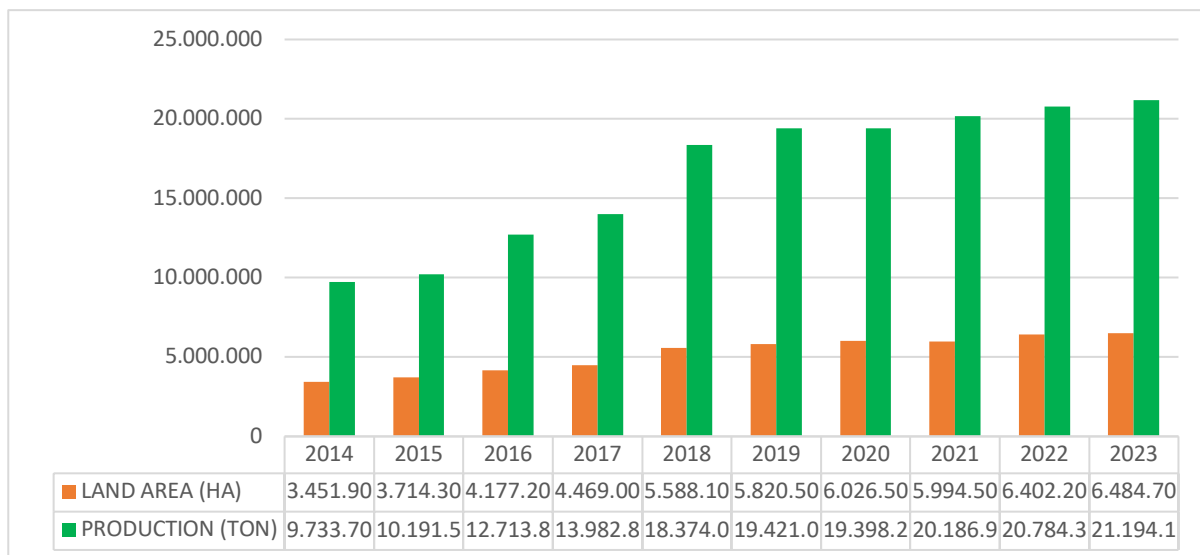


Figure 1. Graph of Land Area and Oil Palm Production for 10 Years in Kalimantan (BPS, 2023)

Table 5. Results of Normality Test

|            | Tests of Normality              |    |      |              |    |      |
|------------|---------------------------------|----|------|--------------|----|------|
|            | Kolmogorov-Smirnov <sup>a</sup> |    |      | Shapiro-Wilk |    |      |
|            | Statistic                       | df | Sig. | Statistic    | df | Sig. |
| Luas Lahan | .228                            | 10 | .148 | .878         | 10 | .124 |
| Produksi   | .254                            | 10 | .066 | .847         | 10 | .054 |

a. Lilliefors Significance Correction

The results of the normality test show that Sig. Shapiro-Wilk for land area and production data shows a number  $> 0.05$ , namely for land area the Sig. value is 0.124 and production the Sig. value is

0.054, which means that the data for both variables are normal so that they can be continued to be analyzed with the Pearson correlation test bivariate correlation.

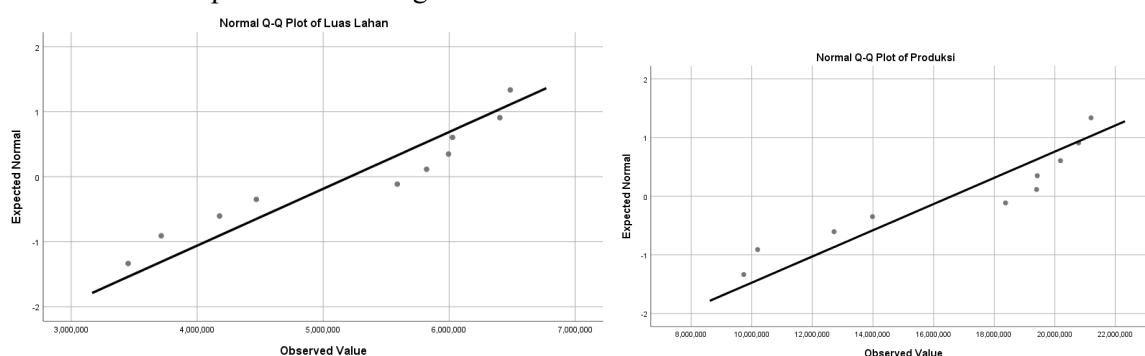


Figure 2. Q-Q Plot data distribution graph for land area and production

The image above shows that the data distribution for both land area and palm oil production is

normally distributed, this is indicated by the data distribution which still follows the diagonal line.

Table 6. Pearson Correlation Test Results

| Correlations |                     | Luas Lahan | Produksi |
|--------------|---------------------|------------|----------|
| Luas Lahan   | Pearson Correlation | 1          | .996**   |
|              | Sig. (2-tailed)     |            | .000     |
|              | N                   | 10         | 10       |
| Produksi     | Pearson Correlation | .996**     | 1        |
|              | Sig. (2-tailed)     | .000       |          |
|              | N                   | 10         | 10       |

\*\* . Correlation is significant at the 0.01 level (2-tailed).

From the results of the correlation analysis above, it can be concluded that between the land area and palm oil production in Sumatra there is a positive correlation, this can be seen from the Pearson correlation value showing a positive number and a very strong correlation of 0.996, meaning that the larger the area of palm oil land, the higher the

production will be. The results of the interpretation by looking at Sig. (2-tailed) also show that between the variables of land area and production there is a significant correlation because it is less than 0.05, which is 0.000 for both land area and palm oil production in the Kalimantan region.

## CONCLUSION

1. This study confirms the existence of a positive relationship and a very strong correlation between the area of plantations and palm oil production in Indonesia, especially in the regions of Sumatra and Kalimantan over the past 10 years.
2. The results of the analysis show a significant positive relationship between the two variables, namely land area and palm oil production in both the Sumatra and Kalimantan regions. This is indicated by a positive figure and a strong correlation of 0.852 for the Sumatra region and a very strong correlation of 0.996 for the Kalimantan region.
3. The results of the interpretation of the correlation by looking at Sig. (2-tailed) also show that there is a significant correlation between the variables of land area and production, namely 0.002 for the Sumatra region and 0.000 for the Kalimantan region.
4. The positive correlation between land area and production must also be followed by good management, use of appropriate technology, and consideration of environmental factors is also important to ensure sustainable production.

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