# Analysis of the effect of topographic differences on the production of oil palm (Elaeis guineensis Jacq)

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## ABSTRACT

Crop production is an important output for palm oil companies that can be managed properly to achieve optimal production. Factors that affect production include land suitability class, fertilizer, labor, land area, rainfall and plant age. One of the factors that causes diversity in production is topography, which affects differences in production potential, production losses and soil conditions. This study aims to analyze the influence of topographical differences on oil palm production in Rantau Utara sub-district, Labuhan Batu district, North Sumatra. This research was conducted in Rantau Utara sub-district, Labuhan Batu regency, North Sumatra Province, Indonesia. This research was conducted from June to July 2024. Sampling was carried out by direct observation in the field by observing the number of bunches, silt losses, soil pH and soil top soil from each topography, namely, flat (0-80), sloping (8-150) and steep (15-300) topography. The study used non-factorial RAK. The results of the BBC (Black Bunch Count) census observation obtained the average result of the number of bunches on flat topography (0-80) of 77.3 bunches/ha, on sloping topography (8-150) of 72.3 bunches/ha and on steep topography (15-300) of 70.3 bunches/ha. From this data, results were obtained that were not significantly different from production.



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## 1. INTRODUCTION

Oil palm plants (*Elaeis guineensis* Jacq) is a plant that produces the largest amount of vegetable oil compared to other oil-producing crops. Palm oil production on an industrial scale produces a variety of semi-finished products, including processed food and chemical products (Azzahro et al., 2022). This product is widely used in the food, cosmetic, pharmaceutical, and metal mill industries. The potential of palm oil to meet various needs makes it play a very important role in various countries (Adrianus et al., 2018).

The development of the palm oil industry in Indonesia has made rapid progress, the Central Statistics Agency (BPS) noted that the area of oil palm plantations in Indonesia reached 14.99 million hectares (ha) in 2022. This number increased by 2.49% compared to the previous year which covered an area of 14.62 million ha (BPS, 2022). However, when compared to the land area with the growth in productivity level, oil palm plantations only produce 2.75 tons/ha which is below the national average of around 3.15 tons/ha (Alamanda, 2023).

Topography has an important role in influencing oil palm productivity, especially in terms of soil preservation systems. The influence of topography on production reached around 4.56%. Topography also has a significant impact on raw fruit yields and rotting fruit rates (Dewa et al., 2016). According to Wijaya et al., 2018, On hilly land the harvesting process is a little difficult compared to flat topography land, this is because the concept of road network in hilly areas is made according to the contour of the soil. In addition, the nutrient deficiency factor caused by the loss of fertilizer due to erosion or loss due to rainwater washing is greater, affecting the productivity and growth of oil palm plants (Kafrawi et al., 2023).

On land with sloping or hilly topography, it is necessary to make continuous terraces and individual terraces (horse tracks, form plates) so that they can reduce the danger of erosion, while also preserving the soil so that it stores water well (Riyadi, 2022). The ideal topography for oil palm plants is flat to wavy (slope 0-50 degrees). Although the plant can still produce well in undulating areas (5-150 degree slope), it is not recommended to use very undulating or hilly land with a slope of more than 150 degrees as it requires more intensive handling (Pranata et al., 2017).

Another problem encountered in the sloping topography is the occurrence of oil palm losses in the harvest area. Loss of oil palm is the loss of production due to the non-collection of oil palm leaves during harvesting activities (Ramadon, 2023). Generally, baldolan losses are more commonly found in certain places in oil palm plantations such as in the armpits of fronds, disks, wickets, truck bodies, roadsides and yield weighing places.

Land topography is one of the main factors in plantation plantation crops, including oil palm plants. Topography also has a significant influence on oil palm production because of limiting factors if oil palm plants are planted in the wrong land suitability class. For example, oil palm plants planted on sloping or slightly hilly land consequently have lower production compared to oil palm plants planted on flat-topography land. However, it is not certain that flat-topography land will automatically have a higher production rate than slanted topography land.

## 2. METHOD

### 2.1 Place and Time

This research was conducted in an oil palm plantation located in North Rantau District, Labuhan Batu Regency, North Sumatra. This research was carried out from June to July 2024.

### 2.2 Research Design

#### 2.2.1 Research design

This research was carried out by collecting data (primary and secondary) and using the non-factor group Random Design method (RAK) where there are 3 levels, namely flat, sloping and steep topography. With a sample tree of 5% - 10% of each area studied, then the observation results are processed by analysis of varience (ANOVA). Then if the results are significantly different, continue with the DMRT test (5%).

#### 2.2.2 Arrangement of treatment

The treatment arrangement consists of: T0 = Flat topography (0 - 8°); T1 = Topography Miring (8 - 15°); T2 = Topography Curam (15 - 30°). Research repetition: In this study, there are 3 levels of replication in this study, which is 6 replicates.

### 2.3 Materials and Tools

#### 2.3.1 Tools

Some of the tools used in the research include pens, books, digital pH meters, inclinometers, meters, hoes and several other supporting tools.

#### 2.3.2 Ingredients

Some of the materials studied in this study include oil palm trees, brondolan and several other supporting materials.

### 2.4 Data Analysis

Data were analyzed using a variety of non-factorial random group designs (RAKs). If there are real or very real differences between treatments, analysis of variance (ANOVA) is continued. If the results are significantly different, then continue with the DMRT test (5%).

### 2.5 Observation Parameters

The observed parameters The parameters observed included potential production data, soil pH, topsoil depth and losses in each block and sample tree observed.

## 3. RESULTS AND DISCUSSION

### 3.1 Soil pH

The results of soil pH analysis for each different topography can be seen in the following table:

**Table 1.** Average Soil pH Based on Topography

| Treatment | Detestation | | | | | | Average |
|---|---|---|---|---|---|---|---|
| | U1 | U2 | U3 | U4 | U5 | U6 | |
| T0 | 5,43 | 6,43 | 5,79 | 6,29 | 6,43 | 6,50 | 6,14 b |
| T1 | 6,64 | 6,43 | 6,14 | 6,21 | 4,93 | 4,83 | 5,86 b |
| T2 | 5,86 | 4,63 | 5,00 | 4,51 | 4,79 | 4,60 | 4,90 a |
| Total | 17,93 | 17,49 | 16,93 | 17,01 | 16,14 | 15,93 | |

Description: flat land (T0) 1,880, sloping land (T1) 11,670, steep land (T2) 21,590

In Table 1, the results were obtained that the highest average pH value was obtained in flat topography (T0) with an average pH value of 6.14. Based on the results of this study, it can be seen that land with flat topography (T0) has the closest pH when compared to sloping topography (T1) and steep topography (T2). According to Tampubolon et al., 2022, low soil pH will cause a decrease in nutrient availability for plants which will ultimately reduce the production of Fresh Fruit Bunches (FFB).

### 3.2 Top Soil

Based on the results of the soil top soil observations carried out, they are presented in the following table:

**Table 2**. Average Top Soil Depth

| Treatment | Detestation | | | | | | Average |
|---|---|---|---|---|---|---|---|
| | U1 | U2 | U3 | U4 | U5 | U6 | |
| T0 | 6,57 | 6,00 | 3,79 | 3,64 | 8,00 | 7,71 | 5,95 |
| T1 | 7,79 | 6,71 | 7,57 | 5,71 | 5,21 | 6,57 | 6,60 |
| T2 | 5,93 | 3,50 | 3,43 | 3,64 | 3,87 | 3,50 | 3,98 |
| Total | 20,29 | 16,21 | 14,79 | 13,00 | 17,09 | 17,79 | |

Description: flat land (T0) 1,880, sloping land (T1) 11,670, steep land (T2) 21,590

In table 2, it can be seen that the average depth of the highest top soil is found in the oblique topography (T1) with an average top soil value of 6.60 cm. Based on the results of this study, it can be seen that land with sloping topography (T1) has the deepest top soil when compared to flat topography land (T0) and steep topographic land (T2). This is due to the very sloping contour of the soil, when it rains, the soil is very easily eroded, resulting in the erosion of the top soil layer.

Based on table 2, it can be seen that the average value of top soil soil in the steep topographic area (T2) has an average depth of 3.98 cm. Meanwhile, flat topography (T0) has an average depth of 5.95 cm and sloping topography (T1) has an average depth of 6.60 cm. This happens because of the high erosion caused by rainwater so that the top soil layer tends to be thin. The thickness of the top soil layer can also be affected by the soil tillage process at the time of replanting, this is in accordance with an explanation that on the lower slope the erosion process that occurs is not as large as the middle slope and there is a deposition of soil particles from the upper slope so that in the position of this slope it has a thick topsoil so that the influence of erosion can be seen from the thickness of the top soil (Arifin et al., 2018).

### 3.3 Losses

The results of the observations made are presented in the following table:

**Tabel 3**. Losses

| Treatment | Detestation | | | | | | Total | Rate-Rate (oil palm fruit bunches / ha) |
|---|---|---|---|---|---|---|---|---|
| | U1 | U2 | U3 | U4 | U5 | U6 | | |
| T0 | 45 | 31 | 102 | 33 | 75 | 16 | 302 | 50,33 |
| T1 | 23 | 34 | 11 | 30 | 30 | 27 | 155 | 25,83 |
| T2 | 29 | 39 | 13 | 54 | 14 | 39 | 188 | 31,33 |
| Total | 97 | 104 | 126 | 117 | 119 | 82 | | |

Description: flat land (T0) 1,880, sloping land (T1) 11,670, steep land (T2) 21,590

In Table 3, it can be seen that the lowest average losses are found in the sloping topography (T1) with an average loss of 25.83 bogs/ha. Based on the results of this study, it can be seen that land with sloping topography (T1) has the lowest losses, indirectly, less production loss when compared to flat topography (T0) of 50.33 brondolans/ha and steep topography (T2) of 31.33 brondolans/ha. The low losses in the oblique topographic area (T1) are influenced by harvesters who work very carefully to collect the undulating so that no undulating is left behind. Losses can also occur due to factors of plant height, the results of observations obtained that oil palm trees with the 2016 planting year have a height ranging from 5-6 meters with a harvest maturity criterion of 20 poplars/FFB, so that the losses are very large. These losses can be minimized by the gardener by giving directions to the harvesters to continue to quote the unripe fruits on the disc without being left so this can be a factor that can minimize the losses that occur on the disc although sometimes there are some non-compliant harvesters which results in an increase in losses on the disc, this is in accordance with the explanation that losses that often occur in the harvesting process are in the form of ripe fruits that are not harvested, raw fruits that are harvested, theft of fruit and brondolan, brondolan that are not transported on the disk, pikul market and TPH (Burga et al., 2017).

Another factor that greatly affects losses in oil palm plants is the cleanliness of the discs, dirty or overgrown discs can also be an indicator of losses in the field. If during harvesting the disk is filled with weeds and garbage, then when the fruit falls on the disk that comes off the bunch, it will be difficult to quote and even be invisible due to too much weeds and garbage in the disk so that losses occur (Manurung et al., 2019).

### 3.4 Production Potential Based on BBC (*Black Bunch Count*)

The results of observations made in the field can be seen in the following table:

**Table 4.** Production Data Results by BBC (*Black Bunch Count*)

| Treatment | Detestation | | | | | | Total | Average |
|---|---|---|---|---|---|---|---|---|
| | U1 | U2 | U3 | U4 | U5 | U6 | | (FFB/ha) |
| T0 | 73 | 66 | 88 | 90 | 69 | 78 | 464 | 77,3 |
| T1 | 76 | 86 | 73 | 77 | 67 | 55 | 434 | 72,3 |
| T2 | 60 | 75 | 83 | 86 | 50 | 68 | 422 | 70,3 |
| Total | 209 | 227 | 244 | 253 | 186 | 201 | | |

Description: flat land (T0) 1,880, sloping land (T1) 11,670, steep land (T2) 21,590

Based on Table 4, it can be seen that the comparison of the number of bunches in each of the different topographies does not show a real difference but the observation results show that the land with flat topography (T0) is still superior when compared to the sloping topography (T1) and steep topography (T2), it can be explained that the bunches on the flat topography (T0) have an average number of bunches of 77.3 tbs/ha, Furthermore, the least number of bunches is found on land with a sloping topography (T1) with an average number of bunches of 72.3 TBS/ha and bunches on steep topography (T2) with an average number of 70.3 TBS/ha. The highest number of bunches is still favored on flat topography land, but testing using ANOVA did not differ significantly.

Satrianto, 2024 stated that there are several factors that can affect the number of bunches in different topographies, including the influence of low soil pH which can result in a decrease in nutrient availability due to acidic soils that can reduce productivity in oil palm trees. The effect of soil pH on oil palm bunches production, namely land with flat topography (T0) tends to have a larger number of bunches when compared to land with sloping topography (T1) and land with steep topography (T2), so it is true that soil pH also greatly affects the productivity of oil palm plants, soil pH also greatly affects crop yields until harvest failure. The pH of the soil determines the nutrients absorbed by the plant. Soil contains nutrients such as Nitrogen (N), Potassium (K), and Phosphorus (P) which plants need in certain amounts to grow (Home & Rohmah, 2020).

## 4. CONCLUSION

From the research carried out, it was obtained that different land topography did not have a real effect on production, this can be seen from the data on the results of production potential based on the BBC (Black Bunch Count) calculation carried out. Topography also has no real effect on silt losses, but topography has a real effect on soil pH and soil topsoil. Further research is recommended to examine the effect of topography on oil palm production by adding more comprehensive physical and chemical soil variables, such as organic matter content, cation exchange capacity, and nutrient availability, and considering differences in plant age and plantation management systems. In addition, the use of actual production data over a longer observation period and the application of a spatial approach based on Geographic Information Systems are expected to provide a more comprehensive understanding of the dynamics of oil palm productivity under various topographical conditions and to produce more specific and sustainable land management recommendations.

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