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The Relationship between Soil Conservation Techniques, Topsoil Depth and Vegetation Density in Oil Palm *(Elaeis guineensis Jacq.) Plantation Areas* at Nusantara IV Plantation Regional II Adolina

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Abstract

This study aims to identify the soil conservation techniques applied and analyze their relationship with topsoil depth and weed vegetation density in oil palm areas at PT Perkebunan Nusantara IV Regional II Adolina. This research is important because oil palm is a strategic commodity whose productivity is influenced by soil conditions and land management. The study was conducted in April–May 2026 using a survey method with a descriptive approach. The study purposively selected samples based on differences in soil conservation techniques. Data were collected through field observations, measurements of topsoil depth, weed identification, and soil organic carbon (C) analysis. The results showed that topsoil depth ranged from 24 to 31 cm, with an average of 28.6 cm. Six weed species with a total of 4,645 individuals were identified, dominated by Lophatherum gracile (INP 66.70%) and Cenchrus purpureus (INP 65.10%). Soil organic carbon content ranged from 2.17% to 3.39%, with an average of 2.79%. This study indicates that effective soil conservation is associated with thicker topsoil, higher organic carbon content, and denser vegetation, thereby supporting sustainable land productivity.

Keywords: Importance Value Index, Land Management, Organic Matter, Plantation Sustainability, Soil Organic C

1. Introduction

Oil palm (*Elaeis guineensis* Jacq.) is a leading plantation commodity that plays a vital role in the Indonesian economy. Indonesia has been the world's largest producer of palm oil since 2006, with crude palm oil (CPO) production reaching 47.12 million tons in 2019, increasing to 48.29 million tons in 2020, and then slightly decreasing to 46.22 million tons in 2021 (BPS, 2023). The palm oil industry contributes significantly as a source of foreign exchange, provides employment, and drives national economic growth. The continued expansion of oil palm plantations indicates that sustainable crop productivity is a crucial aspect of plantation management to meet both domestic and global market demand (Ministry of Agriculture, 2015).

Environmental conditions and land characteristics at the cultivation site strongly influence oil palm productivity. One important factor is land topography, which includes slope gradient and land surface shape (Fikri et al., 2023).

Land with certain slopes is at risk of erosion, which can cause the loss of topsoil, reduced organic matter content, decreased nutrient availability, and reduced water retention capacity. These conditions can ultimately reduce the growth and productivity of oil palm plants (Miskana, 2022). Soil degradation due to erosion can also increase soil density, leading to suboptimal root system development (Abdillah & Budi, 2021). Continuous loss of topsoil causes a decline in the physical, chemical, and biological quality of the soil, which plays a vital role in supporting plant growth. Erosion-driven reductions in organic matter and nutrient content further reduce the soil's ability to supply water and nutrients, resulting in a 10–30% decrease in oil palm productivity compared with land that implements proper soil conservation measures. Therefore, the application of soil conservation techniques is necessary to maintain land quality and support sustainable oil palm

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production (A. Saputra et al., 2025).

Topsoil is the layer of soil with the highest fertility because it is rich in organic matter and nutrients needed by plants (Gusti & Hamzah, 2021). The depth of the topsoil determines the soil's ability to provide water and nutrients for plant growth (Zahrah, 2022). Soil with a deep topsoil layer allows for better root development, thus optimizing nutrient absorption. In contrast, soil with a shallow topsoil layer tends to limit root development and reduce nutrient absorption efficiency (Imansyah & Firdaus, 2022). Therefore, soil conservation efforts are needed to maintain the existence of topsoil and minimize soil damage due to erosion so that land productivity can be maintained sustainably (Ahmad, 2024).

In addition to affecting the physical properties of the soil, topsoil conditions and the use of soil conservation techniques also influence weed growth. Weeds are plants whose presence is undesirable because they can compete with the main crop for light, water, nutrients, and growing space (Lumbantobing, 2018). The presence of uncontrolled weeds can reduce oil palm production by up to 20%, especially if dominated by certain species such as Mikania micrantha, Asystasia gangetica, and Imperata cylindrica (Directorate General of Plantations, 2014). The composition and density of weeds are influenced by various environmental factors, including soil fertility, light availability, humidity, cultivation techniques, and land topography (Dibisono et al., 2022).

Extensive research has examined land and vegetation conditions in oil palm plantations. (RP Saputra et al., 2025) examined weed identification and dominance in oil palm plantations of varying ages and found that weed composition and dominance were influenced by plant age and environmental conditions.

Prayoga et al. (2026) examined erosion prediction across slope classes in oil palm plantations using the USLE method. It showed that erosion rates differed in each slope class, so that appropriate soil conservation measures were needed to reduce soil loss.

Wigena et al. (2023) examined weed dominance in oil palm plantations and found that topographic conditions and light intensity influenced dominant weed types.

Santi (2022) examined weed composition in oil palm plantations with flat and hilly topography. The results showed that dominant weed species differed between flat and hilly land, indicating that topography influences weed community structure.

These studies generally address topography, erosion, soil properties, and weed vegetation separately. However, studies linking soil conservation techniques to topsoil depth and weed density in oil palm plantations are relatively limited. However, understanding the relationship among these three aspects is crucial for sustainable, site-specific land management.

Based on these conditions, research on soil conservation techniques, topsoil depth, and weed vegetation density at PTPN IV Regional II Adolina is necessary. This research will provide information on the effectiveness of soil conservation techniques in maintaining the topsoil layer and their effect on weed vegetation density. The results of the research are expected to form the basis for developing more effective land management strategies to reduce the impact of erosion, maintain soil quality, and support sustainable oil palm productivity. Therefore, this study aims to identify the applied soil conservation techniques, analyze the relationship between soil conservation techniques and topsoil depth, and analyze the relationship between topsoil depth and weed vegetation density in the oil palm area of PTPN IV Regional II Adolina.

2. Material and Methods

This research was conducted at PT Perkebunan Nusantara IV Regional II Adolina, Serdang Bedagai Regency, North Sumatra Province, in April–May 2026. The research location is at coordinates around 3°28'–3°32' N and 99°06'–99°10' E with an altitude of ±15–30 meters above sea level (masl). The research used a field survey method with a descriptive approach to examine the relationship between soil conservation techniques, topsoil depth, and vegetation density in oil palm plantation areas. The research population included all plantation areas with varying topographic characteristics, soil types, and vegetation, while the sample was determined using a purposive sampling method based on the differences in soil conservation techniques applied.

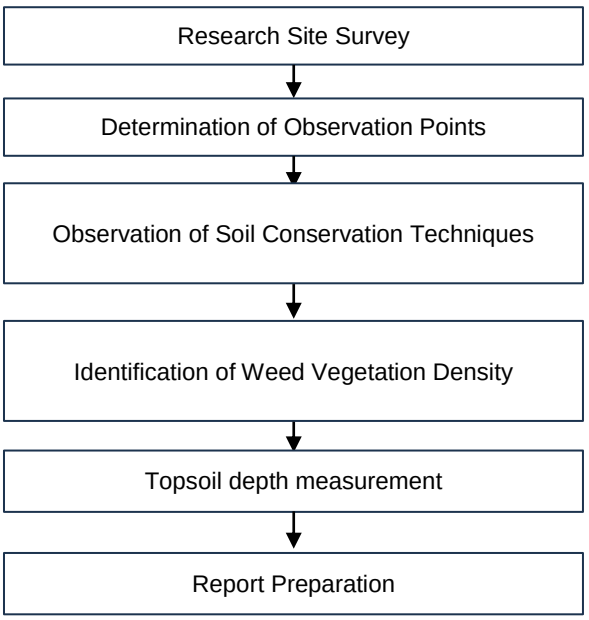


Figure 1. Research Flow Diagram

Observed variables included soil conservation techniques, topsoil depth, and weed vegetation density. Data collection involved field observations to identify

applied soil conservation techniques, measure topsoil depth using a soil drill or simple digging tool, and observe vegetation using the quadratic method. The vegetation found was then identified, and its density, relative density, frequency, relative frequency, importance value index (IVI), summed dominance ratio (SDR), and diversity index (H') were calculated.

Observation data were processed and analyzed descriptively using Microsoft Excel and IBM SPSS Statistics version 26. The analysis was conducted by presenting data in the form of tables, graphs, average values, standard deviations, minimum values, maximum values, and frequency distributions. In addition, correlation and regression analyses were conducted to determine the relationship between soil conservation techniques, topsoil depth, and vegetation density at the research site.

3. Results and Discussion

3.1. Description of Research Location

The research was conducted at PT Perkebunan Nusantara IV Regional II Adolina, located in Perbaungan District, Serdang Bedagai Regency, North Sumatra Province. According to company operational documents, the plantation area covers 5,878 hectares at an altitude of approximately 15 meters above sea level. The plantation area has varied topography, diverse soil types, and relatively high rainfall, which supports the growth of oil palm plants and weeds (PTPN IV Regional II Adolina, 2026).

In its management, the Adolina plantation employs various mechanical and vegetative soil conservation techniques to reduce erosion, maintain soil fertility, and maintain topsoil depth. Dividing the area into several divisions facilitates cultivation activities and field supervision, from maintenance to harvest. The undulating topography of some areas makes soil conservation and drainage management crucial for supporting sustainable plantation productivity (PTPN IV Regional II Adolina, 2026).

3.2. Field Observation Results

3.2.1. Results of Weed Vegetation Identification in Adolina

Based on the results of weed vegetation identification at PT Perkebunan Nusantara IV Regional II Adolina Afdeling II, 6 types of weeds were found, which were classified into three groups, namely broadleaf weeds, grasses, and sedges. The weed composition shows that the grass and sedge groups are dominant, with the most frequently found types being Lophaterum gracile and Kyllinga nemoralis. The dominance of these two types of weeds indicates that the environmental conditions at the research location are quite supportive of their growth, which is characterized by adequate water availability, relatively high soil moisture, and sufficient sunlight intensity to support vegetation development. The presence of relatively shaded areas on the ground surface also supports the growth of certain types of weeds, causing the distribution of weeds at the research location to be quite diverse.

3.2.2. Topsoil Thickness in Adolina

The measurement results show that the topsoil depth at PT Perkebunan Nusantara IV Regional II Adolina Afdeling II is in the range of 24–31 cm, with an average of 28.6 cm. This topsoil thickness indicates that the soil at the research location still has a fairly good topsoil layer to store organic matter and nutrients needed by plants. This condition indicates that the soil's ability to provide nutrients and maintain water availability for plants is still relatively good. Supported by the presence of weed vegetation that generally grows in moist soil conditions, these results indicate that the research land has a fairly high level of fertility, a relatively good water management system, and has the potential to support optimal growth and productivity of oil palm plants.

3.2.3. Vegetation Density on Each Plot

Based on Table 3, the weed species with the highest number of individuals in plot 3 was Kyllinga nemoralis (pendul jukut) with 820 individuals. Conversely, the lowest number of individuals was found in Thelypteris parasitica (swamp fern), with 15 individuals. The difference in the number of individuals indicates variations in the adaptability and level of dominance of each weed species to environmental conditions at the study site. Kyllinga nemoralis grew and developed better, resulting in a higher population than other weed species, while Thelypteris parasitica occurred in relatively small numbers. These results indicate a fairly high dominance of Kyllinga nemoralis, which is approximately 54.1 times greater than Thelypteris parasitica.

Table 1. Types of Weeds at the Adolina Location

No	Types of Weeds	Regional Name	Family	Group
1	*Thelypteris Parasitica*	Swamp Fern	*Thelypteridaceae*	Nails
2	*Boerharvia Difussa*	Claw Leaf	*Nyctaginaceae*	Broad leaves
3	*Lophaterum Gracile*	Bamboo Grass	*Poaceae*	Grass
4	*Origanum bright green*	Cumin Leaves	*Lamiaceae*	Broad leaves
5	*Cenchrus Purpureus*	Elephant Grass	*Poaceae*	Forage Grass
6	*Kylinga Nomeralis*	Jukut Pendul	*Cyperaceae*	Teki Tekian Weed

Table 2. Topsoil Thickness in Adolina

No	Plot	Thickness (cm)
1	Plot 1	24
2	Plot 2	28
3	Plot 3	28
4	Plot 4	30
5	Plot 5	27
6	Plot 6	28
7	Plot 7	31
8	Plot 8	30
9	Plot 9	29
10	Plot 10	31
Average		**28.6**

Description: Plots 1–10 are observation points determined in the research area. We measured topsoil thickness at each plot using a tape measure on flat ground.

Table 3. Vegetation Density in Plot 1

No	Scientific Name	Vegetation Name	Amount
1	Thelypteris Parasitica	swamp fern	15
2	Boerhavia Diffusa	scratched leaves	30
3	kylinga nomeralis	jukut pendul	820
4	Cenchrus purpureus	elephant grass	60

This finding aligns with research by Megayanti et al., 2022, which reported that dominant weed species in oil palm plantations typically number more than 500 individuals per observation unit, while species with low dominance generally number less than 50. The number of Kyllinga nemoralis individuals in this study (820 individuals) was approximately 64% higher than the high-dominance limit reported in that study, indicating that this species is highly adaptable to environmental conditions at the study site.

Based on Table 4, it is known that the most abundant vegetation in plot 3 is bamboo grass (A*xonopus compressus)* with 500 individuals. Based on Table 5, it is known that the vegetation with the highest number in Plot 3 is bamboo grass with 125 individuals. Based on Table 6, it is known that the most abundant vegetation in Plot 3 is bamboo grass with 658 individuals. Based on Table 7, it is known that the most abundant vegetation in plot 3 is bamboo grass with 596 individuals. Based on Table 8, it is known that the largest vegetation in Plot 1 is jakut pendul with 520 individuals. Based on Table 9, it is known that the most abundant vegetation in plot 1 is elephant grass with 310 individuals. Based on Table 10, it is known that the largest vegetation in Plot 1 is the swamp axis with 60 individuals. Based on Table 11, it is known that the most abundant vegetation in Plot 1 is jakut pendul with 128 individuals. Based on Table 12, it is known that the most abundant vegetation in plot 2 is Jakut pendul with 166 individuals.

Table 4. Weed Vegetation Density in Plot 2

No	Scientific Name	Vegetation Name	Amount
1	Thelypteris Parasitica	swamp fern	23
2	kylinga nomeralis	jukut pendul	170
3	axonopus compressus	bamboo grass	500
4	Lophatherum Gracile	elephant grass	5

Table 5. Vegetation Density in Plot 3

No	Scientific Name	Vegetation Name	Amount
1	*kylinga nomeralis*	jukut pendul	85
2	*Lophatherum Gracile*	elephant grass	19
3	*Cenchrus purpureus*	bamboo grass	125

Table 6. Vegetation Density in Plot 4

No	Scientific Name	Vegetation Name	Amount
1	*kylinga nomeralis*	jukut pendul	5
2	*Thelypteris Parasitica*	swamp fern	8
3	*Cenchrus purpureus*	bamboo grass	658
4	*Boerhavia Diffusa*	scratched leaves	27

Table 7. Vegetation Density in Plot 5

No	Scientific Name	Vegetation Name	Amount
1	*Thelypteris Parasitica*	swamp fern	55
2	*Boerhavia Diffusa*	scratched leaves	41
3	*Cenchrus purpureus*	bamboo grass	596

Table 8. Vegetation Density in Plot 6

No	Scientific Name	Vegetation name	Amount
1	*kylinga nomeralis*	jukut pendul	520
2	*Cenchrus purpureus*	bamboo grass	4
3	*Lophatherum Gracile*	elephant grass	33

Table 9. Vegetation Density in Plot 7

No	Scientific Name	Vegetation Name	Amount
1	*Lophatherum Gracile*	elephant grass	310
2	*Boerhavia Diffusa*	scratched leaves	15

Table 10. Vegetation Density in Plot 8

No	Scientific Name	Vegetation Name	Amount
1	*Thelypteris Parasitica*	swamp fern	60
2	*Origanum bright green*	cumin leaves	20

Table 11. Vegetation Density in Plot 9

No	Scientific Name	Vegetation Name	Amount
1	*kylinga nomeralis*	jukut pendul	128
2	*Cenchrus purpureus*	bamboo grass	18
3	*Cenchrus purpureus*	elephant grass	48
4	*Origanum bright green*	cumin leaves	10

Table 12. Vegetation Density in Plot 10

No	Scientific Name	Vegetation Name	Amount
1	*ageratum conyzoides*	swamp fern	15
2	*kylinga nomeralis*	jukut pendul	166
3	*Cenchrus purpureus*	elephant grass	35
4	*Orogenia bright green*	bamboo grass	21

Table 13. Vegetation Density Based on the Formulas K, KR, F, FR, INP

Species	Amount	Number of Petals Found	K	KR (%)	F	FR (%)	INP (%)
Thelypteris Parasitica	176	6	17.6	4.50%	0.6	14.00%	18.50%
Boerhavia Diffusa	72	3	7.2	1.80%	0.3	7.00%	8.80%
Lophatherum Gracile	1,894	8	189.4	48.10%	0.8	18.60%	66.70%
Orageno Bright Green	510	7	51	13.00%	0.7	16.30%	29.30%
Cenchrus purpureus	1,922	7	192.2	48.80%	0.7	16.30%	65.10%
kylinga nomeralis	71	3	7.1	1.80%	0.3	7.00%	8.80%
Total	**4,645**		**464.5**	**100%**	**4.3**	**100%**	**200%**

The dominance *of Lophatherum gracile* and *Cenchrus purpureus*, indicated by Important Value Index (INP) values of 66.70% and 65.10%, respectively, provides an overview of the environmental conditions at the research site. The presence of high numbers *of Lophatherum gracile* indicates that the land has relatively good humidity levels and microclimate conditions that support vegetation growth. Meanwhile, the dominance of *Cenchrus purpureus* indicates that the soil has sufficient nutrient and organic matter availability to support optimal weed biomass growth.

The vegetation composition also reflects the relatively good physical condition of the soil. The presence of species such as *Kyllinga nemoralis* and *Boerhavia diffusa* indicates that the soil has a fairly loose structure and good drainage, supporting the growth of various weeds. Furthermore, the total number of vegetation individuals, reaching 4,645, indicates that the topsoil at the study site is still biologically active and provides a suitable environment for the development of plant root systems and understory vegetation. This number is higher than the results of research (Asbur & Ariyanti, 2022), which reported a total vegetation density of 3,850 individuals in oil palm areas with different land conditions, indicating that the study site has a vegetation density approximately 20.6% higher.

The high INP values of Lophatherum gracile and Cenchrus purpureus also indicate a fairly high level of

competition in the utilization of growth resources, especially nutrients, water, and growing space. The INP value of Lophatherum gracile is 66.70% higher than the INP value of dominant weeds reported (Farrasati et al., 2019) of 54.30%, while the INP value of Cenchrus purpureus is 65.10% higher, approximately 19.9% higher than the INP value of dominant weeds in that study. This yield indicates that both species are more adaptable and competitive at the study site. Therefore, regular weed control is necessary, especially in the planting disc area, to minimize nutrient competition and maintain the effectiveness of fertilization and oil palm plant growth.

3.3. Laboratory analysis results on 10 samples

Soil analysis results show that organic carbon content varied across the study site. Data on the soil organic carbon content in each plot are presented in the following Table 14.

Based on the analysis results in Table 4.14, the soil organic carbon content at the study site ranged from 2.17% to 3.96%. The lowest value was found in Plot 3 at 2.17%, while the highest value was found in Plot 4 at 3.96%. These differences indicate variations in soil organic matter content in each observation plot, influenced by environmental conditions and land management.

Table 14. Results of Organic C Analysis

No Lab	Sample	Parameter
		C-Organic%
21	Plot 1	2.38
22	Plot 2	2.74
23	Plot 3	2.17
24	Plot 4	3.39
25	Plot 5	2.96
26	Plot 6	2.38
27	Plot 7	3.25
28	Plot 8	3.32
29	Plot 9	2.46
30	Plot 10	2.89

Description: The organic C content of each plot is the result of analysis by the USU Research and Technology Laboratory.

The average soil organic carbon content of 2.79% indicates that the soil conditions in the study area are in the moderate to high category. Adequate organic matter supports soil microbial activity, maintains soil structure stability, increases water retention capacity, and provides essential nutrients for oil palm plants.

Organic carbon content is of key indicator of soil fertility. Higher organic carbon content improves the soil's physical, chemical, and biological properties. Organic matter plays a role in improving soil aggregation, increasing porosity, increasing cation exchange capacity, and supporting the activity of soil organisms involved in decomposition and nutrient cycling.

Plots with high organic carbon content are thought to receive a greater supply of organic matter from vegetation debris, litter, and the decay of organic matter on the soil surface. Plots with lower organic carbon content indicate limited organic matter availability, necessitating maintenance efforts through the addition of organic sources such as compost, manure, or empty oil palm bunches.

The results of this study align with those of (2021), which state that low organic carbon content can reduce soil fertility by reducing the soil's ability to retain nutrients and water. Increasing organic matter has been shown to improve the physical, chemical, and biological properties of the soil, thus supporting optimal plant growth (Murtilaksono et al., 2020).

This finding is also supported by research (Walida, 2020), which shows that organic carbon content is closely related to soil fertility and the sustainability of oil palm plantation ecosystems. Low organic carbon content can degrade soil quality and reduce its ability to provide nutrients to plants (Theobroma et al., 2021).

Research (Gilang et al., 2024) explains that low organic C content can inhibit soil microbial activity, resulting in less-than-optimal plant growth (Mahendra, 2020). Based on research results at PTPN IV Regional II Adolina, organic C content in the medium-to-high category indicates good soil conditions that support oil palm productivity. The implementation of sustainable organic material management through the return of crop residues, compost, manure, and empty oil palm bunches needs to be continuously carried out to maintain topsoil quality and soil fertility in the long term.

3.4. Relationship between Topsoil Depth and Vegetation Density

Based on the research results, vegetation density shows a close relationship with soil organic carbon content in oil palm plantations at PT Perkebunan Nusantara IV Regional II Adolina. Plots with denser vegetation generally show higher organic carbon content than plots with sparser vegetation. This is related to the accumulation of litter, crop residues, and vegetation biomass that decompose and become a source of organic matter for the soil.

Dense vegetation plays a role in maintaining stable soil conditions by reducing the direct impact of rainfall on the soil surface, retaining moisture, and suppressing erosion.

The greater the vegetation biomass present on a plot of land, the greater the amount of organic matter that can be returned to the soil through the decomposition process. The presence of ground cover vegetation is a crucial factor in increasing organic matter content and sustainably maintaining soil quality.

The results of this study align with research by Susetyo et al., 2025, which found that vegetation density has a strong relationship with soil organic carbon content. Increasing the amount of vegetation on a plot of land results in greater litter accumulation, resulting in more intensive decomposition processes and increased soil organic matter content. Vegetation also maintains soil moisture and supports the activity of soil organisms involved in the decomposition of organic matter (Theobroma et al., 2021).

The study explains that high organic carbon content can improve soil quality by enhancing the physical, chemical, and biological properties of the soil. Ground cover vegetation helps maintain soil structural stability, increases the soil's ability to retain water, and reduces the risk of soil loss due to erosion. This condition indicates that the presence of vegetation not only plays a role in increasing soil organic carbon content but also supports the sustainability of soil fertility in oil palm plantation areas (Bu'ulolo, 2026). In this study, 4,645 individual vegetation units were found with an average soil organic carbon content of 2.79%. This value indicates relatively good conditions compared to the results of research (Telaumbanua, 2026), which reported a soil organic carbon content of 2.31% in areas with lower vegetation cover. The organic carbon content in this study was higher by 0.48% (around 20.8%), indicating that higher vegetation density contributes to the accumulation of soil organic matter and the maintenance of soil fertility.

3.5. The Relationship between Soil Conservation Techniques and Topsoil Depth and Organic C Content

Based on the results of research conducted in the oil palm plantation area of PT Perkebunan Nusantara IV Regional II Adolina, soil conservation techniques show a close relationship with topsoil depth and soil organic carbon content. The implementation of conservation measures, such as the use of ground cover vegetation, erosion control, and organic matter management, plays a role in maintaining the topsoil layer so that it is not easily lost due to surface runoff and rainfall. Topsoil is a soil layer with a high level of fertility because it contains nutrients and organic matter that are important for plant growth. In this study, the topsoil thickness ranged from 24–31 cm with an average of 28.6 cm. This value is higher than the results of research (Ardiyaningrum & Budiastuti, 2023), which reported an average topsoil thickness of 24.3 cm in oil palm areas with less-than-optimal conservation conditions. The difference of 4.3 cm, or approximately 17.7%, indicates that the implementation of conservation measures at the study site can maintain the topsoil layer better, thus minimizing the potential for soil loss due to erosion.

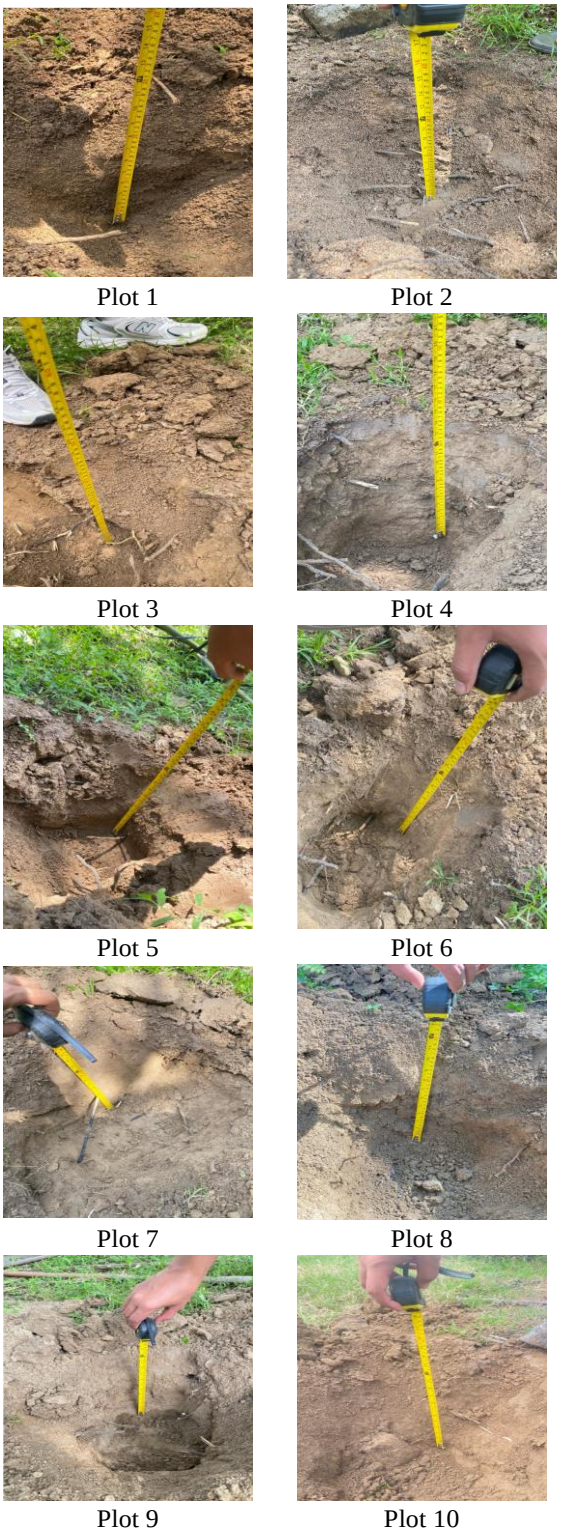


Figure 2. Documentation of Research Results

Observations show that plots with denser vegetation

tend to have deeper topsoil and higher organic carbon content than plots with less vegetation cover. Ground cover vegetation protects the soil surface from the kinetic energy of raindrops, thereby reducing the risk of erosion. The accumulation of litter and decomposing plant biomass also serves as a source of organic matter, contributing to increased soil organic carbon content. These conditions support the formation of a more stable soil structure and enhance the soil's ability to maintain its fertility.

High organic carbon content reflects better soil conditions because it influences the soil's physical, chemical, and biological properties. Organic matter increases the soil's capacity to retain water and nutrients, improves soil aggregation, and supports the activity of microorganisms that play a role in nutrient cycling. Therefore, efforts to maintain organic matter through the application of compost, manure, and the return of crop residues to the land are necessary to maintain topsoil quality.

The results of this study align with Ariyanti's (2017) view that organic carbon content is closely related to topsoil conditions. Topsoil is the part of the soil that contains the most organic matter, nutrients, and microorganisms, making it a center of biological activity that supports soil fertility. Better topsoil conditions increase the soil's potential organic carbon content (Ardiyaningrum & Budiastuti, 2023).

Deterioration in topsoil quality due to erosion or improper land management can lead to a reduction in soil organic matter content. This reduces the soil's ability to retain water and nutrients and reduces biological activity, which plays a role in maintaining soil fertility. Long-term loss of topsoil can also lead to decreased productivity of oil palm plantations (Vani et al., 2024).

The findings of this study indicate that the application of sound soil conservation techniques plays a role in maintaining topsoil thickness and stable soil organic carbon content. These conditions support the continued function of the soil as a growing medium for plants while also helping maintain the productivity of oil palm plantations. Therefore, the implementation of soil conservation and sustainable management of organic matter are crucial factors in maintaining land quality in oil palm plantations.

4. Conclusion

The results showed that the average topsoil depth at the study site was 28.6 cm, with relatively good organic carbon content supported by a vegetation density of 4,645 individuals. The strength of this study lies in its ability to demonstrate the relationship between topsoil conditions, soil organic matter content, and vegetation density in oil palm areas, thereby serving as indicators of land quality. The dominant species identified were Lophatherum gracile (INP 66.70%) and Cenchrus purpureus (INP 65.10%).

These findings of this research can inform oil palm plantation management, particularly through the implementation of soil conservation measures, integrated weed control, and the use of weed biomass as organic mulch. These efforts are expected to maintain soil quality and support sustainable crop productivity.

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