# Relationship Between Soil Organic Matter and Texture and Soil Erodibility under Salak-Based Agroforestry Land Use

**Natanael Sihombing[1], Yusriani Nasution[2], Irwan Zulfikri[3]**
[1,2,3]Universitas Graha Nusantara Padangsidimpuan, Indonesia
Email: yusrianinasution17@gmail.com

**Abstract**

Salak-based agroforestry is a land-use system that combines salak plants (Salacca sumatrana Becc.) with woody plants or other crops within the same area. Soil erosion is influenced by soil erodibility, which refers to the susceptibility of soil to erosion, or how easily soil particles are detached and transported. This study aimed to determine soil erodibility values and analyze the relationships of soil organic matter and soil texture with erodibility under salak-based agroforestry in West Angkola District, South Tapanuli Regency. The study was conducted from June to August 2026 using a survey method and purposive sampling at seven observation points. Soil samples were collected from a depth of 0–20 cm and analyzed for pH, organic matter, and texture, including sand, silt, and clay fractions. Soil erodibility was calculated using the K-factor equation, while relationships among the study variables were examined using simple and multiple linear regression. Soil erodibility values ranged from 0.06 to 0.46. Organic matter, sand, and clay fractions showed strong relationships with erodibility, but their individual effects were not statistically significant. The silt fraction showed a very strong and statistically significant relationship with erodibility ($R = 0.915$; $R^2 = 0.837$). Collectively, organic matter, sand, clay, and silt fractions showed a very strong and statistically significant relationship with soil erodibility ($R = 1.00$; $R^2 = 0.999$; $F = 564.107 > F\text{-critical} = 19.25$). These results indicate that the silt fraction was among the most influential variables associated with erodibility, while organic matter and soil texture collectively showed a strong relationship with changes in erodibility in salak-based agroforestry land.

***Keywords***: *Agroforestry, Soil Organic Matter, Soil Erodibility, Salak Plantations, Soil Texture.*

## A. INTRODUCTION

Salak is one of the leading commodities of South Tapanuli Regency and is widely cultivated in West Angkola District. Salak-based agroforestry combines salak (*Salacca sumatrana Becc.*) with woody plants or other crops on the same land. Soil is a natural resource that plays an important role in supporting agricultural productivity and environmental sustainability. One of the major problems affecting agricultural land on slopes is soil erosion. Under intensive land management, soil conditions may change as a result of tillage, vegetation management, rainfall, and cultivation practices. Erosion is a form of soil degradation involving the detachment and transport of soil particles by water or other agents. Continuous land use that exceeds the land's carrying capacity without appropriate management can lead to land degradation and declining land quality (Hanifa & Suwardi, 2022). Soil erosion is the movement of soil materials from one location to another (Arsyad, 2010). Soil susceptibility to erosion is closely associated with soil erodibility.

Soil erodibility refers to the susceptibility of soil to erosion caused by rainfall energy and surface runoff. Erodibility is influenced by several factors, including soil texture, organic matter content, soil structure, and permeability. Soils with low organic matter content and poor structure are generally more susceptible to erosion. Soil erodibility is largely determined by the soil's resistance to external forces and its capacity to absorb water (Utomo, 1994). Differences in soil erodibility among sites may result from differences in texture, structure, organic matter, and permeability (Arsyad, 2010). Soil particle composition and aggregate condition can determine how easily soil particles are detached and transported by rainfall and surface runoff.

Soil organic matter is an important component associated with erodibility. It contributes to the formation and stabilization of soil aggregates, improves soil structure, and affects the capacity of soil to store and infiltrate water. Mesfin and Haileselassie (2022) reported that intensive tillage and inadequate organic matter inputs can substantially reduce soil organic carbon, which is essential for maintaining soil fertility and water retention.

Soil texture is an important factor in determining erodibility and represents the relative proportions of sand, silt, and clay. Differences in the proportions of these fractions affect pore size, infiltration, permeability, water-holding capacity, and aggregate stability. Soils containing fractions that are readily dispersed and transported by water may be more susceptible to erosion. Keefer (1999) noted that sand, silt, and clay fractions are associated with water movement into and through soil, while texture, structure, permeability, and organic matter are soil properties that determine erodibility.

Agroforestry is a land-use system that combines perennial crops with other plant components within the same land unit. Salak-based agroforestry combines salak plants with forestry species or other crops. Salak plants and associated vegetation can provide ground cover and organic matter inputs that potentially influence soil physical conditions. Agroforestry may therefore affect soil erodibility. It can also contribute to carbon sequestration, nutrient cycling, biodiversity enhancement, and soil protection. Young (1997) and Heriansyah (2020) described the environmental benefits of agroforestry, including organic matter and nutrient inputs and erosion control through canopy cover and litter.

Salak Sidimpuan is cultivated across several districts of South Tapanuli Regency, including West Angkola, which is one of the major production areas. Nasution (2013) stated that many salak farmers in South Tapanuli Regency still use traditional cultivation systems, planting seasonal crops between perennial trees. This farming system relies on available natural resources. West Angkola has extensive areas of salak-based agroforestry across varied topography. This variation makes an assessment of soil erodibility important for understanding soil conditions and supporting more conservation-oriented land management. This study aimed to determine soil erodibility in salak-based agroforestry, analyze the relationship between soil organic matter and erodibility, and analyze the relationship between soil texture and erodibility.

## B. METHODS

The study was conducted in productive salak agroforestry areas in West Angkola District from June to July 2026. Laboratory analyses were conducted at the Faculty of Agriculture, Universitas Graha Nusantara, Padangsidimpuan, and at the Agricultural Instrument Standardization Agency (BSIP) laboratory in Medan.

A survey method was used. Soil samples were collected by purposive sampling at seven observation points representing salak-based agroforestry land. Samples were taken from the 0–20 cm topsoil layer and transported to the laboratory. Analyses included soil physical and chemical properties, namely texture (sand, silt, and clay), organic matter, and soil pH. These properties are related to soil erodibility.

Data were analyzed using simple and multiple linear regression. Simple regression was used to examine the individual relationships of soil texture, organic matter, and pH with erodibility. Multiple regression was used to assess the combined relationship of these variables with soil erodibility. The linear regression models used were as follows:

1. Simple linear regression model

$$\hat{Y} = bx + c$$

Where:

Y = dependent variable (soil erodibility)
b = regression coefficient
x = soil organic matter, soil texture (silt, clay, and sand), or soil pH
c = constant

2. Multiple linear regression model

$$Y = a + b1X1 + b2X2 + b3X3 + e$$

Where:

Y = dependent variable (soil erodibility)
X1 = soil organic matter
X2 = soil texture (silt, clay, and sand)
X3 = soil pH
A = constant
b1, b2, b3 = regression coefficients
e = error term

3. Determination of Soil Physical Properties

Soil erodibility was calculated using the equation attributed to Oszaer (1994):

$$K = [(0.043)\ (H) + 0.621/OM + 0.0082.S – 0.0062.C]/Si$$

Where:

K = soil erodibility factor
H = soil pH
OM = organic matter content (%)
S = sand content (%)
C = clay content (%)
Si = silt content (%)

Soil texture was measured using the Bouyoucos hydrometer method. The percentages of the soil fractions were calculated using the following equations:

a. Clay percentage (%) $\frac{R2}{W}$
b. Sand percentage (%) = 100 − (silt + clay)
c. Silt percentage (%) = (silt + clay) − clay

Where:

$R_1$ = hydrometer reading at 40 seconds (g/L)
$R_2$ = hydrometer reading at 2 hours (g/L)
W = oven-dry soil weight (g)

Organic matter can be measured using the Walkley–Black method or the loss-on-ignition (LOI) method.

## C. RESULT AND DISCUSSION

### 1. Soil Erodibility Values

The results of the laboratory soil analyses are presented in Table 1:

**Table 1 Soil erodibility at seven study locations in West Angkola District**

| No. | Texture | | | pH | Organic matter (%) | Soil erodibility |
|---|---|---|---|---|---|---|
| | Sand (%) | Silt (%) | Clay (%) | | | |
| 1. | 90.7 | 4.65 | 4.65 | 4.77 | 4.05 | 0.23 |
| 2. | 95.12 | 2.44 | 2.44 | 4.80 | 5.80 | 0.40 |
| 3. | 95.28 | 4.72 | 4.72 | 4.83 | 0.428 | 0.46 |
| 4. | 90.40 | 4.95 | 4.95 | 5.17 | 5.36 | 0.21 |
| 5. | 90.51 | 7.12 | 2.37 | 5.68 | 4.97 | 0.13 |
| 6. | 75.00 | 5.00 | 19.00 | 7.00 | 1.89 | 0.23 |
| 7. | 60.00 | 17.00 | 21.00 | 7.00 | 1.70 | 0.06 |

The results showed that soil erodibility at the seven observation points ranged from 0.06 to 0.46. The highest value was recorded at observation point 3 (0.46), whereas the lowest was recorded at point 7 (0.06). The values at the remaining points were 0.23, 0.40, 0.21, 0.13, and 0.23, respectively. According to the Ministry of Agriculture (Deptan, 2004), the K-factor is calculated using a formulation that incorporates sand, silt, and clay fractions, organic matter, and soil pH.

Variation in K values indicates differences in soil properties among observation points. Salak agroforestry land has vegetation cover and shelter trees that can reduce raindrop impact and surface runoff, supporting the soil-conservation function of agroforestry. Nevertheless, differences in texture and organic matter still result in variation in erodibility among sites. Salak Sidimpuan reportedly performs well under partial shade, with maximum sunlight exposure of approximately 70%. Its robust stems and broad fronds, together with perennial shelter trees, can provide substantial rainfall interception (>70%). These characteristics have been described as contributing to the soil-conservation role of salak on sloping land (Nasution et al., 2019).

## 2. Relationship between Soil Organic Matter and Erodibility

Simple regression analysis indicated that the relationship between soil organic matter and soil erodibility in salak-based agroforestry was not statistically significant (Table 2):

**Table 2 Simple linear regression analysis of the relationship between soil organic matter and erodibility**

| Organic Matter | Regression equation | R | $R^2$ | F calculated | F critical | Remark |
|---|---|---|---|---|---|---|
| | Y = 13.017 – 1.572 X (organic matter) | 0.662 | 0.438 | 3.90 | 5.99 | Not significant |

Simple linear regression indicated a strong relationship between organic matter and erodibility in salak-based agroforestry (r = 0.662). The $R^2$ value of 0.438 indicates that organic matter accounted for 43.8% of the variation in erodibility, while the remaining 56.2% was associated with other factors. Agroforestry systems may increase soil organic matter content to more than 5%, creating favorable conditions for plant growth (Maula et al., 2024).

The simple regression equation was Y = 13.017 − 1.572X, with r = 0.662 and $R^2$ = 0.438. The calculated F value (3.90) was lower than the critical F value (5.99), indicating that the relationship was not statistically significant at the applied test level. The negative regression coefficient suggests that higher soil organic matter content tends to be associated with lower erodibility. Organic matter helps improve soil structure and aggregate stability and increases water retention. Atmojo (2003) described the role of soil organic matter in improving water retention, while Rosati et al. (2020) reported that agroforestry can improve soil quality by increasing organic matter, which may help reduce soil erosion. Dwiastuti et al. (2016) noted that organic matter inputs vary among land-use types according to management practices; forests with diverse vegetation and complex canopies may produce more litter than other land uses.

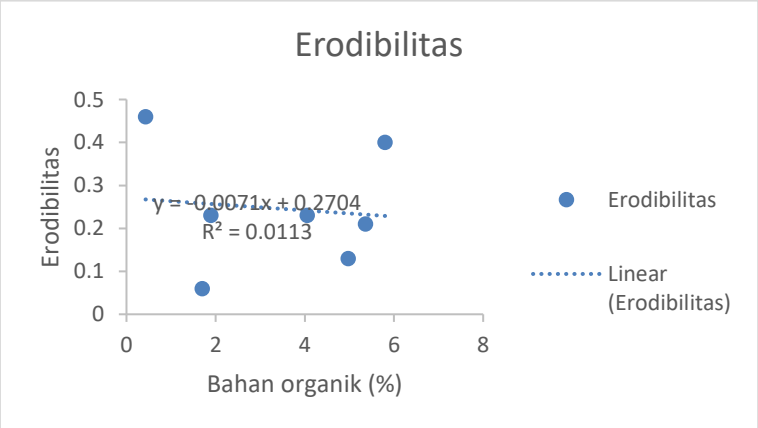



**Figure 1. Relationship between soil organic matter and erodibility**

The graph indicates a negative trend between organic matter and erodibility, described by the regression equation Y = −0.0071X + 0.2704. The $R^2$ value of 0.0113 indicates that organic matter explains only about 1.13% of the variation in erodibility. Thus, increased organic matter tends to correspond to lower erodibility,

but the association shown in this graph is very weak and erodibility is likely influenced by other soil factors.

### 3. Relationship between the Sand Fraction and Erodibility

Simple regression analysis showed that the relationship between the sand fraction and soil erodibility in salak-based agroforestry was not statistically significant (Table 3):

**Table 3. Simple linear regression analysis of the relationship between the sand fraction and erodibility**

| Sand | Regression equation | R | $R^2$ | F calculated | F critical | Remark |
|---|---|---|---|---|---|---|
| | Y= 31.643 – 0.282 (sand) | 0.720 | 0.518 | 5.37 | 5.99 | Not significant |

Simple linear regression produced a correlation coefficient of r = 0.720, indicating a strong relationship between the sand fraction and soil erodibility. The regression coefficient was negative, although the correlation coefficient reflects the strength of the association between the variables at the study sites. The coefficient of determination ($R^2$ = 0.518) indicates that the sand fraction accounted for 51.8% of the variation in erodibility, with the remainder associated with other factors.

The relationship between the sand fraction and erodibility was described by Y = 31.643 − 0.282X, with r = 0.720 and $R^2$ = 0.518. The negative coefficient suggests that erodibility tended to decrease as sand content increased. This may be related to the larger particle size of sand, which can facilitate water movement into soil. In salak-based agroforestry, this may reduce surface runoff and the detachment and transport of soil particles. Bezuayehu and Sterk (2010) noted that soil texture, particularly the sand fraction, may affect erosion when considered alongside appropriate soil conservation practices, especially on steep terrain.

The sand fraction affects soil pore characteristics and infiltration. However, its effect on erodibility does not operate independently because the K value is also influenced by other texture fractions and organic matter. Although the correlation was strong, the F-test indicated that the sand fraction did not have a statistically significant effect under the conditions of this study. Yanti et al. (2020) reported that high sand content may increase susceptibility to dispersion and transport by surface water when vegetation cover is inadequate.

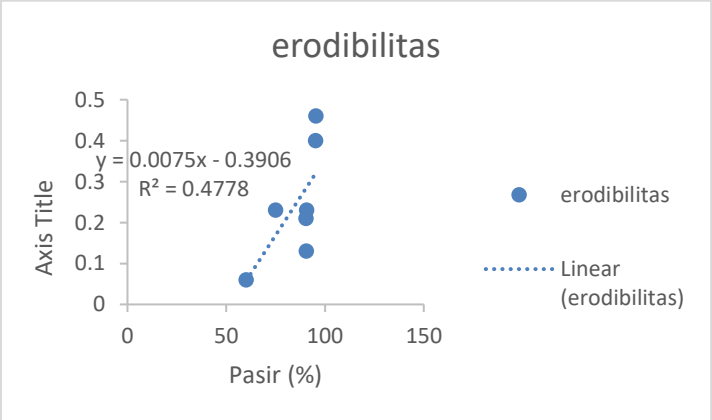



**Figure 2. Relationship between sand content and erodibility**

The graph shows a positive trend between sand content and erodibility, as indicated by an upward-sloping regression line. The $R^2$ value of 0.4778 indicates that sand content explains approximately 47.78% of the variation in erodibility. At sand contents of approximately 60–95%, erodibility ranged from 0.06 to 0.46. The highest value occurred at about 95% sand, while the lowest occurred at about 60% sand. Thus, the graph suggests that erodibility tends to increase with sand content, although the data points are dispersed.

**4. Relationship between the Clay Fraction and Erodibility**

Simple regression analysis showed that the relationship between the clay fraction and soil erodibility in salak-based agroforestry was not statistically significant (Table 4):

**Table 4. Simple linear regression analysis of the relationship between the clay fraction and erodibility**

| Clay | Regression equation | R | $R^2$ | F calculated | F critical | Remark |
|---|---|---|---|---|---|---|
| | Y= .330 + 0.385 (clay) | 0.616 | 0,380 | 3.06 | 5.99 | Not significant |

Simple linear regression produced the equation Y = 0.330 + 0.385X, with r = 0.616 and $R^2$ = 0.380. This indicates a strong positive relationship between the clay fraction and soil erodibility. The $R^2$ value indicates that the clay fraction accounted for 38.0% of the variation in erodibility, while the remainder was associated with other factors.

Clay particles are very fine and contribute to the formation of micropores, which can affect infiltration and surface runoff. However, the effect of clay on erodibility depends on mineralogy, soil structure, aggregation, organic matter, and the proportions of sand and silt. Musakkir et al. (2024) reported that good vegetation cover can slow surface runoff and reduce erosion because plant roots stabilize soil and maintain aggregate integrity. Haghnazari et al. (2015) noted that clay particles are the smallest soil fraction and are associated with high total porosity dominated by micropores or capillary pores, which can result in low infiltration rates.

Clay particles generally retain more water than silt and sand. Their colloidal size and large specific surface area allow them to bind more water per unit mass than silt and sand (Wu et al., 2017). Clay soils may contain many micropores, and compact structure can restrict aeration and root respiration, potentially limiting plant growth (Hanafiah, 2005).

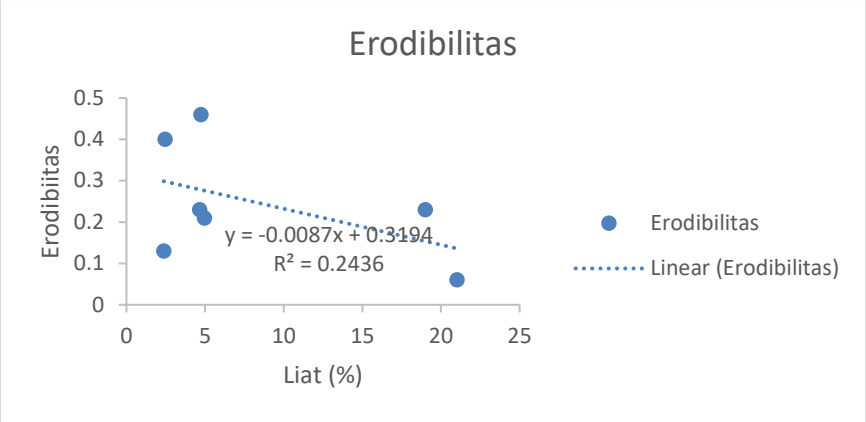



**Figure 3. Relationship between clay content and erodibility**

The graph gives the regression equation Y = −0.0087X + 0.3194, with $R^2$ = 0.2436, suggesting an inverse relationship between clay content and erodibility in the plotted data. At clay contents of approximately 2–5%, erodibility ranged from 0.13 to 0.46. At higher clay contents (approximately 19–21%), erodibility ranged from 0.06 to 0.23. Lower erodibility values indicate lower susceptibility to erosion.

### 5. Relationship between the Silt Fraction and Erodibility

Simple regression analysis indicated a statistically significant relationship between the silt fraction and soil erodibility in salak-based agroforestry (Table 5):

**Table 5. Simple linear regression analysis of the relationship between the silt fraction and erodibility**

| Silt | Regression equation | R | $R^2$ | F calculated | F critical | Remark |
|---|---|---|---|---|---|---|
| | Y = 1.355 + 0.950 (silt) | 0.915 | 0.837 | 25.67 | 5.99 | Significant |

Simple regression showed that the silt fraction had a correlation coefficient of r = 0.915, indicating a very strong relationship with soil erodibility. The regression equation was Y = 1.355 + 0.950X, with $R^2$ = 0.837. The calculated F value (25.67) exceeded the critical value (5.99), indicating a statistically significant relationship. The coefficient of determination indicates that the silt fraction accounted for 83.7% of the variation in erodibility, while the remainder was associated with other factors. Zhang et al. (2002) reported that clay-rich soils are more resistant to erosion.

The regression equation indicates a positive relationship between the silt fraction and erodibility: as silt content increases, soil erodibility tends to increase, assuming other factors remain constant. Therefore, higher silt content may indicate greater erosion potential.

The silt fraction is important in salak agroforestry soils because silt particles can be readily dispersed and transported by surface runoff, particularly when soil aggregates are unstable. Sites with higher silt content may require conservation practices such as maintaining ground cover and litter, adding organic matter, and retaining shelter vegetation. Arsyad (2010) noted that soils with high silt content are often more susceptible to erosion because their aggregates can break down and be transported by flowing water. Erosion control is more effective when integrated approaches combine soil conservation techniques, cover crops, and improvements in

soil structure (Morgan, 2005).

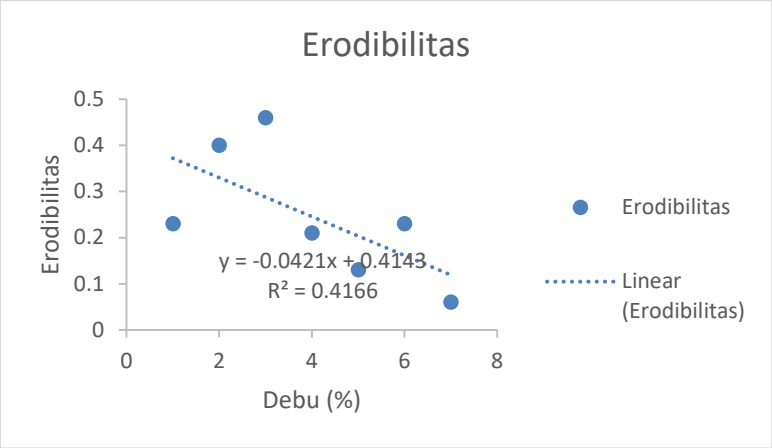



**Figure 4. Relationship between silt content and erodibility**

In contrast, the plotted graph shows a negative trend between silt content and erodibility, with the equation Y = −0.0421X + 0.4143. The $R^2$ value of 0.4166 indicates that silt content explains approximately 41.66% of the variation in erodibility. At silt contents of about 1–3%, erodibility ranged from 0.23 to 0.46, whereas at silt contents of about 4–7%, it ranged from 0.06 to 0.23. Thus, the plotted data suggest that erodibility decreased as silt content increased, although variation among observations remains.

## 6. Combined Relationship of Organic Matter and Texture Fractions

Multiple linear regression showed that organic matter and the sand, clay, and silt fractions collectively had a very strong and statistically significant relationship with soil erodibility in salak-based agroforestry (Table 6):

**Table 6. Multiple linear regression analysis of the relationship of organic matter, sand, clay, and silt fractions with soil erodibility**

| Organic matter, sand, silt, clay | Regression equation | R | $R^2$ | F calculated | F critical | Remark |
|---|---|---|---|---|---|---|
| | Y = -101,884 – 0,131 (organic matter) + 1,024 (sand) + 1,994 (silt) + 1,106 (clay) | 0,999 | 0,999 | 564,107 | 19,25 | Significant |

The multiple regression analysis indicated a correlation coefficient of approximately 1.00, showing a very strong combined relationship between organic matter, sand, silt, and clay fractions and soil erodibility. The coefficient of determination ($R^2$ = 0.999) indicates that these variables collectively accounted for 99.9% of the variation in soil erodibility, while approximately 0.1% was associated with other factors. Ramdani (2011) noted that an $R^2$ value closer to 1 indicates a stronger model fit. Soil properties such as texture, structure, permeability, and profile depth can affect erodibility (Veiche, 2002). Arifin (2010) also identified soil texture, structure, organic matter, and permeability as factors influencing soil erodibility.

The multiple regression equation was Y = −101.884 − 0.131(organic matter) + 1.024(sand) + 1.994(silt) + 1.106(clay). The model had $R^2$ = 0.999, and the calculated F

value (564.107) exceeded the critical value (19.25), indicating a statistically significant overall model. Organic matter and soil texture are important in relation to erodibility: organic matter promotes aggregate stability, while the proportions of sand, silt, and clay affect porosity, infiltration, and permeability. Organic matter had a negative coefficient, indicating that greater organic matter content was associated with lower erodibility when the other variables were held constant. Adjidirman (2012) reported that high organic matter content promotes stable aggregates and influences soil structure, bulk density, total porosity, drainage pores, available-water pores, and soil moisture.

The sand fraction showed a positive relationship with erodibility in the multiple regression model. The coefficients indicate that differences in soil texture composition were associated with changes in erodibility. The silt fraction had the largest positive coefficient in this model, suggesting a comparatively strong association with erodibility relative to sand and clay. Wischmeier and Mannering (1969) reported that soils with high silt content, low clay content, and low organic matter are particularly susceptible to erosion.

Hanifa and Suwardi (2022) noted that clay and organic matter are important in soil aggregate formation. Priatna (2011) identified organic matter as an important factor affecting erodibility in addition to soil texture. Organic matter can absorb and retain water, support soil structure development, and improve fertility, thereby influencing vegetation growth (Arsyad, 2010). Rachman et al. (2003) reported that management practices that accumulate plant residues can improve soil quality and reduce erosion. Soil erodibility is influenced by texture—particularly silt and fine sand content—as well as organic matter, structure, and permeability (Hardjowigeno, 2003).

## D. CONCLUSION

Based on the results, the following conclusions can be drawn: 1) Soil organic matter, sand, and clay fractions had strong relationships with soil erodibility in salak-based agroforestry, but their individual relationships were not statistically significant; 2) The silt fraction had a very strong and statistically significant relationship with soil erodibility ($R = 0.915$; $R^2 = 0.837$); and 3) Collectively, organic matter, sand, clay, and silt fractions had a very strong and statistically significant relationship with soil erodibility ($R = 1.00$; $R^2 = 0.999$; $F = 564.107 > F\text{-critical} = 19.25$).

## ACKNOWLEDGMENTS

The authors would like to thank Universitas Graha Nusantara, the Faculty of Agriculture, the academic supervisors, and fellow students and colleagues in the Faculty of Agriculture for their support during this research.

## REFERENCES

1. Ajidirman. (2012). *Kajian restorasi C-organik tanah dan hubungannya dengan kesuburan fisik di bawah vegetasi sawit*. Universitas Jambi.

2. Arifin, M. (2010). Kajian sifat fisika tanah dan berbagai penggunaan lahan dalam hubungannya dengan pendugaan erosi tanah. *Jurnal Pertanian MAPETA, 12*(2), 272–274.
3. Arsyad, S. (2010). *Konservasi tanah dan air*. Bogor: IPB Press.
4. Atmojo, S. W. (2003). *Peranan bahan organik terhadap kesuburan tanah dan upaya pengelolaannya*. Faculty of Agriculture, Universitas Sebelas Maret.
5. Bezuayehu, T., & Sterk, G. (2010). Land management, erosion problems and soil and water conservation in Fincha'a Watershed, Western Ethiopia. *Land Use Policy, 27*(4), 1027–1037.
6. Dwiastuti, S., Maridi, Suwarno, & Puspitasari, D. (2016). Bahan organik tanah di lahan marjinal dan faktor-faktor yang mempengaruhinya. *Proceeding Biology Education Conference, 13*(1), 748–751.
7. Haghnazari, F., Shahgholi, H., & Feizi, M. (2015). Factors affecting the infiltration of agricultural soil: A review. *International Journal of Agronomy and Agricultural Research, 6*(5), 21–35.
8. Hanafiah, K. A. (2005). *Dasar-Dasar Ilmu Tanah*. Depok; Raja Grafindo Persada.
9. Hanifa, H., & Suwardi. (2022). Nilai erodibilitas tanah pada berbagai penggunaan lahan dan tingkat kemiringan lahan di sub daerah aliran. *Ilmiah Pertanian, 18*(2), 160–165.
10. Hardjowigeno, S. (2003). *Klasifikasi tanah dan pedogenesis*. Akademika Pressindo.
11. Keefer, R. F. (1999). *Nature of soil erodibility*. In Handbook of soils for landscape architects (pp. 61–68). Oxford University Press.
12. Maula, S., Siswanto, S., Aditya, H. F., Yusnaini, S., & Ramadhani, W. S. (2024). Pemanfaatan kompos dalam peningkatan bahan organik tanah pada perkebunan nanas PT. Great Giant Food. *Jurnal Agrotek Tropika, 12*(1), 154–161.
13. Mesfin, S., & Haileselassie, H. (2022). Evaluation of soil physico-chemical properties as affected by canopies of scattered agroforestry trees on croplands. *South African Journal of Plant and Soil, 39*(2), 153–162.
14. Morgan, R. P. C. (2005). *Soil erosion and conservation*. Blackwell Publishing.
15. Musakkir, Tjoneng, A., & Syarif, M. (2024). Menentukan nilai erodibilitas tanah (K) pada jenis tanah di Sub DAS Jenelata. *Agrotekmas, 5*(2), 203–213.
16. Nasution, Y., Rasyidin, A., & Yulnafatmawita, A. (2019). Evaluation of Salacca sumatrana as soil conservation crop in South Tapanuli, North Sumatra, Indonesia. *Biodiversitas, 20*(3), 8.
17. Priatna, S. J. (2011). Indeks erodibilitas dan potensi erosi pada areal perkebunan kopi rakyat dengan umur dan lereng yang berbeda. *Jurnal Ilmu-Ilmu Pertanian Indonesia, 3*(2), 84–88.
18. Pusat Penelitian dan Pengembangan Tanah dan Agroklimat. (2004). *Teknologi konservasi tanah pada lahan pertanian berlereng*. Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian.
19. Rachman, A., Anderson, S. H., Gantzer, C., & Thompson, A. L. (2003). Influence of long-term cropping system on soil physical properties related to soil erodibility. *Soil Science Society of America Journal, 67*, 637–644.

20. Ramdani, T. (2011). *Analisis statistika sosial*. Yayasan Pendidikan Madani Sumbawa.
21. Rosati, A., Borek, R., & Canali, S. (2021). Agroforestry and organic agriculture. *Agroforestry Systems, 95*(5), 805–821.
22. Utomo, W. H. (1994). *Erosi dan konservasi tanah*. Penerbit IKIP Malang.
23. Veihe, A. (2002). The spatial variability of erodibility and its relation to soil types: a study from northern Ghana. *Geoderma*, *106*(1-2), 101-120.
24. Winarso, S. (2005). *Kesuburan tanah: Dasar kesehatan dan kualitas tanah*. Gava Media.
25. Wu, X., Wei, Y., Wang, J., Wang, D., She, L., Wang, J., & Cai, C. (2017). Effects of soil physicochemical properties on aggregate stability along a weathering gradient. *Catena, 156*, 205–215.
26. Yanti, D. F., Mansyur, I., Rusdiana, O., & Kirmi, H. (2020). Pendugaan laju erosi tanaman serai wangi (Cymbopogon nardus L.) pada lahan pasca tambang. *Jurnal Teknik Pertanian Lampung, 9*(1), 55–62.
27. Zhang, K., Shuangchai, L., & Wenying, P. (2002). Erodibility of agricultural soils in the Loess Plateau of China. *Proceedings of the 12th ISCHO Conference, Beijing*, 551–558.