Prosiding Seminar Nasional Pembangunan dan Pendidikan Vokasi Pertanian
Manokwari, 7 Juli 2026
e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Soil Physical Characteristics for Smallholder Plantation Land Management in Kutai Kartanegara, East Kalimantan

Arum Sekar Kedhaton[1]*, Juwari[1], Prince Clinton Immanuel Christian Damanik[2], Muhammad Zidan Ikhwanuttaqwa [1], Sabrina Nur Fhazira Nazwa[1]
[1] Pendidikan Geografi, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Mulawarman
[2]Pendidikan Guru Sekolah Dasar, Fakultas Ilmu Pendidikan, Universitas Negeri Jakarta
Corresponding Email: arumsekar@fkip.unmul.ac.id

Abstrak

Pengelolaan lahan perkebunan rakyat memerlukan informasi mengenai sifat fisik tanah sebagai dasar penyusunan strategi pengelolaan lahan yang tepat. Penelitian ini bertujuan menganalisis karakteristik fisik tanah pada dua lokasi di Kabupaten Kutai Kartanegara serta menyusun arahan pengelolaan lahan perkebunan berbasis kondisi tapak. Penelitian menggunakan metode deskriptif kualitatif melalui sintesis dua data *mini research* dari Kecamatan Loa Janan dan Desa Sungai Mariam. Data yang diamati meliputi warna, tekstur, struktur, konsistensi tanah, horizon, serta kondisi lingkungan. Hasil penelitian menunjukkan bahwa tanah Loa Janan memiliki tekstur lempung liat berpasir dengan daya dukung baik, namun memerlukan penambahan bahan organik dan pengelolaan kesuburan tanah. Sementara itu, tanah Sungai Mariam memiliki drainase yang baik tetapi kemampuan menyimpan air dan hara relatif rendah. Oleh karena itu, pengelolaan lahan dianjurkan melalui penggunaan kompos, mulsa, penutup tanah, pengurangan pemadatan, serta konservasi berbasis vegetasi.

Kata kunci: Lahan Perkebunan, Laterit, Konservasi Tanah, Sifat Fisik Tanah, Tekstur Tanah

Abstract

he management of smallholder plantation land requires information on soil physical properties to support appropriate land management practices. This study aimed to analyze the physical characteristics of soils from two locations in Kutai Kartanegara Regency and formulate site-specific plantation land management recommendations. A descriptive qualitative approach was employed by synthesizing two mini-research datasets from Loa Janan District and Sungai Mariam Village. The observed parameters included soil color, texture, structure, consistency, horizon, and environmental conditions. The results showed that the soil in Loa Janan has a sandy clay loam texture with good mechanical strength but requires additional organic matter and soil fertility improvement. In contrast, the soil in Sungai Mariam has good drainage but relatively low water and nutrient retention capacity. Therefore, land management should emphasize the application of compost, mulching, ground cover, reduced soil compaction, and vegetation-based conservation.

Keywords: Plantation Land; Laterite, Soil Conservation, Soil Physical Properties, Soil Texture

Prosiding Seminar Nasional Pembangunan dan Pendidikan Vokasi Pertanian
Manokwari, 7 Juli 2026
e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

INTRODUCTION

Smallholder plantation land is an important form of land use in East Kalimantan because it is closely related to household income, the continuity of perennial crop production, and the maintenance of ecological functions at the site level. Plantation management is not only determined by crop species, but also by the quality of the soil medium. Soil with favorable structure, adequate porosity, moderate consistency, and sufficient water-holding capacity provides a more stable rooting environment for plantation crops. Conversely, compacted soil, soil with low organic matter, easily leached soil, or soil that rapidly loses moisture may reduce cultivation efficiency and increase the need for management inputs.

Kutai Kartanegara Regency has diverse landforms, ranging from undulating uplands to lowlands near rivers. This variation produces different soil conditions among sites. Observations in Loa Janan Subdistrict indicate the presence of reddish-brown lateritic soil that is visually influenced by lateritization, iron oxide accumulation, and undulating to hilly topography. In contrast, observations from Sungai Mariam Village, Anggana Subdistrict, show gray soil with moderately coarse texture, medium structure, and very friable consistency under moist conditions. These two conditions represent important contrasts for smallholder plantation management: lateritic land that tends to be hard and may have limited available nutrients, and moderately coarse soil that has good drainage but weak water and nutrient retention.

Soil physical properties are essential initial indicators for assessing plantation land suitability. Syahputera et al. (2024) showed that the physical and chemical characteristics of Ultisols in rubber plantation land are interrelated in determining soil quality. Damanik et al. (2021) also emphasized that slope gradient and oil palm age can influence aggregate stability in Ultisols. In plantation land, texture, structure, consistency, and aggregate stability affect infiltration, erosion, rooting, and crop response to fertilization. Therefore, site-scale soil physical diagnosis remains necessary even when laboratory analysis is not yet available.

Research on soil physical properties has been widely conducted across different land uses, including dry land, tea plantations, oil palm plantations, and degraded land (Bintoro et al., 2017; Nurhartanto et al., 2022; Suhemi et al., 2022; Wulansari et al., 2022). However, studies that synthesize student field-observation datasets from two contrasting

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

sites and explicitly orient them toward smallholder plantation management recommendations remain limited. Such synthesis is important because smallholder plantations are often located on heterogeneous land, managed with limited inputs, and require practical recommendations that can be implemented by local communities.

Based on this background, this study aimed to analyze soil physical characteristics from Loa Janan Subdistrict and Sungai Mariam Village, Anggana Subdistrict, and to formulate initial recommendations for smallholder plantation land management based on site-specific soil physical conditions. The results are expected to serve as an initial reference for soil conservation, planting-medium improvement, and plantation management planning on humid tropical land in Kutai Kartanegara.

METHOD

This study used a qualitative descriptive method with a comparative site-based approach. This method was selected because the analyzed data consisted of field observation results, visual soil descriptions, simple texture and consistency tests, and photographic documentation. The two main data sources were mini-research soil reports prepared by Muhammad Zidan Ikhwanuttaqwa in Loa Janan Subdistrict and Sabrina Nur Fhazira Nazwa in Sungai Mariam Village, RT 13, Anggana Subdistrict, Kutai Kartanegara Regency, East Kalimantan Province.

At the Loa Janan site, observations focused on a lateritic soil sample identified visually based on color, texture, structure, consistency, and inferred profile position. The sample showed a reddish-brown color, sandy clay loam texture, irregular blocky to massive structure, slightly sticky wet consistency, hard dry consistency, and was inferred to represent a lower layer or subsoil. The report also noted that Loa Janan Subdistrict has undulating to hilly topography and is influenced by smallholder plantation and mining activities.

At the Sungai Mariam site, direct observation was conducted using simple tools, including a wooden stick for soil excavation, a plastic bag for sample storage, and a mobile phone for documentation and color identification using a downloaded Munsell Soil Color Charts file. The observed parameters included soil color and code, texture, structure, wet-moist-dry consistency, and surrounding vegetation conditions. The observation results showed a gray color of 10 YR 5/1, moderately coarse texture, medium structure of 10-20 mm, non-plastic consistency, slightly sticky wet condition, very friable moist condition, and soft dry condition.

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Data analysis was conducted in three stages. First, each primary dataset was reorganized into tables of soil physical characteristics. Second, the data from the two sites were compared to identify differences in soil properties relevant to smallholder plantation management. Third, the interpretation was linked with literature on lateritic soils, Ultisols, physical properties of plantation soils, erodibility, ground cover, organic matter, and soil conservation. The recommendations are presented as initial guidance because the study did not include laboratory measurements such as pH, cation exchange capacity, organic matter, bulk density, permeability, and nutrient status.

RESULTS AND DISCUSSION

Characteristics of The Study Sites

The two observation sites have different site characteristics. Loa Janan represents undulating to hilly land that, according to the field report, is influenced by a history of smallholder plantation and mining activities. This condition is important for plantation management because uneven topography can accelerate surface runoff when soil is exposed, whereas land clearing can alter soil structure and reduce aggregate stability. Field documentation shows exposed soil surfaces with vegetation along the land margins, indicating that ground cover should be maintained to protect lateritic surfaces from direct raindrop impact.

Sungai Mariam, Anggana, represents a site with gray soil, moderately coarse texture, and surface vegetation consisting of grasses and low plants. Moderately coarse soil has relatively large macropores that allow water to move easily, but its ability to retain water and nutrients is lower than that of medium- to fine-textured soils. The contrast between the two sites indicates that plantation management recommendations cannot be generalized. Loa Janan requires organic matter improvement, ground cover, and runoff control on undulating land, whereas Sungai Mariam requires increased water retention, mulch, and litter return to reduce nutrient leaching.

Table 1. Synthesis of Study-Site Characteristics

Aspect	Loa Janan	Sungai Mariam, Anggana	Plantation Implication
Landform	Undulating to hilly	Village site with open soil and low vegetation	Management guidance must be site-specific

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Aspect	Loa Janan	Sungai Mariam, Anggana	Plantation Implication
Surface cover	Reddish-brown lateritic soil	Gray 10 YR 5/1 and moderately coarse	Indicates different soil processes and amendment needs
Vegetation	Adequate physical support for perennial crops	Good drainage and very friable moist soil	Can support smallholder plantations with organic inputs
Conservation focus	Hard when dry, massive structure, possible nutrient leaching	Low water and nutrient retention	Requires compost, mulch, cover crops, and laboratory testing

Source: Primary field observation, 2026

Soil physical characteristics in Loa Janan Subdistrict

The Loa Janan soil sample showed a reddish-brown to brick-red color. This color is an important visual characteristic of lateritic soil formed through intensive weathering under humid tropical conditions. During lateritization, base cations and silica are leached, while iron and aluminum oxides remain relatively accumulated, producing the reddish color. Tufaila et al. (2010) explained that laterite soil profiles in Southeast Sulawesi show chemical-element variation associated with advanced weathering. Practically, red color does not automatically indicate fertile soil; it is more accurately interpreted as a strong indication of weathering and iron oxide accumulation.

The texture of the Loa Janan soil was sandy clay loam. This combination indicates the presence of clay fractions that can retain water and sand fractions that support drainage. However, when clay content is relatively high and organic matter is low, the soil can become hard when dry and slightly sticky when wet. The irregular blocky to massive structure also indicates that aggregation is not yet ideal for root development. Massive structure may restrict fine-root penetration, reduce aeration under wet conditions, and increase the need for careful minimum tillage.

In the context of smallholder plantation land, Loa Janan lateritic soil can still be used for perennial crops, but it requires more careful input management. The addition of compost, mature manure, litter, and ground cover can improve aggregation and soil biological activity. Liming should not be decided solely based on soil color; it should be applied only after pH testing because the report does not include soil acidity data. On

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

undulating land, cover crops and contour-based planting are important measures to prevent rapid surface erosion.

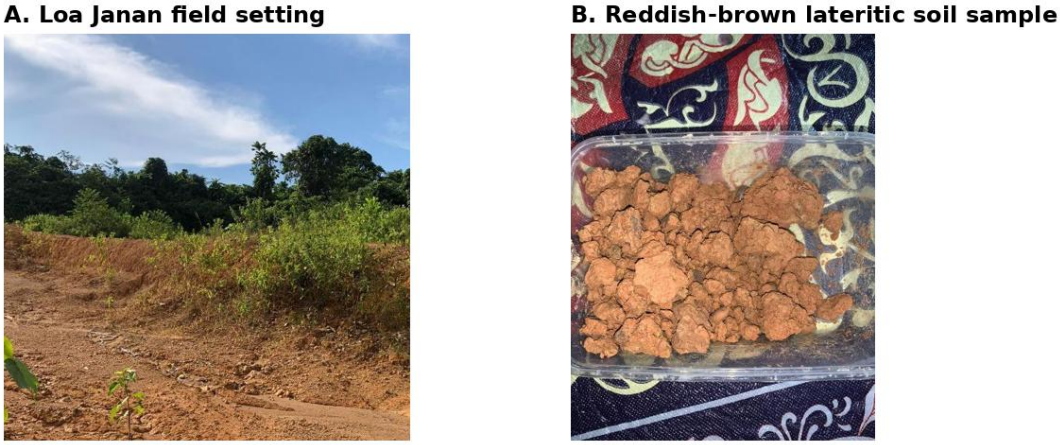

Figure 1. Documentation of site condition and lateritic soil sample in Loa Janan Subdistrict
(Source: Primary documentation, 2026)

Erosion Potential of Gray Soil in Sungai Mariam

The Sungai Mariam soil had a gray color with the code 10 YR 5/1. Gray color may indicate moist conditions, iron reduction processes, or a leached horizon, but this interpretation requires confirmation through more complete profile observation and drainage analysis. In plantation land, gray color deserves attention because it may be related to groundwater dynamics. If drainage is too rapid, the soil can dry quickly; if it is too saturated, the roots of certain crops may experience aeration stress. Therefore, water management is an important component at this site.

Moderately coarse texture indicates the dominance of sand or coarse materials. The observation report noted that the soil was easily broken apart, did not form strong clods, had large pores, and rapidly lost moisture when exposed to direct sunlight. These conditions are beneficial for drainage and root penetration but may reduce fertilizer efficiency because nutrients are more easily leached. Sari and Basuki (2025) emphasized that the physical and chemical characteristics of Inceptisols need to be analyzed together to understand soil capacity as a growth medium. Thus, physical improvement at the Sungai Mariam site should be followed by soil fertility testing.

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Table 1. Comparison of Soil Physical Characteristics at The Two Sites

Parameter	Loa Janan	Sungai Mariam	Management meaning
Color	Reddish brown to brick red	Gray 10 YR 5/1	Color indicates different soil processes and needs profile confirmation
Texture	Sandy clay loam	Moderately coarse	Loa Janan needs structural improvement; Sungai Mariam needs improved water retention
Structure	Irregular blocky to massive	Medium 10-20 mm	Massive structure requires organic matter; medium structure should be protected from compaction
Wet consistency	Slightly sticky	Non-plastic and slightly sticky	Soil should be tilled only under suitable moisture conditions
Moist/dry consistency	Hard when dry	Very friable when moist and soft when dry	Mulch is needed to maintain moisture and aggregate stability
Inferred profile	Lower layer or lateritic B horizon	Observed surface layer under low vegetation	Further profile observation is needed at several depths

Source: Primary soil-observation data, 2026

The Sungai Mariam soil structure was classified as medium, with aggregate size of 10-20 mm. Soil consistency was non-plastic, slightly sticky when wet, very friable when moist, and soft when dry. The very friable moist condition is favorable for root growth, but the soft dry condition and moderately coarse texture indicate relatively low soil cohesion. If the surface is left exposed, fine particles and nutrients may be easily transported by water flow. Therefore, organic mulch, litter, cover crops, and reduced total land clearing are important practices for smallholder plantations on similar sites.

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Gray moderately coarse soil surface in Sungai Mariam

Figure 2. Documentation of gray moderately coarse soil in Sungai Mariam Village, Anggana
(Source: Primary documentation, 2026)

Management Implications for Smallholder Plantation Land

The synthesis of the two sites shows that smallholder plantation management must be adjusted to soil physical properties. In the Loa Janan lateritic soil, the main priorities are increasing organic matter, improving massive structure, and reducing runoff risk on undulating topography. In the Sungai Mariam soil, the main priorities are increasing water and nutrient retention through compost, mulch, litter, and ground cover. Fuady et al. (2014) showed that vegetative conservation in oil palm can reduce surface runoff, erosion, and nutrient loss in sediment. This finding is relevant to both sites because both require more stable soil surface cover.

Practical management options include establishing cover crops between plantation rows, placing pruning residues as mulch, constructing small bunds or micro-terraces on sloping land, and regulating walking paths to avoid compaction in root zones. In lateritic soil, tillage should not be excessive because intensive soil turning may accelerate structural degradation. In moderately coarse soil, fertilization should be applied in split doses and combined with organic materials to reduce nutrient loss through leaching.

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

The limitation of this study is that the data remain descriptive and based on simple observations. Laboratory data on pH, cation exchange capacity, organic matter, mechanical texture, permeability, bulk density, total porosity, and nutrient status were not available. Therefore, the recommendations should be understood as an initial diagnosis rather than a final fertilizer recommendation. Future research should integrate soil profile observation, sampling at several depths, laboratory analysis, slope-gradient measurement, and evaluation of plantation crop types most suitable for each site condition.

Table 3. Initial Recommendations for Smallholder Plantation Land Management

Main problem	Priority location	Management recommendation	Expected impact
Massive structure and hard dry consistency	Loa Janan	Compost, mature manure, litter, minimum tillage	Improved aggregation and root space
Low water retention	Sungai Mariam	Organic mulch, organic matter, biochar or rice husk when available	More stable soil moisture
Nutrient leaching risk	Both sites	Split fertilization combined with organic matter	Improved fertilizer efficiency
Exposed soil surface	Both sites	Cover crops, litter, pruning residues as mulch	Reduced raindrop impact and surface erosion
Uncertain chemical fertility	Both sites	Test pH, CEC, organic C, N, P, K, and laboratory texture	More accurate fertilizer recommendations

Source: Synthesis of field observation and literature review, 2026.

CONCLUSION

The synthesis of the two mini-research datasets shows that smallholder plantation land in Kutai Kartanegara requires different management strategies according to soil physical characteristics. The Loa Janan soil is lateritic, with reddish-brown color, sandy clay loam texture, irregular blocky to massive structure, slightly sticky wet consistency, hard dry consistency, and an inferred subsoil position. These conditions indicate potential as a medium for perennial crops, but require organic matter input, ground-cover

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

management, reduced intensive tillage, and pH and fertility testing before fertilizer recommendations are determined.

The Sungai Mariam soil has a gray color of 10 YR 5/1, moderately coarse texture, medium structure of 10-20 mm, non-plastic consistency, slightly sticky wet condition, very friable moist condition, and soft dry condition. These characteristics indicate adequate drainage and root space, but water and nutrient retention need to be improved through mulch, compost, litter, and cover crops. Therefore, smallholder plantation management at both sites should place vegetative conservation and organic matter improvement as key strategies.

This study is limited to visual observation and simple field testing; therefore, it does not provide quantitative values for pH, CEC, organic matter, bulk density, permeability, porosity, or nutrient status. Further research should integrate laboratory analysis, soil profile observation, slope measurement, and plantation crop suitability evaluation to produce more precise and applicable management recommendations.

REFERENCES

Aisyah, B. N., Baskoro, D. P. T., & Murtilaksono, K. (2022). Pendugaan erosi tanah dan perencanaan tutupan lahan Hulu DAS Jeneberang, Sulawesi Selatan. Jurnal Ilmu Pertanian Indonesia, 27(2), 302-310. https://doi.org/10.18343/jipi.27.2.302

Akbar, H. (2021). Prediksi erosi dan teknik konservasi tanah sistem agroforestri di Sub DAS Krueng Meueh Kabupaten Bener Meriah. Jurnal Agrium, 18(2). https://doi.org/10.29103/agrium.v18i2.5327

Anggraini, L. R., Agus, A. T., Novianti, Y. S., Mulyono, E. E., & Yuliyanto, Y. (2019). Indeks bahaya erosi pada lahan reklamasi. Jurnal GEOSAPTA, 5(2), 141-145. https://doi.org/10.20527/jg.v5i2.5804

Bintoro, A., Widjajanto, D., & Isrun. (2017). Karakteristik fisik tanah pada beberapa penggunaan lahan di Desa Beka Kecamatan Marawola Kabupaten Sigi. Agrotekbis: Jurnal Ilmu Pertanian, 5(4), 423-430.

Damanik, A., Refliaty, & Achnopha, Y. (2021). Analisis kemantapan agregat Ultisol pada beberapa tingkat kemiringan lereng dan umur tanaman kelapa sawit (Elaeis guineensis Jacq.) yang berbeda. Jurnal Agroecotania, 4(2), 41-50.

Farikha, A., Wijaya, K., & Purwadi, P. (2023). Analisis erosi dan indeks bahaya erosi pada berbagai penggunaan lahan di Sub DAS Opak Hulu-Tengah. Jurnal Ecosolum, 12(2), 128-144. https://doi.org/10.20956/ecosolum.v12i2.29361

Fuady, Z., Satriawan, H., & Mayani, N. (2014). Aliran permukaan, erosi, dan hara sedimen akibat tindakan konservasi tanah vegetatif pada kelapa sawit. Sains Tanah - Journal of Soil Science and Agroclimatology, 11(2), 95-103. https://doi.org/10.15608/stjssa.v11i2.225

Hadi, F., Syafjanuar, T. E., Arrahman, N., & Ramli, I. (2023). Nilai erosi dengan metode RUSLE dari pemanfaatan citra Sentinel-2 di Wilayah Sungai Pasee Peusangan.

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Jurnal Ilmiah Rekayasa Pertanian dan Biosistem, 11(2), 172-187. https://doi.org/10.29303/jrpb.v11i2.523

Injiliana, L., Widiastuti, T., & Riyono, J. N. (2020). Erodibilitas tanah (K) pada berbagai tutupan lahan di Desa Baru Kecamatan Silat Hilir Kabupaten Kapuas Hulu. Jurnal Hutan Lestari, 8(4), 773-781. https://doi.org/10.26418/jhl.v8i4.44323

Killa, Y. M., Ndapamuri, M. H., Ratu, E. U., & Teul, M. U. (2024). Kajian sifat fisik tanah pada lahan kering beriklim kering di Kecamatan Wulla Waijelu Kabupaten Sumba Timur. Jurnal Galung Tropika, 13(1), 19-26.

Lasaiba, M. A., Leuwol, F. S., Pinoa, W. S., Lasaiba, I., Riry, R. B., & Sandia, S. (2023). Integrasi SIG dengan USLE dalam penilaian erosi di DAS Wairutung. Jurnal Tanah dan Sumberdaya Lahan, 10(2), 191-201. https://doi.org/10.21776/ub.jtsl.2023.010.2.02

Mirza, M. I., Andawayanti, U., & Sisinggih, D. (2023). Pemetaan sebaran indeks bahaya erosi dan arahan penggunaan lahan berbasis sistem informasi geografis pada DAS Bedadung Kabupaten Jember. Jurnal Teknologi dan Rekayasa Sumber Daya Air, 3(2), 334-345. https://doi.org/10.21776/ub.jtresda.2023.003.02.029

Neswati, R., Lopulisa, C., & Adzima, A. F. (2019). Characterization and classification of soils from different topographic positions under sugarcane plantation in South Sulawesi, Indonesia. Journal of Tropical Soils, 24(2), 93-100.

Nifen, S. Y., & Idris. (2021). Pengaruh tutupan vegetasi terhadap erosi pada Hulu Sungai Batang Arau, Kota Padang. Ensiklopedia of Journal, 3(2), 98-108.

Nurhartanto, N., Zulkarnain, Z., & Wicaksono, A. A. (2022). Analisis beberapa sifat fisik tanah sebagai indikator kerusakan tanah pada lahan kering. Jurnal Agroekoteknologi Tropika Lembab, 4(2), 107-112.

Nurida, N. L., Mulyani, A., Widiastuti, F., & Agus, F. (2018). Potensi dan model agroforestri untuk rehabilitasi lahan terdegradasi di Kabupaten Berau, Paser, dan Kutai Timur, Provinsi Kalimantan Timur. Jurnal Tanah dan Iklim, 42(1), 13-26.

Sari, R. P., & Basuki. (2025). Analisis karakteristik sifat fisik dan kimia tanah Inceptisol di Desa Jember Lor, Kecamatan Patrang, Kabupaten Jember. Plumula: Berkala Ilmiah Agroteknologi, 13(2), 71-79.

Sarminah, S., Sari, D. W., & Aipassa, M. I. (2023). Analisis tingkat bahaya erosi pada lahan terdegradasi. ULIN: Jurnal Hutan Tropis, 7(2). https://doi.org/10.32522/ujht.v7i2.10674

Septiaji, E. D., Bimasri, J., & Amin, Z. (2024). Karakteristik sifat fisik tanah Ultisol berdasarkan tingkat kemiringan lereng. AGRORADIX: Jurnal Ilmu Pertanian, 7(2), 41-49. https://doi.org/10.52166/agroteknologi.v7i2.6462

Suhemi, S., Hayati, R., & Nusantara, R. W. (2022). Status kesuburan tanah Inceptisol pada penggunaan lahan kelapa sawit di Desa Pengadang Kecamatan Sekayam Kabupaten Sanggau. Pedontropika: Jurnal Ilmu Tanah dan Sumber Daya Lahan, 8(2), 25.

Syahputera, A., Mahbub, M., & Mariana, Z. T. (2024). Karakteristik fisika dan kimia pada tanah Ultisol di lahan perkebunan karet di Desa Gunung Kupang Provinsi Kalimantan Selatan. Acta Solum, 2(3), 158-166.

e ISSN : 2774-1982
DOI: https://doi.org/10.47687/snppvp.v7i1.2366

Tufaila, M., Alam, S., & Leomo, S. (2010). Variation of chemical elements and their associations in laterite soil profiles from Southeast Sulawesi. Jurnal Tanah Tropika, 15(3), 197-204.

Wulansari, R., Pranoto, E., & Saragih, J. (2022). Karakteristik sifat fisik Andisols Typic Melanudands pada beberapa kemiringan lereng di Perkebunan Teh Gambung, Jawa Barat. Jurnal Pengelolaan Perkebunan, 3(1), 17-24.

Yusuf, S. M., Murtilaksono, K., & Laraswati, D. M. (2020). Pemetaan sebaran erosi tanah prediksi melalui integrasi model USLE ke dalam Sistem Informasi Geografis. Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan, 10(4), 594-606. https://doi.org/10.29244/jpsl.10.4.594-606