DAFTAR PUSTAKA

Baver, L.D., W.H. Gardner, & W.R. Gardner. (1972). 'Soil Physics'. *4th. Ed. John Wiley*. New York.

Brewer, R., 1964. *Fabric and Mineral Analysis of Soils*. New York: Wiley, p. 470.

Buckman, H. O. and N. C. Brady, (1982). 'Ilmu Tanah'. Terjemahan oleh: *Soegiman. Bhratara Karya Aksara*. Jakarta. 788h.

Alaoui, A., Lipiec, J., & Gerke, H. H. (2011). A review of the changes in the soil pore system due to soil deformation: A hydrodynamic perspective. *Soil and Tillage Research*, *115–116*, 1–15. https://doi.org/10.1016/j.still.2011.06.002

Andrenelli, M. C., Maienza, A., Genesio, L., Miglietta, F., Pellegrini, S., Vaccari, F. P., & Vignozzi, N. (2016). Field application of pelletized biochar: Short term effect on the hydrological properties of a silty clay loam soil. *Agricultural Water Management*, *163*, 190–196. https://doi.org/10.1016/j.agwat.2015.09.017

Aprilia, G. S. (2017). Pengaruh perbedaan umur tanaman sengon (paraserianthes falcataria l. Nielson) terhadap pori makro dan infiltrasi tanah. *Universitas Brawijaya*, 1–14.

Ayi, Q., Zeng, B., Liu, J., Li, S., Van Bodegom, P. M., & Cornelissen, J. H. C. (2016). Oxygen absorption by adventitious roots promotes the survival of completely submerged terrestrial plants. *Annals of Botany*, *118*, 675–683. https://doi.org/10.1093/aob/mcw051

Bastardie, F., Capowiez, Y., De Dreuzy, J. R., & Cluzeau, D. (2003). X-ray tomographic and hydraulic characterization of burrowing by three earthworm species in repacked soil cores. *Applied Soil Ecology*, *24*(1), 3–16. https://doi.org/10.1016/S0929-1393(03)00071-4

Bauke, S. L., Landl, M., Koch, M., Hofmann, D., Nagel, K. A., Siebers, N., Schnepf, A., & Amelung, W. (2017). Macropore effects on phosphorus acquisition by wheat roots – a rhizotron study. *Plant and Soil*, *416*, 67–82. https://doi.org/10.1007/s11104-017-3194-0

Beven, K., & Germann, P. (1982). Macropores and water flow in soils. *Water Resources Research*, *18*, 1311–1325.

Blake, G. R., & Hartge, K. H. (1986). Bulk density. *In: Klute, A. (Eds.), Methods of Soil Analysis: Part 1. Physical and Mineralogical Methods". Agronomy Monograph 9 (2nd Eds.)*, *9*(11718), 363–375. https://doi.org/10.2136/sssabookser5.1.2ed.c13

Bodner, G., Leitner, D., & Kaul, H. P. (2014). Coarse and fine root plants affect pore size distributions differently. *Plant and Soil*, *380*(1), 133–151. https://doi.org/10.1007/s11104-014-2079-8

Bouyoucos, G. J. (1936). *Directions for making mechanical analysis of soils by the hydrometer method* (pp. 225–228).

Buczko, U., Kuchenbuch, R. O., & Gerke, H. H. (2009). *Evaluation of a core sampling scheme to characterize root length density of maize*. 205–215. https://doi.org/10.1007/s11104-008-

9771-5

Carr, M. K. V., & Lockwood, G. (2011). The water relations and irrigation requirements of cocoa (Theobroma cacao L.): A review. *Experimental Agriculture*, *47*(4), 653–676. https://doi.org/10.1017/S0014479711000421

Carvalho, J. L. N., Carlos Eduardo Pelegrino, C., Feigl, B. J., Píccolo, M. de C., Godinho, V. de P., Herpin, U., & Cerri, C. C. (2009). Conversion of cerrado into agricultural land in the south-western Amazon: carbon stocks and soil fertility. *Scientia Agricola*, *66*(2), 233–241. https://doi.org/10.1590/S0103-90162009000200013

Centeno, L. N., Hu, W., Timm, L. C., She, D., da Silva Ferreira, A., Barros, W. S., Beskow, S., & Caldeira, T. L. (2020). Dominant Control of Macroporosity on Saturated Soil Hydraulic Conductivity at Multiple Scales and Locations Revealed by Wavelet Analyses. *Journal of Soil Science and Plant Nutrition*, *20*(4), 1686–1702. https://doi.org/10.1007/s42729-020-00239-5

Cepy, & Wangiyana, W. (2011). Pertumbuhan dan hasil tanaman Padi (Oryza sativa L.) di media Vertisol dan Entisol pada berbagai teknik pengaturan air dan jenis pupuk (Growth and yield rice on vertisol and entisol media under various irrigation techniques and types of fertilizers). *Crop Agro*, *4*, 49–56.

Clemmensen, K. E., Finlay, R. D., Dahlberg, A., Stenlid, J., Wardle, D. A., & Lindahl, B. D. (2015). Carbon sequestration is related to mycorrhizal fungal community shifts during long-term succession in boreal forests. *New Phytologist*, *205*, 1525–1536. https://doi.org/10.1111/nph.13208

Dariah, A., Yusrial, & Mazwar. (2004). Penetapan konduktivitas hidrolik tanah dalam keadaan jenuh : Metode Laboratorium. *Balai Besar Penelitian Dan Pengembangan Sumberdaya Lahan Pertanian*, *2*, 177–185. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian

Darmayanti, A. S., & Rindyastuti, R. (2016). Peran perakaran dan serasah tanaman Mahoni (Swietenia macrophylla), Jabon (Anthocephalus cadamba), dan Trembesi (Samanea saman) terhadap pembentukan makroporositas tanah. *Prosiding Seminar Nasional II 2016. Universitas Muhammadiya Malang*, *3*(1), 595–606

Daynes, C. N., Field, D. J., Saleeba, J. A., Cole, M. A., & McGee, P. A. (2013). Development and stabilisation of soil structure via interactions between organic matter, arbuscular mycorrhizal fungi and plant roots. *Soil Biology and Biochemistry*, *57*, 683–694. https://doi.org/10.1016/j.soilbio.2012.09.020

De Oliveira Leite, J., & Valle, R. R. (1990). Nutrient cycling in the cacao ecosystem: rain and throughfall as nutrient sources for the soil and the cacao tree. *Agriculture, Ecosystems and Environment*, *32*(1–2), 143–154. https://doi.org/10.1016/0167-8809(90)90130-6

Droogers, P., Stein, A., Bouma, J., & De Boer, G. (1998). Parameters for describing soil macroporosity derived from staining patterns. *Geoderma*, *83*(3–4), 293–308. https://doi.org/10.1016/S0016-7061(98)00005-6

Eluozo, S. N. (2013). Predictive Model To Monitor the Rate of Bulk Density in Fine and Coarse

Soil Formation Influenced Variation of Porosity in Coastal Area of Port Harcourt. *American Journal of Engineering Science and Teachnology Research*, *1*(8), 115–127.

Gaiotti, F., Marcuzzo, P., Belfiore, N., Lovat, L., Fornasier, F., & Tomasi, D. (2017). Influence of compost addition on soil properties, root growth and vine performances of Vitis vinifera cv Cabernet sauvignon. *Scientia Horticulturae*, *225*, 88–95. https://doi.org/10.1016/j.scienta.2017.06.052

Gardner, F. P., Pearce, R. B., & Mitchell, R. L. (1985). Physiology of crop plant. *State University Press*, 327.

Hairiah, K., Sulistyani, H., Suprayogo, D., Widianto, Purnomosidhi, P., Widodo, R. H., & Van Noordwijk, M. (2006). Litter layer residence time in forest and coffee agroforestry systems in Sumberjaya, West Lampung. *Forest Ecology and Management*, *224*(1–2), 45–57. https://doi.org/10.1016/j.foreco.2005.12.007

Haridjaja, O., Hidayat, Y., & Maryamah, L. S. (2010). Pengaruh Bobot Isi Tanah Terhadap Sifat Fisik Tanah Dan Perkecambahan Benih Kacang Tanah Dan Kedelai (Effect of Soil Bulk Density on Soil Physical Properties and Seed Germinations of Peanut and Soybean). *Jurnal Ilmu Pertanian Indonesia*, *15*(3), 147–152.

Hartemink, A. E. (2005). Nutrient stocks, nutrient cycling, and soil changes in Cocoa Ecosystems: A review. *Advances in Agronomy*, *86*, 227–253. https://doi.org/10.1016/S0065-2113(05)86005-5

Hidmatulloh, A. (2016). Makroporositas tanah dan kapasitas infiltrasi pada lahan sistem budidaya lorong vetiveria zizanioides dan flemingia congesta. *Institut Pertanian Bogor*, 1–42.

Kummerow, J., Kummerow, M., & Souza da Silva, W. (1982). Fine-root growth dynamics in cacao (Theobroma cacao). *Plant and Soil*, *65*(2), 193–201. https://doi.org/10.1007/BF02374650

Kurniatun Hairiah, Widianto, Suprayogo, D., Widodo, R. H., Purnomosidhi, P., Rahayu, S., & Noordwijk, M. van. (2004). Ketebalan serasah sebagai indikator daerah aliran sungai (DAS) sehat. *World Agroforestry Centre*, *53*(9), 1689–1699.

Kurniawan, D. (2018). Kajian nilai kepadatan tanah (Bulk Density) dalam alih guna lahan dari monokultur Tebu. *Universitas Brawijaya*, 1–34.

Lamandé, M., Hallaire, V., Curmi, P., Pérès, G., & Cluzeau, D. (2003). Changes of pore morphology, infiltration and earthworm community in a loamy soil under different agricultural managements. *Catena*, *54*(3), 637–649. https://doi.org/10.1016/S0341-8162(03)00114-0

Lesturgez, G., Poss, R., Hartmann, C., Bourdon, E., Noble, A., & Ratana-Anupap, S. (2004). Roots of Stylosanthes hamata create macropores in the compact layer of a sandy soil. *Plant and Soil*, *260*(1–2), 101–109. https://doi.org/10.1023/B:PLSO.0000030184.24866.aa

Lipiec, J., Walczak, R., Witkowska-Walczak, B., Nosalewicz, A., Słowińska-Jurkiewicz, A., & Sławiński, C. (2007). The effect of aggregate size on water retention and pore structure of two silt loam soils of different genesis. *Soil and Tillage Research*, *97*, 239–246.

https://doi.org/10.1016/j.still.2007.10.001

LN, F., Wulandari, S., & Mulyeni, G. D. (2013). Pertumbuhan akar tanaman karet pada tanah bekas tambang bauksit dengan aplikasi bahan organik. *Biogenesis*, *10*(1), 53–64.

Lukito. (2010). *Budidaya Kakao*. Pusat penelitian kopi dan kakao Indonesia.

Maghfiroh, C. N., & Putra, E. T. S. (2020). Morphological characters of root and yield of three cocoa (Theobroma cacao L.) clones in the field with dead-end trench. *Ilmu Pertanian (Agricultural Science)*, *5*(2), 58. https://doi.org/10.22146/ipas.51284

Mayrowani, H., & Ashari, N. (2016). Pengembangan Agroforestry untuk mendukung ketahanan pangan dan pemberdayaan petani sekitar Hutan. *Forum Penelitian Agro Ekonomi*, *29*(2), 83. https://doi.org/10.21082/fae.v29n2.2011.83-98

Naharuddin, N., Sari, I., Harijanto, H., & Wahid, A. (2020). Sifat Fisik Tanah Pada Lahan Agroforestri dan Hutan Lahan Kering Sekunder di Sub Das Wuno, Das Palu. *Jurnal Pertanian Terpadu*, *8*(2), 189–200. https://doi.org/10.36084/jpt..v8i2.251

Nair, K. P. P. (2010). Cocoa (Theobroma cacao L.). In *The Agronomy and Economy of Important Tree Crops of the Developing World*. https://doi.org/10.1016/b978-0-12-384677-8.00005-9

Neneng, N. L., & Jubaedah. (2014). Teknologi peningkatan cadangan karbon lahan kering dan potensinya pada skala nasional. *Balai Penelitian Tanah. Balitbangtan*, *1989*, 53–81.

Niether, W., Schneidewind, U., Fuchs, M., Schneider, M., & Armengot, L. (2019). Below- and aboveground production in cocoa monocultures and agroforestry systems. *Science of the Total Environment*, *657*, 558–567. https://doi.org/10.1016/j.scitotenv.2018.12.050

Nio, S. A., & Torey, P. (2013). Karakter morfologi akar sebagai indikator kekurangan air pada tanaman (Root morphological characters as water-deficit indicators in plants). *Jurnal Bios Logos*, *3*(1). https://doi.org/10.35799/jbl.3.1.2013.3466

Nita, C. E., Siswanto, B., & Utomo, W. H. (2015). Pengaruh pengolahan tanah dan pemberian bahan organik (Blotong dan Abu Ketel) terhadap porositas tanah dan pertumbuhan tanaman Tebu pada Ultisol. *Jurnal Tanah Dan Sumberdaya Lahan*, *2*(1), 119–127.

Ono, K., Noguchi, H., Noguchi, K., Imaya, A., Ugawa, Y., Komoriya, A., Tachibana, R., Murakami, H., Kida, K., & Kawahihashi, M. (2021). Soil hardness regulates the root penetration by trees planted on anthropogenic growing bases in coastal forests in Japan: new endeavors to reforest the coastal disaster prevention forests with high resilience for tsunami. *Journal of Soils and Sediments*, *21*(5), 2035–2048. https://doi.org/10.1007/s11368-020-02788-9

Ou, Y., Rousseau, A. N., Wang, L., & Yan, B. (2017). Spatio-temporal patterns of soil organic carbon and pH in relation to environmental factors—A case study of the Black Soil Region of Northeastern China. *Agriculture, Ecosystems and Environment*, *245*(May), 22–31. https://doi.org/10.1016/j.agee.2017.05.003

Pierret, A., Doussan, C., Capowiez, Y., Bastardie, F., & Pagès, L. (2007). Root Functional

Architecture: A Framework for Modeling the Interplay between Roots and Soil. *Vadose Zone Journal*, *6*(2), 269–281. https://doi.org/10.2136/vzj2006.0067

Pires, L. F., Borges, J. A. R., Rosa, J. A., Cooper, M., Heck, R. J., Passoni, S., & Roque, W. L. (2017). Soil structure changes induced by tillage systems. *Soil and Tillage Research*, *165*, 66–79. https://doi.org/10.1016/j.still.2016.07.010

Prihastanti, E., Tjitrosemito, S., Sopandie, D., & Qoyim, I. (2015). Pertumbuhan fineroot kakao (Theobroma cacao)pada cekaman kekeringan selama 13 bulan di kawasan agroforestri dengan pohon pelindung utama gamal (Gliricidia sepium). *Biodiversitas*, *1*, 1683–1688.

Rivenshield, A., & Bassuk, N. L. (2007). Using organic amendments to decrease bulk density and increase macroporosity in compacted soils. *Arboriculture and Urban Forestry*, *33*(2), 140–146.

Riyami. (2018). Cadangan karbon dan keterkaitannya dengan beberapa sifat tanah pada kebun kakao pola agroforestri sederhana. Skripsi. Tidak diterbitkan. Fakultas pertanian. *Universitas Hasanuddin*, 1–56.

Saputra, D. D., Putrantyo, A. R., & Kusuma, Z. (2018). Hubungan kandungan bahan organik tanah dengan berat isi, porositas dan laju infiltrasi pada perkebunan salak di Kecamatan Purwosari, Kabupaten Pasuruan. *Jurnal Tanah Dan Sumberdaya Lahan*, *5*, 647–654.

Schneider, C. A., Rasband, W. S., & Eliceiri, K. W. (2012). NIH Image to ImageJ: 25 years of image analysis. *Nature Methods*, *9*(7), 671–675. https://doi.org/10.1038/nmeth.2089

Schwerz, F., Elli, E. F., Behling, A., Schmidt, D., Caron, B. O., & Sgarbossa, J. (2019). Yield and qualitative traits of sugarcane cultivated in agroforestry systems: Toward sustainable production systems. *Renewable Agriculture and Food Systems*, *34*(4), 280–292. https://doi.org/10.1017/S1742170517000382

Suleman, S., Rajamuddin, U. A., & Isrun. (2016). Penilaian kualitas tanah pada beberapa tipe penggunaan lahan di Kecamatan Sigi Biromaru Kabupaten Sigi. *E-Journal Agroteknis*, *4*(6), 712–718.

Supangat, A. B., & Putra, P. B. (2010). Kajian infiltrasi tanah pada berbagai tegakan jati (Tectona grandis L.) di Cepu, Jawa Tengah. *Jurnal Penelitian Hutan Dan Konservasi Alam*, *7*(2), 149–159. https://doi.org/10.20886/jphka.2010.7.2.149-159

Suprayogo, D., Widianto, Purnomosidi, P., Widodo, R. H., Rusiana, F., Aini, Z. Z., Khasanah, N., & Kusuma, Z. (2004). Degradasi sifat fisik tanah sebagai akibat alih guna lahan hutan menjadi sistem kopi monokultur: kajian perubahan makroporositas tanah. *Agrivita*, *26*, 60–68.

Susswein, P. M., van Noordwijk, M., & Verbist, B. (2001). Forest watershed functions and tropical land use change. *Towards Integrated Natural Resource Management in the Forest Margins of the Humid Tropics: Local Action and Global Concerns. ASB Lecture Note*, *7*.

Taufiq, A., & Purwono. (2020). Budidaya tanaman aneka kacang di antara tanaman kakao. *Badan Penelitian Dan Pengembangan Pertanian*, 1–33.

Tennant, D. (1975). A Test of a Modified Line Intersect Method of Estimating Root Length. *The Journal of Ecology*, *63*(3), 995. https://doi.org/10.2307/2258617

Valentine, T. A., Hallett, P. D., Binnie, K., Young, M. W., Squire, G. R., Hawes, C., & Bengough, A. G. (2012). Soil strength and macropore volume limit root elongation rates in many UK agricultural soils. *Annals of Botany*, *110*(2), 259–270. https://doi.org/10.1093/aob/mcs118

Waluyaningsih, S. R. (2008). Studi analisis kualitas tanah pada beberapa penggunaan lahan dan hubungannya dengan tingkat erosi di Sub DAS Keduang Kecamatan Jatisrono Wonogiri. *Universitas Sebelas Maret*, 1–91.

Wang, J. G., Yang, W., Yu, B., Li, Z. X., Cai, C. F., & Ma, R. M. (2016). Estimating the influence of related soil properties on macro- and micro-aggregate stability in ultisols of south-central China. *Catena*, *137*, 545–553. https://doi.org/10.1016/j.catena.2015.11.001

Watson, G. W., Hewitt, A. M., Custic, M., & Lo, M. (2014). The management of tree root systems in urban and suburban settings: A review of soil influence on root growth. *Arboriculture and Urban Forestry*, *40*(5), 249–271.

Zakariyya, F. (2017). Karakter morfologi perakaran beberapa semaian klon kakao asal biji. *Agropross, National Conference Proceedings of Agriculture*, 1–4.

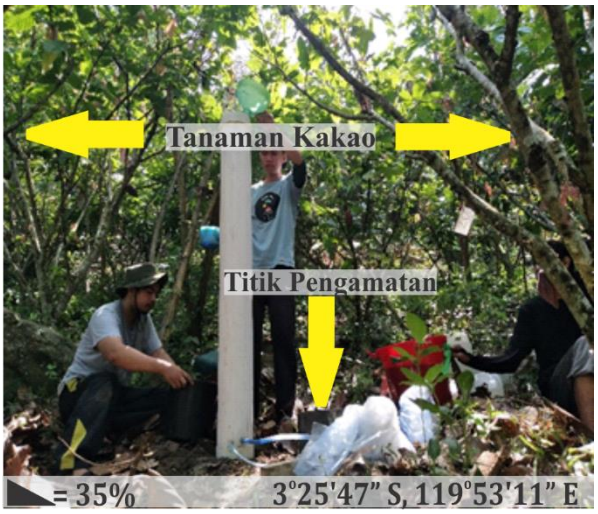
Zuidema, P. A., Leffelaar, P. A., Gerritsma, W., Mommer, L., & Anten, N. P. . (2005). A physiological production model for cocoa (Theobroma cacao): Model presentation, validation and application. *Agricultural Systems*, *84*(2), 195–225. https://doi.org/10.1016/j.agsy.2004.06.015

LAMPIRAN

Lampiran 1. Titik Pengamatan

(Lokasi pengamatan Kakao 1)

(Lokasi pengamatan Kakao 2)



(Lokasi pengamatan Kakao 3)

Lampiran 2. Vegetasi yang Terdapat pada Titik Pengamatan

(Lokasi pengamatan Kakao 1)

(Lokasi pengamatan Kakao 2)

(Lokasi pengamatan Kakao 3)

Lampiran 3. Agregat Permukaan Tanah di Titik Pengamatan



(Lokasi Kakao 1) **(Lokasi Kakao 2)** **(Lokasi Kakao 3)**

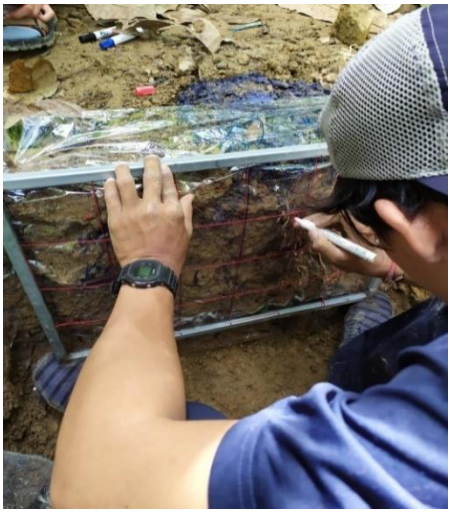
Lampiran 4. Pengaplikasian Larutan Methylen Blue



Lampiran 5. Pembuatan profil tanah

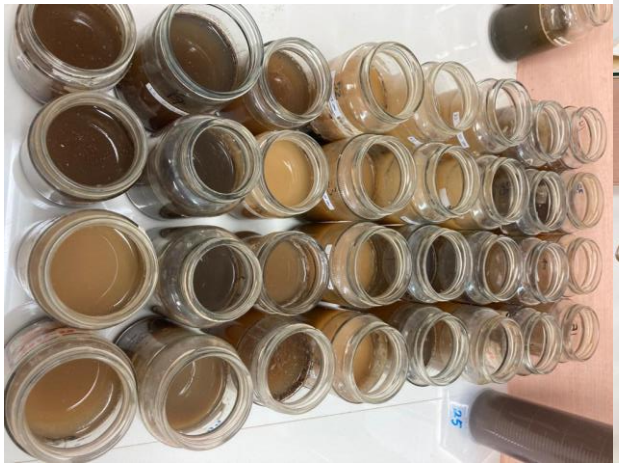

Lampiran 6. Proses Pengamatan Pori Makro Tanah


Lampiran 7. Proses Pengamatan Sebaran Akar Tanaman Kakao

Lampiran 8. Pengambilan Sampel Akar Kakao

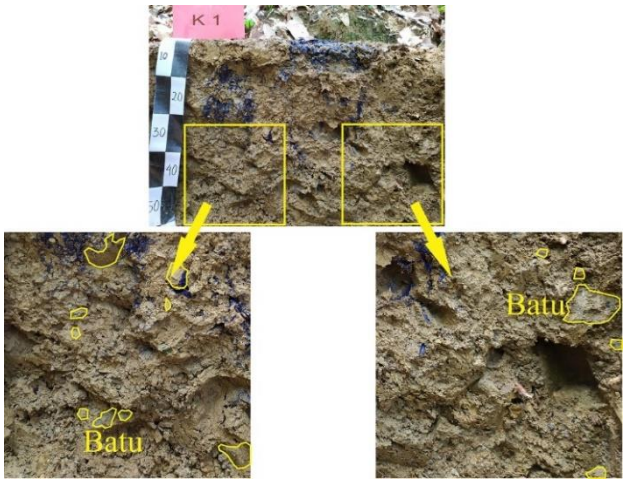

Lampiran 9. Proses Analisis Tanah di Laboratorium



Lampiran 10. Hasil Analisis Sampel Tanah Di Laboratorium

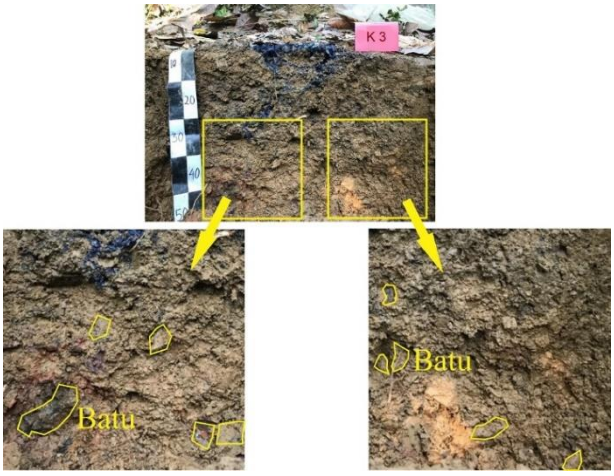
Pertanaman kakao	Kedalaman tanah (cm)	Bulk density (g cm^{-3})	Fraksi partikel (g $kg^{-1)}$			Kelas tekstur	C-Organik (%)
			Pasir	Debu	Liat		
Kakao 1	0-20	1.11	49.4	575.085	375.5	Lempung Liat Berdebu	1.24
	20-40		39.8	596.4	363.8	Lempung Liat Berdebu	0.92
Kakao 2	0-20	1.34	386.81	421.3	192.5	Lempung	1.5
	20-40	1.37	392.2	266.1	341.7	Lempung Berliat	1.45
Kakao 3	0-20	1.4	42.3	470.5	487.2	Liat Berdebu	1.71
	20-40		86	413.5	500.5	Liat Berdebu	1.37

Lampiran 11. Kenampakan Sebaran Pori Makro (warna biru) pada Penampang Profil Tanah



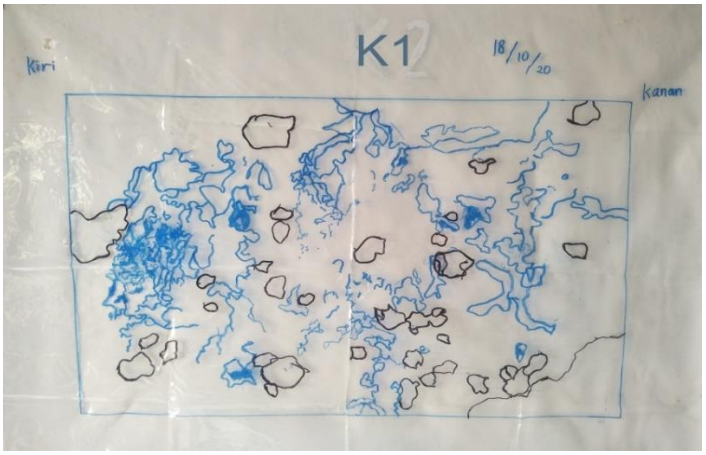
(Lokasi pengamatan Kakao 1)

(Lokasi pengamatan Kakao 2)



(Lokasi pengamatan Kakao 3)

Lampiran 12. Hasil Overlay Pori Makro (warna biru) dan Batu (warna hitam) dari Lokasi Pengamatan



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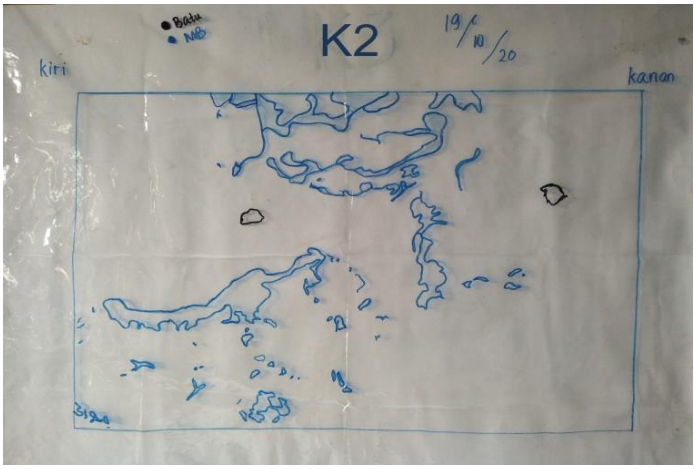

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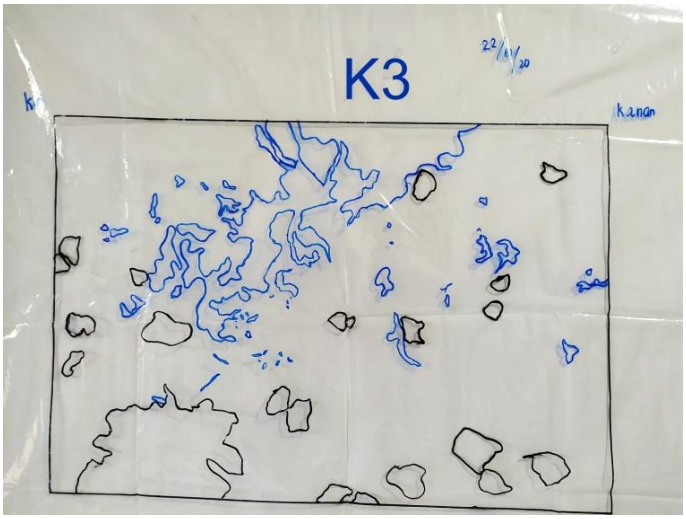
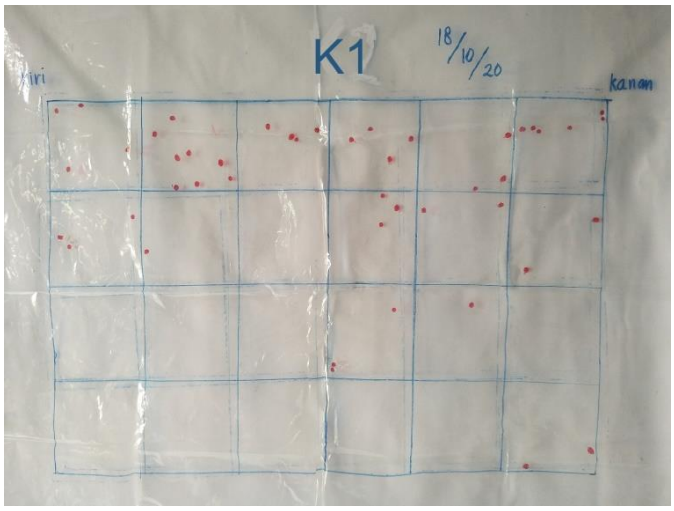


(Lokasi pengamatan Kakao 3)

Lampiran 13. Hasil Overlay Sebaran Akar Tanaman Kakao dari Lokasi Pengamatan



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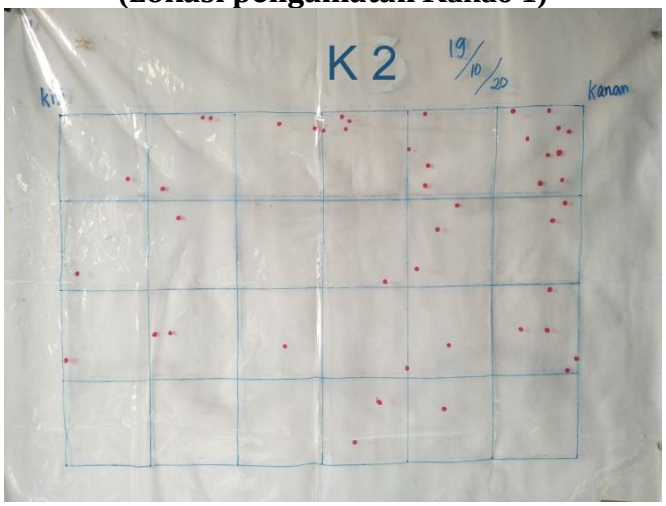

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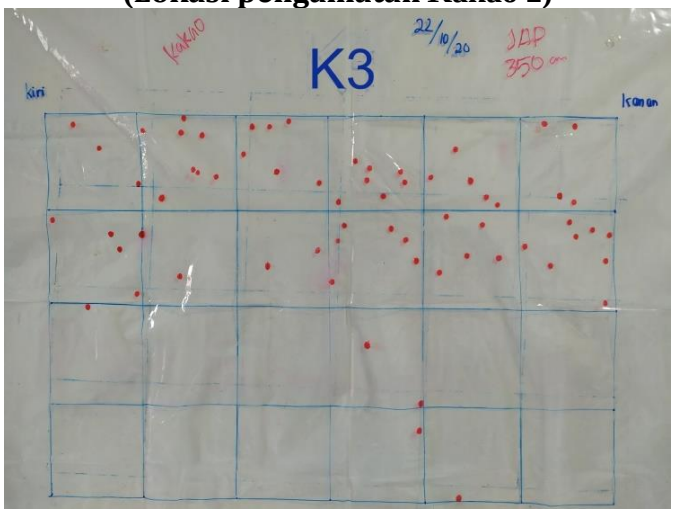
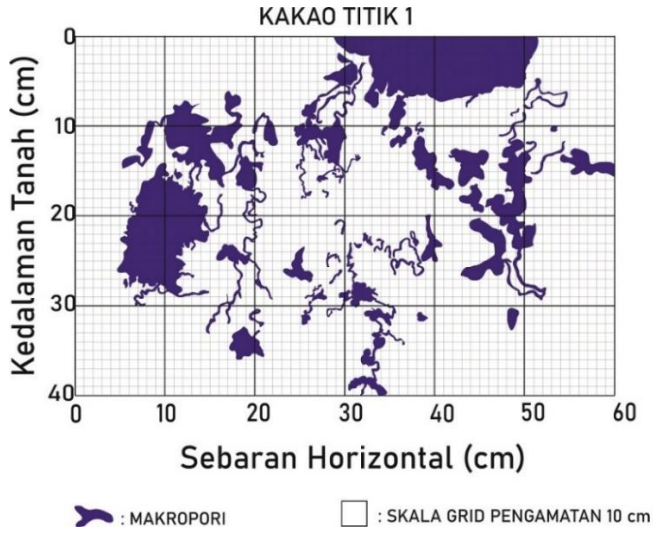
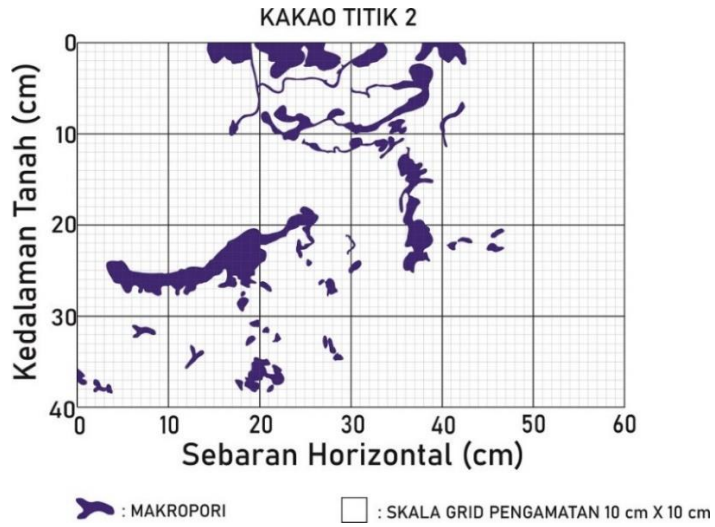
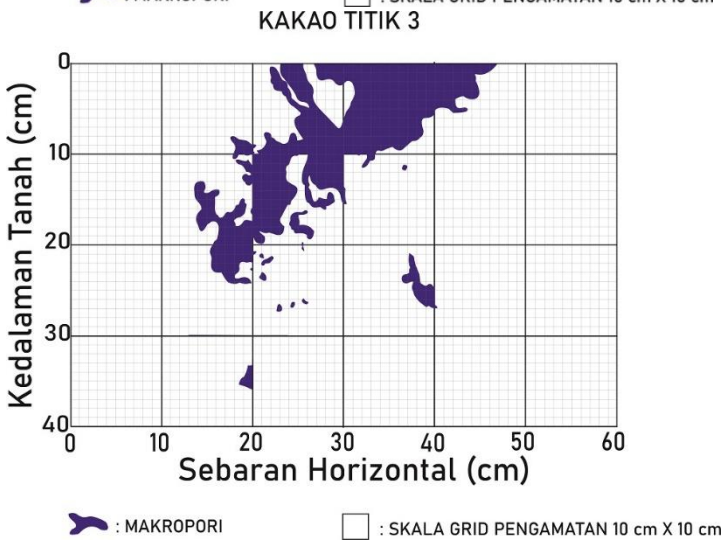


(Lokasi pengamatan Kakao 3)

Lampiran 14. Hasil Digitasi Pori Makro Tanah dari Lokasi Pengamatan







Lampiran 15. Hasil Pengukuran Pori Makro dan Akar Tanaman Kakao dari Lokasi Pengamatan

Pori makro				LRV				DRV				JUMLAH AKAR			
K1	K2	K3	RATA-RATA	k2	k3	k4	RATA-RATA	K2	K3	K4	RATA-RATA	K2	K3	K4	RATA-RATA
0.27	0.29	0.6	0.3867	0.43	0.16	0.09	0.2293	0.16	0.24	0.02	0.14	14	5	5	8
0.36	0.72	0.71	0.5967	0.27	0.34	0.28	0.2974	0.15	0.35	0.76	0.42	7	12	5	8
0.76	0.16	0.31	0.41	0.39	0.08	0.22	0.2319	0.44	0.27	0.12	0.27	9	14	11	11.333
0.27	0.4	0.08	0.25	0.23	0.18	0.29	0.2353	0.31	0.07	0.19	0.19	4	3	12	6.3333
0.7	0.02	0	0.24	0.15	0.31	0.05	0.1707	0.16	0.02	0.02	0.068	4	7	1	4
0.49	0.24	0	0.2433	0	0.04	0	0.0155	0	0.03	0	0.01	0	2	0	0.6667
0.66	0.55	0.23	0.48	0	0.28	0	0.0945	0	0.02	0	0	0	5	0	1.6667
0.2	0.15	0	0.1167	0	0	0	0	0	0	0	0	0	0	0	0
0.27	0.23	0	0.1667	0	0.01	0	0.0047	0	0	0	0.0	0	0	0	0
0.18	0.24	0	0.14	0.06	0.03	0	0.0317	0.0083	0.06	0	0.02	2	0	0	0.6667
0.5	0	0	0.1667	0	0	0	0	0	0	0	0	0	0	0	0

Lampiran 16. Kriteria Penilaian Hasil Analisis C-Organik

Parameter tanah	Sangat rendah	Rendah	Sedang	Tinggi	Sangat Tinggi
C (%)	<1	1 – 2	2 – 3	3 – 5	>5

(Sumber : Pusat Penelitian Tanah, 1995)

Lampiran 17. Klasifikasi Permeabilitas Tanah menurut Uhland And O'neal (1951) dalam (Dariah Et Al., 2004)

Kelas	Permeabilitas (cm jam-1)
Sangat lambat	<0,125
Lambat	0,125-0,50
Agak lambat	0,50-2,00
Sedang	2,00-6,25
Agak cepat	6,25-12,5
Cepat	12,5-25,00
Sangat cepat	>25,00