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DAFTAR PUSTAKA

Adebajo, S. O., Oluwatobi, F., Akintokun, P. O., Ojo, A. E., Akintokun, A. K., & Gbodope, I. S. (2022). Impacts of rice-husk biochar on soil microbial biomass and agronomic performances of tomato (Solanum lycopersicum L.). *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-05757-z

Agegnehu, G., Bass, A. M., Nelson, P. N., Muirhead, B., Wright, G., & Bird, M. I. (2015). Biochar and biochar-compost as soil amendments: Effects on peanut yield, soil properties and greenhouse gas emissions in tropical North Queensland, Australia. *Agriculture, Ecosystems and Environment*, *213*, 72–85. https://doi.org/10.1016/j.agee.2015.07.027

Ahmad, M., Lee, S. S., Dou, X., Mohan, D., Sung, J. K., Yang, J. E., & Ok, Y. S. (2012). Effects of pyrolysis temperature on soybean stover- and peanut shell-derived biochar properties and TCE adsorption in water. *Bioresource Technology*, *118*, 536–544. https://doi.org/10.1016/j.biortech.2012.05.042

Ahmad, M., Rafique, M. I., Akanji, M. A., Al-Swadi, H. A., Usama, M., Mousa, M. A., Al-Wabel, M. I., & Al-Farraj, A. S. F. (2023). Microplastic-Assisted Removal of Phosphorus and Ammonium Using Date Palm Waste Derived Biochar. *Toxics*, *11*(11). https://doi.org/10.3390/toxics11110881

Ahmad, M., Rajapaksha, A. U., Lim, J. E., Zhang, M., Bolan, N., Mohan, D., Vithanage, M., Lee, S. S., & Ok, Y. S. (2014). Biochar as a sorbent for contaminant management in soil and water: A review. In *Chemosphere* (Vol. 99, pp. 19–33). Elsevier Ltd. https://doi.org/10.1016/j.chemosphere.2013.10.071

Altıkat, A., Alma, M. H., Altıkat, A., Bilgili, M. E., & Altıkat, S. (2024). A Comprehensive Study of Biochar Yield and Quality Concerning Pyrolysis Conditions: A Multifaceted Approach. *Sustainability (Switzerland)*, *16*(2). https://doi.org/10.3390/su16020937

Anca-Couce, A., Mehrabian, R., Scharler, R., & Obernberger, I. (2014). Kinetic scheme of biomass pyrolysis considering secondary charring reactions. *Energy Conversion and Management*, *87*, 687–696. https://doi.org/10.1016/j.enconman.2014.07.061

Andreasi Bassi, Susanna., Biganzoli, Fabrizio., Ferrara, Nicola., Amadei, Andrea., Valente, Antonio., Sala, Serenella., & Ardente, Fulvio. (2023). *Updated characterisation and normalisation factors for the environmental footprint 3.1 method*. Publications Office of the European Union.

Annabi, M., Houot, S., Francou, C., Poitrenaud, M., & Bissonnais, Y. Le. (2007). Soil Aggregate Stability Improvement with Urban Composts of Different

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Maturities. *Soil Science Society of America Journal*, *71*(2), 413–423. https://doi.org/10.2136/sssaj2006.0161

Ariningsih, E., Ashari, Mardiharini, M., Sujianto, Irawan, Rahayu, H. S. P., Saleh, Y., Slameto, Suharyon, & Septanti, K. S. (2024). The potential utilisation of rice biomass for biochar to support sustainable rice farming development in Indonesia. *BIO Web of Conferences*, *119*. https://doi.org/10.1051/bioconf/202411905001

Arranz, J. I., Miranda, M. T., Montero, I., & Sepúlveda, F. J. (2021). Thermal study and emission characteristics of rice husk using tg-ms. *Materials*, *14*(20). https://doi.org/10.3390/ma14206203

Associates, F. (2018). *Life Cycle Impacts of Plastic Packaging Compared To Substitutes In The United States And Canada Theoretical Substitution Analysis Prepared For The Plastics Division Of The American Chemistry Council (ACC)*.

Azzi, E. S., Karltun, E., & Sundberg, C. (2022). Life cycle assessment of urban uses of biochar and case study in Uppsala, Sweden. biochar, *4*(1). https://doi.org/10.1007/s42773-022-00144-3

Bartram, D., Short, MD., Ebie, Y., Farkaš, J., Gueguen, C., Peters, G., Zanzottera, N., & Karthik, M. (2019). *Chapter 6: Wastewater Treatment and Discharge*.

Bergman, R., Sahoo, K., Englund, K., & Mousavi-Avval, S. H. (2022). Lifecycle Assessment and Techno-Economic Analysis of Biochar Pellet Production from Forest Residues and Field Application. *Energies*, *15*(4). https://doi.org/10.3390/en15041559

Berman, J. D., Fann, N., Hollingsworth, J. W., Pinkerton, K. E., Rom, W. N., Szema, A. M., Breysse, P. N., White, R. H., & Curriero, F. C. (2012). Health benefits from large-scale ozone reduction in the United States. *Environmental Health Perspectives*, *120*(10), 1404–1410. https://doi.org/10.1289/ehp.1104851

Biswal, B. K., & Balasubramanian, R. (2025). Use of biomass-derived biochar as a sustainable material for carbon sequestration in soil: recent advancements and future perspectives. *Npj Materials Sustainability*, *3*(1), 26. https://doi.org/10.1038/s44296-025-00066-8

Bjørn, A., Bey, N., Georg, S., Røpke, I., & Hauschild, M. Z. (2017). Is Earth recognized as a finite system in corporate responsibility reporting? *Journal of Cleaner Production*, *163*, 106–117. https://doi.org/10.1016/j.jclepro.2015.12.095

Blanke, M. M. (2023). Advances in the Sustainable Use of Plastics in Horticulture—Perspectives, Innovations, Opportunities, and Limitations. In *Sustainability*

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

(Switzerland) (Vol. 15, Issue 15). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/su151511629

Bos, U., Makishi, C., & Fischer, M. (2007). Life Cycle Assessment of Common Used Agricultural Plastic Products in the EU. *Proc. IS on Greensys 2007 341 Eds.:S. De Pascale et al. Acta Hort. 801, ISHS 2008*.

Bridgwater, A. V. (2012). Review of fast pyrolysis of biomass and product upgrading. *Biomass and Bioenergy*, *38*, 68–94. https://doi.org/10.1016/j.biombioe.2011.01.048

Cao, G. L., Zhang, X. Y., Wang, Y. Q., & Zheng, F. C. (2008). Estimation of emissions from field burning of crop straw in China. *Chinese Science Bulletin*, *53*(5), 784–790. https://doi.org/10.1007/s11434-008-0145-4

Cao, J., Liu, J., Cheng, Y., Ai, S., Li, F., Xue, T., Zhang, Q., & Zhu, T. (2024). Impacts of different vehicle emissions on ozone levels in Beijing: Insights into source contributions and formation processes. *Environment International*, *191*. https://doi.org/10.1016/j.envint.2024.109002

Carvalho, J., Nascimento, L., Soares, M., Valério, N., Ribeiro, A., Faria, L., Silva, A., Pacheco, N., Araújo, J., & Vilarinho, C. (2022). Life Cycle Assessment (LCA) of Biochar Production from a Circular Economy Perspective. In *Processes* (Vol. 10, Issue 12). MDPI. https://doi.org/10.3390/pr10122684

Cayuela, M. L., Sánchez-Monedero, M. A., Roig, A., Hanley, K., Enders, A., & Lehmann, J. (2013). Biochar and denitrification in soils: When, how much and why does biochar reduce N2O emissions? *Scientific Reports*, *3*. https://doi.org/10.1038/srep01732

Cayuela, M. L., Van Zwieten, L., Singh, B. P., Jeffery, S., Roig, A., & Sánchez-Monedero, M. A. (2014). biochar*'s role in mitigating soil nitrous oxide emissions: A review and meta-analysis*.

Chatterjee, R., Sajjadi, B., Chen, W. Y., Mattern, D. L., Hammer, N., Raman, V., & Dorris, A. (2020). Effect of Pyrolysis Temperature on PhysicoChemical Properties and Acoustic-Based Amination of Biochar for Efficient CO2 Adsorption. *Frontiers in Energy Research*, *8*. https://doi.org/10.3389/fenrg.2020.00085

Chen, Q., Hu, N., Zhang, Q., Sun, H., & Zhu, L. (2024). Effects of Biodegradable Plastic Film Mulching on the Global Warming Potential, Carbon Footprint, and Economic Benefits of Garlic Production. *Agronomy*, *14*(3). https://doi.org/10.3390/agronomy14030504

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Chen, W., Yang, H., Chen, Y., Xia, M., Chen, X., & Chen, H. (2017). *Transformation of nitrogen and evolution of N-containing species during algae pyrolysis*. http://pubs.acs.org

Cheng, S., Yao, K., Tian, H., Yang, T., & Chen, L. (2024). Synergistic Catalytic Effects on Nitrogen Transformation during Biomass Pyrolysis: A Focus on Proline as a Model Compound. *Molecules*, *29*(13). https://doi.org/10.3390/molecules29133118

Cheng, X., Xu, Y., Li, J., Wang, Z., & Ma, C. (2017). Heating Process Characteristics and Kinetics of Biomass at Different Oxygen Concentrations. *International Journal of Chemical Reactor Engineering*, *15*(4). https://doi.org/10.1515/ijcre-2017-0009

Clough, T. J., & Condron, L. M. (2010). Biochar and the Nitrogen Cycle: Introduction. *Journal of Environmental Quality*, *39*(4), 1218–1223. https://doi.org/10.2134/jeq2010.0204

Colombo, M., Raposo, G., & Théry, C. (2014). Biogenesis, secretion, and intercellular interactions of exosomes and other extracellular vesicles. In *Annual review of cell and developmental biology* (Vol. 30, pp. 255–289). https://doi.org/10.1146/annurev-cellbio-101512-122326

Costa, L. P., Vaz De Miranda, D. M., & Pinto, J. C. (2022). Critical Evaluation of Life Cycle Assessment Analyses of Plastic Waste Pyrolysis. *ACS Sustainable Chemistry and Engineering*, *10*(12), 3799–3807. https://doi.org/10.1021/acssuschemeng.2c00265

CREA. (2023). *Enforcing more stringent air pollution controls at Banten-Suralaya would prevent over 1,000 deaths and save USD billions: Health impact assessment (HIA)*.

Dada, O. I., Habarakada Liyanage, T. U., Chi, T., Yu, L., DeVetter, L. W., & Chen, S. (2025). Towards sustainable agroecosystems: A life cycle assessment review of soil-biodegradable and traditional plastic mulch films. In *Environmental Science and Ecotechnology* (Vol. 24). Elsevier B.V. https://doi.org/10.1016/j.ese.2025.100541

de Lange, C. A., Ferguson, J. D., Happer, W., & van Wijngaarden, W. A. (2022). *Nitrous Oxide and Climate*. http://arxiv.org/abs/2211.15780

de Sadeleer, I., & Woodhouse, A. (2024). Environmental impact of biodegradable and non-biodegradable agricultural mulch film: A case study for Nordic conditions. *International Journal of Life Cycle Assessment*, *29*(2), 275–290. https://doi.org/10.1007/s11367-023-02253-y

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Demirbas, A. (2000). *Biomass resource facilities and biomass conversion processing for fuels and chemicals*. www.elsevier.com/locate/enconman

Deng, X., Teng, F., Chen, M., Du, Z., Wang, B., Li, R., & Wang, P. (2024). Exploring negative emission potential of biochar to achieve carbon neutrality goal in China. *Nature Communications*, *15*(1). https://doi.org/10.1038/s41467-024-45314-y

Divyangkumar, N., Panwar, N. L., Agrawal, C., Gupta, T., Meena, G. L., & Singh, M. (2024). Cradle-to-gate analyses of biochar produced from agricultural crop residues by vacuum pyrolysis. *Clean Energy*, *8*(6), 1–15. https://doi.org/10.1093/ce/zkae069

Dong, Y., Yang, J. L., Zhao, X. R., Yang, S. H., Mulder, J., Dörsch, P., & Zhang, G. L. (2022). Nitrate leaching and N accumulation in a typical subtropical red soil with N fertilization. *Geoderma*, *407*. https://doi.org/10.1016/j.geoderma.2021.115559

Durak, H. (2023). Comprehensive Assessment of Thermochemical Processes for Sustainable Waste Management and Resource Recovery. In *Processes* (Vol. 11, Issue 7). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/pr11072092

EBC. (2023). Guidelines European Biochar Certificate for a sustainable production of biocha. *European* biochar *Certificate*.

EPA. (2016). *Overview of Nitrogen Dioxide (NO 2) Air Quality in the United States*.

European Commission. (2007). *Reference Document on Best Available Techniques in the Production of Polymers*. http://eippcb.jrc.es.

Fang, H., & Michalski, G. (2022). Assessing the roles emission sources and atmospheric processes play in simulating δ15N of atmospheric NOx and NO3- using CMAQ (version 5.2.1) and SMOKE (version 4.6). *Geoscientific Model Development*, *15*(10), 4239–4258. https://doi.org/10.5194/gmd-15-4239-2022

Fang, Y., Singh, B., & Singh, B. P. (2015). Effect of temperature on biochar priming effects and its stability in soils. *Soil Biology and Biochemistry*, *80*, 136–145. https://doi.org/10.1016/j.soilbio.2014.10.006

FAO. (2021). World Food and Agriculture – Statistical Yearbook 2021. In *World Food and Agriculture – Statistical Yearbook 2021*. Food and Agriculture Organization of the United Nations. https://doi.org/10.4060/cb4477en

Fermanelli, C. S., Córdoba, A., Pierella, L. B., & Saux, C. (2020). Pyrolysis and copyrolysis of three lignocellulosic biomass residues from the agro-food industry: A comparative study. *Waste Management*, *102*, 362–370. https://doi.org/10.1016/j.wasman.2019.10.057

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Foschi, E., Zanni, S., & Bonoli, A. (2020). Combining eco-design and LCA as decision-making process to prevent plastics in packaging application. *Sustainability (Switzerland)*, *12*(22), 1–13. https://doi.org/10.3390/su12229738

Franklin Associates. (2020). *Cradle-to-Gate Life Cycle Analysis of High-Density Polyethylene (HDPE) Resin Final Report*.

Frazier, R. S., Jin, E., & Kumar, A. (2015). Life cycle assessment of biochar versus metal catalysts used in syngas cleaning. *Energies*, *8*(1), 621–644. https://doi.org/10.3390/en8010621

Frimpong, K. A., Abban-Baidoo, E., & Marschner, B. (2020). *Can combined compost and* biochar *application improve the quality of a highly weathered coastal savanna soil?* https://doi.org/10.1101/2020.07.24.219279

Gao, S., Harrison, B. P., Thao, T., Gonzales, M. L., An, D., Ghezzehei, T. A., Diaz, G., & Ryals, R. A. (2023). Biochar co-compost improves nitrogen retention and reduces carbon emissions in a winter wheat cropping system. *GCB Bioenergy*, *15*(4), 462–477. https://doi.org/10.1111/gcbb.13028

Gao, Y., Xue, Y., Sun, C., She, L., & Peng, Y. (2025). Emission Characteristics of Volatile Organic Compounds from Material Extrusion Printers Using Acrylonitrile–Butadiene–Styrene and Polylactic Acid Filaments in Printing Environments and Their Toxicological Concerns. In *Toxics* (Vol. 13, Issue 4). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/toxics13040276

Glarborg, P., Allingham, J. S., Skov, A. B., Hashemi, H., & Marshall, P. (2023). Re-Examination of the N2O + O Reaction. *Journal of Physical Chemistry A*, *127*(31), 6521–6531. https://doi.org/10.1021/acs.jpca.3c02515

Glaser, B., Lehmann, J., & Zech, W. (2002). Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal - A review. In *Biology and Fertility of Soils* (Vol. 35, Issue 4, pp. 219–230). https://doi.org/10.1007/s00374-002-0466-4

Guo, S., Wang, Y., Zhu, S., Qu, H., Zhao, D., Li, X., & Zhao, Y. (2024). Reactive Force Field Molecular Dynamics Investigation of NH3 Generation Mechanism during Protein Pyrolysis Process. *Molecules*, *29*(9). https://doi.org/10.3390/molecules29092016

Hagan, R., Markey, E., Clancy, J., Keating, M., Donnelly, A., O'Connor, D. J., Morrison, L., & McGillicuddy, E. J. (2022). Non-Road Mobile Machinery Emissions and Regulations: A Review. *Air*, *1*(1), 14–36. https://doi.org/10.3390/air1010002

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Halalsheh, M., Shatanawi, K., Shawabkeh, R., Kassab, G., Mohammad, H., Adawi, M., Ababneh, S., Abdullah, A., Ghantous, N., Balah, N., & Almomani, S. (2024). Impact of temperature and residence time on sewage sludge pyrolysis for combined carbon sequestration and energy production. *Heliyon*, *10*(7). https://doi.org/10.1016/j.heliyon.2024.e28030

Hamidu, I., Afotey, B., Kwakye-Awuah, B., & Anang, D. A. (2025). Synthesis of silica and silicon from rice husk feedstock: A review. In *Heliyon* (Vol. 11, Issue 4). Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2025.e42491

Han, K.-H., Yun, S.-I., Choi, D.-H., & Lee, S.-I. (2024). Net CO2 removal of rice husk biochar as soil amendment depending on energy reuse in the production stage. *Korean Journal of Soil Science and Fertilizer*, *57*(2), 130–139. https://doi.org/10.7745/kjssf.2024.57.2.130

Harris, Z. M., Spake, R., & Taylor, G. (2015). Land use change to bioenergy: A meta-analysis of soil carbon and GHG emissions. *Biomass and Bioenergy*, *82*, 27–39. https://doi.org/10.1016/j.biombioe.2015.05.008

Harsanti, E. S., Ardiwinata, A. N., Sukarjo, Zu'amah, H., Kurnia, A., Sutriadi, M. T., Nursyamsi, D., Yusuf, W. A., & Wihardjaka, A. (2024). Nitrogen losses (N2O and NO3–) from mustard (Brassica juncea L.) cropping applied urea coated bio-charcoal. *Plant, Soil and Environment*, *70*(1), 1–10. https://doi.org/10.17221/282/2023-PSE

Hejna, A., Marć, M., Szymański, P., Mizera, K., & Barczewski, M. (2024). Analysis of emission of volatile organic compounds and thermal degradation in investment casting using fused deposition modeling (FDM) and three-dimensional printing (3DP) made of various thermoplastic polymers. *Environmental Science and Pollution Research*, *31*(50), 60371–60388. https://doi.org/10.1007/s11356-024-35200-x

Hodgson, S. C., Casey, R. J., Bigger, S. W., & Scheirs, J. (2000). Review of volatile organic compounds derived from polyethylene. *Polymer - Plastics Technology and Engineering*, *39*(5), 845–874. https://doi.org/10.1081/PPT-100101409

Hu, X., Zhang, R., Xia, B., Ying, R., Hu, Z., Tao, X., Yu, H., Xiao, F., Chu, Q., Chen, H., & Qian, J. (2022). Effect of Pyrolysis Temperature on Removal Efficiency and Mechanisms of Hg(II), Cd(II), and Pb (II) by Maize Straw Biochar. *Sustainability (Switzerland)*, *14*(15). https://doi.org/10.3390/su14159022

Huijbregts, M. A. J., Steinmann, Z. J. N., Elshout, P. M. F., Stam, G., Verones, F., Vieira, M. D. M., Hollander, A., Zijp, M., & van Zelm, R. (2016). ReCiPe 2016 A harmonized life cycle impact assessment method at midpoint and endpoint level Report I: Characterization. *National Institute for Public Health and the Environment*.

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

IBI. (2015). *Standardized Product Definition and Product Testing Guidelines for* biochar *That Is Used in Soil (aka IBI* biochar *Standards)*. http://www.biochar-international.org/characterizationstandard.

Ibitoye, S. E., Loha, C., Mahamood, R. M., Jen, T. C., Alam, M., Sarkar, I., Das, P., & Akinlabi, E. T. (2024). An overview of biochar production techniques and application in iron and steel industries. In *Bioresources and Bioprocessing* (Vol. 11, Issue 1). Springer. https://doi.org/10.1186/s40643-024-00779-z

Izhar, T. N. T., & May, Y. V. (2020). Life cycle analysis of plastic packaging. *IOP Conference Series: Earth and Environmental Science*, *616*(1). https://doi.org/10.1088/1755-1315/616/1/012036

Javaid, S. F., Dai, M., Wu, Y., Luo, H., Amjed, M. A., Ali, I., Peng, C., & Naz, I. (2024). Production of Biochar by Slow and Solar-Biomass Pyrolysis: Focus on the Output Configuration Assessment, Adaptability, and Barriers to Market Penetration. In *Arabian Journal for Science and Engineering* (Vol. 49, Issue 6, pp. 7731–7750). Springer Nature. https://doi.org/10.1007/s13369-023-08549-3

Jerzak, W., Acha, E., & Li, B. (2024). Comprehensive Review of Biomass Pyrolysis: Conventional and Advanced Technologies, Reactor Designs, Product Compositions and Yields, and Techno-Economic Analysis. In *Energies* (Vol. 17, Issue 20). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/en17205082

Jia, Y., Sun, Y., Zhang, D., Yang, W., Pang, J., Siddique, K. H. M., & Qu, Z. (2025). Mitigation of Greenhouse Gas Emissions Using Straw Biochar in Arid Regions of Northwest China: Evidence from Field Experiments. *Agronomy*, *15*(5). https://doi.org/10.3390/agronomy15051007

Kalina, M., Sovova, S., Svec, J., Trudicova, M., Hajzler, J., Kubikova, L., & Enev, V. (2022). The Effect of Pyrolysis Temperature and the Source Biomass on the Properties of Biochar Produced for the Agronomical Applications as the Soil Conditioner. *Materials*, *15*(24). https://doi.org/10.3390/ma15248855

Kammann, C., Ratering, S., Eckhard, C., & Müller, C. (2012). Biochar and Hydrochar Effects on Greenhouse Gas (Carbon Dioxide, Nitrous Oxide, and Methane) Fluxes from Soils. *Journal of Environmental Quality*, *41*(4), 1052–1066. https://doi.org/10.2134/jeq2011.0132

Karali, N., Khanna, N., & Shah, N. (2024). *Climate Impact of Primary Plastic Production | 1 Climate Impact of Primary Plastic Production*.

Keiluweit, M., Nico, P. S., Johnson, M., & Kleber, M. (2010). Dynamic molecular structure of plant biomass-derived black carbon (biochar). *Environmental Science and Technology*, *44*(4), 1247–1253. https://doi.org/10.1021/es9031419

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IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Khan, T. F., & Hodson, M. E. (2024). Polyethylene microplastic can adsorb phosphate but is unlikely to limit its availability in soil. *Heliyon*, *10*(1). https://doi.org/10.1016/j.heliyon.2023.e23179

KLHK. (2022). Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor 21 Tahun 2022. *Kementerian LIngkungan Hidup*.

Kloss, S., Zehetner, F., Dellantonio, A., Hamid, R., Ottner, F., Liedtke, V., Schwanninger, M., Gerzabek, M. H., & Soja, G. (2012). Characterization of Slow Pyrolysis Biochars: Effects of Feedstocks and Pyrolysis Temperature on Biochar Properties. *Journal of Environmental Quality*, *41*(4), 990–1000. https://doi.org/10.2134/jeq2011.0070

Köppel, M., Witzig, N., Klausmann, T., Cerrato, M., Schweitzer, T., Weber, J., Yilmaz, E., Chimbo, J., del Campo, B., Davila, L., & Barreno, D. (2024). *Predicting NOx emissions in* biochar *Production Plants using Machine Learning*. http://arxiv.org/abs/2412.07881

Kumar, A., Saini, K., & Bhaskar, T. (2020). Hydochar and biochar: Production, physicochemical properties and techno-economic analysis. In *Bioresource Technology* (Vol. 310). Elsevier Ltd. https://doi.org/10.1016/j.biortech.2020.123442

Kurniawan, A. R., & Kurniawan, ali. (2014). The Behavior of Heavy Metals Content in Combustion Products the behavior of heavy metals content in coal combustion products (ccp s) and its leachate from indonesia coal power plants sifat kandungan logam berat pada limbah pembakaran batubara dan air lindiannya dari pembangkit listrik tenaga uap (pltu) di indonesia. In *IndonesIan MInIng Journal* (Vol. 17, Issue 2).

Lal, R. (2018). Digging deeper: A holistic perspective of factors affecting soil organic carbon sequestration in agroecosystems. In *Global Change Biology* (Vol. 24, Issue 8, pp. 3285–3301). Blackwell Publishing Ltd. https://doi.org/10.1111/gcb.14054

Lal, R. (2020). Regenerative agriculture for food and climate. In *Journal of Soil and Water Conservation* (Vol. 75, Issue 5, pp. 123A-124A). Soil and Water Conservation Society. https://doi.org/10.2489/jswc.2020.0620A

Lalić, B., Fitzjarrald, D. R., Firanj Sremac, A., Marčić, M., & Petrić, M. (2022). Identifying Crop and Orchard Growing Stages Using Conventional Temperature and Humidity Reports. *Atmosphere*, *13*(5). https://doi.org/10.3390/atmos13050700

Lee, J. W. (2013). *Advanced Biofuels and Bioproducts*. https://doi.org/10.1007/978-1-4614-3348-4

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Lehmann, J., Cowie, A., Masiello, C. A., Kammann, C., Woolf, D., Amonette, J. E., Cayuela, M. L., Camps-Arbestain, M., & Whitman, T. (2021). Biochar in climate change mitigation. In *Nature Geoscience* (Vol. 14, Issue 12, pp. 883–892). Nature Research. https://doi.org/10.1038/s41561-021-00852-8

Lehmann, J., & Joseph, S. (2024). Biochar for environmental management: An introduction. In biochar *for Environmental Management: Science, Technology and Implementation* (pp. 1–14). Taylor and Francis. https://doi.org/10.4324/9781003297673-1

Lehmann, J., Rillig, M. C., Thies, J., Masiello, C. A., Hockaday, W. C., & Crowley, D. (2011). Biochar effects on soil biota - A review. In *Soil Biology and Biochemistry* (Vol. 43, Issue 9, pp. 1812–1836). https://doi.org/10.1016/j.soilbio.2011.04.022

Lestari, P., Damayanti, S., & Arrohman, M. K. (2020). Emission Inventory of Pollutants (CO, SO2, PM2.5, and NOX) in Jakarta Indonesia. *IOP Conference Series: Earth and Environmental Science*, *489*(1). https://doi.org/10.1088/1755-1315/489/1/012014

Li, F., Wang, J., Xie, Y., Li, H., Li, X., & Li, F. (2015). Effects of pyrolysis temperature on carbon retention and stability of biochar. *Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering*, *31*(4), 266–271. https://doi.org/10.3969/j.issn.1002-6819.2015.04.037

Li, S. (2024). Reviewing Air Pollutants Generated during the Pyrolysis of Solid Waste for Biofuel and Biochar Production: Toward Cleaner Production Practices. In *Sustainability (Switzerland)* (Vol. 16, Issue 3). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/su16031169

Lijewski, P., Fuc, P., Dobrzynski, M., & Markiewicz, F. (2017). *Exhaust emissions from small engines in handheld devices*. https://doi.org/10.1051/matecconf/201711800016

Liu, H., Yu, S., Wang, T., Li, J., & Wang, Y. (2024). A systematic review on sustainability assessment of internal combustion engines. In *Journal of Cleaner Production* (Vol. 451). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2024.141996

Liu, J., Huang, S., Chen, K., Wang, T., Mei, M., & Li, J. (2020). Preparation of biochar from food waste digestate: Pyrolysis behavior and product properties. *Bioresource Technology*, *302*. https://doi.org/10.1016/j.biortech.2020.122841

Liu, J., Ouyang, X., Shen, J., Li, Y., Sun, W., Jiang, W., & Wu, J. (2020). Nitrogen and phosphorus runoff losses were influenced by chemical fertilization but not by pesticide application in a double rice-cropping system in the subtropical

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

hilly region of China. *Science of the Total Environment*, *715*. https://doi.org/10.1016/j.scitotenv.2020.136852

Liyanage, T. D. P., Maeda, M., Somura, H., Mori, M., & Fujiwara, T. (2022). Nitrous oxide and carbon dioxide emissions from two types of soil amended with manure compost at different ammonium nitrogen rates. *Soil Science and Plant Nutrition*, *68*(4), 473–490. https://doi.org/10.1080/00380768.2022.2087198

Lu, W., Ding, W., Zhang, J., Li, Y., Luo, J., Bolan, N., & Xie, Z. (2014). Biochar suppressed the decomposition of organic carbon in a cultivated sandy loam soil: A negative priming effect. *Soil Biology and Biochemistry*, *76*, 12–21. https://doi.org/10.1016/j.soilbio.2014.04.029

Lv, Q., Yang, Z., Chen, Z., Li, M., Gao, B., Yang, J., Chen, X., & Xu, B. (2024). Crop residue burning in China (2019–2021): Spatiotemporal patterns, environmental impact, and emission dynamics. *Environmental Science and Ecotechnology*, *21*. https://doi.org/10.1016/j.ese.2024.100394

Lyu, H., Zhang, H., Chu, M., Zhang, C., Tang, J., Chang, S. X., Mašek, O., & Ok, Y. S. (2022). Biochar affects greenhouse gas emissions in various environments: A critical review. In *Land Degradation and Development* (Vol. 33, Issue 17, pp. 3327–3342). John Wiley and Sons Ltd. https://doi.org/10.1002/ldr.4405

Manyà, J. J. (2012). Pyrolysis for biochar purposes: A review to establish current knowledge gaps and research needs. In *Environmental Science and Technology* (Vol. 46, Issue 15, pp. 7939–7954). https://doi.org/10.1021/es301029g

Maraveas, C. (2020). Environmental sustainability of plastic in agriculture. In *Agriculture (Switzerland)* (Vol. 10, Issue 8, pp. 1–15). MDPI AG. https://doi.org/10.3390/agriculture10080310

Martin, M., & Molin, E. (2019). Environmental assessment of an urban vertical hydroponic farming system in Sweden. *Sustainability (Switzerland)*, *11*(15). https://doi.org/10.3390/su11154124

Marzeddu, S., Cappelli, A., Ambrosio, A., Décima, M. A., Viotti, P., & Boni, M. R. (2021). A life cycle assessment of an energy-biochar chain involving a gasification plant in Italy. *Land*, *10*(11). https://doi.org/10.3390/land10111256

Masson-Delmotte, V., Zhai, P., Chen, Y., Goldfarb, L., Gomis, M. I., Matthews, J. B. R., Berger, S., Huang, M., Yelekçi, O., Yu, R., Zhou, B., Lonnoy, E., Maycock, T. K., Waterfield, T., Leitzell, K., & Caud, N. (2021). *Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change Edited by*. www.ipcc.ch

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN
APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Mazhandu, Z. S., Muzenda, E., Belaid, M., & Nhubu, T. (2023). Comparative assessment of life cycle impacts of various plastic waste management scenarios in Johannesburg, South Africa. *International Journal of Life Cycle Assessment*, *28*(5), 536–553. https://doi.org/10.1007/s11367-023-02151-3

Méndez, R. (2012). *Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco El Colegio de la Frontera Sur*.

Meng, L., & Sager, J. (2017). Energy consumption and energy-related CO2 emissions from China's petrochemical industry based on an environmental input-output life cycle assessment. *Energies*, *10*(10). https://doi.org/10.3390/en10101585

Min, H., Huang, X., Xu, D., Shao, Q., Li, Q., Wang, H., & Ren, L. (2022). Determining the Effects of Compost Substitution on Carbon Sequestration, Greenhouse Gas Emission, Soil Microbial Community Changes, and Crop Yield in a Wheat Field. *Life*, *12*(9). https://doi.org/10.3390/life12091382

Moretti, C., Junginger, M., & Shen, L. (2020). Environmental life cycle assessment of polypropylene made from used cooking oil. *Resources, Conservation and Recycling*, *157*. https://doi.org/10.1016/j.resconrec.2020.104750

Murtaza, G., Ahmed, Z., Eldin, S. M., Ali, B., Bawazeer, S., Usman, M., Iqbal, R., Neupane, D., Ullah, A., Khan, A., Hassan, M. U., Ali, I., & Tariq, A. (2023). Biochar-Soil-Plant interactions: A cross talk for sustainable agriculture under changing climate. In *Frontiers in Environmental Science* (Vol. 11). Frontiers Media S.A. https://doi.org/10.3389/fenvs.2023.1059449

Nan, H., Xiao, Z., Zhao, L., Yang, F., Xu, H., Xu, X., & Qiu, H. (2020). Nitrogen Transformation during Pyrolysis of Various N-Containing Biowastes with Participation of Mineral Calcium. *ACS Sustainable Chemistry and Engineering*, *8*(32), 12197–12207. https://doi.org/10.1021/acssuschemeng.0c03773

Nguyen, L. X., Do, P. T. M., Nguyen, C. H., Kose, R., Okayama, T., Pham, T. N., Nguyen, P. D., & Miyanishi, T. (2018). Biochar properties. In *BioResources* (Vol. 13, Issue 4).

Nie, P., Liu, J., Mo, Z., & Zhang, Y. (2025). Emission characteristics and environmental health risk assessment of VOCs from the typical plastic products industry. *Journal of Environmental Engineering Technology*, *15*(2), 358–367. https://doi.org/10.12153/j.issn.1674-991X.20240841

Nkomo, N., Odindo, A. O., Musazura, W., & Missengue, R. (2021). Optimising pyrolysis conditions for high-quality biochar production using black soldier fly larvae faecal-derived residue as feedstock. *Heliyon*, *7*(5). https://doi.org/10.1016/j.heliyon.2021.e07025

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN
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Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Nurdin, M., Usnawiyah, Handayani, R. S., Zuliati, S., Ulham, H., & Tumangger, K. (2024). The Role of Rice Husk Biochar As An Amelioration Agent on The Growth And Production of Various Groundnut Varieties. *Jurnal Agrium*, *21*(4), 358–366.

Osman, A. I., Farghali, M., & Rashwan, A. K. (2024). Life cycle assessment of biochar as a green sorbent for soil remediation. In *Current Opinion in Green and Sustainable Chemistry* (Vol. 46). Elsevier B.V. https://doi.org/10.1016/j.cogsc.2024.100882

Pahnila, M., Koskela, A., Sulasalmi, P., & Fabritius, T. (2023). A Review of Pyrolysis Technologies and the Effect of Process Parameters on Biocarbon Properties. In *Energies* (Vol. 16, Issue 19). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/en16196936

Pandiangan, F. I., & Audah, K. A. (2022). Heavy metal contamination status in the soil-water-rice system near coal-fired power plants in Cilacap, Indonesia. *Jurnal Ilmiah Pertanian*, *19*(3). https://doi.org/10.31849/jip.v19i3.10568

Pant, R. ., & Zampori, L. . (2019). *Suggestions for updating the organisation environmental footprint (OEF) method*. Publications Office of the European Union.

Parkes, M. G., Azevedo, D. L., Cavallo, A. C., Domingos, T., & Teixeira, R. F. M. (2023). Life cycle assessment of microgreen production: effects of indoor vertical farm management on yield and environmental performance. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-38325-0

Parkin, T. B., Venterea, R. T., & Hargreaves, S. K. (2012). Calculating the Detection Limits of Chamber-based Soil Greenhouse Gas Flux Measurements. *Journal of Environmental Quality*, *41*(3), 705–715. https://doi.org/10.2134/jeq2011.0394

Patel, K., Vashist, M., Goyal, D., Sarma, R., Garg, R., & Singh, S. K. (2025). From waste to resource: A life cycle assessment of biochar from agricultural residue. *Environmental Progress and Sustainable Energy*, *44*(2). https://doi.org/10.1002/ep.14558

Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G. P., & Smith, P. (2016). Climate-smart soils. In *Nature* (Vol. 532, Issue 7597, pp. 49–57). Nature Publishing Group. https://doi.org/10.1038/nature17174

Pivato, A., Gohar, H., Antille, D. L., Schievano, A., Beggio, G., Reichardt, P., Maria, F. Di, Peng, W., Castegnaro, S., & Lavagnolo, M. C. (2024). Air-Polluting Emissions from Pyrolysis Plants: A Systematic Mapping. In *Environments - MDPI* (Vol. 11, Issue 7). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/environments11070149

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Prakash, J., Agrawal, S. B., & Agrawal, M. (2023). Global Trends of Acidity in Rainfall and Its Impact on Plants and Soil. In *Journal of Soil Science and Plant Nutrition* (Vol. 23, Issue 1, pp. 398–419). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/s42729-022-01051-z

Pulleman, M. M., & Marinissen, J. C. Y. (2004). Physical protection of mineralizable C in aggregates from long-term pasture and arable soil. *Geoderma*, *120*(3–4), 273–282. https://doi.org/10.1016/j.geoderma.2003.09.009

Putri, R. W., Rahmatullah, Haryati, S., Santoso, B., & Hadi, A. A. (2022). The Residence Time and Slow Pyrolysis Temperature Effect on Chemical Composition Pyrolysis Gas Product of Durian (Durio Zibethinus Murr) Skin. *Chemical Engineering Transactions*, *97*, 247–252. https://doi.org/10.3303/CET2297042

Qi, D., Wu, Q., & Zhu, J. (2020). Nitrogen and phosphorus losses from paddy fields and the yield of rice with different water and nitrogen management practices. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-020-66757-5

Quintero-Naucil, M., Salcedo-Mendoza, J., Solarte-Toro, J. C., & Aristizábal-Marulanda, V. (2024). Assessment and comparison of thermochemical pathways for the rice residues valorization: pyrolysis and gasification. *Environmental Science and Pollution Research*. https://doi.org/10.1007/s11356-024-32241-0

Raga Mexico, G., Nakajima, T., Ramanathan, V., Ramaswamy, V., Artaxo, P., Berntsen, T., Betts, R., Fahey, D., Haywood, J., Lean, J., Lowe, D., Myhre, G., Nganga, J., Prinn, R., Raga, G., Schulz, M., Van, R., Solomon, C., Qin, D., … Averyt, K. (2007). *The Physical Science Basis. Contribution of Working Group I*.

Raghu, K. C., Aalto, M., Korpinen, O. J., Ranta, T., & Proskurina, S. (2020). Lifecycle assessment of biomass supply chain with the assistance of agent-based modelling. *Sustainability (Switzerland)*, *12*(5). https://doi.org/10.3390/su12051964

Rajkovich, S., Enders, A., Hanley, K., Hyland, C., Zimmerman, A. R., & Lehmann, J. (2012). Corn growth and nitrogen nutrition after additions of biochars with varying properties to a temperate soil. *Biology and Fertility of Soils*, *48*(3), 271–284. https://doi.org/10.1007/s00374-011-0624-7

Raugei, M., Kamran, M., & Hutchinson, A. (2020). A prospective net energy and environmental life-cycle assessment of the UK electricity grid. *Energies*, *13*(9). https://doi.org/10.3390/en13092207

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Ravish, P., Chaudhry, S., & Sharma, A. (2025). Impact of different crop residue burning activities on seasonal variation in ambient air quality. *Discover Atmosphere*, *3*(1). https://doi.org/10.1007/s44292-025-00037-7

Ren, Q., & Zhao, C. (2012). NO x and N 2O precursors from biomass pyrolysis: Nitrogen transformation from amino acid. *Environmental Science and Technology*, *46*(7), 4236–4240. https://doi.org/10.1021/es204142e

Rikhter, P., Dinc, I., Zhang, Y., Jiang, T., Miyashiro, B., Walsh, S., Wang, R., Dinh, Y., & Suh, S. (2022). *Benchmarking evaluation methodologies for existing reinforced concrete buildings*. https://doi.org/10.6028/NIST.GCR.22-032

Roberts, J. M., Stockwell, C. E., Yokelson, R. J., De Gouw, J., Liu, Y., Selimovic, V., Koss, A. R., Sekimoto, K., Coggon, M. M., Yuan, B., Zarzana, K. J., Brown, S. S., Santin, C., Doerr, S. H., & Warneke, C. (2020). The nitrogen budget of laboratory-simulated western US wildfires during the FIREX 2016 Fire Lab study. *Atmospheric Chemistry and Physics*, *20*(14), 8807–8826. https://doi.org/10.5194/acp-20-8807-2020

Roberts, K. G., Gloy, B. A., Joseph, S., Scott, N. R., & Lehmann, J. (2010). Life cycle assessment of biochar systems: Estimating the energetic, economic, and climate change potential. *Environmental Science and Technology*, *44*(2), 827–833. https://doi.org/10.1021/es902266r

Ronsse, F., van Hecke, S., Dickinson, D., & Prins, W. (2013). Production and characterization of slow pyrolysis biochar: Influence of feedstock type and pyrolysis conditions. *GCB Bioenergy*, *5*(2), 104–115. https://doi.org/10.1111/gcbb.12018

Roy, P., Nei, D., Okadome, H., Nakamura, N., Orikasa, T., & Shiina, T. (2008). Life cycle inventory analysis of fresh tomato distribution systems in Japan considering the quality aspect. *Journal of Food Engineering*, *86*(2), 225–233. https://doi.org/10.1016/j.jfoodeng.2007.09.033

Sahoo, T. P., & Kumar, M. A. (2023). Remediation of phthalate acid esters from contaminated environment—Insights on the bioremedial approaches and future perspectives. In *Heliyon* (Vol. 9, Issue 4). Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2023.e14945

Saires, P., Ariza Barraza, C., Bertero, M., Pujro, R., Falco, M., & Sedran, U. (2024). Characterization of Pyrolytic Tars Derived from Different Biomasses. *Processes*, *12*(4). https://doi.org/10.3390/pr12040817

Saygin, D., & Gielen, D. (2021). Zero-emission pathway for the global chemical and petrochemical sector. *Energies*, *14*(13). https://doi.org/10.3390/en14133772

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Schulze, J. MP., & Williams, N. D. (2025). Volatile Organic Chemical Emissions from Standard and "Eco" Resins for Vat Photopolymerization Additive Manufacturing ("3D") Printers and Potential Mitigation Strategies. *ACS Chemical Health and Safety*, *32*(2), 175–185. https://doi.org/10.1021/acs.chas.4c00087

Shaheen, J., Fseha, Y. H., & Sizirici, B. (2022). Performance, life cycle assessment, and economic comparison between date palm waste biochar and activated carbon derived from woody biomass. *Heliyon*, *8*(12). https://doi.org/10.1016/j.heliyon.2022.e12388

Shen, L., Worrell, E., & Patel, M. K. (2010). Open-loop recycling: A LCA case study of PET bottle-to-fibre recycling. *Resources, Conservation and Recycling*, *55*(1), 34–52. https://doi.org/10.1016/j.resconrec.2010.06.014

Shen, X., Zhao, C., Yao, Z., Wu, B., Yu, W., Cao, X., Hao, X., Zhou, Q., Li, X., & Zhang, H. (2023). Real-world emissions and ozone formation potential of carbonyl compounds originating from construction machinery based on a portable emission measurement system. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.1078133

Singh, B. P., & Cowie, A. L. (2014). Long-term influence of biochar on native organic carbon mineralisation in a low-carbon clayey soil. *Scientific Reports*, *4*. https://doi.org/10.1038/srep03687

Singh, B., Shen, Q., Arbestain, M. C., Dolk, M. M., & Camps-Arbestain, M. (2018). *Chapter 3.* biochar *pH, electrical conductivity and liming potential*. https://www.researchgate.net/publication/319206365

Singh Karam, D., Nagabovanalli, P., Sundara Rajoo, K., Fauziah Ishak, C., Abdu, A., Rosli, Z., Melissa Muharam, F., & Zulperi, D. (2022). An overview on the preparation of rice husk biochar, factors affecting its properties, and its agriculture application. In *Journal of the Saudi Society of Agricultural Sciences* (Vol. 21, Issue 3, pp. 149–159). King Saud University. https://doi.org/10.1016/j.jssas.2021.07.005

Smith, P. (2012). Soils and climate change. In *Current Opinion in Environmental Sustainability* (Vol. 4, Issue 5, pp. 539–544). https://doi.org/10.1016/j.cosust.2012.06.005

Somboon, S., Rossopa, B., Yodda, S., Sukitprapanon, T. S., Chidthaisong, A., & Lawongsa, P. (2024). Mitigating methane emissions and global warming potential while increasing rice yield using biochar derived from leftover rice straw in a tropical paddy soil. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-59352-5

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Southavong, S., Ismail, M., Preston, T., Saud, H., & Ismail, R. (2018). Effects of Pyrolysis Temperature and Residence Time on Rice Straw-derived Biochar for Soil Application. *International Journal of Plant & Soil Science*, *23*(3), 1–11. https://doi.org/10.9734/ijpss/2018/42197

Sparrevik, M., Field, J. L., Martinsen, V., Breedveld, G. D., & Cornelissen, G. (2013). Life cycle assessment to evaluate the environmental impact of biochar implementation in conservation agriculture in Zambia. *Environmental Science and Technology*, *47*(3), 1206–1215. https://doi.org/10.1021/es302720k

Spokas, K. A., Cantrell, K. B., Novak, J. M., Archer, D. W., Ippolito, J. A., Collins, H. P., Boateng, A. A., Lima, I. M., Lamb, M. C., McAloon, A. J., Lentz, R. D., & Nichols, K. A. (2012). Biochar: A Synthesis of Its Agronomic Impact beyond Carbon Sequestration. *Journal of Environmental Quality*, *41*(4), 973–989. https://doi.org/10.2134/jeq2011.0069

Strassmann, K. M., Joos, F., & Fischer, G. (2008). Simulating effects of land use changes on carbon fluxes: Past contributions to atmospheric CO2 increases and future commitments due to losses of terrestrial sink capacity. *Tellus, Series B: Chemical and Physical Meteorology*, *60*(4), 583–603. https://doi.org/10.1111/j.1600-0889.2008.00340.x

Sun, H., Jeyakumar, P., Xiao, H., Li, X., Liu, J., Yu, M., Rana, P. B. J., & Shi, W. (2022). Biochar can increase Chinese cabbage (Brassica oleracea L.) yield, decrease nitrogen and phosphorus leaching losses in intensive vegetable soil. *Phyton-International Journal of Experimental Botany*, *91*(1), 197–206. https://doi.org/10.32604/phyton.2022.016492

Sun, J., He, F., Pan, Y., & Zhang, Z. (2017). Effects of pyrolysis temperature and residence time on physicochemical properties of different biochar types. *Acta Agriculturae Scandinavica Section B: Soil and Plant Science*, *67*(1), 12–22. https://doi.org/10.1080/09064710.2016.1214745

Sun, K., Gao, B., Ro, K. S., Novak, J. M., Wang, Z., Herbert, S., & Xing, B. (2012). Assessment of herbicide sorption by biochars and organic matter associated with soil and sediment. *Environmental Pollution*, *163*, 167–173. https://doi.org/10.1016/j.envpol.2011.12.015

Sun, X., Yang, X., Hu, Z., Liu, F., Xie, Z., Li, S., Wang, G., Li, M., Sun, Z., & Bol, R. (2024). Biochar effects on soil nitrogen retention, leaching and yield of perennial citron daylily under three irrigation regimes. *Agricultural Water Management*, *296*. https://doi.org/10.1016/j.agwat.2024.108788

Taheripour, F., Zhao, X., & Tyner, W. E. (2017). The impact of considering land intensification and updated data on biofuels land use change and emissions

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

estimates. *Biotechnology for Biofuels*, *10*(1). https://doi.org/10.1186/s13068-017-0877-y

Talang, R. P. N., Na Sorn, W., Polruang, S., & Sirivithayapakorn, S. (2024). Alternative crop residue management practices to mitigate the environmental and economic impacts of open burning of agricultural residues. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-65389-3

Tamoor, M., Samak, N. A., Yang, M., & Xing, J. (2022). The Cradle-to-Cradle Life Cycle Assessment of Polyethylene terephthalate: Environmental Perspective. *Molecules*, *27*(5). https://doi.org/10.3390/molecules27051599

Tariq, M., Iqbal, B., Khan, I., Khan, A. R., Jho, E. H., Salam, A., Zhou, H., Zhao, X., Li, G., & Du, D. (2024). Microplastic contamination in the agricultural soil—mitigation strategies, heavy metals contamination, and impact on human health: a review. In *Plant Cell Reports* (Vol. 43, Issue 3). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/s00299-024-03162-6

Tavakoli, S., Jensen, M. V., Pedersen, E., & Schramm, J. (2021). Unburned hydrocarbon formation in a natural gas engine under sea wave load conditions. *Journal of Marine Science and Technology (Japan)*, *26*(1), 128–140. https://doi.org/10.1007/s00773-020-00726-5

Tian, H., Xu, R., Canadell, J. G., Thompson, R. L., Winiwarter, W., Suntharalingam, P., Davidson, E. A., Ciais, P., Jackson, R. B., Janssens-Maenhout, G., Prather, M. J., Regnier, P., Pan, N., Pan, S., Peters, G. P., Shi, H., Tubiello, F. N., Zaehle, S., Zhou, F., … Yao, Y. (2020). A comprehensive quantification of global nitrous oxide sources and sinks. *Nature*, *586*(7828), 248–256. https://doi.org/10.1038/s41586-020-2780-0

Tonini, D., & Garcia-Gutierrez, P. (2021). *Environmental effects of plastic waste recycling Focus on Climate Change effects*. https://doi.org/10.2760/6309

Tsai, W. T., Lin, Y. Q., & Huang, H. J. (2021). Valorization of rice husk for the production of porous biochar materials. *Fermentation*, *7*(2). https://doi.org/10.3390/fermentation7020070

Turconi, R., Boldrin, A., & Astrup, T. (2013). Life cycle assessment (LCA) of electricity generation technologies: Overview, comparability and limitations. In *Renewable and Sustainable Energy Reviews* (Vol. 28, pp. 555–565). Elsevier Ltd. https://doi.org/10.1016/j.rser.2013.08.013

Walsh, M., & Williams, S. A. (2006). *Agriculture, Forestry and Other Land Use 11* (Vol. 4).

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Waluyo, J., Amal, R. R. I., Yudistira, A. A., Mustofa, H., & Maulana, M. L. (2022). Pengaruh Fly Ash sebagai Katalis pada Proses Pirolisis Pelet Sekam Padi terhadap Karakteristik Termal dan Produksi Synthetic Gas (Syngas). *ALCHEMY Jurnal Penelitian Kimia*, *18*(2), 148. https://doi.org/10.20961/alchemy.18.2.55193.148-157

Wang, C., Duan, W., Cheng, S., & Jiang, K. (2023). *Emission inventory and air quality impact of non-road construction equipment 2 in different emission stages*. https://ssrn.com/abstract=4514387

Wang, H., Gao, J. E., Li, X. H., Zhang, S. L., & Wang, H. J. (2015). Nitrate accumulation and leaching in surface and ground water based on simulated rainfall experiments. *PLoS ONE*, *10*(8). https://doi.org/10.1371/journal.pone.0136274

Wang, L., Gao, J., Wu, W. M., Luo, J., Bank, M. S., Koelmans, A. A., Boland, J. J., & Hou, D. (2024). Rapid Generation of Microplastics and Plastic-Derived Dissolved Organic Matter from Food Packaging Films under Simulated Aging Conditions. *Environmental Science and Technology*, *58*(45), 20147–20159. https://doi.org/10.1021/acs.est.4c05504

Wang, S., Dai, G., Yang, H., & Luo, Z. (2017). Lignocellulosic biomass pyrolysis mechanism: A state-of-the-art review. In *Progress in Energy and Combustion Science* (Vol. 62, pp. 33–86). Elsevier Ltd. https://doi.org/10.1016/j.pecs.2017.05.004

Wei, B., Yu, J., Cao, Z., Meng, M., Yang, L., & Chen, Q. (2020). The availability and accumulation of heavy metals in greenhouse soils associated with intensive fertilizer application. *International Journal of Environmental Research and Public Health*, *17*(15), 1–13. https://doi.org/10.3390/ijerph17155359

Wei, X., Shao, M., Gale, W., & Li, L. (2014). Global pattern of soil carbon losses due to the conversion of forests to agricultural land. *Scientific Reports*, *4*. https://doi.org/10.1038/srep04062

Weldon, S. (2022). biochar *for N 2 O mitigation and improved delivery and retention of mineral nitrogen in compost and soil Bruk av biokull for reduksjon av N 2 O utslipp og effektivisering av nitrogenutnyttelse i jord og kompost*. Norwegian University of Life Sciences Faculty of Environmental Sciences and Natural Resource Management.

Werf, V. R., Randerson, J. T., Giglio, L., Collatz, G. J., Mu, M., Kasibhatla, P. S., Morton, D. C., Defries, R. S., Jin, Y., & Van Leeuwen, T. T. (2010). Global fire emissions and the contribution of deforestation, savanna, forest, agricultural, and peat fires (1997-2009). *Atmospheric Chemistry and Physics*, *10*(23), 11707–11735. https://doi.org/10.5194/acp-10-11707-2010

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

WHO. (2021). WHO global air quality guidelines Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. *Geneva: World Health Organization*, *WHO global air quality guidelines. Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide*.

Williams, R., Belo, J. B., Lidia, J., Soares, S., Ribeiro, D., Moreira, C. L., Almeida, L., Barton, L., & Erskine, W. (2023). Productivity gains in vegetables from rice husk biochar application in nutrient-poor soils in Timor-Leste. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-38072-2

Wong, C. T. F., Falcone, M., Rich, G., Stubler, C., Malama, B., Lazcano, C., & Decock, C. (2023). Short-term effects of increasing compost application rates on soil C and greenhouse gas (N2O and CO2) emissions in a California central coast vineyard. *Frontiers in Environmental Science*, *11*. https://doi.org/10.3389/fenvs.2023.1123510

Woolf, D., Amonette, J. E., Street-Perrott, F. A., Lehmann, J., & Joseph, S. (2010). Sustainable biochar to mitigate global climate change. *Nature Communications*, *1*(5). https://doi.org/10.1038/ncomms1053

Xia, L., Xia, Y., Ma, S., Wang, J., Wang, S., Zhou, W., & Yan, X. (2016). Greenhouse gas emissions and reactive nitrogen releases from rice production with simultaneous incorporation of wheat straw and nitrogen fertilizer. *Biogeosciences*, *13*(15), 4567–4579. https://doi.org/10.5194/bg-13-4569-2016

Yadav, V., Sherly, M. A., Ranjan, P., Prasad, V., Tinoco, R. O., & Laurent, A. (2022). Risk of plastics losses to the environment from Indian landfills. *Resources, Conservation and Recycling*, *187*. https://doi.org/10.1016/j.resconrec.2022.106610

Yang, Y. Y., Wu, H. N., Shen, S. L., Horpibulsuk, S., Xu, Y. S., & Zhou, Q. H. (2014). Environmental impacts caused by phosphate mining and ecological restoration: a case history in Kunming, China. *Natural Hazards*, *74*(2), 755–770. https://doi.org/10.1007/s11069-014-1212-6

Yao, Z., Zheng, X., Wang, R., Dong, H., Xie, B., Mei, B., Zhou, Z., & Zhu, J. (2013). Greenhouse gas fluxes and NO release from a Chinese subtropical rice-winter wheat rotation system under nitrogen fertilizer management. *Journal of Geophysical Research: Biogeosciences*, *118*(2), 623–638. https://doi.org/10.1002/jgrg.20061

Ye, L., Camps-Arbestain, M., Shen, Q., Lehmann, J., Singh, B., & Sabir, M. (2020). Biochar effects on crop yields with and without fertilizer: A meta-analysis of field studies using separate controls. In *Soil Use and Management* (Vol. 36,

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN
APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Issue 1, pp. 2–18). Blackwell Publishing Ltd. https://doi.org/10.1111/sum.12546

Yu, H., Zhang, Y., Tan, W., & Zhang, Z. (2022). Microplastics as an Emerging Environmental Pollutant in Agricultural Soils: Effects on Ecosystems and Human Health. In *Frontiers in Environmental Science* (Vol. 10). Frontiers Media S.A. https://doi.org/10.3389/fenvs.2022.855292

Yu, Y., Yang, Y., Cheng, Z., Blanco, P. H., Liu, R., Bridgwater, A. V., & Cai, J. (2016). Pyrolysis of Rice Husk and Corn Stalk in Auger Reactor. 1. Characterization of Char and Gas at Various Temperatures. *Energy and Fuels*, *30*(12), 10568–10574. https://doi.org/10.1021/acs.energyfuels.6b02276

Yuan, J. H., & Xu, R. K. (2011). The amelioration effects of low temperature biochar generated from nine crop residues on an acidic Ultisol. *Soil Use and Management*, *27*(1), 110–115. https://doi.org/10.1111/j.1475-2743.2010.00317.x

Zeng, F., Zuo, Z., Mo, J., Chen, C., Yang, X., Wang, J., Wang, Y., Zhao, Z., Chen, T., Li, Y., Zhang, Z., Hu, Z., & Xu, H. (2021). Runoff Losses in Nitrogen and Phosphorus From Paddy and Maize Cropping Systems: A Field Study in Dongjiang Basin, South China. *Frontiers in Plant Science*, *12*. https://doi.org/10.3389/fpls.2021.675121

Zhang, A., Bian, R., Pan, G., Cui, L., Hussain, Q., Li, L., Zheng, J., Zheng, J., Zhang, X., Han, X., & Yu, X. (2012). Effects of biochar amendment on soil quality, crop yield and greenhouse gas emission in a Chinese rice paddy: A field study of 2 consecutive rice growing cycles. *Field Crops Research*, *127*, 153–160. https://doi.org/10.1016/j.fcr.2011.11.020

Zhang, H., Voroney, R. P., & Price, G. W. (2015). Effects of temperature and processing conditions on biochar chemical properties and their influence on soil C and N transformations. *Soil Biology and Biochemistry*, *83*, 19–28. https://doi.org/10.1016/j.soilbio.2015.01.006

Zhang, J., Li, X., Amini, M. R., Kolmanovsky, I., Tsutsumi, M., & Nakada, H. (2023). *Modeling and Control of Diesel Engine Emissions using Multi-layer Neural Networks and Economic Model Predictive Control*. https://doi.org/10.1016/j.ifacol.2023.10.724

Zhang, X., Lv, J., Zhang, Y., Li, S., Chen, X., & Sha, Z. (2023). A Meta-Analysis Study on the Use of Biochar to Simultaneously Mitigate Emissions of Reactive Nitrogen Gases (N2O and NO) from Soils. *Sustainability (Switzerland)*, *15*(3). https://doi.org/10.3390/su15032384

Zhang, X., Zhang, Q., Xu, X., Dong, Y., & Xiong, Z. (2022). Biochar Mitigated Yield-Scaled N2O and NO Emissions and Ensured Vegetable Quality and Soil

UNIVERSITAS GADJAH MADA
IMPLEMENTASI LIFE CYCLE ASSESSMENT (LCA) UNTUK PENGEMBANGAN PRODUK BIOCHAR SEKAM PADI DAN APLIKASINYA PADA BUDIDAYA SAWI HIJAU (Brassica Juncea L.) DI TANAH TAILING PASCA TAMBANG TIMAH
Tri Wahyuni, Prof. Dr. Ir. Bambang Purwantana, M.Agr; Tri Martini
Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Fertility: A 3-Year Greenhouse Field Observation. *Agronomy*, *12*(7). https://doi.org/10.3390/agronomy12071560

Zhang, Y., Ma, Z., Zhang, Q., Wang, J., Ma, Q., Yang, Y., Luo, X., & Zhang, W. (2019). *Comparsion of the physicochemical characteristics of bio-char pyrolyzed from moso bamboo and rice husk with fifferent pyrolysis temperatures*. https://www.researchgate.net/publication/316717111

Zhu-Barker, X., Doane, T. A., & Horwath, W. R. (2015). Role of green waste compost in the production of N2O from agricultural soils. *Soil Biology and Biochemistry*, *83*, 57–65. https://doi.org/10.1016/j.soilbio.2015.01.008

Zimmerman, A. R., Gao, B., & Ahn, M. Y. (2011). Positive and negative carbon mineralization priming effects among a variety of biochar-amended soils. *Soil Biology and Biochemistry*, *43*(6), 1169–1179. https://doi.org/10.1016/j.soilbio.2011.02.005

Zoghlami, R. I., Hechmi, S., Weghlani, R., Jedidi, N., & Moussa, M. (2021). Biochar Derived from Domestic Sewage Sludge: Influence of Temperature Pyrolysis on Biochars' Chemical Properties and Phytotoxicity. *Journal of Chemistry*, *2021*. https://doi.org/10.1155/2021/1818241

Zulfiqar, F., Navarro, M., Ashraf, M., Akram, N. A., & Munné-Bosch, S. (2019). Nanofertilizer use for sustainable agriculture: Advantages and limitations. In *Plant Science* (Vol. 289). Elsevier Ireland Ltd. https://doi.org/10.1016/j.plantsci.2019.110270

Zustika, S., Khusrizal, Akbar, H., & Nasruddin. (2025). Penggunaan Berbagai Jenis dan Dosis Biochar Terhadap Emisi Karbon Dioksida, Nitrat dan Mikroorganisme Pada Tanah. *Jurnal Tanah Dan Sumberdaya Lahan*, *12*(1), 89–96. https://doi.org/10.21776/ub.jtsl.2025.012.1.9