

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. *Bioresour 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

- 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., Karlton, 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., Breyse, 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*

- (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>

- 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., & Condon, 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.es.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>

- 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 (NO₂) 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 $\delta^{15}\text{N}$ of atmospheric NO_x 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>

- 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>

- 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*.

- 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>

- 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). Hydrochar and biochar: Production, physicochemical properties and techno-economic analysis. In *Bioresourcetechnology* (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>

- 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, PM_{2.5}, and NO_x) 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/mateconf/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

- 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

- 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>

- 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>
- Pahnla, 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>

- 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>

- 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 N₂O 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>

- 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>

- 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

- 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 II* (Vol. 4).

- 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/alchemistry.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 N₂O mitigation and improved delivery and retention of mineral nitrogen in compost and soil* *Bruk av biokull for reduksjon av N₂O 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>

- WHO. (2021). WHO global air quality guidelines Particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. *Geneva: World Health Organization, WHO global air quality guidelines. Particulate matter (PM_{2.5} 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>
- Wolf, 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,

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

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>