



## REFERENCE

- Abd Elsalam, H. E., El-Sharnouby, M. E., Mohamed, A. E., Raafat, B. M., & El-Gamal, E. H. (2021). Effect of sewage sludge compost usage on corn and faba bean growth, carbon and nitrogen forms in plants and soil. *Agronomy*, 11(4). <https://doi.org/10.3390/agronomy11040628>
- Al-Gheethi, A. A., Efaq, A. N., Bala, J. D., Norli, I., Abdel-Monem, M. O., & Ab. Kadir, M. O. (2018). Removal of pathogenic bacteria from sewage-treated effluent and biosolids for agricultural purposes. In *Applied Water Science* (Vol. 8, Issue 2). Springer Verlag. <https://doi.org/10.1007/s13201-018-0698-6>
- Balittanah. 2009. Petunjuk Teknis Analisis Kimia Tanah, Tanaman, Air dan. Pupuk. Balai Penelitian dan Pengembangan Pertanian. Bogor.
- Banger, K., Tian, H., & Lu, C. (2012). Do nitrogen fertilizers stimulate or inhibit methane emissions from rice fields? *Global Change Biology*, 18(10), 3259–3267. <https://doi.org/10.1111/j.1365-2486.2012.02762.x>
- Brust, G. E. (2019). Chapter 9 - Management Strategies for Organic Vegetable Fertility. In D. Biswas & S. A. Micallef (Eds.), *Safety and Practice for Organic Food* (pp. 193–212). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-812060-6.00009-X>
- Buol, S., Southard, R., Graham, R., & McDaniel, P. (2011). *Soil Genesis and Classification: Buol/Soil Genesis and Classification*. <https://doi.org/10.1002/9780470960622>
- Chapuis-lardy, L., Wrage, N., Metay, A., Chotte, J. L., & Bernoux, M. (2007). Soils, a sink for N<sub>2</sub>O? A review. In *Global Change Biology* (Vol. 13, Issue 1, pp. 1–17). <https://doi.org/10.1111/j.1365-2486.2006.01280.x>
- Cheng, W., Kimani, S., Kanno, T., Tang, S., Oo, A., Tawaraya, K., Sudo, S., Sasaki, Y., & Yoshida, N. (2017). Forage rice varieties Fukuhibiki and Tachisuzuka emit larger CH<sub>4</sub> than edible rice Haenuki. *Soil Science and Plant Nutrition*, 64, 1–7. <https://doi.org/10.1080/00380768.2017.1378569>
- Conrad, R. (1996). Soil Microorganisms as Controllers of Atmospheric Trace Gases (H<sub>2</sub>, CO, CH<sub>4</sub>, OCS, N<sub>2</sub>O, and NO). In *MICROBIOLOGICAL REVIEWS* (Vol. 60, Issue 4).
- Das, S., & Adhya, T. K. (2014). Effect of combine application of organic manure and inorganic fertilizer on methane and nitrous oxide emissions from a tropical flooded soil planted to rice. *Geoderma*, 213, 185–192. <https://doi.org/10.1016/j.geoderma.2013.08.011>
- Della Lunga, D., Brye, K. R., Slayden, J. M., Henry, C. G., & Wood, L. S. (2021). Relationships among soil factors and greenhouse gas emissions from furrow-irrigated Rice in the mid-southern, USA. *Geoderma Regional*, 24. <https://doi.org/10.1016/j.geodrs.2021.e00365>



Eash, N., Sauer, T., O'Dell, D., Odoi, E., & Bratz, M. (2015). *Soil Science Simplified* (6th ed.). Wiley.

Fagodiya, R. K., Malyan, S. K., Singh, D., Kumar, A., Yadav, R. K., Sharma, P. C., & Pathak, H. (2022). Greenhouse Gas Emissions from Salt-Affected Soils: Mechanistic Understanding of Interplay Factors and Reclamation Approaches. In *Sustainability (Switzerland)* (Vol. 14, Issue 19). MDPI. <https://doi.org/10.3390/su141911876>

FAO (1985) Guidelines: Land Evaluation for Irrigated Agriculture. FAO Soils Bulletin 55, FAO, Rome, 290.

Fischer, S., McCarty, G., Ramirez, M., & Torrents, A. (2020). Nitrogen release and leachable organic matter decomposition of anaerobically digested biosolids with variable pre-treatments. *Waste Management*, 104, 82–93. <https://doi.org/https://doi.org/10.1016/j.wasman.2019.12.049>

Fukai, S., & Wade, L. J. (2021). Chapter 2 - Rice. In V. O. Sadras & D. F. Calderini (Eds.), *Crop Physiology Case Histories for Major Crops* (pp. 44–97). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-819194-1.00002-5>

García-Marco, S., Ravella, S. R., Chadwick, D., Vallejo, A., Gregory, A. S., & Cárdenas, L. M. (2014). Ranking factors affecting emissions of GHG from incubated agricultural soils. *European Journal of Soil Science*, 65(4), 573–583. <https://doi.org/https://doi.org/10.1111/ejss.12143>

Gupta, K., Kumar, R., Kumar Baruah, K., Hazarika, S., Karmakar, S., & Bordoloi, N. (n.d.). *Greenhouse gas emission from rice fields: a review from Indian context*. <https://doi.org/10.1007/s11356-021-13935-1/Published>

Haque, M. M., Kim, G. W., Kim, P. J., & Kim, S. Y. (2016). Comparison of net global warming potential between continuous flooding and midseason drainage in monsoon region paddy during rice cropping. *Field Crops Research*, 193, 133–142. <https://doi.org/10.1016/j.fcr.2016.04.007>

HU, M., WADE, A. J., SHEN, W., ZHONG, Z., QIU, C., & LIN, X. (2023). Effects of organic fertilizers produced by different production processes on nitrous oxide and methane emissions from double-cropped rice fields. *Pedosphere*. <https://doi.org/https://doi.org/10.1016/j.pedsph.2023.03.006>

Intergovernmental Panel on Climate Change (IPCC). (2014). *Climate Change 2013 – The Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://doi.org/DOI: 10.1017/CBO9781107415324>

Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://doi.org/DOI: 10.1017/9781009157896>

Islam, S. F., Sander, B. O., Quilty, J. R., de Neergaard, A., van Groenigen, J. W., & Jensen, L. S. (2020). Mitigation of greenhouse gas emissions and reduced irrigation water use in rice production through water-saving irrigation scheduling, reduced tillage



and fertiliser application strategies. *Science of The Total Environment*, 739, 140215.  
<https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.140215>

Islam, S. M. M., Gaihre, Y. K., Islam, M. R., Ahmed, M. N., Akter, M., Singh, U., & Sander, B. O. (2022a). Mitigating greenhouse gas emissions from irrigated rice cultivation through improved fertilizer and water management. *Journal of Environmental Management*, 307. <https://doi.org/10.1016/j.jenvman.2022.114520>

Islam, S. M. M., Gaihre, Y. K., Islam, M. R., Ahmed, M. N., Akter, M., Singh, U., & Sander, B. O. (2022b). Mitigating greenhouse gas emissions from irrigated rice cultivation through improved fertilizer and water management. *Journal of Environmental Management*, 307. <https://doi.org/10.1016/j.jenvman.2022.114520>

Jones, J., J.B. (2001). Laboratory Guide for Conducting Soil Tests and Plant Analysis. 1st ed. CRC Press. <https://doi.org/10.1201/9781420025293>

Japan Meteorological Agency (JMA). 気象庁 | 過去の気象データ検索. (2023). <https://www.data.jma.go.jp/obd/stats/etrn/>. Accessed December 30<sup>th</sup> 2023.

Kamal, A., Wichuk, K., Mccartney, D., Londry, K., & Felske, C. (2017). Effect of Treated Wood on Biosolids Composting. *Compost Science & Utilization*, 25, 1–16. <https://doi.org/10.1080/1065657X.2016.1268937>

Kanteraki, A. E., Isari, E. A., Svarnas, P., & Kalavrouziotis, I. K. (2022). Biosolids: The Trojan horse or the beautiful Helen for soil fertilization? In *Science of the Total Environment* (Vol. 839). Elsevier B.V. <https://doi.org/10.1016/j.scitotenv.2022.156270>

Khaliq, M. A., Khan Tarin, M. W., Jingxia, G., Yanhui, C., & Guo, W. (2019). Soil liming effects on CH<sub>4</sub>, N<sub>2</sub>O emission and Cd, Pb accumulation in upland and paddy rice. *Environmental Pollution*, 248, 408–420. <https://doi.org/10.1016/j.envpol.2019.02.036>

Kimani, S. M., Bimantara, P. O., Kautsar, V., Torita, R., Hattori, S., Tawaraya, K., Sudo, S., & Cheng, W. (2022). Influence of Azolla incorporation and/or dual cropping on CH<sub>4</sub> and N<sub>2</sub>O emission from a paddy field. *Soil Science and Plant Nutrition*, 68(2), 246–255. <https://doi.org/10.1080/00380768.2022.2047580>

Koutroubas, S. D., Antoniadis, V., Damalas, C. A., & Fotiadis, S. (2023). Municipal Sewage Sludge Effects on Maize Yield, Nitrogen Use Efficiency, and Soil Properties. *Journal of Soil Science and Plant Nutrition*, 23(1), 1209–1221. <https://doi.org/10.1007/s42729-022-01115-0>

Lagomarsino, A., Agnelli, A. E., Linquist, B., Adviento-Borbe, M. A., Agnelli, A., Gavina, G., Ravaglia, S., & Ferrara, R. M. (2016). Alternate Wetting and Drying of Rice Reduced CH<sub>4</sub> Emissions but Triggered N<sub>2</sub>O Peaks in a Clayey Soil of Central Italy. *Pedosphere*, 26(4), 533–548. [https://doi.org/10.1016/S1002-0160\(15\)60063-7](https://doi.org/10.1016/S1002-0160(15)60063-7)

Le Mer, J., & Roger, P. (2001). Production, oxidation, emission and consumption of methane by soils: A review. *European Journal of Soil Biology*, 37, 25–50. [https://doi.org/10.1016/S1164-5563\(01\)01067-6](https://doi.org/10.1016/S1164-5563(01)01067-6)



- Liang, L. L., Grantz, D. A., & Jenerette, G. D. (2016). Multivariate regulation of soil CO<sub>2</sub> and N<sub>2</sub>O pulse emissions from agricultural soils. *Global Change Biology*, 22(3), 1286–1298. [https://doi.org/https://doi.org/10.1111/gcb.13130](https://doi.org/10.1111/gcb.13130)
- Maimunah, M. A., Kautsar, V., Bimantara, P. O., Kimani, S. M., Torita, R., Tawaraya, K., Murayama, H., Utami, S. N. H., Purwanto, B. H., & Cheng, W. (2021). Weeding frequencies decreased rice–weed competition and increased rice n uptake in organic paddy field. *Agronomy*, 11(10). <https://doi.org/10.3390/agronomy11101904>
- Masscheleyn, P. H., DeLaune, R. D., & Patrick, W. H. (1993). Methane and nitrous oxide emissions from laboratory measurements of rice soil suspension: Effect of soil oxidation-reduction status. *Chemosphere*, 26(1), 251–260. [https://doi.org/https://doi.org/10.1016/0045-6535\(93\)90426-6](https://doi.org/https://doi.org/10.1016/0045-6535(93)90426-6)
- Padre, A., Minamikawa, K., Tokida, T., & Sudo, S. (2015). *Guidelines for Measuring CH<sub>4</sub> and N<sub>2</sub>O Emissions from Rice Paddies by a Manually Operated Closed Chamber Method Version 1*.
- Palmer, A. (2005). INCEPTISOLS. In D. Hillel (Ed.), *Encyclopedia of Soils in the Environment* (pp. 248–254). Elsevier. <https://doi.org/https://doi.org/10.1016/B0-12-348530-4/00027-8>
- Panesar, P. S., & Kaur, S. (2016). Rice: Types and Composition. In B. Caballero, P. M. Finglas, & F. Toldrá (Eds.), *Encyclopedia of Food and Health* (pp. 646–652). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-384947-2.00596-1>
- Patrick Jr., W. H., Mikkelsen, D. S., & Wells, B. R. (1985). Plant Nutrient Behavior in Flooded Soil. In *Fertilizer Technology and Use* (pp. 197–228). <https://doi.org/https://doi.org/10.2136/1985.fertilizertechnology.c6>
- Pattnaik, P., Mishra, S. R., Bharati, K., Mohanty, S. R., Sethunathan, N., & Adhya, T. K. (2000). Influence of salinity on methanogenesis and associated microflora in tropical rice soils. *Microbiological Research*, 155(3), 215–220. [https://doi.org/https://doi.org/10.1016/S0944-5013\(00\)80035-X](https://doi.org/https://doi.org/10.1016/S0944-5013(00)80035-X)
- Phung, L. D., Ichikawa, M., Pham, D. V., Sasaki, A., & Watanabe, T. (2020). High yield of protein-rich forage rice achieved by soil amendment with composted sewage sludge and topdressing with treated wastewater. *Scientific Reports*, 10(1). <https://doi.org/10.1038/s41598-020-67233-w>
- Prates, A. R., Coscione, A. R., Teixeira Filho, M. C. M., Miranda, B. G., Arf, O., Abreu-Junior, C. H., Oliveira, F. C., Moreira, A., Galindo, F. S., Pereira Sartori, M. M., He, Z., Jani, A. D., Capra, G. F., Ganga, A., & Rodrigues Nogueira, T. A. (2020). Composted sewage sludge enhances soybean production and agronomic performance in naturally infertile soils (Cerrado Region, Brazil). *Agronomy*, 10(11). <https://doi.org/10.3390/agronomy10111677>
- Rahimpour, M. R. (2020). Editors biography. In M. R. Rahimpour, M. Farsi, & M. A. Makarem (Eds.), *Advances in Carbon Capture* (pp. xi–xiii). Woodhead Publishing. <https://doi.org/https://doi.org/10.1016/B978-0-12-819657-1.09988-6>



Rahman, M. M., & Yamamoto, A. (2020). Methane Cycling in Paddy Field: A Global Warming Issue. In R. S. Meena (Ed.), *Agrometeorology* (p. Ch. 6). IntechOpen. <https://doi.org/10.5772/intechopen.94200>

Rochette, P., Liang, C., Pelster, D., Bergeron, O., Lemke, R., Kroebel, R., MacDonald, D., Yan, W., & Flemming, C. (2018). Soil nitrous oxide emissions from agricultural soils in Canada: Exploring relationships with soil, crop and climatic variables. *Agriculture, Ecosystems and Environment*, 254, 69–81. <https://doi.org/10.1016/j.agee.2017.10.021>

Roman-Perez, C. C., Hernandez-Ramirez, G., Kryzanowski, L., Puurveen, D., & Lohstraeter, G. (2021). Greenhouse gas emissions, nitrogen dynamics and barley productivity as impacted by biosolids applications. *Agriculture, Ecosystems and Environment*, 320. <https://doi.org/10.1016/j.agee.2021.107577>

Ryden, J. C. (1981). N<sub>2</sub>O exchange between a grassland soil and the atmosphere. *Nature*, 292(5820), 235–237. <https://doi.org/10.1038/292235a0>

Schütz, H., Seiler, W., & Conrad, R. (1990). Influence of Soil Temperature on Methane Emission from Rice Paddy Fields. *Biogeochemistry*, 11(2), 77–95. <http://www.jstor.org/stable/1468546>

Shaaban, M., Wu, Y., Khalid, M. S., Peng, Q., Xu, X., Wu, L., Younas, A., Bashir, S., Mo, Y., Lin, S., Zafar-ul-Hye, M., Abid, M., & Hu, R. (2018). Reduction in soil N<sub>2</sub>O emissions by pH manipulation and enhanced nosZ gene transcription under different water regimes. *Environmental Pollution*, 235, 625–631. <https://doi.org/https://doi.org/10.1016/j.envpol.2017.12.066>

Shrivastava, P., & Kumar, R. (2015). Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. In *Saudi Journal of Biological Sciences* (Vol. 22, Issue 2, pp. 123–131). Elsevier B.V. <https://doi.org/10.1016/j.sjbs.2014.12.001>

Souza, R., Yin, J., & Calabrese, S. (2021). Optimal drainage timing for mitigating methane emissions from rice paddy fields. *Geoderma*, 394. <https://doi.org/10.1016/j.geoderma.2021.114986>

Stephens, A., Callahan, J., Challenger, L., & Adams, R. (2017). Biosolids composting at the Borough of Mechanicsburg, PA WWTP. *Water Practice and Technology*, 12, 978–986. <https://doi.org/10.2166/wpt.2017.104>

Sun, X. K., Huang, Y., Dong, X., Xu, C. B., & Bai, J. (2016). A Study on Nutrient Properties and Heavy Metal Concentrations of Waste Activated Sludge Derived from Municipal and Small Town Domestic Sewage Treatment Plants. *Proceedings of the 2015 International Conference on Materials Chemistry and Environmental Protection (Meep-15)*, 139–141. <https://doi.org/10.2991/meep-15.2016.37>

Tang, J., Wang, J., Li, Z., Wang, S., & Qu, Y. (2018). Effects of irrigation regime and nitrogen fertilizer management on CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub> emissions from saline–alkaline paddy fields in Northeast China. *Sustainability (Switzerland)*, 10(2). <https://doi.org/10.3390/su10020475>



Tian, S., Xu, Y., Wang, Q., Zhang, Y., Yuan, X., Ma, Q., Feng, X., Ma, H., Liu, J., Liu, C., & Hussain, M. B. (2023). The effect of optimizing chemical fertilizers consumption structure to promote environmental protection, crop yield and reduce greenhouse gases emission in China. *Science of The Total Environment*, 857, 159349. <https://doi.org/https://doi.org/10.1016/j.scitotenv.2022.159349>

USDA. 2017. Soil survey manual. USDA Handbook 18. Government Printing Office, Washington, D.C.

USDA. 2022. Keys to Soil Taxonomy, 13th ed. U.S Department of Agriculture Natural Resources Conservation Service.

Walling, E., & Vaneekhaute, C. (2020). Greenhouse gas emissions from inorganic and organic fertilizer production and use: A review of emission factors and their variability. In *Journal of Environmental Management* (Vol. 276). Academic Press. <https://doi.org/10.1016/j.jenvman.2020.111211>

Wang, J., Bogena, H. R., Vereecken, H., & Brüggemann, N. (2018). Characterizing Redox Potential Effects on Greenhouse Gas Emissions Induced by Water-Level Changes Special Section: Lysimeters in Vadose Zone Research. *J*, 17, 170152. <https://doi.org/10.2136/v>

Wei, L., Zhu, Z., Liu, S., Xiao, M., Wang, J., Deng, Y., Kuzyakov, Y., Wu, J., & Ge, T. (2021). Temperature sensitivity (Q10) of stable, primed and easily available organic matter pools during decomposition in paddy soil. *Applied Soil Ecology*, 157. <https://doi.org/10.1016/j.apsoil.2020.103752>

Wijesekara, H., Bolan, N. S., Kumarathilaka, P., Geekiyanage, N., Kunhikrishnan, A., Seshadri, B., Saint, C., Surapaneni, A., & Vithanage, M. (2016). Chapter 3 - Biosolids Enhance Mine Site Rehabilitation and Revegetation\*. In M. N. V Prasad & K. Shih (Eds.), *Environmental Materials and Waste* (pp. 45–71). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-803837-6.00003-2>

Wu, L., Tang, S., Hu, R., Wang, J., Duan, P., Xu, C., Zhang, W., & Xu, M. (2023). Increased N<sub>2</sub>O emission due to paddy soil drainage is regulated by carbon and nitrogen availability. *Geoderma*, 432, 116422. <https://doi.org/https://doi.org/10.1016/j.geoderma.2023.116422>

Xiao, K., Guo, C., Maspolini, Y., Zhou, Y., & Ng, W. J. (2016). The role of methanogens in acetic acid production under different salinity conditions. *Chemosphere*, 161, 53–60. <https://doi.org/https://doi.org/10.1016/j.chemosphere.2016.06.112>

Xu, F., & Chang, H. (2022). Soil Greenhouse Gas Emissions and Nitrogen Change for Wheat Field Application of Composted Sewage Sludge. *Agronomy*, 12(8). <https://doi.org/10.3390/agronomy12081946>

Yoshida, S. (1981). *Fundamentals of Rice Crop Science*. International Rice Research Institute. <https://books.google.co.id/books?id=wS-teh0I5d0C>

Yost, J. L., & Hartemink, A. E. (2019). Chapter Four - Soil organic carbon in sandy soils: A review. In D. L. Sparks (Ed.), *Advances in Agronomy* (Vol. 158, pp. 217–310). Academic Press. <https://doi.org/https://doi.org/10.1016/bs.agron.2019.07.004>



**The Effects of Composted Sewage Sludge on Methane and Nitrous Oxide Emissions from Paddy Field in Tsuruoka, Japan**

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You, X., Wang, S., Du, L., Wu, H., & Wei, Y. (2022). Effects of organic fertilization on functional microbial communities associated with greenhouse gas emissions in paddy soils. *Environmental Research*, 213. <https://doi.org/10.1016/j.envres.2022.113706>

Zhang, J., Lu, Z., Pan, Y., Ren, T., Cong, R., Lu, J., & Li, X. (2019). Potassium deficiency aggravates yield loss in rice by restricting the translocation of non-structural carbohydrates under *Sarocladium oryzae* infection condition. *Physiologia Plantarum*, 167(3), 352–364. [https://doi.org/https://doi.org/10.1111/ppl.12896](https://doi.org/10.1111/ppl.12896)

Zhang, Z., Zimmermann, N. E., Stenke, A., Li, X., Hodson, E. L., Zhu, G., Huang, C., & Poulter, B. (2017). Emerging role of wetland methane emissions in driving 21st century climate change. *Proceedings of the National Academy of Sciences of the United States of America*, 114(36), 9647–9652. <https://doi.org/10.1073/pnas.1618765114>

Zhou, M., Wang, X., Wang, Y., & Zhu, B. (2018). A three-year experiment of annual methane and nitrous oxide emissions from the subtropical permanently flooded rice paddy fields of China: Emission factor, temperature sensitivity and fertilizer nitrogen effect. *Agricultural and Forest Meteorology*, 250–251, 299–307. <https://doi.org/10.1016/j.agrformet.2017.12.265>