

# **A Review on Anaerobic Digestate as a Biofertilizer: Characteristics, Production, and Environmental Impacts from a Life Cycle Assessment Perspective**

C. Martín-Sanz-Garrido; M. Revuelta Aramburu; A. Santos Montes; C. Morales Polo

## **Abstract-**

**Digestate valorization is essential for sustainable waste management and circular economy strategies, yet large-scale adoption faces technical, economic, and environmental challenges. Beyond waste-to-energy conversion, digestate is a valuable soil amendment, enhancing soil structure and reducing reliance on synthetic fertilizers. However, its agronomic benefits depend on feedstock characteristics, treatment processes, and application methods. This study reviews digestate composition, treatment technologies, regulatory frameworks, and environmental impact assessment through Life Cycle Assessment. It analyzes the influence of functional unit selection and system boundary definitions on Life Cycle Assessment outcomes and the effects of feedstock selection, pretreatment, and post-processing on its environmental footprint and fertilization efficiency. A review of 28 JCR-indexed articles (2018&ndash;present) analyzed LCA studies on digestate, focusing on methodologies, system boundaries, and impact categories. The findings indicate that Life Cycle Assessment methodologies vary widely, complicating direct comparisons. Transportation distances, nutrient stability, and post-processing strategies significantly impact greenhouse gas emissions and nutrient retention efficiency. Techniques like solid&ndash;liquid separation and composting enhance digestate stability and agronomic performance. Digestate remains a promising alternative to synthetic fertilizers despite market uncertainty and regulatory inconsistencies. Standardized Life Cycle Assessment methodologies and policy incentives are needed to promote its adoption as a sustainable soil amendment within circular economy frameworks.**

**Index Terms-** digestate; anaerobic digestion; life cycle assessment; circular economy; biofertilizer; waste valorization

Due to copyright restriction we cannot distribute this content on the web. However, clicking on the next link, authors will be able to distribute to you the full version of the paper:

[Request full paper to the authors](#)

If your institution has an electronic subscription to Applied Sciences, you can download the paper from the journal website:

[Access to the Journal website](#)

**Citation:**

*Martín-Sanz-Garrido, C.; Revuelta-Aramburu, M.; Santos-Montes, A.; Morales-Polo, C. "A Review on Anaerobic Digestate as a Biofertilizer: Characteristics, Production, and Environmental Impacts from a Life Cycle Assessment Perspective", Applied Sciences, vol.15, no.15, pp.8635-1-8635-32, August, 2025.*