FARMING PRACTICE
MANURE PROCESSING TECHNIQUES

IMPACT: EUTROPHICATION (LCA)

Reference 1

Zhang J., Wang M., Yin C., Dogot T. 2021 The potential of dairy manure and sewage management pathways towards a circular economy: A meta-analysis from the life cycle perspective Sci. Total Environ. 779, 146396. 10.1016/j.scitotenv.2021.146396

Background and objective

The interest in implementing life cycle assessments of various manure and sewage management (MSM) strategies is increasing on a global scale, which is motivated by the concerns of environmental degradation caused by unsustainable MSM and growing awareness of circular economy. Life cycle thinking concept has been widely introduced to favor the comparative studies of different MSM strategies, with the aim of identifying suitable MSM strategies and formulating related policies. Make robust and comprehensive conclusions on life cycle comparative performances of various MSM strategies and explore the research questions: (1) what knowledge gaps existed in current life cycle comparative studies of dairy MSM strategies? (2) to what extent can MSM pathways and specific technologies address the potential benefits of life cycle impacts, and can a consensus be reached for specific impacts? (3) what are the key determinants affecting mitigation potential for some specific indicators?

Search strategy and selection criteria

In the present global meta-analysis, a literature search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline to identify studies reporting any of life cycle impacts of improved manure and sewage management pathways compared to a reference system in the dairy farming industry. The data were collected using the search engines of Scopus, Science Direct, Google Scholar, and the Chinese journal database CNKI to a cut-off date of September 2020 without language restrictions. The retrieval strategy is as follows: "manure" OR "sewage" OR "slurry" OR "waste" OR "wastewater" OR "water" and "dairy" OR "milk" OR "cow" OR "cattle" and "life cycle", to fully cover the scope of this research. 1) the focus of the study should be on life cycle comparison analysis of MSM strategies in dairy farms; 2) the reference system was the conventional or existing dairy MSM strategy, while the treatment one was the improved strategy; 3) only studies reporting at least one life cycle environmental, economic or social indicator were retained. It is noted that reference system largely varies depending on the definition of authors according to their study aims, which mainly refers to direct land application, existing MSM strategy in a specified farm, or a common-used strategy in a region.

Data and analysis

The statistical analysis can be conducted to reveal if a consensus can be reached. It is worth mentioning that the difference in the definition of reference system scenarios in these life cycle studies can be neglected to some extent. The authors adopted median values instead of mean values to avoid the influence of outliers as much as possible. Kolmogorov-Smirnov normality test was conducted to assess the data normality. Due to the non-normal distributions of most Effect sizes values, the non-parameter tests were performed. Firstly, regarding the indicators with sufficient measure results, the Wilcoxon Signed Rank test was performed to examine whether the median Effect sizes values were different from zero significantly. The significant difference and direction of Effect sizes value for an indicator could be used to ascertain that the specific MSM strategy increased or reduced the environmental or economic impacts remarkably. Secondly, the authors assessed whether Effect sizes values differed among groups (involving MSM pathway types, income level, farm location, and farm scale) using the Kruskal-Wallis test to identify the key influencing factors, followed by multiple pairwise comparisons between groups. All the statistical analyses were conducted in R software (version 3.4.2).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
23	Dairy farm manure	1) Anaerobic digestion (general); 2) Anaerobic monodigestion (only manure); 3) Anaerobic mono-digestion (only manure) + integrated treatment techniques (including filtration, reverse osmosis, microalgae, drying, stripping); 4) Anaerobic co-digestion (manure + other substrates)	No treatment	Metric: Eutrophication; Effect size: Standardized difference of of the considered metrics between intervention and control	62.5

Results

- Waste-to-energy pathway significantly decreased eutrophication impact by 17.8% ($P < 0.01$).
- It was observed that anaerobic mono-digestion, which uses manure as only feedstock, potentially reduced eutrophication by 17.7% ($P < 0.01$).
- The integrated technology of anaerobic mono-digestion with other technologies (Mix-AD) was observed a considerable decrease in eutrophication potential by 48.7% ($P = 0.06$).
- For anaerobic co-digestion, decreases in eutrophication by 18.1% were found, but not statistically significant.

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

All types of waste-to-energy (anaerobic digestion) pathway could have a consensus on reducing eutrophication. Uncertain results (for lack of sufficient data) resulted for anaerobic co-digestion.