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Zhang Z., Liu D., Qiao Y., Li S., Chen Y., Hu C. 2021 Mitigation of carbon and nitrogen losses during pig manure composting: A meta-analysis Science of the Total Environment 783 147103 10.1016/j.scitotenv.2021.147103

Background and objective

Composting is a reliable way to recycle manure for use on croplands in sustainable agriculture. Poor management of the composting process can result in a decrease in the final compost quality and negative environmental impacts. Optimization technologies during composting have varied effects on the mitigation of carbon (C) and nitrogen (N) losses. Assess the effects of seven technologies on reducing C and N losses during pig manure composting.

Search strategy and selection criteria

Global per-reviewed publications from 2000 to 2019 were collected using the China Knowledge Resource Integrated Database (CNKI) and Web of Science (WOS). The keywords aimed to identify researches focusing on the pig manure, composting, C loss, and N loss. The selected studies were restricted by the following criteria: (i) the study should focus on pig manure composting; (ii) the study should include control group and treatment group; (iii) the study reported on at least one of TC, CH₄, CO₂, TN, NH₃, and N₂O; and (iv) the composting process was complete. TC loss, CH₄ and CO₂ emissions were calculated as cumulative TC, CH₄-C and CO₂-C losses, respectively, and as a proportion of the TC content of the initial feedstock, and TN loss, NH₃ and N₂O emissions were calculated as cumulative TN, NH₃-N and N₂O-N losses, respectively, and as a proportion of the TN content of the initial feedstock.

Data and analysis

Many of the studies did not report any measure of variance for the response variables. Therefore, to include as many studies as possible, an unweighted meta-analysis was used in this study. Mean effect size and bias-corrected 95% confidence intervals for each study were calculated by a bootstrapping product (5000 iterations) using Meta-Win software (version 2.1.4).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
68	Pig manure composts	Optimized composting techniques. Optimal C/N ratios, optimal moisture, turning once weekly, intermittent aeration or optimized aeration rates, and using air-dry or hyperthermophilic pretreatment.	No application of technology	Metric: Total C loss, CH ₄ -C loss, CO ₂ -C loss, N ₂ O-N loss; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	68.75

Results

- In average, the techniques for optimized composting (optimal C/N ratios, optimal moisture, turning once weekly, intermittent aeration or optimized aeration rates, and using air-dry or hyperthermophilic) reduced losses of total C, CH₄-C, CO₂-C and N₂O-N by 12.4%, 18.1%, 6.8% and 23.8% during pig manure composting, respectively.
- The different technologies had variable effects.
- The use of additives significantly reduced CH₄-C (29.9%) and N₂O-N (24.2%) emissions during pig manure composting. However, the mitigation efficiencies varied with the different additive types.

Factors influencing effect sizes

- Type of technology : Adjusting the C/N ratio and covering did not reduce total C or CH₄-C losses and significantly increased CO₂-C emission by 33.1% and 17.1%, respectively. Adjusting the moisture and optimizing ventilation did not affect TC or CO₂-C losses, and significantly reduced CH₄-C loss by 25.6% and 39.5%, respectively. Adjusting the turning frequency increased TC loss by 3.5%, and significantly reduced CH₄-C loss by 41.5%. Additives significantly reduced TC, CH₄-C and CO₂-C by 19.7%, 29.9% and 14.7%, respectively. Others approaches (air dried or hyperthermophilic pretreatment) significantly reduced total C by 18.1%.

Conclusion

Overall, the studied technologies can reduce total C and N losses, including N₂O, CH₄ and CO₂ emissions.