Reference 10

Hou, Y; Velthof, GL; Oenema, O 2015 Mitigation of ammonia, nitrous oxide and methane emissions from manure management chains: a meta-analysis and integrated assessment Glob. Chang. Biol. 21, 1293–1312 10.1111/gcb.12767

Background and objective

Livestock manure contributes considerably to global emissions of ammonia (NH_3) and greenhouse gases (GHG), especially methane (CH_4) and nitrous oxide (N_2O). Various measures have been developed to mitigate these emissions, but most of these focus on one specific gas and/or emission source. The overall objective of this study is to make a quantitative assessment of the effects of (sets of) mitigation options on the NH_3, N_2O and CH_4 emissions from the whole manure chain, namely livestock housing, manure storage and land application. First, the impacts of a suite of NH_3 mitigation measures on NH_3 emissions at individual stages, and also the associated impacts on N_2O and CH_4 emissions were analysed by means of a meta-analysis of published data. Second, we evaluated the overall impacts of combinations of mitigation measures (including manure processing) on NH_3, CH_4, and (direct and indirect) N_2O emissions from the whole manure management chain through scenario analysis.

Search strategy and selection criteria

Studies related to manure management and emissions of NH_3, N_2O and CH_4 were searched using the bibliographical database Scopus, until the beginning of 2014. Only data from studies with reference treatments (i.e. without mitigation/processing measures) were included in our database, so as to allow side-by-side comparisons. To maximize the number of studies, both laboratory and field experiments were taken into account. The reported experiments and measurements were predominately conducted in EU, United States and Canada. Mean values of replicates for each treatment were included in the database. Manure characteristics (e.g. manure type, dry matter content, total N content, ammoniacal N content and pH), land use parameters (e.g. soil texture, vegetation), environmental conditions (e.g. temperature, seasons and geographical locations) were also included, and used to, if possible, quantify their relationships with emissions and the effectiveness of the measures.

Data and analysis

For calculation of grouped effect sizes, a mixed-effects model was used and performed in the nlme package of R statistical software Version 3.1. Experimental sites were considered as a random effect factor, to allow accounting for variances among studies. The lnR of individual pairwise comparison was the dependent variable. The mean effect size and the 95% confidence intervals (CIs) of each categorical group were estimated. The significance of the effects on emissions was statistically assessed at 0.05 level. In the graphs (forest plots), the 'effect-size' (the mean value and 95% CIs) of each grouping was transformed back (i.e. exponentially transformed) and converted to a percentage change in gas emissions relative to the reference treatment.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
126	Liquid manure of dairy cows and swine stables	Manure land application techniques (Band spreading, incorporation, injection), Anaerobic digested slurry	Conventional storage technique, surface spreading with broadcast, Raw slurry	Metric: N_2O emissions; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	87.5

Results

- Statistically higher emissions of N_2O (98%) were found for injection/incorporation of manure compared with surface broadcasted manure ($P < 0.01$)
- The overall effect of liquid fractions on N_2O emissions did not differ from that of raw slurry. Field-applied digestates and solid fractions showed on average 25% ($P > 0.05$) and 46% ($P < 0.01$) lower N_2O emissions than field-applied untreated manure, respectively.
- NULL
- NULL
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Injection or direct incorporation of manure into soil significantly decreased ammonia emissions, but significantly increased N_2O emissions.