Research Brief: ReUseWaste ESR 7.1

Mitigation of ammonia, nitrous oxide and methane emissions from manure management chains

ReUseWaste News
November
2014
No. 13

Yong Hou [1], Gerard L. Velthof [2], Oene Oenema [1,2]

Livestock farming systems are the main sources of emissions of ammonia (NH_3), nitrous oxide (N_2O) and methane (CH_4), leading to negative environmental impacts. Emissions of these gases may occur simultaneously from different sources of the manure management chains that generally include animal housing, manure storage and processing and field application of manure. A series of measures have been developed to address manure-related emissions, and some have been implemented successfully in practice. However, the effects of these measures are typically considered for a specific gas or emission source only, although it is well-known now that measures may have possible environmental side-effects.

A meta-analysis was conducted using results of 126 published studies to explore the possible interactions between emissions of NH_3, N_2O and CH_4 upon the adoption of certain mitigation measures. Significant NH_3 reduction efficiencies were observed for i) housing via lowering the crude protein (CP) content in animal diets (24-65%), for ii) external slurry storages via acidification (83%) and covers of straw (78%) or artificial films (98%), for iii) solid manure storages via compaction and covering (61%, compared to composting), and for iv) manure application through incorporation (70%, relative to surface application) and injection (80%).

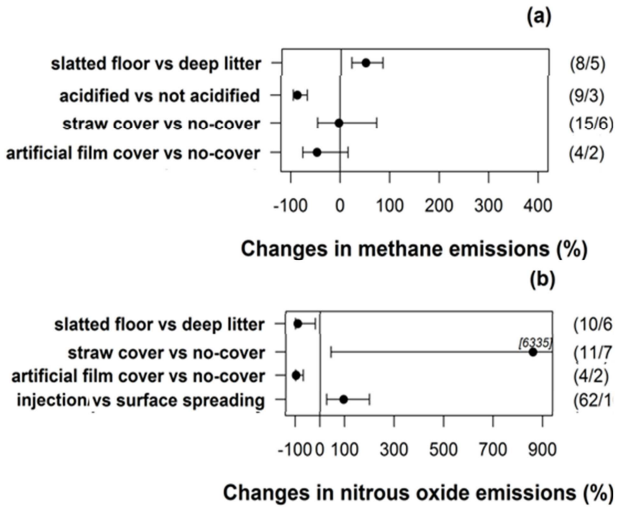

Figure 1. The mean change in methane (a) and nitrous oxide (b) emissions as a percentage of the reference treatment, for the grouped side-by-side comparisons between treatments with vs without mitigation measures. Number of observations/ studies are indicated in the parentheses.

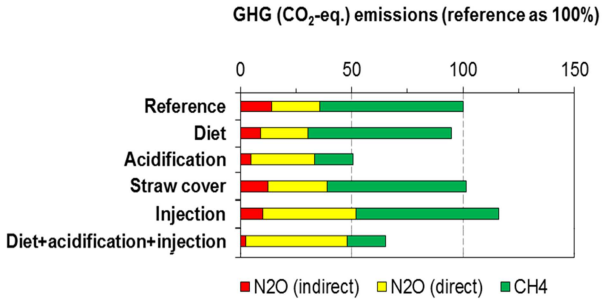

Figure 2. Impacts of mitigation measures on GHG emissions from (model) slurry-based systems, expressed as percentage of the reference system.

In addition to NH_3 emissions, some of these measures also significantly impact N_2O and CH_4 emissions (Fig. 1). For example, covers of straw increased N_2O emissions during slurry storages. Injecting or incorporating manure into soils can stimulate N_2O emissions from land. Acidifying slurry during storage significantly decreased both NH_3 and CH_4 emissions.

To explore possible pollution swapping, greenhouse gas emissions from the whole manure management chains were estimated under scenarios in which different mitigation measures were applied. Figure 2 shows covering slurry with straw during storages and injection of slurry slightly increased total GHG emissions from the chain, but can be mitigated when combining with other measures such as lowering CP in feed and acidifying slurry. We conclude that proper farm-scale combinations of mitigation measures are important to successfully minimize impacts of livestock production on global emissions of NH_3 and GHG.

Contact Yong: yong.hou@wur.nl

[1] Soil Quality Group, Wageningen University, The Netherlands
[2] Alterra, Wageningen University and Research Centre, The Netherlands

Reference: Y. Hou, G.L. Velthof, O. Oenema. Mitigation of ammonia, nitrous oxide and methane emissions from manure management chains: a meta-analysis and integrated assessment (In press), Global Change Biology. DOI: 10.1111/gcb.12767