

### Reference 21

Sajeev, EPM; Winiwarter, W; Amon, B 2018 Greenhouse gas and ammonia emissions from different stages of liquid manure management chains: Abatement options and emission interactions JOURNAL OF ENVIRONMENTAL QUALITY, 47, 30-41. 10.2134/jeq2017.05.0199

### Background and objective

Farm livestock manure is an important source of ammonia and greenhouse gases. Concerns over the environmental impact of emissions from manure management have resulted in research efforts focusing on emission abatement. However, questions regarding the successful abatement of manure-related emissions remain. The present study identifies potential abatement options to reduce greenhouse gases and ammonia emissions collectively. It also sheds light on the potential co-benefits and the issue of pollution swapping by determining the trends in interactions of methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and NH<sub>3</sub> among the various abatement options identified. Here, results for low protein diets and feed additives on GHG emissions are presented.

### Search strategy and selection criteria

Emission reduction potentials for the identified abatement options were estimated using effective observations from published literature according to the methods described in recent studies that focus on emission abatement in manure management systems. 1) The animal category was either cattle or pigs; 2) the study was subject to at least one of the eight chosen abatement options; 3) the study measured and reported either NH<sub>3</sub> and/or GHG emissions for at least one of the manure management stages of housing, treatment, storage, or application; 4) the study included data on reference treatments and base emissions; and 5) the article was peer reviewed and available in English

### Data and analysis

Descriptive statistics were used to quantify and describe the emission reductions. Means and SDs were calculated and reported for all existing datasets. The use of complex statistical models was not possible due to a small sample size.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
89	Beef cattle and swine	1) Low crude protein diet; 2) Diet additives supplementation	1) High protein feeds; 2) no additives	Metric: 1) Methane (CH <sub>4</sub> ) emissions; 2) Nitrous oxide (N <sub>2</sub> O) emissions; Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control	43.75

### Results

- CH<sub>4</sub> emissions increased with a reduction in dietary CP. Feed additives led to slight increases in overall CH<sub>4</sub> emissions by 20 ± 33%.
- Averaged over all manure management stages, lowering dietary CP reduced N<sub>2</sub>O emissions by 30 ± 38%, which is a decrease in N<sub>2</sub>O emissions by 9 ± 12% per %-point reduction in CP. This is primarily due to the lower N content in the manure.
- The effect of feed additives (both acids and fiber) on N<sub>2</sub>O emissions during the housing stage indicated an increase in emissions by 9 ± 9%.
- NULL
- NULL

### Factors influencing effect sizes

- No factors influencing effect sizes to report

### Conclusion

Low crude protein diet reduced N<sub>2</sub>O emissions but not CH<sub>4</sub> emissions, while feed additives did not reduce both CH<sub>4</sub> and N<sub>2</sub>O emissions. "Reviewers' note: We labelled the results as uncertain due to the lack of statistical testing."