FARMING PRACTICE
LIVESTOCK FEEDING TECHNIQUES

IMPACT: AIR POLLUTANTS EMISSIONS

Reference 20

Sajeev, EPM; Amon, B; Ammon, C; Zollitsch, W; Winiwarter, W 2018 Evaluating the potential of dietary crude protein manipulation in reducing ammonia emissions from cattle and pig manure: A meta-analysis NUTRIENT CYCLING IN AGROECOSYSTEMS, 110, 161–175. 10.1007/s10705-017-9893-3

Background and objective

Dietary manipulation of animal diets by reducing crude protein (CP) intake is a strategic ammonia (NH_3) abatement option as it reduces the overall nitrogen input at the very beginning of the manure management chain. The present study aims to address a comprehensive analysis of NH_3 emission reductions from lowering CP content in animal diets for both cattle and pigs.

Search strategy and selection criteria

Google Scholar was used to search the literature for studies pertaining to NH_3 emissions from a reduction of CP in animal diets. 1) The animal type was either cattle or pigs subject to reduced CP in their diets; 2) NH_3 emissions were measured and reported in at least one of the following manure management stages: housing, storage or application; 3) reference treatments included initial and final CP levels along with reference NH_3 fluxes; 4) studies complied with standards related to animal nutrition and experimental design; 5) the articles were peer reviewed and available in English.

Data and analysis

Regression analysis was used to determine the relationships between NH_3 emission reductions, total ammoniacal nitrogen (TAN) reductions and the CP traits (CP reductions, initial CP and final CP levels) along with their associated interactions. Three models were tested for cattle and pigs separately. The criterion for the best suited model was the highest adjusted R2. All regression analyses and selections were done with the REG procedure in the statistical software SAS 9.4. A fixed-effect analysis of covariance (ANCOVA) model was fitted to combine the data of the two species, pigs and cattle, with the aim to test if there were differences between the species with respect to NH_3 emission reductions. In addition, the models were also tested to check if measurement stage and animal category were significant in explaining NH_3 emission reductions. For comparison between the models the standard deviation (SD) of the residuals was considered, with the better fit indicated by a lower SD. All ANCOVA models were analysed with the MIXED procedure of SAS 9.4. All factors were tested at a significance level of 0.05. Differences between class levels of significant factors were tested in post hoc t tests. When interactions between class effect and regression effect were significant, differences were tested at a range of values of the dependent variable to identify ranges where the class factors are different. For multiple pairwise comparisons between least squaresmeans, the "simulate" optionwas used to keep the global significance level of 0.05.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
22	Cattle and swine	Low crude protein (CP) diet	Reference diet	Metric: Ammonia (NH_3) emissions; Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control	50

Results

- Descriptive statistics of NH_3 emissions with reduced CP in pig diets show average NH_3 reductions of 38 ± 19% (n: 47, Max: 76%, Min: 0%). High reductions of NH_3 can be achieved when the final CP level is low and the reductions in CP are high.
- Descriptive statistics of NH_3 emission reduction estimates for cattle with reduced CP report average emission reductions of 43 ± 18% (n: 20, Max: 73%, Min: 4%). Greater reductions of NH_3 can be achieved at high CP reductions. Contrary to the case in pigs, there was no influence of final CP on NH_3 emission reductions.
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Factors influencing effect sizes

- Interaction between dietary crude protein (CP) and final CP level : In pigs, high reductions of NH_3 can be achieved when the final CP level is low and the reductions in CP are high. Contrary to the case in pigs, there was no influence of final CP on NH_3 emission reductions.
- Animal type : Even at low crude protein levels, the NH_3 reductions for a particular crude protein reduction is higher for cattle than pigs.

Conclusion

The results confirm that crude protein in animal diets and emissions of NH_3 show a clear relationship. The meta-analysis revealed mean NH_3 reduction of 17 ± 6% per %-point CP for cattle and 11 ± 6% for pigs.