FARMING PRACTICE
LIVESTOCK FEEDING TECHNIQUES

IMPACT: GHG EMISSIONS

Reference 22

Wang, Y; Li, XR; Yang, JF; Tian, Z; Sun, QP; Xue, WT; Dong, HM 2018 Mitigating greenhouse gas and ammonia emissions from beef cattle feedlot production: A system meta-analysis ENVIRONMENTAL SCIENCE AND TECHNOLOGY, 52, 11232-11242. 10.1021/acs.est.8b02475

Background and objective

Beef cattle production systems are the largest contributors of greenhouse gas (GHG) and ammonia (NH_3) emissions in the livestock industry. The overall objective of this study was to make a quantitative assessment of GHG and NH_3 emissions from beef cattle feedlot production systems and the effects of (sets of) mitigation options on the methane (CH_4), nitrous oxide (N_2O), and NH_3 emissions from the whole production chain using meta-analysis. Here, effects of different feeding techniques on NH_3 emissions are reported.

Search strategy and selection criteria

The ISI Web of Knowledge database and the Chinese journal database were used to search all published datasets as of December 2017. Specific search terms were combined and used, including animal categories (beef, cattle, bull, steer, bovine, heifer, and livestock), manure, manure management (feedlot, pad, yard, open-lot, pen, compost, and stockpile), land application (surface spread, and incorporation), gaseous emissions (NH_3, CH_4, N_2O, and GHG gas), and mitigation measures (diet, crude protein, additive, amendment, urease inhibitor, biofilter, biotrickling, cover, nitrification inhibitor, incorporation, reduction, mitigation, and abatement). 1) The research object was beef cattle; 2) the study included at least one of the CH_4, N_2O, and NH_3 gases; 3) gas emission flux or gas emission factor was available; and 4) for literature related to mitigation, only studies that reported at least one control group were selected, so that emission mitigation efficiency (ME) could be calculated.

Data and analysis

The median mitigation emission (Em) values for each measure were calculated using an analytical approach adapted from Benayas et al (2009) and Tuomisto et al (2012). The normality of the data was tested using the Kolmogorov–Smirnov test. Not all of the Em values for each mitigation measure were normally distributed; therefore, the Wilcoxon Signed-Rank test was used to determine if the median Em values were significantly different from 0 when there were sufficient results for specific measures. SPSS 20.0 software was used for the statistical analyses.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
104	Beef cattle	1) Lipids; 2) Electron receptors additives; 3) Inhibitors additives; and 4) Plant bioactive compounds supplementation; 5) Low forage-to-concentrate ratio diet; 6) Low crude protein (CP) diet	1-5) No additives; 6) High forage-to-concentrate ratio; 7) Normal diet	Metric: 1) Methane (CH_4) emissions; 2) Nitrous oxide (N_2O) emissions; Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control	62.5

Results

- The mitigation efficiency on CH_4 emissions for dietary lipid additives was −14.9% ($p < 0.05$). The most commonly used ionophore is monensin, and it showed a strong anti-methanogenic effect, leading to the mitigation efficiency being −11.5% ($p < 0.05$). However, ionophores are banned in the European Union and are therefore not applicable everywhere.
- In the electron receptor category, nitrate, fumaric, and malic acids have been studied most, with the median mitigation eficiency being −15.2% ($p < 0.001$). The CH_4 mitigating effect of plant bioactive compounds in vivo remains controversial, and it was calculated that the plant bioactive compounds additives such as saponin and essential oil caused an increase of 2.8% on beef cattle CH_4 emission ($p = 0.109$). The effect of a low crude protein diet on CH_4 was not appreciable.
- A low CP diet is highly beneficial because it limits N at the source, resulting in a lower N content in the excreta (−12.8%, $p < 0.01$) and, thus, may reduce N-related gaseous emissions during subsequent manure management phases. The effect of low CP on N_2O emission was not obvious, being of −3.5% ($p = 0.753$). However, it delivers an obvious mitigation potential for NH_3 emissions during the manure on the feedlot phase, being of −46.5% ($p = 0.068$).
- Little research has been performed related to N_2O mitigation with feed additives. Reducing the FC ratio can lower CH_4 emission by −3.8% ($p = 0.221$).
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Dietary lipids, ionophores additives and electron receptors additives showed positive effect on CH_4 emissions, while all techniques showed no effect or uncertain effect for N_2O emissions.