Acidification of slurry during application

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Horizontal tabs

Summary

Aim of Measure:

Reduce ammonia emissions

Principle of measure:

Reducing pH of manures to 6.5 or less reduces ammonia volatilisation

Nitrogen Species:

Ammonia emissions (NH_3)

Climatic Zone:

All climates

Geographic Region:

Global

Technological Requirement:

Intermediate technology - small investment may be needed

Sector:

Agriculture (livestock)

Sector Category:

- Manure Application
- Manure Management

Efficacy Status:

Category 2 techniques and strategies

Level of Management:

Medium

Relationships with other measures:

This technique can be combined with the measure 'Acidification of slurry in housing' for cattle and pigs. In combination of these measure the ammonia emission potential increases.

Measure Description

Measure overview:

Acidification of liquid manure (i.e. slurry) can significantly reduce ammonia volatilisation. Acids can be added to slurry during storage but also during application of slurry to land (see (figure 1). Acids commonly used include sulphuric acid, but also phosphoric acid and nitric acid. Acidification of manures is one of the most effective measures to reduce ammonia emissions, and comparable in terms of ammonia reductions to those achieved by liquid manure injection (UBA 2019). Acidification can be carried out in the barn, during slurry storage or during spreading.

The pH value of slurry at the time it is applied to land is typically higher than 7.0 and can be higher than 8.0. Reducing slurry pH value from 7.5 to 6.5 has been shown to reduce NH3 emissions by over 60%. Although field measurements do not always show such a clear relationship between slurry pH and total NH_3 emission this measure is a reliable mean to reduce ammonia emissions (European Commission, 2017).

Most field trials have used sulphuric acid to reduce the pH value of slurry. The amount of sulphuric acid needed for a tonne of slurry is approximately 2.5 to 3 litres. This corresponds to about 4.6–5.5 kg of acid for each tonne of raw slurry, to reduce the pH to between 5.5 and 6. However, adding too much sulphuric acid result in the production of hydrogen sulphide, which can cause odour problems and health and safety issues. Acidification with sulphuric acid (or phosphoric acid) can add nutrient concentrations (i.e. sulphur or phosphorus) in the slurry and should be monitored to ensure excess nutrient are not applied to soils (UBA, 2019).

How to implement the measure:

When acidification is carried out immediately before spreading the slurry in the tank is continuously acidified in a system directly mounted on the slurry spreader. In this case, the acidified slurry is spread with standard equipment (e.g. trailing hoses) and an additional acid tank is placed in front of the tractor or on the drawbar of the tank wagon (Figure 1).

Co-benefits and trade offs:

Nitric acid has the advantage of increasing the slurry nitrogen content so giving a more balanced NPK (nitrogen-phosphorus-potassium) fertilizer but has the potentially large disadvantage of nitrification – denitrification mediated nitrous oxide production and associated pH rise. If nitric acid is used the pH of the slurry needs to be reduced to around 4.0 in order to avoid nitrification and denitrification and the production of unacceptable quantities of nitrous oxide.

Acidification of slurry to reduce ammonia emissions increases the amount of slurry-nitrogen available for crop uptake thereby reducing the need for nitrogen fertilizer application. This reduce greenhouse gas emissions associated with the manufacture and application of nitrogen fertilizers.

The changes in the manure properties induced by acidification can improve plant availability of other nutrient contained in the slurry (e.g. nitrogen, phosphorus, magnesium and calcium). Improving plant uptake of nutrients in the manures, can reduce potential leaching and nitrous oxide gas emission from the soil (UBA, 2019)

Challenges:

Handling strong acids on farms is hazardous. A fully automated system, with no manual contact with sulphuric acid and automated management of the slurry (including discharging operations) is needed to ensure the safety of farm staff. However, the acidification of slurry in slurry stores and during spreading is possible without danger, and numerous technical solutions are available on the market (UBA 2019)

The technique may lead to marginal soil acidification, increasing the need for liming. All practical experience shows this is a minor issue corresponding to less than 10% of the additional liming needed. Theoretically, 1.4 kg lime should be enough to neutralise each kg of sulphuric acid used for slurry acidification (UBA 2019).

Measure Efficiency

Indicator for the efficiency of the measure:

Nitrogen Species	% reduction in N losses from reference system
Ammonia	
Ammonium Nitrate	
Nitrogen Dioxide	

Nitrogen Species	% reduction in N losses from reference system
Nitrous Oxide	
NOx	
Nr	
Total N	

Finanacial Implications

Overview of cost:

An additional cost of approximately €20 per ha is reported where acidified slurry is applied during landspreading; this extra cost includes depreciation of the investment.

Financial Implications table definitions:

Types of Cost	US $
Cost savings and production benefits	
Capital costs of implementing this measure	
Operational costs of implementing this measure	

Refs and Further Info

References:

Bittman, S., M. Dedina, C.M. Howard, O. Oenema, and M.A. Sutton. 2014. Options for ammonia mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen.

Further Information:

Bittman, S., M. Dedina, C.M. Howard, O. Oenema, and M.A. Sutton. 2014. Options for ammonia mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen.

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