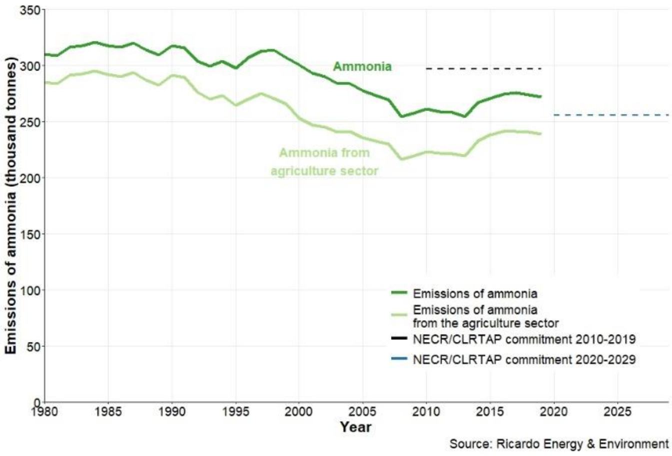
Reducing agricultural emissions of ammonia

Ammonia (NH3) is a gas that negatively affects air quality. The primary source of UK ammonia emissions is agriculture which accounted for 88% of the UK's total in 2019. Emissions of ammonia have fallen by 12% since 1990 and have remained relatively static since 2017. Emissions dropped by nearly 1% between 2018 and 2019. Further reductions in emissions are needed to hit future commitments. Most agricultural emissions are linked to production, storage and spreading of manures, slurries and agricultural fertiliser with the increase between 2013 and 2017 linked to an increase in the tonnage of fertiliser (organic and inorganic) spread.

Annual emissions of ammonia in the UK: 1980 to 2019



This technical note outlines the opportunities available to farmers to reduce ammonia emissions from their holdings and therefore play their part in improving UK air quality.

Why?

Ammonia gas negatively affects human health and the environment in various ways. When combined with other pollutants in the atmosphere Particulate Matter (PM) is produced. PM has a significant impact on respiratory and cardiovascular disease. Emitted ammonia can travel significant distances from its source and can combine with Nitrogen Oxides contributing to urban smog. Furthermore, some ammonia will return, indiscriminately, to earth acidifying and over-fertilising sensitive habitats with a resultant reduction in biodiversity as low pH and nutrient receptive plants, outcompete others. Ammonia is also toxic to plants and even at very low concentrations can cause damage to lichens and mosses. Biodiversity loss caused by ammonia can affect ecosystem functions of affect habitats functions such as carbon sequestration and flood mitigation.

Opportunities

Changing agricultural practices to reduce ammonia (NH_3) loss from slurry and manure means more nitrogen is retained on farm to be used by crops. Given recent increases in fertiliser prices, plus the carbon challenges posed by nitrogen fertiliser production, this represents a real opportunity.

Systems approach to livestock manure ammonia emissions

The fact that ammonia is a gas directs us to adopt a whole system approach when considering emissions originating from livestock. Ammonia retained at one point in the system is at risk of being lost further down the line if later system loss risks are not addressed. The 'system' is best considered in three sub sections: manure spreading, manure storage and livestock housing.

Livestock Diets

Relevant to all three system sub sections is the principle that prevention is better than cure. It is less wasteful and expensive to reduce the volumes of ammonia in the manure than deal with it as a volatile gas at a later stage. The ultimate prevention tactic when considering bovine ammonia emissions is to manage stock at pasture. Urine, the source of most ammonia emissions, is rapidly absorbed by the soil following deposition and emissions curtailed. For housed livestock the focus is balancing animal nitrogen/protein requirements with the rations provided. Protein requirements will differ and therefore ration should be adapted based on animal age, production levels and sex amongst other factors. Regular analysis of feeds, especially forages, will ensure what is rationed is being fed and further reduce the risk of ammonia waste.

Spreading or organic manures

Spreading the right amount of manure, in the right place at the right time of year is important to reduce potential for loss. Regular soil analysis, a regulatory requirement via the Farming Rules for Water (FRfW), should form the basis of field specific Nutrient Management Plan (NMP). Manure analysis, which can be a practical challenge, is also advisable to improve accuracy. Ammonia is volatile, so reducing prolonged exposure of manure to the air is important so when manures are to be incorporated into the soil the sooner this is done the better. About 50% of the total ammonia emissions from surface spreading of cattle slurry occur within six hours.

1 Rapid incorporation of organic manures will minimise ammonia emissions and increase the nitrogen retain for crop growth (Photo credit D Munday)

Where liquid manures are to be applied and remain on the surface, using low emissions kit is recommended. Injection, trailing shoe and dribble bar machines all reduce ammonia emissions compared to splash plates. Deep injection can cut emissions by up to 90% compared to splash plate. Shallow Injection cuts relative emissions by 70-80% with trailing shoe and dribble bar kit typically reducing emissions by 30-60% and 30-35% respectively. There are pros and cons to different application methods, with more complex kit improving accuracy and nitrogen retention but with higher costs and loss of flexibility.

Ammonia emissions from manure spreading are significantly impacted by the weather conditions at the time. Warm windy conditions and dry soils, tend to result in significantly higher levels of emissions compared to moist, cool, still spreading days. Also remember that wet, rainy days should be avoided because of a higher risk of run-off.

A useful tool to help understand the implications of weather, spreading equipment, time of year and soil type on ammonia emissions is the free to download Manner NPK software. With relatively few entries it is possible to quantify the nutrient content of a manure application. Manner also shows up the likely ammonia losses from different management plans allowing very simple 'What if' scenario planning.

Manure Storage

Having sufficient storage to enable spreading manures at the most suitable time of the year is a starting point when considering emissions from manure storage. The next aim should be to reduce the opportunity for ammonia loss from the manure store surface. Deep, covered (airtight) stores are the ultimate. For slurry and digestate stores, floating or fixed impermeable covers have the potential to cut emissions from the store by around 60 and 80% respectively. Natural crusts or introduced barriers, including chopped straw and clay balls, reduce emissions by around 40%-50% compared to uncovered stores. However, the permeable covers do not have the added rainfall excluding advantage of the impermeable alternatives. Covering solid manure heaps, possibly with old silage sheets, will also reduce emissions. Manures should be kept dry to reduce emissions and stockpiles spread to land as soon as practical to reduce loss from open heaps. If you store silage, slurry or agricultural fuel oil (SSAFO), please ensure you read the rules on GOV.UK.

Housing

The opportunities within animal housing focus around reducing the exposure of urine to air, the point at which most ammonia emissions occur. Use of absorbent bedding such as straw will help as will regular cleaning of yards where manures are deposited. Every effort, particularly when designing new livestock buildings, should be taken to encourage drainage of urine to covered storage. Controlled environment livestock buildings e.g. for poultry have the opportunity to install air scrubbers which 'trap' the ammonia gas before it has chance to escape to the wider environment. Installation of natural wind breaks (such as a tree shelterbelt) offer some potential to reduce wind flow around buildings. The planted wind break may also absorb some of the escaping gas.

Low pH opportunities

Ammonia emissions from liquid slurries and digestates, during housing, subsequent open storage and spreading, can be significantly reduced if the pH of the material is kept below 6 by adding acidifying additives. This low pH method offers many advantages in that its benefits are transferred down through the livestock system especially if applied in the housing or storage phases. Acidifying additives are added in a very controlled manner and the resultant low pH slurry/digestate, after treatment, has a pH much higher than other products on farm including silage.

Manufactured Fertiliser

Emissions from manufactured fertiliser primarily result from Urea based products when Urea is broken down in the soil, relatively quickly, by the urease enzyme with a consequential loss of ammonia. Other forms of nitrogen, including the most common, Ammonium Nitrate (AN) break down in a different way and have far lower ammonia emissions. Losses from urea fertiliser are increase as the temperature increases, but reduce if applied immediately before rainfall so the urea washes into the soil. . Using AN based fertilisers will reduce ammonia emissions when compared with straight Urea. Alternatively, inhibitors can be added to urea to slow down, by a few days, the activity of the enzyme allowing the applied urea to be absorbed into the soil after which emissions are very much lower. The addition of inhibitors to urea is thought to cut ammonia loss by around 70%. Urease inhibitor treatment does increase cost but the increase does not appear to remove the financial competitiveness of the protected urea product.

Conclusions

The implications of PM on human respiratory and cardiovascular disease combined with negative biodiversity implications continues to fuel the drive to reduce ammonia gas emissions. As the largest, emitter of ammonia in the UK, agriculture and the farmers involved, have a massive part to play in future reductions. There are simple, relatively low cost, opportunities available and for the more expensive challenges future support has already been identified. When considering the opportunities, it should be reassuring to note that so many focus on reducing waste in agricultural systems. Reducing waste tends to have the benefit of reducing costs.

This article was written by John Morgan who recently delivered a webinar on ways farmers can reduce ammonia emissions on their farms. You can watch the recording on the FAS website here.