A clear solution for farmers

CATCHMENT SENSITIVE FARMING

Reducing Ammonia Emissions by Effective Nutrient Management Planning on Dairy Farms

Why is ammonia a problem?

Ammonia is a key air pollutant that can affect both the environment and human health. Ammonia emissions are one of the largest contributors to acidification of soils and eutrophication of water courses and water bodies, while adding to the burden of particulate matter. Ammonia emissions may combine with pollution from industry and transport (e.g. diesel fumes) to form very fine particulate matter ($PM_{2.5}$), which can then be transported significant distances in the air adding to background levels to which people are exposed. When inhaled particulate matter can contribute to cardiovascular and respiratory disease.

In the UK around 87 per cent of ammonia emissions come from agriculture. The application of slurry and manure is responsible for approximately 25 per cent and fertilisers 23 per cent of agricultural emissions. Around 28 per cent of all the emissions from agriculture are attributed to dairy farms.

Nitrogen is lost through volatilisation, in the form of ammonia, from organic manures (both solid manures and slurries) when they come into contact with air, particularly on warm and windy days. Therefore, focusing on overall nutrient management practices can reduce ammonia emissions in conjunction with other measures that can be adopted in the dairy sector.

Dairy farm case study

This case study presents best practice in integrated nutrient management, planned and implemented, by a dairy farmer in Lancashire. The herd is currently 370 dairy cows plus followers and youngstock. The farm is 121.4 hectares (ha) in extent, with 85 ha of temporary grass leys cut for silage and 36 ha of land on neighbouring arable farms to produce forage crops (maize, spring barley and spring wheat whole crops). Soils range from organic and sandy to loamy and a small proportion of clay soils which are ideally suited to grass production.

The dairy cows are housed all year round in cubicles and are bedded on green bedding (separated manure solids). This has reduced hock damage and there have been no issues with mastitis. The dry cows and youngstock are loose housed in straw yards. Poor weather in 2016/17 instigated the change to livestock being housed year round. Since then the farm has seen significant improvements in animal health and welfare, fertility, milk yield and milk quality.

Annual slurry production is 20,928 cubic metres. Around 1,200 tonnes of farm yard manure is produced each year, the majority of which is exported to neighbouring arable farms, whose soils benefit from its use.

Case study farm decision making and practices

Nitrogen management is very important to this farm. The farm aims to balance all nutrient sources to improve nitrogen use efficiency, increasing productivity and saving money on buying in manufactured nitrogen fertiliser. This case study highlights good practices on-farm, which have resulted in a reduction in ammonia emissions. The farm operates a multi-cut silage system, taking five to six silage cuts per year, achieving a fresh weight yield of around 59 tonnes per hectare with an even yield between first and second cut, and the remaining cuts generally contributing 25-50 per cent of total yield. The remaining home grown feed requirement is secured on a 'muck for feed' basis, with the farm exporting approximately 5,000 cubic metres of slurry, and in return receiving forage maize, whole crop spring wheat and spring barley.

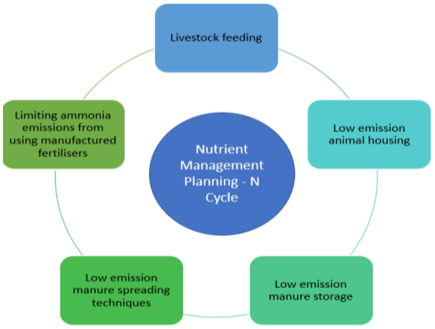
How does this farm plan its nutrient application?

The farm is proactive in its nutrient management planning. Plans are made in advance each year using up to date soil analysis (<4 years old) and current slurry analysis, and then adjusted in season in reaction to the needs of the growing crop, weather conditions and rainfall. Slurry storage is critical to this plan. The farm has recently invested in a 9,000 cubic metre capacity lagoon, in addition to its existing above ground slurry tank and reception pit of 4,500 cubic metres, to give nearly eight months' slurry storage. This investment ensures that the storage needed for compliance with SSAFO rules for storing Silage, Slurry and Agricultural Fuel Oil and Nitrate Vulnerable Zones is exceeded. Importantly it allows the farm to plan and carry out applications at the right time to meet crop need, when the grass is actively growing and able to use supplied nitrogen efficiently. This reduces potential losses to the wider environment e.g. from nitrate leaching or ammonia emissions.

There is no immediate plan to cover the new lagoon but the farm is considering it and also the possibility of roofing over an existing slurry reception pit. The farm has been working with Lancaster University, looking at whether 'slurry bug' additives work effectively in converting the total nutrients in the slurry to more crop available forms that can be readily taken up. This also has the potential to reduce ammonia losses during storage and when preparing to apply the slurry (as no stirring is required). The farmer said, *"it has increased forage production and improved soil biology since using the additive. The slurry remains homogenous during storage, needing no agitation prior to spreading. 750,000 gallons [3,409 cubic metres] were spread last year which had been stored for five months with no agitation prior to spreading".*

The farm has tried injecting slurry (potentially reducing ammonia losses by 70 per cent) but found this was hard on the sward. They now use a trailing shoe to apply cattle slurries, reducing ammonia emissions during application by 30-60 per cent and producing better soil condition and biology. The slurry is 8-9 per cent dry matter. The farmer has found "*this can be difficult to pump and use through the trailing shoe*" but the additive has helped.

What were the benefits and costs of taking an integrated approach to nutrient management?



From 2012, when taking regular soil samples to monitor nutrient levels, the farm began to notice soil phosphorus and potassium levels were building where slurry was being applied. For example in one field, which the farm took over managing five years ago, potassium was Index 2+ (at best) and is now approaching Index 5. In response, from 2015 onwards, the farm stopped applying phosphorus and potassium from manufactured fertiliser as they have learned that their slurry was delivering far more value than was previously understood.

Cost benefit

Investing time in producing a nutrient management plan pays dividends by helping to gain more value from both organic manures and purchased fertiliser products. The case study farm balances slurry nutrients with urea fertiliser. Below we compare the quantities of nitrogen now used from fertiliser versus the RB209 standard recommendations for nitrogen, based on achieving 12-15 t DM/ha target annual grass yield (with moderate Soil Nitrogen Supply and good Grass Growth Class):

	Nitrogen application rate (kg N/ha)				
	1st cut	2nd cut	3rd cut	4th cut	Total
RB209 nitrogen required	120	90	70	30	310
Farm fertiliser nitrogen used	40	35	50	0	125
Nitrogen saving overall	80	55	20	30	185
Nitrogen saving versus RB209* £/ha	**£51.20**	**£35.20**	**£12.80**	**£19.20**	**£118.40**

*Nitrogen fertiliser value based on granular urea at £294/tn is £0.64/kg

Fertiliser nitrogen required to achieve desired yields has reduced more than slurry nitrogen supply alone justifies, perhaps due to improved soil health. For the first four silage cuts £118.40/ha of nitrogen is saved and only slurry is applied for additional cuts thereafter.

Benefits to the farm

By adopting a best practice application method and applying slurry with a trailing shoe rather than a low trajectory splash plate in March, MANNER NPK calculates 26 kilogrammes nitrogen per hectare (kg N/ha) could be available to the grass from a 28 m^3/ha slurry application. Ammonia losses are reduced by 5 kg N/ha (saving £3.20/ha). The cost saving achieved potentially pays for the more precise application technique, whilst making significant gains in grass quality, soil health and productivity.

This farm has reduced the tonnage of granulated urea used by around 56 tonnes per annum (two lorry loads). Based on the AHDB UK Fertiliser Price Market Update, January 2019, at £294 per tonne this equates to a £16,464 annual saving. Ammonia losses from the urea fertiliser are minimised by careful application but would be reduced further with use of a urease inhibitor or polymer coated granule or indeed switching to ammonium nitrate fertiliser. As the graphic above shows, nutrient management planning, along with application method and having sufficient storage are central to reducing ammonia emissions from agriculture. The case study farm has:

- Significantly reduced reliance on manufactured fertiliser, eliminating the need for imported phosphorus and potassium.
- Reduced ammonia emissions when spreading slurry.
- Used slurry to provide over 50 per cent of crop available nitrogen requirements for grass production.
- Used 'slurry bugs' to reduce odour and reduce the need for agitation prior to application, again reducing ammonia emissions.

Catchment Sensitive Farming (CSF) is delivered in partnership by Natural England, the Environment Agency and Defra.

Department for Environment Food & Rural Affairs

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Funding is from the European Agricultural Fund for Rural Development: Europe investing in rural areas.

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Experience and feedback from the case study farm

Adoption of a nutrient management plan has led to focusing on better use of slurry as a major source of 'homegrown' nutrients. Lessons learned at the farm:

- Injection of slurry has positive benefits in supplying more nitrogen to the grass but compromised the sward, (by damaging it), and dragged stones to the surface which were detrimental to the forage harvester.
- Trailing shoe requires 'thin' slurry, 6 per cent dry matter would be preferable, but it does bring benefits of less slurry on the leaf, the leaf canopy appears to enclose the slurry more quickly and it has improved soil biology across the land.

The farmer's view is that *"our slurry application is having less impact on water, air and soil, crops are better utilising nutrients, and our business is able to control variable costs in a challenging dairy market"*.

Three 'take-away' messages

Focus on three key areas for efficient planning, storage and spreading of organic manures and manufactured fertiliser to reduce ammonia emissions from the whole nitrogen cycle:

1. Test soils, estimate soil nitrogen supply and select target grass yield to prepare an accurate nutrient management plan to calculate crop need, decide on suitable application rates and timings of manufactured fertilisers and organic manures. Take into account the value of nutrients in manures when planning fertiliser use and regularly test slurry and manure to potentially make more cost savings.
2. Ensure there is enough or more than enough slurry storage; this ensures slurry can be applied at the right time to crops and in the right way when soil and weather conditions are appropriate.
3. Spread the right amount of both organic manures and manufacture fertilisers, in the right way, and at the right time to optimise their use and reduce ammonia emissions.

Key contacts and information

Catchment Sensitive Farming (CSF) is able to provide events, tailored advice, individual visits and grant support towards air quality measures on farm.

Department for Environment, Food and Rural Affairs (Defra) published a Code of Good Agricultural Practice for Reducing Ammonia Emissions in 2018.

What tools can help you?

There are several freely available tools available to help produce a nutrient management plan. These include Tried and Tested, MANNER-NPK and ENCASH.

Commercial software tools are also available incorporating nutrient recommendations from The Nutrient Management Guide (RB209).

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