A clear solution for farmers

CATCHMENT SENSITIVE FARMING

# Reducing Ammonia Emissions through Integrated Nutrient Planning with Anaerobic Digestion

## Why is ammonia a problem?

In the UK around 87 per cent of ammonia emissions come from agriculture. 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 habitats and water bodies. Ammonia emissions 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.

## Pig farm with AD plant case study

This case study presents best practice in integrated nutrient management planning and implementation by a pig producer with an associated anaerobic digestion (AD) plant and local arable farms in Hampshire and West Sussex.

Nitrogen management across these enterprises considers all sources of nitrogen in pig manure, digestate and fertiliser in the whole nutrient cycle. The farms aim to balance all nutrient sources to improve crop nitrogen use efficiency, increase yields and save money by reducing the use of manufactured fertiliser.

Organic manures and manufactured fertilisers should be applied in the right amount, in the right way, in the right place and at the right time to optimise crop uptake and minimise nutrient losses. If the soil and crops can't harness and use the nitrogen quickly enough, some nitrogen will be lost from the system as ammonia or nitrous oxide to air and nitrate to water.

## Making changes

This case study highlights just some of the good nitrogen management practices being used on farm, resulting in reduced ammonia emissions.

The farm has built a new intensive pig unit with pigs bedded on straw. Livestock housing, together with the application of manures to land, are two of the largest sources of ammonia emissions from agriculture. Rebuilding the pig housing provided an opportunity to introduce techniques to reduce ammonia emissions.

The new housing is based on a straw-based system which is also better for animal welfare than slatted, slurry-based systems. Regular clearing and changing of straw reduces potential ammonia emissions and is good for animal husbandry but leads to production of large quantities of solid stackable manures.

Field heaps of pig manures can lead to significant ammonia emissions. The best solution was to rapidly use these manures within an anaerobic digestion plant adjacent to the pig unit.

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Source: Plandescil Consulting

## What are the benefits of anaerobic digestion?

By anaerobically digesting solid manures, ammonia emissions during storage are significantly reduced. The pig manure is co-digested with crops. Biogas generated from the process is used to run two combined heat and power (CHP) engines to generate electricity which is primarily exported to the grid but is also used to power seven large buildings used for pig production and a feed mill building.

Also produced from the anaerobic digestion process is a stabilised and sanitised nutrient rich whole digestate, with reduced odour loading and a higher nitrogen availability to receiving crops. The whole digestate is separated into a relatively low dry matter liquid (low in odour) and a solid fibre. The separated liquid digestate is stored within a covered lagoon. The cover abates ammonia losses during storage by 60-80 per cent. The liquid digestate can be applied with either a dribble bar to the soil surface beneath a growing crop (to rapidly infiltrate into the soil), applied and soil incorporated or injected prior to drilling crops. The solid fibre fraction (typically lower than 30 per cent readily available nitrogen) can be stored in field heaps, spread and rapidly soil incorporated.

## What are the benefits and challenges?

The reduction in ammonia emissions between applying raw pig manure and digestate may be small as the digestate does have a high pH, making it liable to ammonia emissions. However overall reductions in ammonia emissions from storage and application of solid pig manure, once converted to liquid digestate, are significant.

Any ammonia saved earlier, from livestock housing or manure storage, might be lost if the application of the resulting digestate is not planned effectively and applied using low emission application techniques. The farm has therefore carried out nutrient management planning and invested in precision application equipment to either band spread or inject, and soil incorporate digestate as it is applied.

## Digestate planning

A digestate management plan was produced early in the planning of the AD plant, to see how the digestate produced could be used efficiently, to benefit several farms in the area in replacing the use of manufactured fertiliser and in providing fibre digestate as a soil improver.

Digestate or organic manure storage should be calculated not just to comply with rules for storing under the Silage, Slurry and Agricultural Fuel Oil Regulations (SSAFO) and Nitrate Vulnerable Zone statutory requirements but should also consider availability of land and windows for spreading on crops within the rotation. Available storage both at the AD plant and receiving farms should of sufficient size to avoid spreading on land at times of the year when there is a risk of water pollution through nitrate leaching or ammonia losses through volatilisation and to allow application at the best time to meet crop nitrogen demand.

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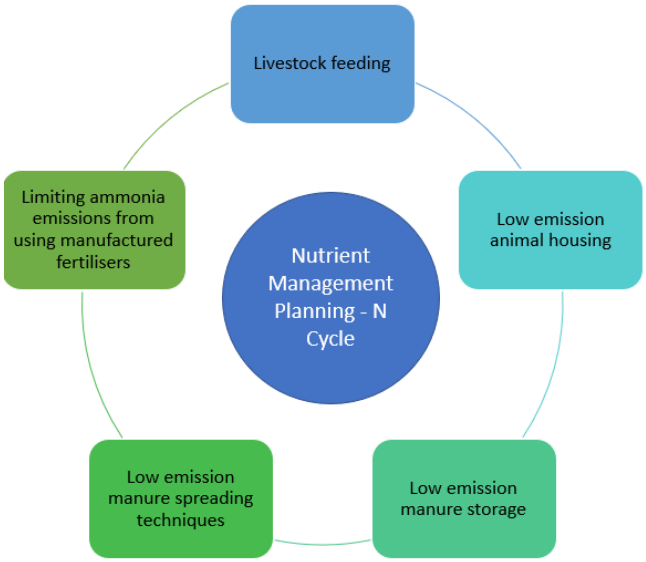


## Benefits of a farm nutrient management plan?

Every farm should create a nutrient management plan to calculate crop need, suitable timings and application rates for organic manures and fertilisers. This will ensure digestate, organic manures and manufactured fertilisers can be applied to complement one another in the right amount, the right way, in the right place and at the right time to optimise crop uptake and minimise losses.

In this case study, the nutrient management planning carried out should ensure the maximum benefit will be gained from the nutrients that the digestate provides. The digestate will be applied in accordance with all relevant regulations including the Farming Rules for Water in England and Nitrate Vulnerable Zone requirements.

The greatest cost-benefit can be gained from optimising the use of crop available nitrogen from the digestate by applying at times of greatest crop uptake.

The application rate of a manure should be based on crop nutrient requirement, using a nutrient recommendation system such as The Nutrient Management Guide (RB209), soil nutrient content and the nutrient content of manure. Application rate may need to be limited due to high phosphate levels in crop and manure-based digestate and soils, to avoid over enriching soils and causing phosphate losses to water. Digestate is very unlikely to replace all manufactured nitrogen fertiliser use on farm or meet the balance of nutrient required by the crop. It is good practice to aim for half of nutrients to be provided from organic manures.

## Tools freely available

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

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

## Cost-benefit of planning ahead?

The economics behind processing organic manures within an anaerobic digestion plant are complex and site-specific, with high installation costs.

Investing time to produce a nutrient management plan will pay dividends by helping the farmer gain more value from any type of organic manure. If over-application of manufactured fertiliser is prevented and crop yield and quality is improved, direct cost benefits are made.

As the graphic opposite shows, nutrient management planning for the nitrogen cycle is central to reducing ammonia emissions from agriculture.

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## Cost-benefit examples

The application of 30 t/ha of pig manure, 25 per cent dry matter containing 7.0 kg/t of total nitrogen, will supply 210 kg/ha of total nitrogen. When applied in the autumn and soil incorporated ahead of winter wheat, 10 per cent of the nitrogen (21 kg N/ha) may be available for crop uptake on medium/heavy soils. A cost saving of £12.60/ha based on £0.60/kg of nitrogen from manufactured nitrogen fertiliser. MANNER NPK calculates ammonia-N losses of 31 kg/ha (-£18.60/ha of nitrogen value), with the pig FYM soil incorporated within 12 hours of application.

Whole digestate (including pig manure), 6 per cent dry matter containing 4.5 kg/t of total nitrogen, applied at 30 t/ha will supply 135 kg/ha of total nitrogen. When applied to winter wheat in the spring through a dribble bar system 35 per cent of the nitrogen (47 kg/ha) may be available for crop uptake. If a second application is made to apply a total of 250 kg N/ha a total of 88 kg N/ha may be provided to the crop from digestate saving £52.80/ha based on £0.60/kg of nitrogen from manufactured fertiliser. MANNER NPK calculates ammonia-N losses of 14 kg/ha (-£8.40/ha of nitrogen value).

## 'Take-away' messages

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

1. Prepare a nutrient management plan to calculate crop need, suitable timings and application rates for both manufactured fertilisers and organic manures. Regularly test nutrient content of organic manures and soils to get more accurate nutrient application rates.
2. Enough slurry or digestate storage to ensure it can be applied at the right time to crops and when soil and weather conditions are appropriate.
3. Spread organic manures and manufactured fertilisers at the right amount, in the right way, in the right place, at the right time using low emission application systems.
4. The anaerobic digestion process converts total organic nitrogen into readily available ammonium nitrogen. Resulting digestate should be managed carefully to abate ammonia losses.

## Key contacts and information

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

Department for Environment, Food and Rural Affairs (Defra) published a new Code of Good Agricultural Practice for reducing ammonia emissions and the Clean Air Strategy 2019.

Farming Rules for Water in England and Nitrate Vulnerable Zone (NVZ) requirements.

The Nutrient Management Guide (RB209) published by Agriculture and Horticulture Development Board (AHDB).

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