A clear solution for farmers

CATCHMENT SENSITIVE FARMING

Reducing Ammonia Emissions from Storage and Field Application of Digestate on an Arable Farm

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 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 in the air significant distances 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 storage and application of livestock manures and digestates from anaerobic digestion plants accounts for almost 40 per cent of total agricultural emissions. This case study describes the adoption of low emission spreading techniques and covering of digestate storage for use on an arable farm.

Farm details and measures adopted

This case study is an arable farm in West Yorkshire with 1,300 hectares (ha) of cereal crops comprising winter wheat, winter and spring barley and winter oilseed rape. Approximately 40,000 cubic metres (m^3) of digestate are imported to the farm each year from a nearby food-based anaerobic digestion plant. The digestate is stored in two temporary lagoons on the farm, with half being applied in the spring to growing crops and half applied to post-harvest stubble.

The applications to the growing crop in the spring are made using a trailing hose band spreader, giving significant emission reduction over surface broadcast application. Application to the stubble was by surface broadcast, followed by incorporation into the soil by tine cultivation within 48 hours. The farm have now replaced this with deep disc injection of digestate to the stubble. Both temporary lagoons are covered with a layer of clay balls.

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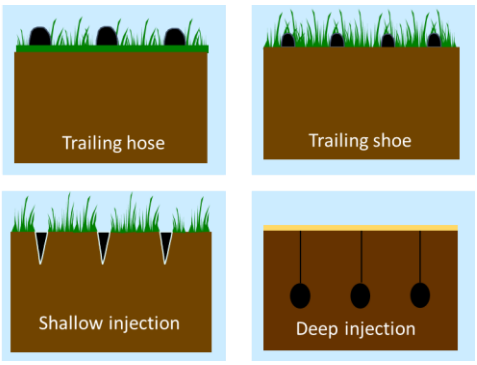
What are the options for low emission spreading?

Surface broadcast application of slurry or digestate to land by splash plate application will cover the whole ground giving a very large surface area and exposure to air for ammonia loss. Low emission spreading techniques (figure below) greatly reduce the exposed surface area and/or place the slurry or digestate directly into the soil, therefore reducing the loss. Trailing hose and trailing shoe place the slurry or digestate in narrow bands 20-30 centimetres (cm) apart. Trailing hose will typically be used on arable crops, with large boom machines available to suit tramlines. Trailing shoe is more suited to grassland, where leading 'shoes' part the grass canopy and place the slurry or digestate directly on the soil surface. In this way, the grass leaves are not coated in slurry or digestate and the slurry or digestate is placed below the canopy where there is reduced air movement at the slurry or digestate surface, further reducing loss.

Shallow injection places the slurry or digestate in a v-shaped cut into the soil at about 5 cm depth, without closure at the soil surface. Deep injection places the slurry or digestate deeper into the soil with complete burial. Typically ammonia losses are reduced by 30 per cent by trailing hose, 60 per cent by trailing shoe, 70 per cent by shallow injection and 90 per cent by deep injection, compared with splash plate application, although this varies with slurry or digestate characteristics.



Why cover the store?

Ammonia will be lost readily from the exposed surface of a slurry or digestate store. Losses tend to be proportionally greater from lagoons than tanks because of the larger surface area. Reducing the exposed surface area by covering and reducing the air movement directly above the slurry or digestate will significantly reduce ammonia loss. A rigid tent-like structure or plastic sheet will give the greatest emission reduction (typically 80 per cent) but floating covers, such as clay balls (picture above) are a more practical solution for lagoons and will reduce emissions by 50-60 per cent. Covering will also significantly reduce odours. Slurry bags (picture below) offer an alternative solution for temporary storage and give very effective emission reduction of up to 100 per cent.

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What influenced the farmer's decision?

The main objectives for the farmer were to improve the nitrogen use efficiency of the imported digestate and also reduce the impact of odour on neighbouring properties.

A trailing hose applicator was chosen based on build quality, company reputation and range of options offered. The machine chosen included a tramline kit, which stops digestate coming out of the outlets directly on the tramlines, reducing the risk of runoff. The 16 metre machine width fitted well with the farm tramline 32 metre spacing.

For digestate injection, the farmer wanted a machine not only to place digestate at depth, to reduce nitrogen losses and odour, but also to cultivate the land and create a stale seedbed for reducing the grass weed burden across the farm. A disc, rather than tine injector was chosen to give better incorporation of the chopped straw residue left after harvest. Also, a design which achieved effective burial of digestate, rather than partial burial seen in some designs (where discs only follow and don't also precede digestate placement) was deliberately chosen.

The clay balls were chosen as a more practical alternative to a plastic sheet covering for the digestate store, which would have been at risk of tearing on stones on the banks of these clay-lined lagoons. Installation was simple, just a case of having the balls blown on. The farmer was provided with good evidence that they worked well on other sites and was also given reassurance by the Environment Agency that this was a good option. Very occasionally, in very windy weather the balls do get blown to one side exposing some digestate and maintenance is also required to maintain appropriate amount of clay balls. Equipment blockage is another potential problem, but has not caused any major issues so far.

Image: Joskin

What are the costs?

Costs for low emission slurry or digestate application machinery can vary greatly according to the size and specification. In this case study, the trailing hose (Vogelsang) was £19,850 in 2012. The disc injector (Joskin) was £26,200 in 2015. Both implements are still working very effectively. It must be remembered that the net cost of the mitigation method is the cost above that of a standard splash plate tanker, so substantially less than the total cost.

The initial cost of the clay ball covering of the two lagoons was £49,000 in 2015. No replacements have yet been made, but it is anticipated that some top-up every 5 years or so would be required at £5,000.

What are the benefits?

The main benefit has been an increase in the nitrogen use efficiency of the digestate and a reduction in the quantity of mineral nitrogen fertiliser required. Fertiliser nitrogen application to the 900 ha receiving digestate has been reduced by 20-25 kilogrammes per hectare (kg/ha) since low emission application was introduced. This has resulted in a saving to the farm of approximately £15,000 per year, giving a net financial benefit over the anticipated investment lifetime.

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Additional benefits of low emission digestate application

An additional benefit of the low emission application techniques is that they give an even application rate across the entire spread width, something very difficult to achieve with splash plate application. Combining this with a good knowledge and measurement of application rate, precision digestate application enables more accurate nutrient management and can greatly help with the farm nutrient management plan. They also reduce direct crop leaf contamination with digestate or slurry, which reduces leaf scorch and potential impacts on livestock health.

Image: Joskin

It is difficult to quantify the financial benefits of reduced odour emissions but where neighbouring properties make this an issue significant benefits in terms of goodwill and permission to operate can be realised through these ammonia mitigation methods which also reduce odours.

Finally, through the introduction of the disc injector, this farm was able to reduce labour requirement by combining digestate application and tillage operations on the post-harvest stubbles.

Three 'take-away' messages

1. Fertiliser costs can be significantly reduced through better use of slurry or digestate nitrogen when applied using low ammonia emission techniques. Low emission application techniques also improve evenness of spread and reduce odours.
2. Seek advice regarding the best system for your farm. Contracting out low emission application may be a cost-effective option, particularly if combined with detail of application rate and nutrient content.
3. Odour and ammonia emission reduction can be achieved from storage lagoons by using floating covers such as expanded clay balls. Slurry bags offer an alternative temporary storage option.

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.

Agriculture and Horticulture Development Board (AHDB) provide advice on nutrient management through the series of RB209 booklets.

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

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