Low Emission Slurry Spreading Systems help to reduce ammonia emissions

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Figure 1 Slurry application using a trailing shoe system

Introduction

Organic manures (such as slurry, solid manure, poultry litter, digestate, sludge and compost) are natural sources of nitrogen and are used to build soil fertility and support plant growth. However, nitrogen in the form of ammonia is lost from organic manures when they come into contact with air, particularly on warm or windy days. The more nitrogen lost as ammonia, the less effective the manure will be as a fertiliser.

Increasing levels of ammonia emissions are adversely affecting air quality in Northern Ireland. Most recent figures show that ammonia emissions in Northern Ireland increased by 22% since 2010 and that 96% of ammonia emissions are from agriculture (2017 data). There is an increasing need to reduce ammonia emissions to prevent damage to sensitive sites, to protect human health, to help to meet UK targets and to improve the efficiency of nutrient use.

Water quality trends are also concerning and the increasing levels of nitrate and phosphorus in water needs to be addressed through appropriate measures. The publication of the Water Framework Directive 2018 report identified that no overall progress has been made towards achieving the target of up to 70% "good status" water quality by 2021. The use of Low Emission Slurry Spreading Equipment (LESSE) is a very effective way to reduce ammonia emissions and improve water quality. It is best practice to apply nutrients to meet crop need taking into account soil analysis and crop type and CAFRE's Crop Nutrient Calculator, available at www.daera-ni.gov.uk/services/daera-online-services, is designed to help farmers plan slurry and fertiliser application rates. Manures and chemical fertilisers should be applied in the right amount, at the right time, in the right place and by the most efficient method to prevent losses to both air and water. If too much manure and/or fertiliser is applied to land, or is applied by an inefficient method, or is applied in unsuitable weather conditions, nitrogen will be lost from the farming system as ammonia or nitrous oxide to air and nitrate to water.

Why is Low Emission Slurry Spreading Equipment Important?

In Northern Ireland the inverted splash plate is the main method of slurry application. Slurry spread with a splash-plate can result in very high losses of 80% - 100% of the total ammonia. These losses can be reduced by up to 60% if the slurry is spread by low emission spreading equipment such as the trailing shoe system. Slash plate systems also increase the risk of surface run-off into waterways. Splash plate systems operate by forcing liquid at high pressure onto an inclined plate and sprays the liquid into the air. Ammonia loss is significantly increased when the manure has a high surface area and when there is a lot of air movement which is the case when slurry is sprayed into the air by a splash plate spreading system and afterwards when it covers all of the soil or crop surface.

What is Low Emission Slurry Spreading Equipment?

Typical Low Emissions Slurry Spreading Equipment (LESSE) includes trailing hose, trailing shoe and shallow injection methods for applying slurry. All LESSE systems place the slurry or digestate onto or into the ground, thereby reducing nitrogen losses to the air as ammonia. Many farmers already use LESSE and they are finding that they get more fertiliser value from slurry leading to increased crop yields, the opportunity to reduce chemical fertiliser rates and potentially less nitrogen loss to waterways. The different LESSE systems are described below.

The trailing hose spreading system, sometimes referred to as dribble bar, can achieve a 30% reduction in ammonia emissions compared to splash plate slurry application and is suitable for grassland and arable crops (where the slope is less than 15%). Hoses connected to the boom of the spreader distribute the slurry directly onto the ground. For best performance i.e. to minimise the ammonia loss and to maximise the fertiliser value of the slurry, the hoses should be kept as close to the ground as possible to minimise sward contamination. This system is the lightest system available and it is suitable for arable crops as it less damaging to the crop.
Figures 2a and 2b show examples of trailing hose systems.

Figure 2a Tanker with trailing hose

Figure 2b Umbilical trailing hose system

The trailing shoe spreading system can achieve a 60% reduction in ammonia emissions compared to the splash plate system and is suitable for grassland and arable land (pre-sowing). Metal 'shoes' ride along the soil surface, parting the vegetation and ensuring that the slurry is placed on the soil surface.

In addition to delivering a higher nutrient value from the slurry there is much lower leaf contamination compared to both splash plate and trailing hose systems, which helps to reduce contamination at ensiling and allows earlier availability for grazing. As the slurry is in bands it can be more susceptible to surface run-off after rainfall if the bands run down the slope. The trailing shoe allows slurry to be applied to fields with a grass cover of up to 2250kg DM/ha (or roughly 15cm) giving a wider window of opportunity to spread the slurry. Spreading slurry with a trailing shoe into a grass sward with a cover of up to 2250kg DM/ha (i.e. longer grass) will also 'shelter' the slurry from wind and so help to reduce ammonia emissions after spreading and reduce the risk of run-off.

Figure 3a Close up of the trailing shoe parting the grass and the hose delivering the slurry.

Figure 3b Trailing shoe slurry application.

Slurry injection systems can achieve a 70-90% reduction in ammonia emissions compared to splash plate slurry application. There are various types of injectors, which can be classed as either a shallow or deep injector based on how deep the liquid organic manure is placed in the soil.

Shallow injectors (70% reduction in ammonia emissions) are suitable for arable land or grassland. Shallow injectors place the organic manure typically 4-6 cm deep in narrow slots cut into the soil, typically 25-30 cm apart.

Deep injectors (90% reduction in ammonia emissions) are only suited to arable land immediately prior to sowing (due to the damage that can occur to grass or crops).Deep injectors should only be used when the soil is sufficiently dry and not on land with a drainage system shallower than 70 cm depth in order to prevent water pollution. Deep injectors cut slots 10-30 cm deep and are spaced about 50 cm apart.

Figure 4 shallow injection equipment

Figure 5 Deep slurry Injection equipment

Comparison of Slurry Application Systems of Low Emission Slurry Spreading Equipment

Extensive research has been carried out to effectively compare and contrast the various methods of Low Emission Slurry Spreading Equipment. It's important to take into consideration the whole range of impacts and effect utilising LESSE can have. These systems don't only help to reduce ammonia emissions, they reduce odour, maximise the nutrient potential of the slurry through increased yield and reduced the potential for leaching to waterways. Studies by AFBI indicate that with slurry spread by splash plate 80% - 100% of the available nitrogen is lost into the atmosphere in the form of ammonia. This results in the slurry being less effective in its nutritional capacity. In their research AFBI have found that using low emission systems also reduces the surface area spread and reduces the amount of slurry exposed to the air, this is important as approximately 30 % of all ammonia losses occur in the first hour after spreading, with 80% being lost within 12 hours.

	Inverted splash plate	Trailing hose (low emission)	Trailing shoe (low emission)	Shallow injector (low emission)
Typical range of dry matter	Up to 12%	Up to 9%	Up to 6%	Up to 6%
Requires separation or chopping	No	Yes (if over 6% DM)	Yes	Yes
Relative work rate	→→→→	→→→	→→→	→→
Uniformity across spread width	✓	✓✓✓	✓✓✓	✓✓✓
Ease of bout matching	✓	✓✓✓	✓✓✓	✓✓✓
Crop damage	Moderate	Low	Low	Moderate
Relative odour	High	Moderate	Low	Low
Relative ammonia reduction	0%	30%	60%	70%
Capital cost	£	££	£££	£££

Table 1 A comparison of slurry application systems Source: DAERA Code of Good Agricultural Practice for the Reduction of Ammonia Emissions - www.daera.gov.uk

Table 1 shows that the inverted splash plate method of application is the least effective method in reducing ammonia emissions. The trailing shoe and shallow injection methods are much more effective in reducing ammonia emissions and therefore securing maximum nutrition from the slurry.

Research by AFBI found a 21% increase in silage yields (Table2) using the trailing shoe system to spread slurry compared to splash plate application. LESSE systems are more precise, reduce overlapping during spreading and so result in a more even distribution of slurry or digestate with considerably reduced odours.

Time of Application				Method of Application (Grass yield (t DM/ha)			
Slurry Application Date	2nd cut Harvest Date	Days between application and harvest	No slurry	Splash plate	Band spread	Trailing-shoe	Slurry average
21-May	27-Jun	37	4.26	4.88	5.09	5.63	5.2
29-May	02-Jul	34	3.87	4.6	5.7	5.47	5.26
04-Jun	03-Jul	29	4.04	4.06	5.33	5.3	4.9
Average			**4.06**	**4.51**	**5.37**	**5.47**	
% increase over splash plate application					**19%**	**21%**	

Table2. Effects of different systems of slurry application after first cut silage on yields of second cut silage (t DM/ha)(AFBI)

Adoption in other countries

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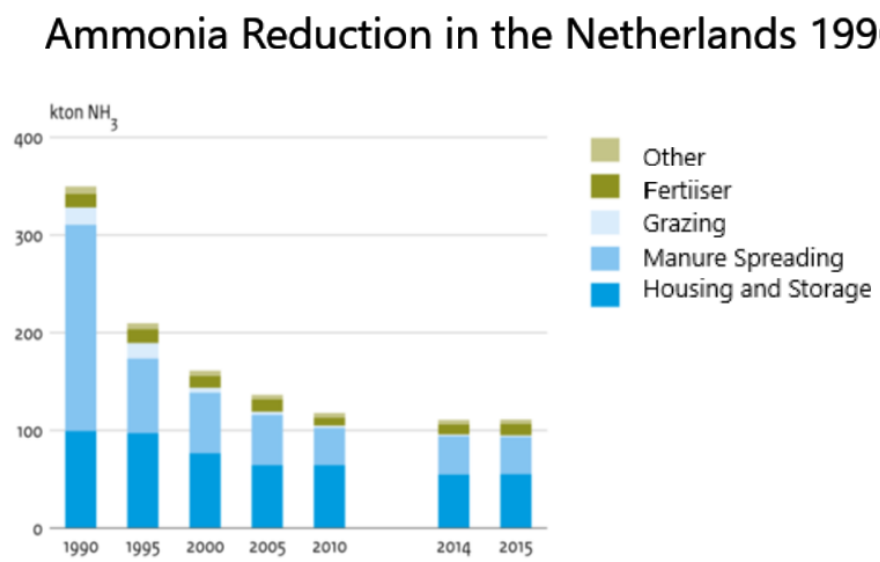

Fig.6 Progress with ammonia reduction in the Netherlands 1990-2015

Source: https://www.clo.nl/indicatoren/nl010114-ammoniakemissie-door-de-land--en-tuinbouw

Fig.6 illustrates the very high levels of ammonia that were emitted in the Netherlands in 1990. As illustrated in the table the majority of ammonia emissions at that time came from the spreading of manure (well over 50%). In 1990 slurry in the Netherlands was mainly applied using the splash plate system. Legislation was brought in to reduce ammonia emissions and this meant a change over from the use of splash plates to shallow injection. As a result between 1990 and 2015 the greatest reduction in ammonia emissions has come from changing the method of slurry spreading.

Legislation on LESSE in N. Ireland

DAERA's recently revised Nutrients Action Programme (NAP) 2019 – 2022 regulations now include new requirements for using low emission slurry spreading equipment (LESSE) which are summarised in Table 3.

Implementation Date	Change to
1st February 2020	Anaerobic digestate must be spread using LESSE.
15th June 2020	Slurry on Derogated farms must be applied using LESSE after 15th June each year.
1st February 2021	Slurry contractors must spread slurry using LESSE
1st February 2022	Slurry to be spread using LESSE on cattle farms with 200 or more livestock units and pig farms with a total annual livestock manure nitrogen production of 20,000kg or more.

Table 3. Summary of the requirements for using low emission slurry spreading equipment in the revised Nutrients Action Programme (NAP) regulations.

N.B Where it is not practical, because of slope, to spread on a field using LESSE, slurry can be spread using an inverted splash plate in that field. A record of the field number and the reason for spreading using a splash plate must be kept for inspection**.**

Further information will be included in the NAP Guidance for 2019 – 2022 which is expected to be available in early 2020.

LESSE being used at CAFRE

On CAFRE farms slurry is spread by LESSE to reduce ammonia loss, to help protect the environment and to increase the quantity of nitrogen from slurry available to the crop. Emphasis is placed on applying slurry to silage fields and arable land in spring at a rate of approximately 3,000 gallons per acre or 34m^3/ha. Please note there is a new maximum application rate of 30m^3/ha (2600gallons/ acre) in February and October to reduce the risk of run- off in these months. Slurry will also be applied after 1st and 2nd cut silage using LESSE at approximately 2,000 gallons per acre or 22.5m^3/ha.

A study of the CAFRE dairy herd performance over the past 20 years found that by integrating LESSE alongside other methods of ammonia reduction has meant an overall total reduction in ammonia of 19% even though, in this time period, the dairy herd has increased by 54% and milk sales have increased by 93%. In addition to LESSE ammonia mitigation technologies used included low emission flooring, reduced CP diets, covered slurry stores, increased scraping frequency and stabilised urea.

Conclusion

Low emission slurry spreading systems can play a significant part in improving nutrient use efficiency by making more nitrogen available to the crop, reducing ammonia emissions and improving water quality in N. Ireland