Working together for a world without waste

Digestate & Compost in Agriculture, Bulletin 5 – April 2013

Good practice in digestate management improves nitrogen use efficiency

The latest results from the Digestate & Compost in Agriculture field experiments are providing strong indicators on how best to use digestate, notwithstanding that 2012 was a difficult season for farmers. This bulletin focuses on the experiments that are measuring the supply of crop available nitrogen from digestate, and the potential for losses to the environment. Also covered is the release of MANNER-*NPK*, a practical software tool that will allow farmers and advisers to gain a quick estimate of crop available nutrients from digestate, compost and a wide range of livestock manures.

The *DC-Agri* project has already established that digestate is a valuable source of readily available nitrogen (see Bulletin 2), but the latest results have shown that to optimise nitrogen use efficiency and crop performance, the timing and method of digestate application are critical.

The new evidence shows when and how potential losses may occur, and how the delivery of nitrogen to the crop can be increased through minimising these losses. By using as much of the nitrogen in digestate as possible, the farmer gains much more in replacing expensive 'bagged' fertiliser. As well as informing good practice, this research has also supported digestate's inclusion in the latest version of MANNER-*NPK* produced by ADAS.

Efficient use of digestate

When organic materials such as livestock slurry or digestate are used, nitrogen losses can occur through natural processes, just like 'bagged' fertilisers. There are three main ways in which nitrogen can be lost:

- volatilisation to the atmosphere as ammonia, which can pollute natural habitats and affect human health;
- leaching of nitrate to groundwater, which affects water quality; and
- denitrification, which emits nitrous oxide (a potent greenhouse gas) and nitrogen gas to the atmosphere.

The pathway for each of these is illustrated in Figure 1. There is established evidence and guidance on minimising these losses from livestock manure and slurry applications, although information on digestate is scarce. Results from the field experiments are addressing this and will support guidance to optimise the efficient use of nitrogen from digestate, and minimise potential impacts on the wider environment.

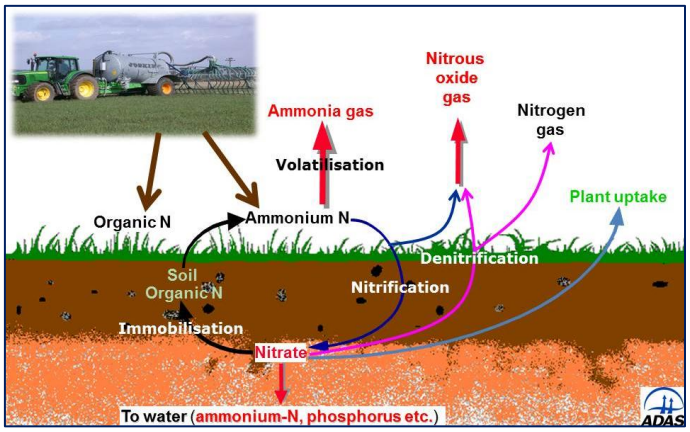

Figure 1. Nitrogen pathways following application of organic materials to land

The experiments

Field experiments in harvest year 2012 measured how efficiently crops took up and used nitrogen (N) supplied by digestate. Autumn and spring applications were made at three sites that represented contrasting soil types and climates:

- Wensum, Norfolk (winter wheat);
- North Wyke, Devon (grass); and
- ADAS Pwllpeiran, Ceredigion (grass).

Digestate applications were compared with 'bagged' fertiliser N and N supply from compost, manures and cattle slurry, applied by either surface broadcasting or bandspreading to fully replicated experimental plots.

Detailed measurements of ammonia and nitrous oxide emissions were taken at all three sites, and at Wensum leaching losses to water of nitrate-N, ammonium-N, phosphorus and *E.coli* were measured from the organic materials treatments.

Ammonia emissions

Wind tunnels were placed on each plot to measure ammonia losses following application. Each wind tunnel consists of two parts; a canopy and a duct with a fan to draw air through at a set speed (Photo 1). A sub-sample of the air entering and leaving the tunnel is taken, and the ammonia present is captured for measurement in the lab. The ammonia content is analysed in the laboratory and combined with the volume of air through the tunnel to calculate ammonia-N losses from the organic materials.

Photo 1: View inside a wind tunnel control box showing the orthophosphoric acid 'bubblers' used to capture ammonia

Ammonia emissions were higher from digestate than from cattle slurry applications at ADAS Pwllpeiran (Figure 2), which was largely a reflection of the greater readily available N (RAN) content of the digestate (72% of total N applied, compared with 53%).

Notably, bandspreading reduced ammonia losses from both the digestate and cattle slurry treatments, compared with surface broadcast application, although emissions were still high. Shallow injection has been demonstrated to be even more effective at reducing ammonia losses from livestock slurry, and we plan to test this for digestate too.

Ammonia emissions were low from the green compost and cattle FYM applications, reflecting the lower RAN content of these materials (<10% of total N applied).

It is recommended that precision application methods (i.e. a bandspreader or shallow injector) are used when applying digestate, to maximise the fertiliser replacement value of the digestate and to minimise ammonia losses.

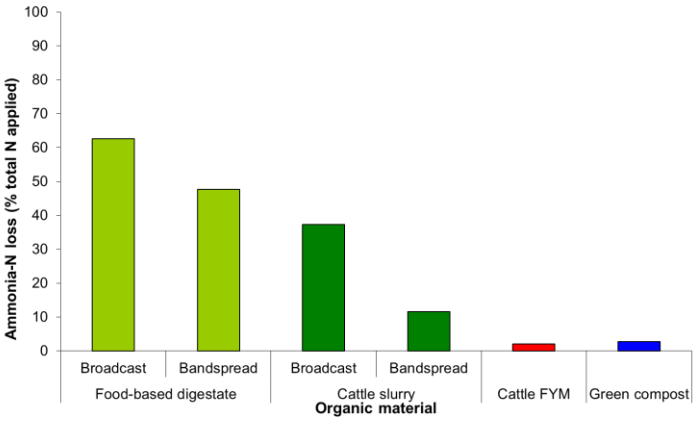

Figure 2. Ammonia emissions following spring (2 May 2012) organic material applications to grassland at ADAS Pwllpeiran

Leaching losses

Nitrate, ammonium, phosphorus and *E.coli* leaching losses were measured using Teflon suction cup samplers following the autumn 2011 organic material applications at the sandy soil site at Wensum (Norfolk). The digestate and pig slurry applications increased nitrate leaching losses above the untreated control; losses were equivalent to 15-20% of the total N applied and reflected the high RAN content of these materials (*c.*80% of total N applied)(Figure 3).

In contrast, nitrate leaching losses were low following the green/food compost and pig FYM applications, reflecting the lower RAN content of these materials (*c.*10% of total N applied). None of the organic material applications had an effect on ammonium-N, phosphorus or *E.coli* losses in drainage waters.

Where for operational reasons late summer applications of digestate need to be made, these are best targeted on oilseed rape and grassland crops that will utilise some of the applied N and reduce the risk of nitrate leaching losses over winter.

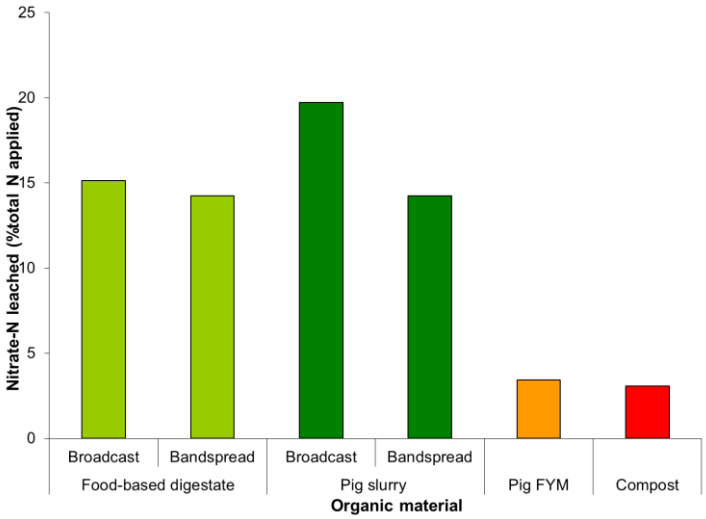

Figure 3. Nitrate leaching losses following autumn (31 August 2011) organic material applications to winter wheat at Wensum

Nitrous oxide emissions

Static chambers were placed on the plots straight after the organic materials had been applied. The chambers are designed to enclose the growing crop without inhibiting its growth. The air is extracted from the chambers at regular intervals and is analysed, using gas chromatography, for nitrous oxide which is a potent greenhouse gas (plus methane and carbon dioxide). The data from these measurements is being analysed and the results will be reported in the next bulletin.

Photo 2. Static chamber used to capture nitrous oxide, methane and carbon dioxide emissions following organic materials applications

Nitrogen Use Efficiency

A key element of the experiments is to quantify crop available N supply from digestate (and compost) use.

It is important to recall the difference between *crop available* N and *readily available* N (see Bulletin 4). *Crop available* N takes into account the potential losses of *readily available* N e.g. as ammonia or nitrate, between the point of application and uptake by the crop. During fertiliser planning and in order to optimise productivity, an estimate of the *crop available* N value must be made and balanced against the crop N requirement.

At the Wensum experimental site, of the total N supplied from food-based digestate applied in autumn, only around 20% was used efficiently by the winter wheat crop (Figure 4). In the spring, when the winter wheat was growing actively, the uptake of applied N increased dramatically to around 80%. The N efficiency of the pig slurry, food and manure-based digestates was consistently much greater when applied in the spring, compared with the autumn application.

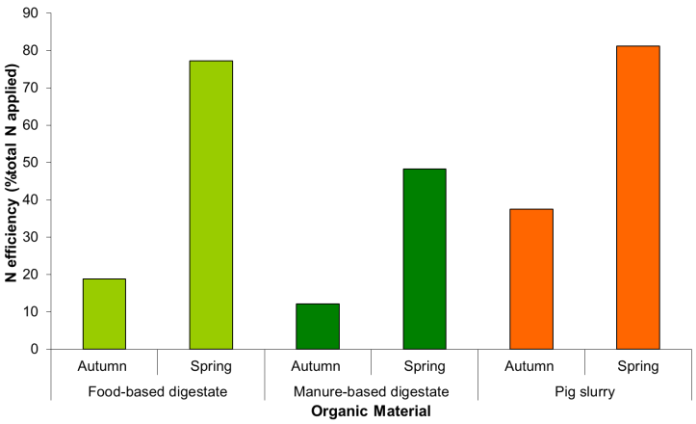

Figure 4. Wensum: N use efficiency - winter wheat 2012 (bandspread)

At ADAS Pwllpeiran (Figure 5), the grass silage crop utilised N from the applied food and manure-based digestates and cattle slurry much more efficiently in the spring, when the crop was growing actively, than from the autumn application. The higher N use efficiency from the spring applied food-based digestate, compared with the manure-based digestate and cattle slurry reflected the relative RAN contents of the different materials.

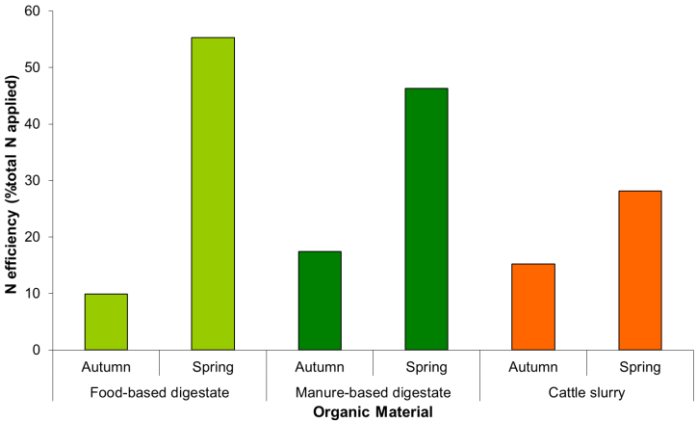

Figure 5. ADAS Pwllpeiran: N use efficiency - first cut silage 2012 (bandspread)

Good Practice

To maximise the nitrogen delivered from digestate to crops, and to reduce reliance on expensive 'bagged' fertiliser, based on the evidence gathered so far we recommend that you follow these six steps:

1. Analyse digestate at spreading to quantify the amount of readily available nitrogen (i.e. ammonium-N) it contains.
2. Use MANNER–*NPK* to predict crop available nitrogen.
3. Apply digestate when the crop is growing actively and will use the readily available nitrogen efficiently.
4. Use precision spreading equipment (e.g. a bandspreader or shallow injector) to apply the digestate for optimum crop uptake and to reduce ammonia losses (and odour nuisance).
5. Digestate must be applied in accordance with NVZ regulations (where appropriate) and the relevant Codes of Good Agricultural Practice in England, Wales and Scotland should be followed.
6. Work with AD operators to provide adequate covered storage to allow applications to be timed to match crop need and not just to avoid Nitrate Vulnerable Zone (NVZ) closed spreading periods.

MANNER-NPK

MANNER-*NPK* is a practical software tool that provides farmers and advisers with a quick estimate of crop available nitrogen, phosphate and potash supply from organic material applications. It now includes food-based digestate as an organic material type, based on data from the *DC-Agri* project.

MANNER-*NPK* can be downloaded from the PLANET website: www.planet4farmers.co.uk/manner

If you want a copy of the new CD, please email: manner.admin@adas.co.uk giving your name, address and telephone number.

Dates for your diary

Here are future opportunities to catch up with the project team:

- *30 May 2013 - IPSS/BSSS Conference held at SRUC Scotland*
- *26 June 2013 – CSF Event at Harper Adams, Newport, Shropshire*
- *tbc June 2013 – Field experiments open day East Malling Research, Maidstone, Kent*
- *2 July 2013 – National Organic Cereals Event, Green Acres Farm Shifnal, Shropshire*

If you would like details of these and future events contact: enquiries@earthcaretechnical.co.uk

Copies of this and previous bulletins can be downloaded from the project website at: www.wrap.org.uk/dc-agri

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