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Distillery by-products: getting the best from them

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Distillery by-products: getting the best from them

- Types of materials
- Key properties
- Soil conditioning benefits?
  - Organic matter (amount and type)
- Fertiliser nutrients
  - Readily available nutrients v slow release
- Fertiliser value
  - £how to calculate
  - £how to store and use for maximise financial benefits
  - How to calculate bagged fertiliser requirement when used with bulky organic fertilisers
- Challenges (odour, separation during storage, change in nutrient concentration, lack of appropriate soil/weather conditions for application)

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Two main types of distillery by-products

- ***Solids*** that can be stacked in field heaps safely
- ***Liquids*** that can be stored in tanks and lagoons, then pumped and ideally spread through a band spreader (trailing hose/trailing shoe)
- Avoid ALL products which are too thin to stack safely yet too thick to pump easily!

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Two main types of distillery by-products

- Liquids such as pot ale, whole and separated liquid digestates are (like cattle slurries) mainly water. They are ***fertilisers***, not soil conditioners.
- Fibre digestates (like strawy cattle manures and compost) are both ***fertilisers AND soil conditioners*** (due to the organic matter they contain).

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To separate or not?.....

- The real costs of using whole digestate can be high for the digestate producer:
  - Storage tanks and lagoons
  - Haulage (of a lot of water!)
  - Potential soil damage
  - Loss of nutrients when digestate applied at inappropriate times of year and in inappropriate soil conditions
- Many AD plants are considering separation into fibre and liquid fractions.

Distillery digestates – key properties

- % Dry matter
- Fertiliser nutrient content (N, P, K, Mg, S)
- % of the N which is readily available (RAN content)
- PTE content (should be low, though Cu and Zn can be high)
- Trace element content (useful or excessive concentrations of Cu and Zn, small amounts of other elements)
- Organic matter content (important only for separated solid products which can stack, e.g. fibre digestates)

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Fibre digestates (and other solids)

- Well made fibre digestates should be dry enough (20-40% DM) to stack and store safely, possibly outdoors uncovered (depends on moisture content and RAN content)
- From producers point of view:
  - reduced “land finding” panic!
  - cheaper to haul the nutrients around
- Most can be spread at any time of year and are not subject to NVZ closed periods
- Contain useful amounts of organic matter and are soil conditioners as well as fertilisers
- The best ones have potential for use in high value applications such as growing media and turf topdressings.

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Soil-conditioning Bulky Organic Fertilisers (high organic matter)

- Strawy cattle manure
- Green and food/green compost
- Biosolids (though usually applied at relatively low rate due to high P content),
- Straw
- Paper crumble
- Fibre digestate
  - important to test for organic matter content
  - Can calculate organic matter applied based on total tonnage applied (will be small amounts with high nutrient digestates……)

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Where soil organic matter content is low, adding more will:

- ✓ Improve structure and workability
- ✓ Increase water holding capacity, giving greater resilience to dry weather
- ✓ Increase water infiltration giving reduced flooding
- ✓ Increase biological activity
- ✓ Improve retention and turnover of nutrients

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Organic matter present in common BOFs?

Organic material	Dry Matter (%)	Organic matter content (%)	Application rate (t/ha) NVZ 250kg N/ha	Organic matter applied (t/ha)
Cattle FYM	25	13.1	42	5.5
Broiler litter	60	31.2	8	2.5
Green Compost	58	24.7	38	9.4
Green/Food Compost	51	19.0	22	4.2
Biosolids (lime cake)	19	13.3	10*	1.3
Crop-based fibre digestate (e.g.)	36	8.9	34	3.0
*Rate usually dependent on phosphate content rather than N content.				

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Whole and separated liquid digestates - primarily fertilisers

- Nutrient content varies depending on product used
- Some products (including most distillery by-products) are very consistent, but still advisable to obtain recent test results)
- Producers of distillery by-products, wastes and PAS 110 digestates will all be able to provide recent test results.

Key distillery by-products

Product type	% Dry matter	N (kg/FT)	% RAN	Phosphate (kg/FT)	Potash (kg/FT)	Sulphate (kg/FT)	MgO (kg/FT)
Distillery pot ale	5	2.5	4	1.8	1.1	0.2	0.3
Distillery bioplant sludge	4	2.2	9	2.1	0.5	0.4	0.3
Distillery effluent	1.5	0.6	<17	0.5	0.2	0.1	0.1
Separated solid (new)	20 – 30	10 - 15	?	5 - 10	5 - 10	?	1 - 3

Black items are mean values published in SRUC TN 650
Red items are averages taken from unpublished analytical data (Earthcare Technical Ltd.)

Some local distillery by-products

Product type	% Dry matter	N (kg/FT)	% RAN	Phosphate (kg/FT)	Potash (kg/FT)	Sulphate (kg/FT)	MgO (kg/FT)	Organic matter content
Liquid *Fairly typical dist. effluent*	1.4	0.70	12	0.90	0.1	N/A	0.15	N/A
Liquid *Very weak dist. effluent*	0.9	0.3	12	< 0.2	<0.1	N/A	0.02	N/A
Liquid *Fairly typical pot ale*	5.1	2.2	2	1.8	1.4	N/A	0.44	N/A
Liquid *thicker, more N/P rich than food-based digestate*	7.3	6.7	39	1.4	1.9	N/A	0.05	N/A
Liquid *As above*	8.4	7.8	50	4.7	2.8	1.5	1.2	N/A
Solid *Unique!*	32.4	14.7	3	10.6	9.1	N/A	2.6	Needed!

Some local distillery by-products

Product type	% Dry matter	Cu (kg/FT)	Cu applied if material applied at :		Zn (kg/FT)	Zn applied if material applied at :	
			30 t/ha	60 t/ha		30 t/ha	60 t/ha
Liquid	1.4	0.0023	0.01	0.14	0.0034	0.10	1.20
Liquid	0.9	0.0283	0.85	1.70	0.0005	0.02	0.03
Liquid	5.1	0.0023	0.07	0.14	0.0009	0.03	0.05
Liquid	7.3	0.0046	0.14	0.28	N/A	N/A	N/A
Liquid	8.4	0.0006	0.02	0.04	0.0008	0.02	0.05
Solid	32.4	0.0318	0.95	1.91	0.0109	0.33	0.65

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Nutrient availability from distillery by-products

- Availability of P ~ 50% available in year of application (remainder of P should become available over time)
- Availability of K ~ 90% available in year of application (remainder of K should become available over time)
- Availability of N is complicated and depends on a range of factors.
- % RAN in distillery by-products can be high (often well over 30%, in whole or separated digestates). This can mean that:
  - They can be excellent N fertilisers!
  - Some of the N present is readily lost through leaching and volatilisation.

Readily Available N i.e. Ammonium-N, Nitrate-N, (Uric-N for poultry manures) by analysis - is *potentially* available for rapid crop uptake

Organic N is broken down slowly to become available over months or years

Crop Available N is the readily available N left for crop uptake after losses are taken into account

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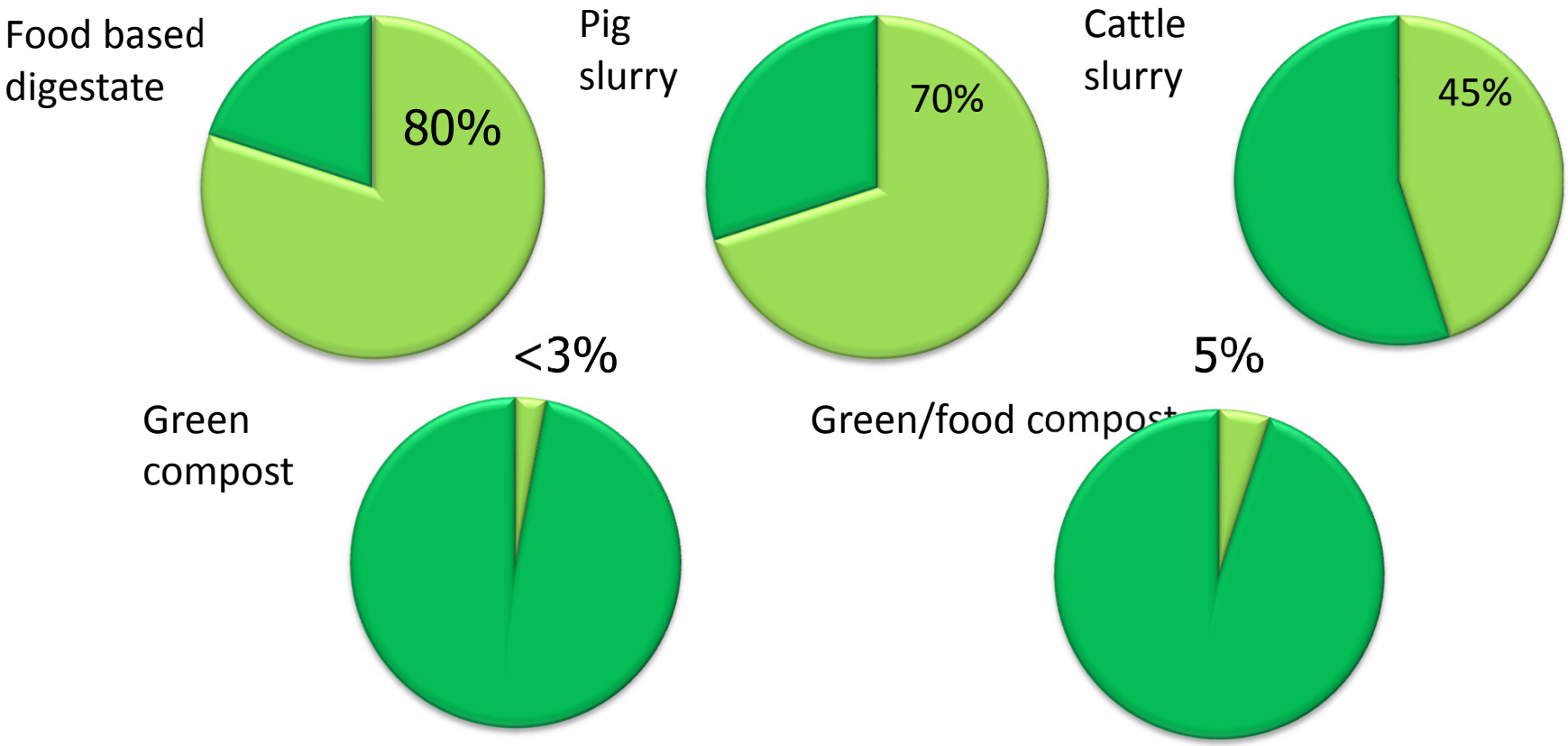
Management of high RAN organic materials

Must be aware of the % RAN in bulky organic materials, to:

- stay within law (closed periods must be observed in NVZs);
- allow optimal planning when using high RAN materials to:
  - maximise N use efficiency
  - maximise financial benefits from using the materials
  - minimise (aim to eliminate) environmental damage.



High readily available N >30% total N (NVZs)

Readily available N (RAN) content of food-based digestate based on 250 kg N/ha

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True value of digestate (and other high RAN materials) will depend on:

1. Crop you apply it to and how the crop uses the nutrients
2. When you apply (spring or autumn)
3. Soil type you apply it to (and the soil depth in some cases)
4. How you apply it (e.g. surface, dribble bar, shallow injection) and whether it is ploughed down straight away.
5. Weather and soil conditions at spreading.

There are still some instances in Scottish farming where the great majority of the N applied in digestates is being lost.....

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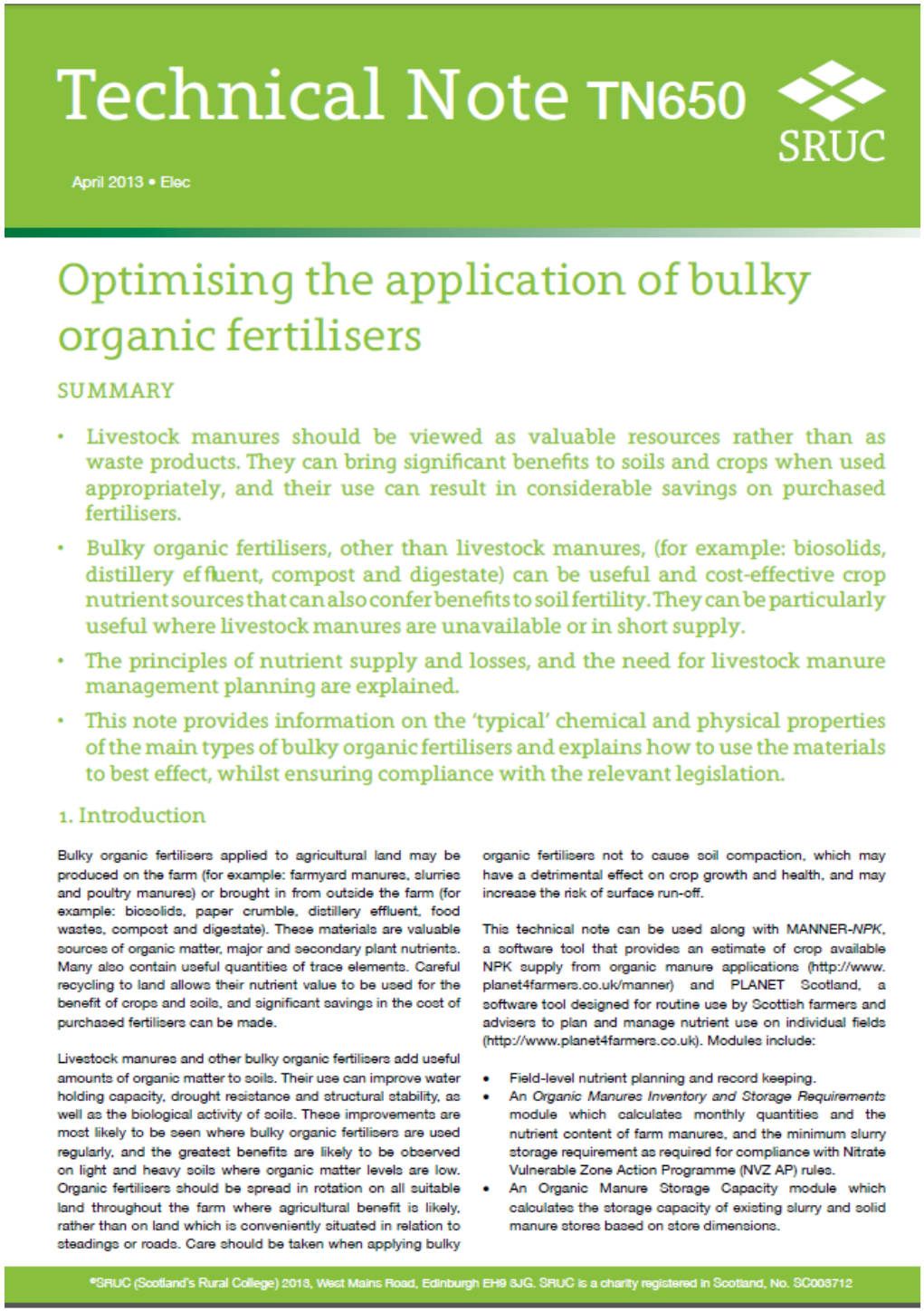
Need to calculate the crop-available N

- Location
- Rainfall
- Soil type, soil depth and drainage
- Timing of application (spring or autumn)
- Method of application (surface, dribble bar, injection and whether p loughed down
- Use MANNER NPK www.planet4farmers.co.uk/manner to calculate crop-available N.
- MUST comply with PEPFAA, Four Point Plan, CAR Regulations and the SEPA Position Statement “Regulation of outputs from Anaerobic Digestion Processes”.

Or if you prefer a more traditional method..... Use SRUC TN 650



Technical Note TN650

SRUC

April 2013 • Elec

Optimising the application of bulky organic fertilisers

SUMMARY

- Livestock manures should be viewed as valuable resources rather than as waste products. They can bring significant benefits to soils and crops when used appropriately, and their use can result in considerable savings on purchased fertilisers.
- Bulky organic fertilisers, other than livestock manures, (for example: biosolids, distillery effluent, compost and digestate) can be useful and cost-effective crop nutrient sources that can also confer benefits to soil fertility. They can be particularly useful where livestock manures are unavailable or in short supply.
- The principles of nutrient supply and losses, and the need for livestock manure management planning are explained.
- This note provides information on the 'typical' chemical and physical properties of the main types of bulky organic fertilisers and explains how to use the materials to best effect, whilst ensuring compliance with the relevant legislation.

1. Introduction

Bulky organic fertilisers applied to agricultural land may be produced on the farm (for example: farmyard manures, slurries and poultry manures) or brought in from outside the farm (for example: biosolids, paper crumble, distillery effluent, food wastes, compost and digestate). These materials are valuable sources of organic matter, major and secondary plant nutrients. Many also contain useful quantities of trace elements. Careful recycling to land allows their nutrient value to be used for the benefit of crops and soils, and significant savings in the cost of purchased fertilisers can be made.

Livestock manures and other bulky organic fertilisers add useful amounts of organic matter to soils. Their use can improve water holding capacity, drought resistance and structural stability, as well as the biological activity of soils. These improvements are most likely to be seen where bulky organic fertilisers are used regularly, and the greatest benefits are likely to be observed on light and heavy soils where organic matter levels are low. Organic fertilisers should be spread in rotation on all suitable land throughout the farm where agricultural benefit is likely, rather than on land which is conveniently situated in relation to steadings or roads. Care should be taken when applying bulky organic fertilisers not to cause soil compaction, which may have a detrimental effect on crop growth and health, and may increase the risk of surface run-off.

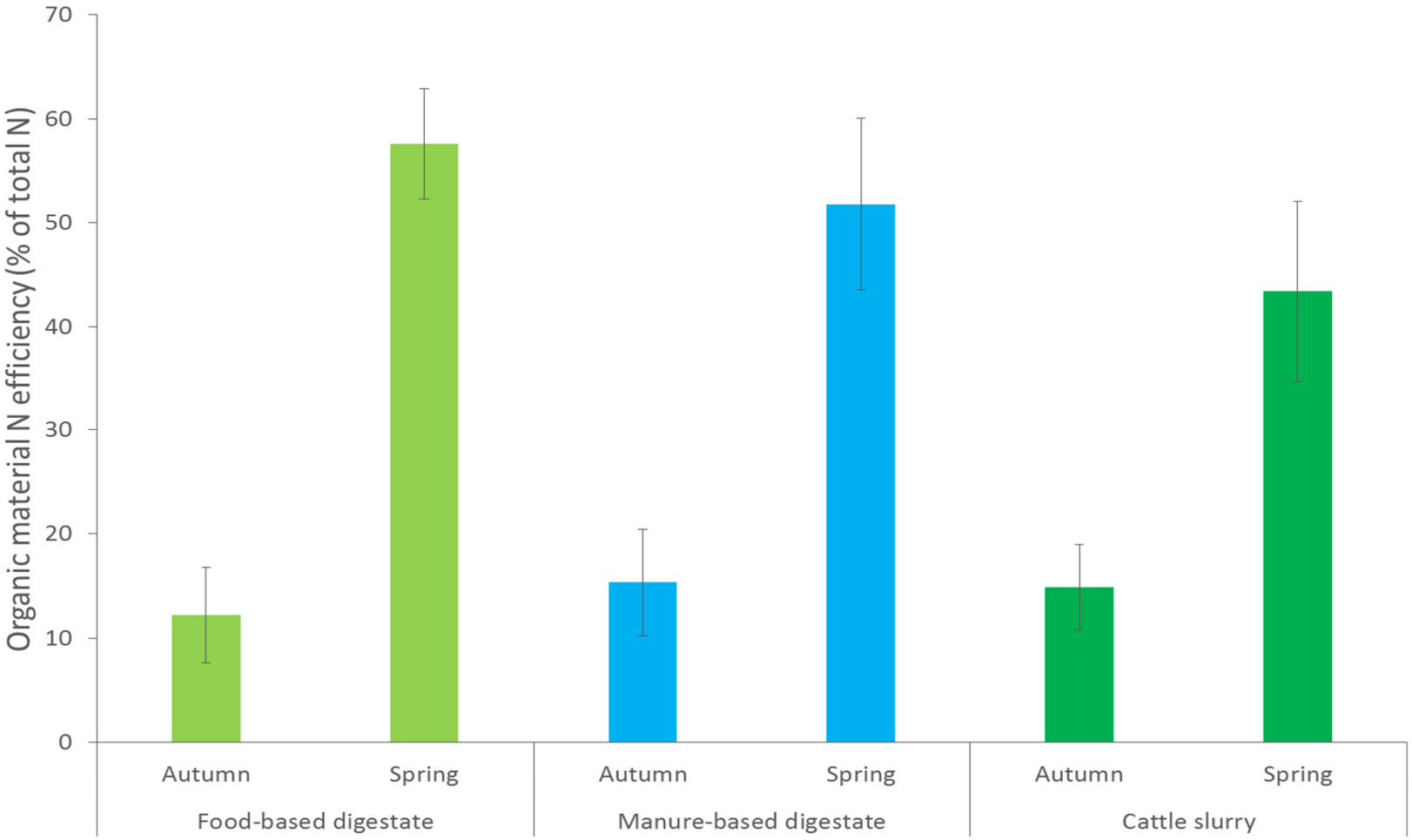
This technical note can be used along with MANNER-*NPK*, a software tool that provides an estimate of crop available NPK supply from organic manure applications (http://www.planet4farmers.co.uk/manner) and PLANET Scotland, a software tool designed for routine use by Scottish farmers and advisers to plan and manage nutrient use on individual fields (http://www.planet4farmers.co.uk). Modules include:

- Field-level nutrient planning and record keeping.
- An *Organic Manures Inventory and Storage Requirements* module which calculates monthly quantities and the nutrient content of farm manures, and the minimum slurry storage requirement as required for compliance with Nitrate Vulnerable Zone Action Programme (NVZ AP) rules.
- An Organic Manure Storage Capacity module which calculates the storage capacity of existing slurry and solid manure stores based on store dimensions.

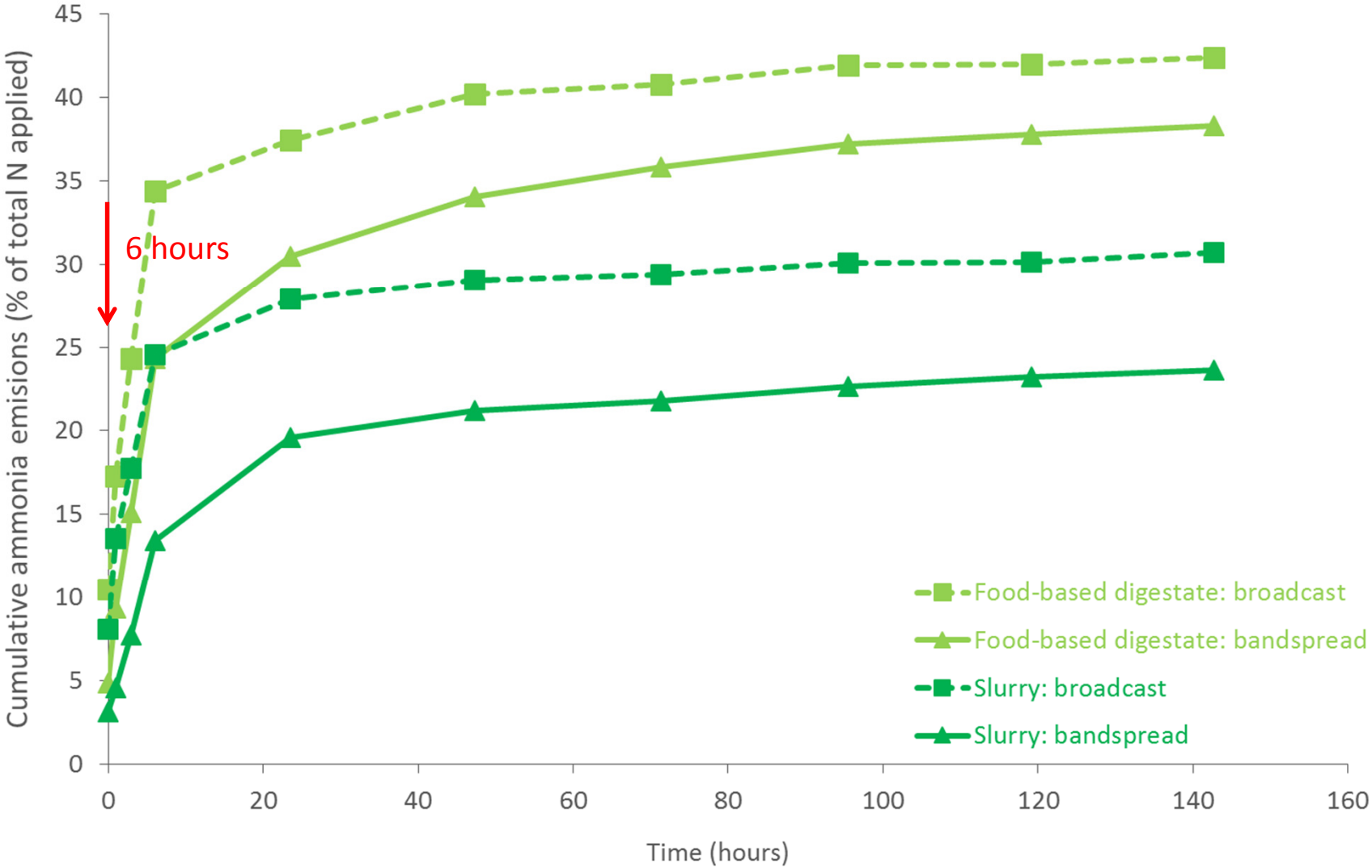
Field experiments for quality digestate and compost in agriculture 2010-2015

DC-*Agri*

WP2.1 – Overall cross-site N use efficiency



WP2.2. – Cross-site ammonia emission curve

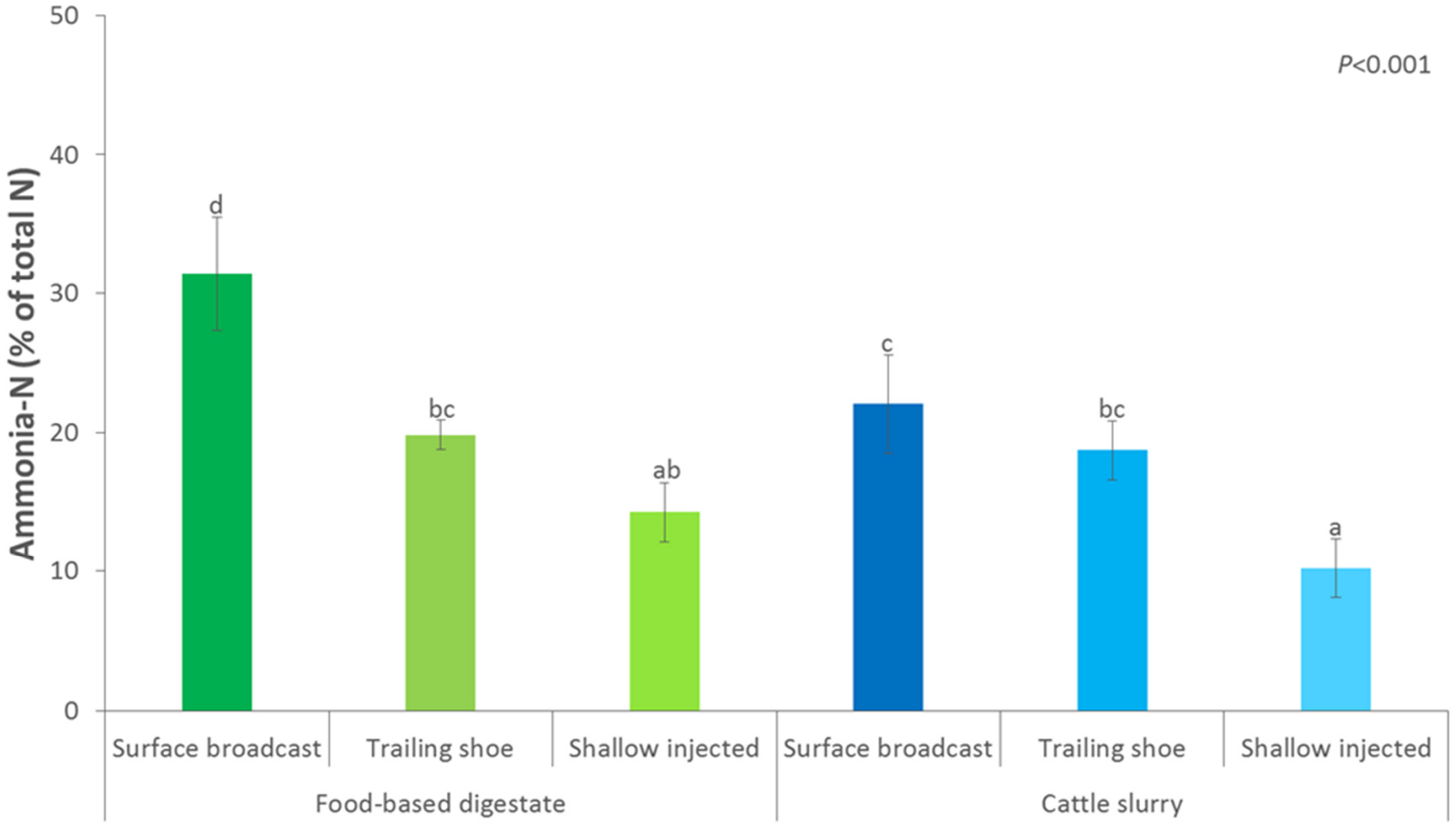


Broadcast application

Bandspread application (trailing shoe)

Shallow injection application

WP2.3 – Cross site ammonia emissions



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Application rates

- Typically apply no more than 50% of crop N requirement from organic materials.
- Some farmers with their own AD plants are applying more than that to some crops (mainly grass).
- Restricted to no more than 250 kg N/ha from organic materials in NVZs
- Typically apply ***up to*** 50 m^3/ha of liquids in a split application (certainly not > 50 m^3/ha in one application and much better with lower rate applications).
- Application rates for solids depends on the material in question.

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Nutrient content and value – distillery by-products

Major Nutrients	Total	Readily available	Potential value £/t
Whole distillery digestate (example 1) (£3.68/m^3)			
Nitrogen (N kg/t)	6.7	3.4 (50%)	£2.52 (Crop available N)
Phosphate (P_2O_5 kg/t)	1.4	0.7 (50%)	£0.41 (total P_2O_5)
Potash (K_2O kg/t)	1.9	1.7 (90%)	£0.75 (total K_2O)
Whole distillery digestate (example 2) (£5.41/m^3)			
Nitrogen (N kg/t)	7.8	3.9 (50%)	£2.89 (Crop available N)
Phosphate (P_2O_5 kg/t)	4.7	2.4 (50%)	£1.42 (total P_2O_5)
Potash (K_2O kg/t)	2.8	2.5 (90%)	£1.10 (total K_2O)
Pot ale (based on SAC TN 650 average nutrient content (£2.08/m^3)			
Nitrogen (N kg/t)	2.5	1.5 (50%)	£1.11 (Crop available N)
Phosphate (P_2O_5 kg/t)	1.8	0.9 (50%)	£0.53 (total P_2O_5)
Potash (K_2O kg/t)	1.1	1.0 (90%)	£0.44 (total K_2O)
Based on fertiliser prices: N 74p/kg; phosphate 59p/kg; potash 44p/kg			

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When deciding on charges, waste producer must understand that the farmer has to:

- Pay fuel, staff and machinery costs associated with applying the materials and must take some degree of risk associated with potential N losses due to weather conditions after spreading.
- Comply with a raft of legislation, guidance and rules associated with handling and applying organic materials (particularly high RAN liquids) to land, e.g.
    - NVZ rules, CAR regulations, Waste Management Licensing rules, PEPFAA code, farm assurance scheme rules

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When deciding whether to accept distillery by-products on farm, farmer must:

- Consider whether the use of distillery by-products is acceptable to his assurance schemes and produce buyers.
- Consider whether he has appropriate storage and application equipment to allow environmentally safe and beneficial use.
- Understand (do not over or underestimate) the fertiliser benefits which distillery by-products can bring.
- Understand that distilleries have by-products to find a home for all year round – consider developing special relationships to offer storage on-farm, but never be prepared to spread when conditions are not suitable.

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Example fertiliser calculation – whole digestate
(soil nutrient indices low, digestate spread in spring, dribble bar)

Major Nutrients	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Saving on fertiliser costs (£)
Winter wheat (8 t/ha) crop requirement (kg/ha)	220	70	120	
Total nutrients supplied by 1 x 32 m^3 digestate/ha (kg/ha)	250	150	90	
Percentage available in year 1	50	50	90	
Available nutrients supplied by 1 x 32 m^3 digestate/ha (kg/ha)	125	75	81	
Bagged fertiliser needed (kg/ha)	95	0	39	
Total saving (year 1) Nutrients for following crops	£92.50	£44.25 £44.25	£35.64 £3.96	£172.39 £48.21

Based on a digestate containing 7.8 kg N, 4.7 kg phosphate and 2.8 kg potash/m^3.
Based on fertiliser prices: N 74p/kg; phosphate 59p/kg; potash 44p/kg

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Very important to obtain test results on the by-products that you use

- Don’t just guess!
- Only if you test can you be sure you are getting crop fertiliser applications right and are not over or under applying fertiliser.
- Distilleries should always provide a recent analysis on request.

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Test parameters

- Dry matter content (how easy/cheap is it to pump/transport/spread/store)
- Total nutrients (N, P, K, Mg, S)
- Ammonium and nitrate-N
- PTEs (to check that you are happy with concentrations)
- Additional trace elements if wished (e.g. B, Mn)

- Worth testing for organic matter content in solid products
- In a few cases you might also test for Na and eC

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Conclusions

- Distillery by-products (whether technically wastes or PAS 110 products) are often excellent fertilisers.
- The liquids can sometimes contain a high percentage of RAN and must be stored and applied with great care.
- The solid by-products can be good soil conditioners too.
- Obtain recent test results for materials you are considering in order to determine £value and to allow you to decide how and when best to use them in your cropping plan.
- Consider potential soil damage associated with applying large volumes of heavy, low-nutrient materials and only apply those which you feel offer value for money for your farm.
- If in doubt about any aspect of the use of distillery by-products, seek advice (use FACTS-qualified specialist in organic materials).

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THANKYOU!

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