7th February 2023 YEN Zero Discussion Workshop - Summary

Dear YEN Zero members,

We recently held the second of three discussion workshops as part of the second year of the YEN Zero network. This workshop was open to all YEN Zero participants and sponsors and was on the topic of *What is the role of organic materials in reaching net zero agriculture?* The virtual event was hosted on the online conference platform Remo to enable better interactivity between attendees.

The aim of the workshop was to discuss the role of organic materials in reaching net zero agriculture. Specifically, how organic materials could be used effectively to reduce emissions while providing wider benefits to crop production systems. We heard from two expert speakers from ADAS: Kate Smith, a Soil Scientist from the ADAS Soils Team, who summarised how to make the most of manures and the importance of knowing the nutrients available in the material; and Christina Baxter, Senior Crop Physiologist at ADAS, who discussed manure application types and their influence on greenhouse gas (GHG) emissions. We also had a presentation from arable farmer Will Oliver, who provided a grower's perspective of smart manure management. The full agenda for the event can be found below with the main takeaway messages from each section.

YEN ZERO DISCUSSION WORKSHOP AGENDA: 09.00-11.00 am 7th February

9.05-9.15	Introduction – **Toby Townsend, ADAS**
9.15-9.35	Value of manures for crop nutrition and soil organic matter – **Kate Smith, ADAS**
9.35-9.45	Manure application types and influence on GHG emissions – **Christina Baxter, ADAS**
9.45-9.55	Grower perspective of smart manure management – **Will Oliver, Arable Farmer**
9.55-10.00	Q&A – **All**
10.00-10.05	Introduction of breakout session – **Pete Berry, ADAS**
10.05-10.30	Discussion around the use of organic materials in arable systems – **Table facilitators**
10.30-10.45	Summary of breakout session – **Pete Berry, ADAS**
10.45-11.00	Meeting close, opportunity to network on tables – **Toby Townsend, ADAS**

Take home messages

- **To maximise returns it is important to determine application rates of organic materials on crop nutrient requirements.**
- **Use of organic materials will improve soil organic matter (SOM) and soil fertility for future crops in rotation, but not all materials are the same.**
- **Application of manures must be chosen with consideration to reduce ammonia volatilisation and maximize nutrients reaching the crop.**
- **Know the nutrient content of your manures**
  - **To balance inputs from bagged fertilisers**
  - **To allow accurate calculation of emissions**

Value of manures for crop nutrition and soil organic matter

Kate Smith, Senior Soil Scientist, ADAS

Organic materials are a valuable source of nutrients:

Manure type	Application rate (t/ha)	Crop available nitrogen* (kg/ha)	Total phosphate (kg/ha)	Total potash (kg/ha)	Value (£/ha)**
Pig FYM*	30	21	180	240	572
Cattle slurry*	35	36	42	88	231
Poultry* manure	8	90	136	168	568
Whole* digestate	25	83	28	60	275
Mushroom* compost	30	33	108	264	513

* Assumes spring application incorporated within 24 hours or bandspread
** Assumes N = £2.03/kg; P_2O_5 = £1.51/kg and K_2O = £1.07/kg

The key steps in making the most of manure nutrients include:

- Know the nutrient content
- Minimise nitrogen losses
- Estimate crop available nitrogen supply in the material
- Spread accurately and evenly
- Build into farm nutrient management plan

There are also many factors affecting manure nutrient content that need to be considered such as livestock type, diet, bedding type and quantity, water use and manure/slurry storage.

Ammonia volatilisation can be a significant nitrogen loss pathway. Minimise losses from manure applications by using precision application kit for liquid manures and/or incorporating solid manures (applied to bare land).

Organic materials can improve soil organic matter. The benefits of organic matter include:

- Improved soil structure and workability
- Increased water holding capacity and infiltration
- Increased biological activity
- Improved retention and turnover of nutrients
- Greater resilience to dry weather conditions

Organic matter sources are shown below.

Organic material	Dry matter	Application rate (t/ha) NVZ 250 kg N/ha	Organic matter (t/ha)
Cattle FYM	25%	42	5.5
Broiler litter	60%	8	2.5
Green compost	60%	33	4.5
Green/Food Compost	60%	22	5.0
Digested cake	25%	20	3.5

Manure application types and influence on GHG emissions

Christina Baxter, Senior Crop Physiologist, ADAS

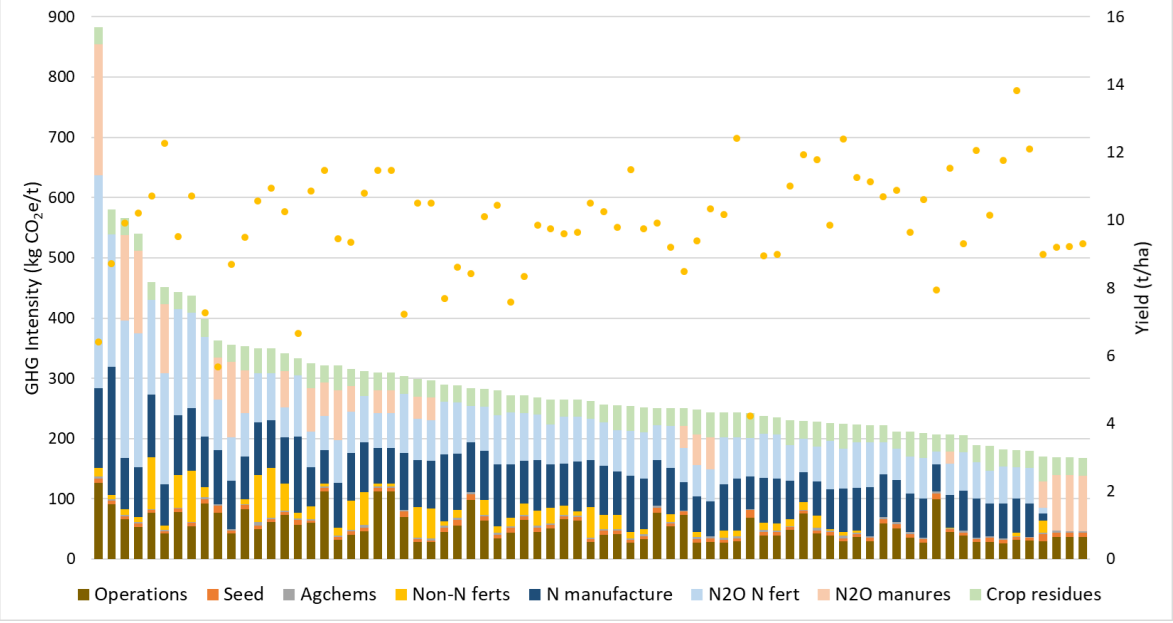
Christina gave an overview of how carbon calculators account for the GHG emissions from organic materials.

YEN Zero calculates GHG emissions using the UK GHG Inventory approach. Emissions considered include:

- **Direct N_2O emissions following application**
  - Influenced by total N content and emission factor associated with material type
- **Indirect N_2O emissions from volatilisation**
  - Influenced by Total Ammoniacal-N (TAN) content and emission factor associated with material type
- **Indirect N_2O emissions from leaching**
  - Assumed to be the same for all organic materials and synthetic N fertiliser.

In the first year of YEN Zero, there were a total of 274 field entries with 78 entries using organic materials (27% of total entries). YEN Zero entries with the highest crop C footprints were associated with use of organic materials (shown by the light orange bar in the below chart). However, the entries with the lowest crop C footprints also used manures. The difference between these entries is the use of synthetic N fertiliser in addition to organic materials.

Organic materials can be responsbile for large GHG emissions due to only a proportion of the N applied being available to the crop. To ensure use of organic materials is associated with low crop C footprints requires balancing organic materials with bagged fertiliser. This will reduce both application and manufacture emissions of synthetic fertilisers. Application method can help to reduce GHG emissions associated with organic materials; methods that quickly incorporate organic materials into the soil reduce the volatilisation losses of N as ammonia (an indirect source of GHG emissions).



Graph showing GHG intensity (kg CO_2e/t) of YEN Zero winter wheat feed crop entries, segregated into the main crop management strategies responsible for emissions, in 2021-22. Yellow dots show yield achieved by these entries.

Grower perspective of smart manure management

Will Oliver, Arable Farmer

Will is an arable and poultry farmer in Leicestershire who provided a case study on how he has used organic manures on his farm to boost production and profitability. To be as efficient as possible with organic manures, he says it is vital that you:

- Know your manures – what is the nutrient content and how does that relate to bagged nutrients?
- Know your soils – what nutrients are already available?
- Know your crop requirements – how much nutrient does the crop require and how can the right amount be supplied from the soil, from bagged nutrients and from organic manures?

Improving efficiency can come from diversification, such as from growing spring crops to broaden the window for manure application, or working with neighbours e.g., growing cover crops for a neighbour's livestock to graze to improve field organic matter content.

Continuous learning is important: use the resources available e.g., RB209, MANNER-NPK; be aware of the rules and regulations; seeking expert advice and getting a second opinion can help you to use organic manures effectively; monitor performance and adapt the approach to better suit your farm.

Breakout session: How can growers be supported in smart use of manures?

Pete Berry, Head of Crop Physiology, ADAS

The attendees of the workshop took part in a breakout session to discuss ways in which growers use or could potentially use organic manures. In this session attendees were asked to discuss three questions. Some of the responses and discussion related to these questions are provided below. The discussion around this topic is continuing online at FarmPep; do get involved if you have further comments or questions.

1. How to measure the wider benefits of using organic materials?

- The benefits to the wider supply chain need to be considered – creating a circular economy whereby waste products are used, and organic materials are recirculated back onto the farm.
- Prescription fertilisers can help balance inputs to close gap between organic material nutrient input.
- Using grain nutrient analysis can show benefits of nutrients applied from organic materials to grain quality.
- There is good recognition of the value of organic materials given fertiliser prices. However, it can be difficult to achieve crop available nutrient values quoted in RB209.
- Capturing the impacts on *soil health* is important. However, it is important to recognise there are a lot of parameters this could include (e.g., SOM, C content, N mineralisation potential). To assess the benefit through soil health an initial baseline value should be established to start with. This would also require assessment over many years to see the long-term effects. In addition, it would be beneficial to link financial value to the soil quality benefits of organic materials, i.e. impacts on crop and reduction in other inputs (e.g., water use).

2. How to enhance the value of manures?

- Use new technologies to increase crop available N e.g., N2 applied, and remove P and K from the organic materials so it can be applied to land that already has high P and K soil indices.
- Use additives to increase availability of nutrients and reduce volatilisation.
- Test manures for nutrient contents.
- Look at soil results and place manure where it's needed across the farm.
- Reduce bagged P & K fertiliser use across rotation.
- More support for measuring soil organic carbon and organic matter changes in soil

- Judge benefits over whole rotation (e.g., allocate emissions from organic manures across whole rotation rather than just the crop in the year in which it is applied).
- Think carefully about which crops manure is applied to, to make sure they have greatest benefit.
- Compost organic material and manures to get a better balance of immediately available N and C. One grower uses a product called Actitherm to aid composting process.

One grower felt conflicted by messages communicated around the use of organic materials. It is difficult to balance reducing ammonia emissions, through soil incorporation by discing, with the additional activity using more fuel and disturbing the soil, increasing GHG emissions. Therefore, is it best not to incorporate? Careful measuring on this one is required as it's important to incorporate solid manures where possible (i.e., not on growing crop or grassland) to reduce ammonia emissions.

3. What technologies do we need to allow application of manures to autumn sown crops in the spring?

- Preferential use of some organic materials for spring application rather than autumn application. Digestate and poultry manure are easier to apply in spring, compared to bulky materials.
- Disc spreader with information on how much is being applied is a useful technology for spring applications.
- Determine how crop is responding to manure applied. Knowing this will allow better balance of bagged fertiliser.
- Spring application on autumn sown crops can cause compaction problems, which would have negative impacts on crop and soils and cause pollution (run-off & loss of nutrients). Reducing compaction risks will be important. Soil sensors or moisture probes could be used to help decide whether it was possible to travel.
- Most muck spreading equipment is less than standard tramline widths of 24 to 36 m. Farmers don't want to spread muck into standing crop if it means adding extra tramlines.
- For liquids, it was suggested that some injector kit was available that can fit tramline width, but expensive and not easily available.
- No one season is the same, the fact that it is not possible to guarantee conditions are right for spring applications makes planning difficult.
- For liquids Umbilical cords damage crops, so would need to look at using irrigation equipment (but this is expensive) and unlikely to be practical dependent on dry matter content of material.
- Increase in slurry storage capacity. Support to invest in this storage is important.
- One grower commented solid manures potentially damages tall crops, so likely to apply early in spring when soils are wet.
- Benefits of applying muck before maize often seen in the following wheat crop.

Wider Questions from the workshop

Below are some questions that were asked during the presentation that have been answered by Kate Smith, Senior Soil Scientist at ADAS.

With recent SFI announcements, IPM, NMP and SMP is going to be very topical. Isn't there an opportunity here to make sure farmers can improve their businesses by making it relatable, rather than a box-ticking exercise?

Agree with this comment. I guess with time it will be interesting to hear how YEN farmers are getting on with SFI and look at what YEN can do to support this.

What is the most carbon friendly method for increasing soil organic matter, taking into account all operations and inputs used?

I think the recommendation for any particular farm would be to use what is available on farm and failing that what is available locally. Target soils dependent upon crop nutrient requirements so that inputs of bagged fertilisers can be reduced & soil nutrients are not applied in excess of crop or rotation (P & K) requirement. For liquid manures, if it's possible to separate liquid from solid. The liquid can be applied close to the farm (therefore reduce fuel use if tanking further away) and the lighter solid material can be transported further away to target soils with a P & K requirement. There was an interesting discussion about moving away from muck for straw contracts, given the expense of importing feed. So it sounds like wider market pressures are also changing how farmers choose to get hold of organic matter.

What are the differences in nutrient availability under different incorporation strategies?

The biggest impact is on nitrogen, and if we focus on ammonia, as this is where the most N can be lost, it also depends on what you're applying solid or liquid. In terms of ammonia, the aim is to get the material into the soil to reduce the ammonia emitting surface. So, for solids discing the soil is effective, I don't have information on different methods. However, the most important thing is timing of incorporation. Typically, 80% of ammonia Is lost within the first 24 hours and the quicker the material is incorporated the bigger the mitigation effect, so incorporate as quickly as is practical. However, if it has rained after application, you may be best delaying a bit so as not to cause issues with compaction and runoff etc. This is why with spring applications of solid manures to autumn sown crops there is a risk of increased ammonia emissions; but will be dependent upon soil and weather conditions.

For incorporation of liquids, injection is effective at reducing ammonia emissions (slide shows 70% reduction), but mitigation can vary by depth of injection. For P responsive crops like maize, if band spread and placed along the crop row, you could argue that placing liquid organic material will allow better contact with P and reduce need for a starter fertiliser; this is something that a farmer in Norfolk tried.

Future Discussion Workshops

Our next discussion workshop will take place alongside the results meeting in April 2023, date TBC. Get in touch if you have suggestions for a particular topic you would like to see covered in this session.

We would like to acknowledge our YEN Zero Sponsors for making the setting up of this network possible and to all those who contributed to this YEN Zero discussion workshop.

Any questions or comments please get in touch: yenzero@adas.co.uk