3rd YEN Zero Discussion Workshop - Summary

Dear YEN Zero members,

Last week we held a YEN Zero discussion workshop, the last of the three workshops to take place in our pilot year. We had a great attendance of over 40 members encompassing our Sponsors, Growers, and their Supporters. The virtual event was hosted on the online conference platform Remo to enable better interactivity between attendees.

The focus of the workshop was mitigation strategies which can be introduced on farm to reduce crop C footprints, and to facilitate discussion between Growers and Supporters. 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, 5th April 2022

1.	Join the Remo platform and sit on a virtual table with your Sponsor, ***All***
2.	Introduction, ***Toby Townsend - ADAS***
3.	"What if" scenario analysis of the YEN Zero results, ***Christina Baxter – ADAS***
4.	Growers' results and introducing mitigation strategies on farm, ***YZ participants***
5.	GHG mitigation opportunities, ***Sarah Wynn - ADAS***
6.	Introduction to the breakout session, ***Toby Townsend - ADAS***
7.	Breakout session, ***All***
8.	Summary and distillation of breakout session, ***Table facilitators***
9.	YEN Zero – The Future, ***Daniel Kindred – ADAS***
10.	Meeting close, opportunity to network on tables, ***Toby Townsend - ADAS***

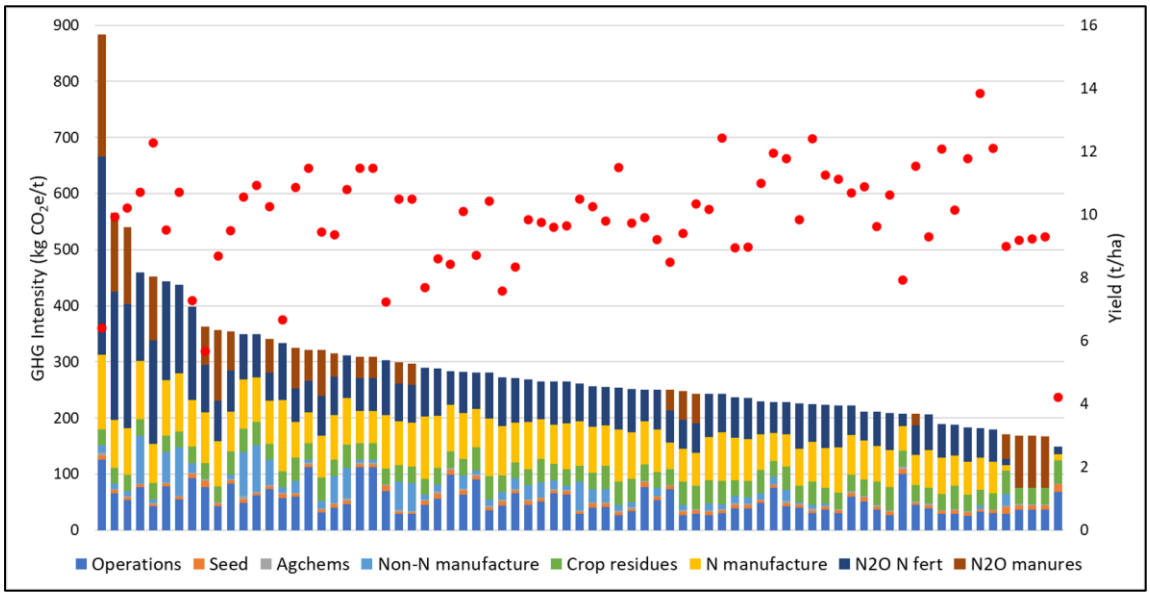
Take home messages

- **Overall, 40 Growers, sponsors and supporters joined the final YEN Zero discussion workshop where we focussed on mitigation strategies to reduce crop C footprints**
- **An analysis of the YEN Zero dataset indicated that if multiple low GHG emitting crop production strategies are introduced on farm, the total crop C footprint can be reduced by 41%**
- **YEN Zero growers presented ideas on achieving smart manure management and introducing agroforestry into their production systems**
- **In the near future, technologies such as carbon neutral fertiliser production, decarbonised fuel, and technologies to sequester and store carbon, will be available on the market**
- **Growers used the first year of YEN Zero to provide a baseline of their crop C footprints and will now work towards introducing strategies to reduce these footprints**
- **Plans for YEN Zero 2022 will be discussed with the network's sponsors in May with YEN Zero opening fully this summer**

"What if" scenario analysis of YEN Zero Results

Christina Baxter, Crop Research Consultant, ADAS

At the start of the meeting, Christina presented an analysis of the YEN Zero pilot year dataset to help quantify the impact of changes in on-farm management strategies on the crop C footprint. The focus of the analyses was on the winter wheat (feed) dataset as this crop category had the largest number of entries (76 entries from the 274 crops entered into the network). Christina presented the GHG intensities of these wheat crops (C footprint on a per tonne of output basis), which demonstrates the range in crop GHG emissions within the network. This range indicates that there is scope to reduce GHG intensities of our crops, as several growers are already producing crops with good yields (>9 t/ha) and low C footprints.



GHG intensities of YEN Zero winter wheat (feed) crops from pilot year.

The average emissions within this dataset attributed to different crop production strategies were presented and the percentage increase or decrease in the C footprint was calculated (using the average C footprint of YEN Zero winter wheat crops of 2,742 kg CO_2e/ha as a baseline) to show how moving from one strategy to another impacts the C footprint. This analysis focused on the following management strategies:

- Cultivations
    - The cultivation strategies from high to low emissions were Ploughing>Deep non-inversion>Minimum shallow tillage>Strip tillage>Direct drill. Emissions associated with cultivations ranged from 266 kg CO_2e/ha for ploughing down to 33 kg CO_2e/ha for direct drill. Moving from ploughing to deep non-inversion can reduce the total crop C footprint by 6% and moving from ploughing to direct drill can reduce the total crop C footprint by 9%.
- Grain drying
    - The grain drying requirement in the dataset ranged from 0-7%, with 27% of winter wheat (feed) entrants not requiring grain drying, 28% requiring 1% grain drying, 20% requiring 3% grain drying and 7% requiring 6% grain drying
    - Emissions associated with grain drying increase from 105 kg CO_2e/ha for 1% grain drying to 655 kg CO_2e/ha for 6% grain drying
    - The percentage increase in the crop C footprint from 0 to 1% grain drying requirement is 4%, this increases to 24% for a 6% grain drying requirement. Consequently, a high grain drying requirement can have a significant impact on the C footprint, when using a diesel powered dryer

- Fertiliser manufacture
    - The bottom 1/3 of YEN Zero winter wheat entries (those with the highest GHG intensities) applied on average 212 kg/ha of nitrogen fertiliser, whereas the top 1/3 (those with the lowest GHG intensities) applied an average of 165 kg N/ha
    - By reducing the nitrogen fertiliser application rate from this higher rate of 212 kg N/ha to 165 kg N/ha reduces the total C footprint by 9%, attributed to the reduced manufacture emissions
- Nitrification and urease inhibitors
    - Nitrification inhibitors reduce the direct N_2O emissions from nitrogen fertiliser application by 44%. Use of a nitrification inhibitor (assuming an average application rate of 198 kg N/ha from the winter wheat dataset) can reduce the total C footprint by 10% when used with ammonium nitrate and 6% for UAN and urea
    - Urease inhibitors reduce the ammonia volatilisation from UAN and urea application and consequently the indirect N_2O emissions from volatilisation by 70% for urea and 44% for UAN. Use of a urease inhibitor (assuming an average application rate of 198 kg N/ha from the winter wheat dataset) can reduce the total C footprint by 3% when used with urea and 1% for UAN

When the lower GHG emitting management strategies from this analysis are combined in one production system, the collective effect on the C footprint is significant, reducing the total C footprint by 41%. This demonstrates that large gains can be made in reducing crop C footprints if the right strategies are introduced on farm.

Combined influences

YEN Zero winter wheat (feed) crops, average yield 9.9 t/ha

Cultivation strategy	Plough based	Direct drill
Grain drying requirement	6%	0%
N form	Urea	Urea
N rate (kg N/ha)	212	165
P rate (kg N/ha)	160	101
K rate (kg N/ha)	109	87
Nitrification inhibitor	No	Yes
Urease inhibitor	No	Yes
Total C footprint/ha	**2,965**	**1,756**
Total C footprint/t	**300**	**177**

C footprint reduction of 41%

Growers' results and introducing mitigation strategies on farm

Two growers from the YEN Zero pilot year spoke about the specific mitigation strategies they are introducing on-farm to reduce their crop C footprints and ensure their farming systems are more sustainable.

YEN Zero Participants, Charlie Steer and Glenn Buckingham

Charlie Steer – Smart manure management

Charlie manages the arable enterprise at Grosvenor Farms which has 2000 ha in total, with 460 ha of this producing combinable crops. Grosvenor Farms has a large dairy unit meaning the farming system has a lot of organic material to manage. Charlie entered three winter wheat crops into YEN Zero, which

were fertilised with manures and had no synthetic fertiliser inputs. Despite organic material being associated with high GHG emissions, these crops achieved an average GHG intensity of 168 kg CO_2e/t, yielding an average of 9.2 t/ha. Several different strategies and technologies are being used/have been introduced on-farm to obtain smart manure management, which include:

- Manure separation technology in the dairy unit which separates the liquid and solid fractions of the manure
- Investing in a range of manure application technologies which are calibrated using a form of tray testing to ensure the correct amount is applied
    - 24 m dribble bar allows large area to be treated and reduces ammonia losses
- Manure is variably applied based on the crop's GAI
- Grosvenor may introduce N_2 Applied technology on farm which uses a plasma unit to strip nitrogen from the air and places this into the manure to produce nitrogen-enriched organic fertiliser, this can double the plant available nitrogen content of the slurry and reduce the ammonia emissions
- Additionally, Grosvenor are looking into introducing an AD plant to reduce emissions associated with manure and increase the nitrogen availability

Charlie also talked about the need to better understand the weather influences on the nitrogen availability to the crop on manure application. The farming system also need to consider exporting their P and K as in the long term their soil indices will be too high.

Glenn Buckingham – Agroforestry

Glenn farms in Framsden, Suffolk and has recently introduced agroforestry into his farming system, with the long-term aim of improving the sustainability of the production system for future generations. The many benefits of agroforestry Glenn discussed include:

- Improving nutrient availability for the crop by drawing nutrients up from the subsoil
- Shading from the trees can mitigate high temperatures, both for crops and livestock, particularly relevant with concerns for increasing temperatures with climate change
- Improvements in biodiversity, drainage, and air quality

Glenn recently planted a range of tree species, including oak, maple, and sweet chestnut, in 46 m wide alleys on one of the farm's arable fields, with the help of local volunteers and part funding from the Woodland Trust. This width fits the farm's system of a 42 m sprayer width. Acorns from the same field were used to grow the oak trees to ensure native species were used. It is planned in the near future that this agroforestry system will be expanded to more fields across the farm and the soil nutrient indices and organic matter profiles have been baselined to monitor improvements in soil health as the trees and farming system mature.

GHG mitigation opportunities

Sarah Wynn, Managing Director Climate and Sustainability, ADAS

Before the breakout sessions, Sarah discussed potential mitigation strategies that are currently being developed and will be used in the near future to help growers reduce crop C footprints. These strategies included:

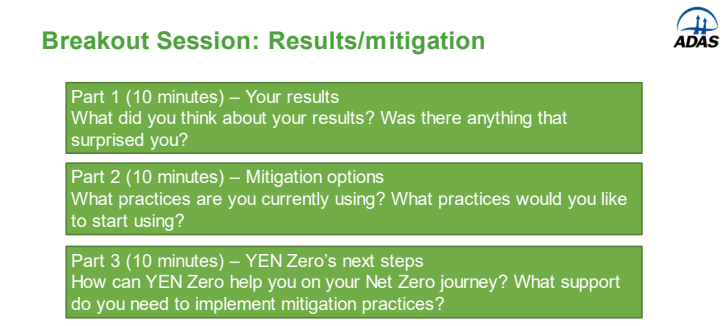
- Low carbon fertilisers

    - Fertiliser manufacturers are working towards decarbonising the manufacture process, such as through green ammonia (produced by sourcing hydrogen from water using electrolysis and combining it with nitrogen fixed from the air using the Haber Bosch process) and blue ammonia (created from fossil fuels but carbon capture and storage technology is used to prevent emissions entering the atmosphere)
    - Other novel nitrogen sources are being explored which include CCm technologies which develop fertiliser products from AD waste streams, and the use of bacteria to fix nitrogen, such as biofilms that complete the Haber Bosch process in the soil
- Fuel and energy alternatives
    - Electric farm machineries are coming onto the market which are either fully electric or use electric power for hydraulics. There is potential diversification to provide charging sites on-farm for other vehicles
    - Crop spraying using drones (e.g., VoloDrone, which is fully electric and uses lithium batteries)
    - Also seeing more robotic machinery being developed that can replace manual tasks and be utilised for increased precision
    - Some of the trade-offs for fuel and energy alternatives include embedded emissions in the machinery and the energy required to run them; hydrogen power is not suited to vibration and dust associated with the farming environment; biofuels are a low-cost tech option but can enough be sourced?
- Productivity and farm level change
    - Other opportunities include new technologies for carbon capture, such as soil amendments and bacterial CO_2 capture and removal

Introducing mitigation strategies on farm, breakout sessions

Facilitated by members of ADAS

Taking advantage of the Remo platform, a breakout session enabled small groups to virtually sit together to discuss any feedback from the YEN Zero benchmark crop C footprint analyses, what mitigation strategies have been introduced on farm already and which practices growers would like to introduce on farm, and finally how YEN Zero can help growers on their Net Zero journey, specifically any support that is required. The main outputs from this discussion were:



1. **Your YEN Zero results**
    a. A lot of YEN Zero growers used the pilot year to baseline some of their fields to understand what their crop C footprint is currently
    b. Some YEN Zero growers mentioned using the analysis to compare the C footprint of different management systems on-farm including comparing a 'regenerative' and 'conventional' approach within a single field and comparing plough, min-till and direct drill
    c. Some growers use a little-and-often nitrogen management approach to improve nitrogen use efficiency, but the benchmark analysis highlighted that this has the trade-off of using more fuel/energy in application passes

d. Growers were surprised at the high emissions associated with organic manures due to accounting for total nitrogen in the material, not just the plant available nitrogen
e. Results are lacking carbon sequestration element

2. **Mitigation options**
    a. Drying with the combine can help to reduce grain drying requirements on farm
    b. Some growers would consider using nitrification inhibitors to reduce emissions associated with nitrogen fertilisers but there are unanswered questions on the impact to soil biology
    c. Growers are working to optimise their nitrogen management where they can which included using leaf nitrogen tester to optimise nitrogen rates
3. **YEN Zero next steps**
    a. Feedback from growers included the want for economic data to be added into the YEN Zero results to understand the profitability of production systems
    b. More information is required on how to reduce nitrogen while maintaining yield, what organic sources of nutrients are accessible and what is known about the potential benefits from controlled release fertilisers
    c. Better understanding of the potential for C sequestration and more information around cover crops is needed

YEN Zero – The Future

Daniel Kindred, Head of Agronomics, ADAS

Following the breakout session, Daniel closed the meeting by discussing our plans for YEN Zero 2022. The ADAS team have been planning how to develop YEN Zero using learnings from the pilot year. These plans will be discussed with our network sponsors in early summer with the aim of fully opening the network shortly after. These plans include:

- Allowing data entry on a more consistent basis
    - Send out C footprint reports on a rolling basis
    - Deliver an annual benchmark report to all members
    - Introduce dynamic benchmarking online so growers can compare themselves to other growers using similar systems
- Develop more detailed soil health assessments such as quantifying the potential of particular soil types to increase organic matter
- Support testing mitigation strategies on farm and sharing the results back into the network

Join the conversation…

Knowledge exchange platform “Farm PEP” is now live, enabling the agricultural industry to discuss any issue, such as net zero – join the conversation here: http://www.farmpep.net/

YEN Zero is a recently established network in the ADAS YEN Family, with the overarching aim of creating a net-zero community. It aims to bring key players from across the agricultural industry together to meet the industry's target of achieving net zero emissions by 2040.

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: christina.baxter@adas.co.uk