Best route to net zero?

Regenerative agriculture – or organic?

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At the World Distilled Spirits Conference in Edinburgh, May 2023, there was real enthusiasm to learn about sustainability initiatives within the supply chain. This article is based on one of the presentations...

It looked specifically at the role of sustainable farming options when growing cereals that are malted or otherwise used in making whisky and beer. This is an area of opportunity for the supply chain to invest, de-risk the impact of climate change – and provide incentives to farmers to be instrumental in the drive towards net zero.

Right at the outset it is important to establish that the apparent choice of regenerative agriculture (often abbreviated to 'regen ag') or organic is not necessarily an 'either or' discussion. Organic has largely been regarded as having the laudable aims of reducing chemical usage where it isn't required, using natural fertilisers rather than applied inorganic options and improving biodiversity.

Regen ag is not so dissimilar, but it focuses more on soil quality and carbon sequestration to minimise the need for artificial enhancement of soil fertility and uses biodiversity as a natural source of warfare against pests.

The thrust of this article is to examine where there could be potential pitfalls depending on which farming method is chosen.

There is still much uncertainty around the terminology used in our supply chains around the terms net zero and carbon neutral and it is brought into sharp focus when there is talk of farming practices being net zero.

Net zero is a way of balancing carbon emitted against carbon removed with the aim of having no requirement for any carbon offsetting. Ultimately the aim of net zero globally is to remove as much of the excess greenhouse gasses (GHG aka 'carbon') as we can from the atmosphere in addition to what has already been sequestered in the past (see panel: *Net Zero or Carbon Balanced farming – why does it matter?*)

Carbon offsetting to become carbon neutral should be the last choice for any of us. Why should we feel comfortable using the good work of others to make our own operations look good unless we have made every effort possible to reduce carbon ourselves? This principle is adopted by those who have set a science-based target but with a degree of realism (see later: some offsetting now permitted).

A science-based target (SBT) is a voluntary emissions reduction target set by the SBT organisation which has identified carbon reduction pathways towards net zero according to the carbon emissions intensity of various sectors using global scenarios.[1,2]

At the time of writing 5,738 companies have made a commitment to

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set a target of which only 2,932 (54%) have a target verified and most of those (2,138, 73%) have a verified net zero target. It is essential to map the whole supply chain for carbon intensity to set a comprehensive SBT.

What is the significance of carbon embedded in cereals used for distilling?

The greenhouse gas (GHG) protocol divides carbon up into operational usage and supply chain (Figure 1). For operations in brewing and distilling scope 1 is almost exclusively gas usage and emissions from the transport fleet if owned and operated directly.

Scope 2 is electricity, heat or steam that is purchased. All the other supply chain activities are collectively called scope 3. The vast majority of carbon is embedded in goods and services bought in: scope 3 upstream. The carbon impact of the products after they are sold is referred to as a scope 3 downstream value. When asked what the carbon footprint of your product is you should include all 3 scopes. It is quite common in our industry to find values quoted that are purely operational. This misses out almost 70-90% of the true carbon. Why would anyone quote a scope 1 and 2 emissions value alone? It is possible that they fear the uncertainty of calculating scope 3 and decide to report just what is invoiced and can be wholly verified. That isn't a robust argument for the cereal sector where there are many good calculators available to determine the impact of barley and wheat to a factor that this author has found would vary by only around 6-10%, thus with 90-94% certainty.

There are also models available to predict the remaining scope 3 emissions using spend-based accounting. These models are a good place to start to determine the most significant contributors to scope 3 carbon footprint.

The resultant apportionment of the major categories contributing to scope 3 can determine which parts of the supply chain should be approached to determine if they have specific factors calculated that can be substituted for spend-based estimation – or they may have a programme of measurement being developed.

The reality is that data will come from many areas all of which are permitted in the GHG accounting model and can be amalgamated into a hybrid number that is the scope 3 emission. So, it is important to encourage

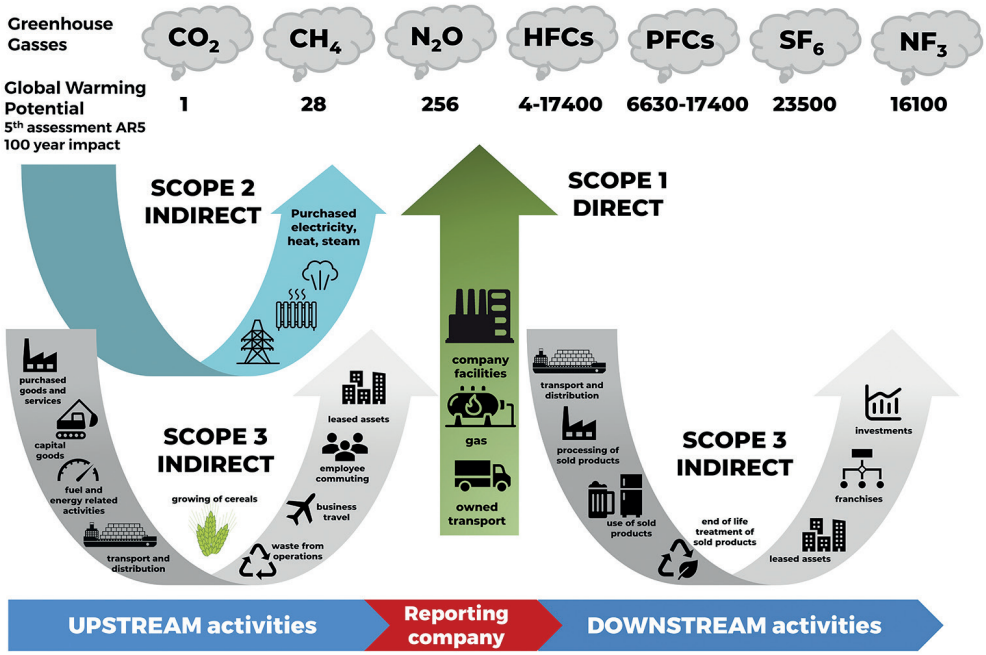

Figure 1: What is a carbon footprint? A carbon footprint is the combined amount of heat holding capacity in the atmosphere as a result of seven greenhouse gasses (GHG's). These are given relative global warming potentials over a 100 year period (GWP) of 1 (Carbon dioxide), 28 (methane), 256 (nitrous oxides), 4–17,400 (Hydrofluorocarbons), 6630–17,400 (Perfluorocarbons), 23,500 (Sulphur hexafluoride) and 17,100 (Nitrogen trifluoride). The amount of each gas emitted is added together and converted back to an equivalent carbon dioxide value using the GWP and collectively is called a carbon footprint. Technically it is a carbon dioxide (CO_2) footprint. Because the GWP equivalent values are used to convert back to CO_2 the carbon footprint is a CO_2 equivalent or CO_2e. (based on GHG Protocol, redrawn by the author)

suppliers to quote an entire scope 1-3 figure otherwise if you use their scope 1 and 2 data only in the figure you pass onto your customers you will be perpetuating an inaccurate picture of the true embedded carbon.

It is accepted that at the moment it is unlikely that technological solutions are sufficiently well developed for businesses to reach net zero completely by 2050. Hence the target adopted by the SBT for those with a verified target is 90% abatement (reduction in emissions) and up to 10% high quality offsets.

High quality refers to the permanence of sequestered carbon such as those locked into rock well below ground but can also be the locking in of organic carbon into soil. (see panels: *Net Zero* and *Carbon Neutral*).

The proportion of scope 3 emissions in brewing and distilling is likely to be in the region of 60-70% and similar again for malt (Figure 2) so it is important to understand what contributes to this and how it can be reduced. The embedded carbon from malt in a brewery or distillery carbon footprint can be in the range 25-40% hence it is worth considering options that can reduce embedded carbon in the malt.

Embedded simply means the carbon emissions used in making a product which is then passed to the next stage of the supply chain. It ensures the total supply chain carbon emissions are recognised to give a true picture of carbon intensity.

Malt has around 60% of carbon arising from the production of cereals used in processing hence it is important to make a detailed analysis of that part of the supply chain. The breakdown of carbon emissions for malting barley (Figure 3) shows a high proportion comes from nitrogen fertilisers even when these are the new abated nitrogen versions which have 40% less emissions than conventional fertilisers. Therefore anything that can reduce the demand for nitrogen fertilisers will be welcomed by farmers especially as prices have soared recently and availability has at times been scarce

What is regenerative agriculture?

Regenerative agriculture is a method of farming that regenerates the soil. Certain people advocate that it must include livestock but that isn't necessary to improve soil carbon, although it is one significant option. An analysis of research papers discussing regenerative agriculture

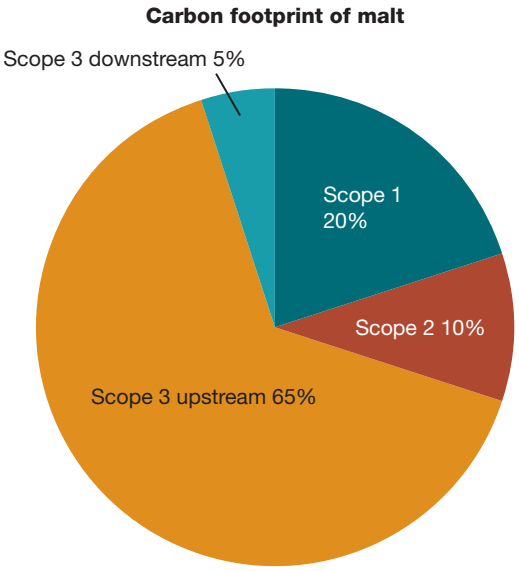

Figure 2: Carbon footprint analysis for malt from growing of barley to delivery of malt to a brewery or distillery. Data is generated via the Euromalt Carbon Calculator and UK farm data.

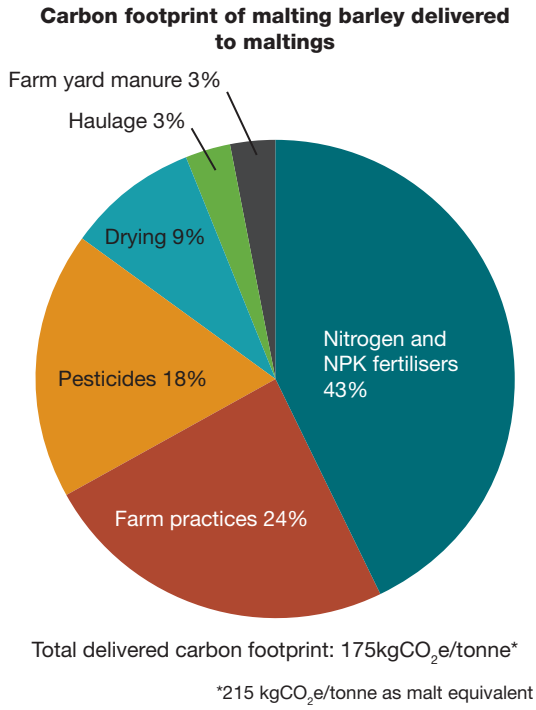

Figure 3: Carbon footprint analysis for barley production. Typical data generated via the Euromalt Carbon Calculator and UK farm data

(Table 1) showed that there was an even split for those selecting use of livestock and those using cover crops.

Ultimately the aim of the vast majority of the programmes (86%) was to build soil organic carbon.[3] This is a key common target and has a number of added benefits of interest to the brewing and distilling supply chain.

Cover crops can be plants such as Phacelia, vetch or clover which are used to cover the land in the period between harvest and next sowing. If soil is left uncovered it can allow carbon to escape whereas when covered this is prevented and in fact reversed because these cover crops photosynthesise and capture CO_2 from the atmosphere and lock it deep into the soil via the root system.

Some argue that if without a suitable pesticide such as glyphosate to remove the crop after the sequestration period this system does not work. That doesn't tell the whole story. It could be an issue, but equally some farmers do not kill off the cover crop and plant the next crop directly through it. There are stories told that cover crops grow too high and it is difficult to harvest the crop the following season, but farmers who advocate the practice report that this is down to using the wrong choice of cover crop.

Many farmers now use such a cover option, and some use the variant where cover crops are sown in the intervening rows (inter cropping). It can be very successful in minimising fertiliser requirements.

A parallel term for this is **carbon farming** which includes other options:

- Sustainable afforestation and reforestation.
- Agroforestry.
- Use of catch crops, cover crops.
- Targeted conversion of cropland to fallow (grassland).
- Restoration of peatlands.

What are the perceived barriers to regenerative agriculture (RA)?

In a recent report by Rabobank[4] five key concerns were found amongst farmers in the USA who were interviewed about regenerative agriculture. These are true of farmers elsewhere who have yet to try RA but have heard this dogma reiterated many times, so it becomes believable! This article attempts to demystify at least some of these and show how there is positive message that needs to be heard that will benefit all in the supply chain.

- RA practices must be adjusted for each crop and each microclimate, making it difficult to create a generalised prioritisation of a specific practice.
- Farmers may find it financially difficult to invest in the required changes.
- Lack of a consistent definition of RA.
- Belief that RA will affect grain protein levels.
- Belief that there will be yield penalties.

> REGENERATIVE AGRICULTURE IS LIKE NAILING JELLO TO A WALL OF MARSHMALLOWS WITH A SLEDGEHAMMER - **RABOBANK (STEVE RANNEKLIEV)**

It is important to recognise that regenerative agriculture is not limited to one practice and that not every practice will work every year. Overall however, farmers who have a regen ag programme report significant reductions in fertiliser use, resilience to drought and overall improvements in yield.

In the list two of the items are 'beliefs' and this strong emotional reaction against adopting regen ag is understandable when farmers are faced with significant challenges such as rising

NET ZERO

Requires action by you and your company to find ways to reduce carbon emissions (**lean**), choose lower carbon emitting options e.g. by fuel choice (**green**) or find activities to stop (**mean**). All these move you towards lower emissions. **Lean** is relatively easy and equates to energy efficiency. **Green** is becoming a more available option as the electricity grid decarbonises, biomass plants or own generation reduces emissions. **Mean** is the hardest and requires a step change in processing that removes a process and replaces it with one which has dramatically lower emissions.

One such example in our supply chain is in nitrogen fertilisers. These used to be made starting with nitric acid and that process was decarbonised by abating emissions giving a 40% lower embedded carbon. Then a move was made to eliminate fossil fuel. The 'mean' step change is the innovation to remove the nitric acid stage to make fertilisers instead from green ammonia.

Net zero would include sequestering carbon (removing it from the atmosphere and permanently locking it away into soil or rock for example so that your carbon removals balance carbon emitted and is therefore net zero.

Science based target setting allows a maximum of 10% purchase of carbon credits to get to net zero if you have no other options using technology currently available.

Regen ag activity	% of authors describing practice as 'regen ag'
Farming practice	
Use of cover or catch crops	46
Inclusion of livestock and use of farmyard manure (FYM) in a farm system	41
Low inputs	32
Use of compost or crop residues	27
Desired outcome	
Improvement of soil organic matter content	86
Improved soil carbon sequestration	64
Improve biodiversity; Improve water health	46
Improve community economic benefit	41
Improve food quality and nutritional benefit; Improve ecosystem services	32

Table 1: Analysis of research papers that describe regenerative agriculture

costs, climate change and the mental health pressures associated with working alone for long periods and constantly having to battle for a reasonable profit.

Introduction of regen ag is in fact a potential solution to some of those pressures, although there is a battle for the hearts and minds of farmers. It is essential that the malting, brewing and distilling sector recognises these pressures and helps facilitate farmer peer to peer groups to unpick the myths and demonstrate by case studies and on-farm visits that this is a success story waiting to happen, but that it is not a one-solution-fits-all scenario.

The Rabobank report that focused on brewers in this case, but by implication applies to all users of cereals, concluded that we need to be prepared to make a long-term commitment to growers and provide support via technical assistance and incentives to implement regenerative agriculture practices.

What are the benefits of regenerative agriculture?

- 1% increase in soil organic matter improves drought resistance by 5-10 days.
- Improved soil water retention results.
- Less additional synthetic fertiliser required.
- Greater resilience to flooding.
- Improved soil structure.
- Soil carbon increase is gained in weeks – can be five times faster than trees.
- Much lower cost than tree planting.
- No long-term land-use change.
- Less run off into ditches and other water courses.

There is a phrase often repeated whenever regen ag is mentioned in farming conferences: "Regen ag and carbon farming is the Wild West!". This emotive statement is just not true. There are rules around how carbon sequestration is measured and certification standards such as Verra, BCarbon, Gold Standard and others that specify in great detail what should be measured and how often.

Sequestration occurs deep down in soils at depths from 30-100cm so even shallow ploughing or discing is not prohibited and as such minimum tillage together with regenerative agriculture such as cover cropping delivers significant advantages for a net zero pathway.

The healthiest soils cycle more carbon in the top 10cm of the soil than those with poor soil health. Thus, reports that soils show increased carbon emissions when measurement equipment is only placed on the surface of the soil need to be qualified and set against the measurement of deeper sequestered carbon.

Soil carbon measurement should be treated like the stock market. You don't look at share prices every day and react to every rise and fall. The best shares gradually trend upwards with time. The

CARBON NEUTRAL

This where you buy the good work of others in removing carbon or other GHGs from the atmosphere and sequestering it. It is the easy option to achieving a carbon balance and does nothing to actually reduce your own impact on the planet. It may be a very expensive option because the credits have to be bought every year unless you make real reductions to your emissions in another way.

Carbon credits are defined as:

Offsets: Carbon credits bought from outside your own supply chain e.g. tree planting projects.

Insets: Carbon credits bought within the supply chain e.g. carbon negative barley.

Credits can be bought on legislative markets such as the EU or UK Emissions trading schemes or voluntary markets such as carbon credits from regenerative farming.

A field of Phacelia grown as a cover crop (Photo: Shutterstock/Vitalii Stock)

same is true of soil carbon. In a three to five year window and beyond regen ag can be shown to improve soil carbon by significant amounts. Over a 20 year period some trials have shown as much as an 8% increase in soil carbon.

The benefits of regen ag are recognised also by insurers as being an effective way to reduce risk.

> COVER CROPS ARE RESPONSIBLE FOR AN AVERAGE 60% REDUCTION IN NITRATE LEACHING, AND EVEN BETTER RESULTS CAN BE ACHIEVED WHEN THEY ARE ESTABLISHED EARLY **(KINGS/FRONTIER, 2023[5])**

The Meridian Institute and University of Illinois reported for USDA in March 2023:

1. Fields with cover crops + no-till 24% less likely than conventional fields to have insurance claims.
2. Cover crops and no-till protect against yield losses by enabling farmers to plant crops sooner after severe rain.
3. Cover crops are more frequently used on less productive fields and reduce crop insurance claims despite disproportionate risk.

So, on balance there is a very positive view of regenerative practices that show a reduction in risk, improvement to soil structure and reduction in input costs. Why is it considered a better option for improving soil health and minimising carbon emissions than organic?

The following description of issues with organic production is not intended to be an attack on organic. The aims of organic farming are to be applauded in that it seeks to minimise use of artificial chemicals where they are not required, to increase biodiversity and utilise waste more effectively. Surely it must have a place in the route to net zero? Unfortunately the scientific research suggests that it is not the solution using current organic practices and carbon accounting due primarily to yield penalties.

NET ZERO OR CARBON BALANCED FARMING – WHY DOES IT MATTER?

Net zero requires a change in emissions that takes carbon out of the atmosphere. We need to take additional carbon out of the atmosphere and this is not done by calculating how much was being taken out by land that has been sequestering for many years.

So, for example a farm may have areas which sequester carbon such as grassland. That sequestration activity was happening before it was determined we needed to reduce emissions to the atmosphere and so effectively it is not sequestering new carbon. It is true that if you calculate emissions from farming activities and subtract the sequestration you can appear carbon balanced, but this is not making any impact on the planet in reducing emissions which is what net zero aims to achieve. So in this scenario a farm is carbon balanced but not strictly net zero.

However, farming practices can go beyond a carbon balance and become carbon negative, sequestering more carbon than is emitted even when accounting for carbon embedded in the chemicals and processes involved in growing a crop. Thus farming provides a useful source of mitigation against climate change whilst we develop better technologies and practices that do not require a balancing carbon factor – because the emissions are genuinely lower or zero in the first place.

What are some issues with organic options?

Two studies – in Germany and in Sweden – showed the yield from organic farming is substantially less than conventional agriculture by a factor of around half (Figure 4). The alternative way of looking at this is twice the amount of land is required to create the same yield. Many studies also ignore the embedded carbon in the farmyard manure that is used as a replacement for synthetic fertilisers and claim organic production has a lower carbon footprint.

In a scientific analysis of the global impact of organic production if the UK moved to all organic production, a 2019 report stated that "We predict major shortfalls in production of most agricultural products against a conventional baseline. Direct GHG emissions are reduced with organic farming, but when increased overseas land use to compensate for shortfalls in domestic supply are factored in, net emissions are greater."[6]

The pattern is true across many geographies. Already described are similar results from Germany, Sweden and the UK. A study in Italy using Comparative Life Cycle Analysis showed organic barley cultivation is the most environmentally sustainable solution but is not efficient in production.[7]

Use of green manures if ploughed in may stimulate N_2O emissions in cereal production relative to moderate mineral fertilisation in a heavy clay soil.[8] Choice of green fertiliser can alleviate this, so replacement of green manure with biogas slurry (anaerobic digestate) circumvents these mulching-induced N_2O emissions.

These reports suggest that currently as a general observation organic production is not a suitable option to address the global net zero ambition. On a single farm level it may reduce total carbon emissions, but total emissions cannot be taken as a measure of success when we have a finite amount of land to grow crops on. If such practices drive production down

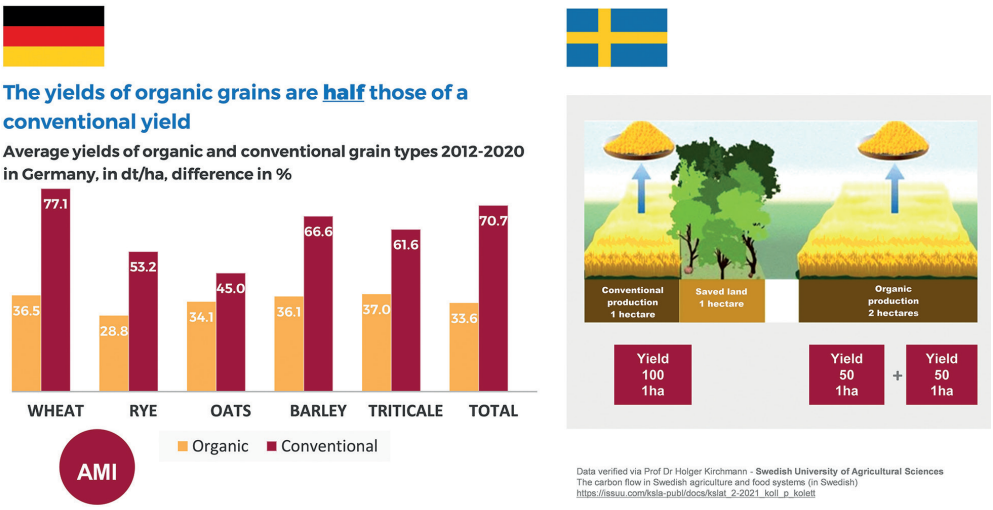

Figure 4: Organic farming improves nature but is impeded by yield

in one country it would lead to greater imports to make up the shortfall and an increase in transportation related carbon emissions.

This carbon emission data seems contradictory to the target within the EU Farm to Fork strategy[9] which proposes 25% of EU land must be organically farmed by 2030. Figure 5 displays the current position from Eurostat data. The problem with this target is that nowhere in the stated aims does it address carbon emissions and concentrates solely on other areas.

The action plan correctly explains that organic farming contributes to the protection of the environment and the climate, the long-term fertility of the soil, high levels of biodiversity, a non-toxic environment and high animal welfare standards. It is also true that land farmed organically has about 30% more biodiversity than land farmed conventionally, is beneficial to pollinators, restricts use of antibiotics, bans the use of GMOs and ionising radiation.

Yes, there are many benefits of this approach, but there has to be a carbon accounting and a recognition that land use is going to become of increasing importance hence the yield question has to be addressed to make organic a solution that enables the world to grow sufficient food in a carbon efficient way.

There are other exciting possibilities that will help lower carbon emissions in whichever farming system is chosen. For example, cereal breeders are promoting carbon efficiency such as in the new variety Curtis which in AHDB and KWS trials have shown high field yields and spirit yields.

It is being used in a competitive and comparative way by showing that for every 1,000 litres of alcohol 120kg less CO_2 is produced than with Laureate and having 10% less GHG emissions than specialist brewing variety Planet for the same hot water extract (Kirsty Richards, cereals product manager, KWS, 2023, Farmers Weekly)

Nitrogen uptake efficiency is also a new tool in a breeder's measure of success. In a study of two varieties differing in N uptake efficiency the variety with the greater nitrogen uptake efficiency resulted in much lower emissions per tonne of production due to a combination of higher yield, soil carbon sequestration and lower indirect emissions of N_2O due to lower N leaching. Increased yield reduces the pressure to transform land elsewhere and further lowers the carbon footprint.[10]

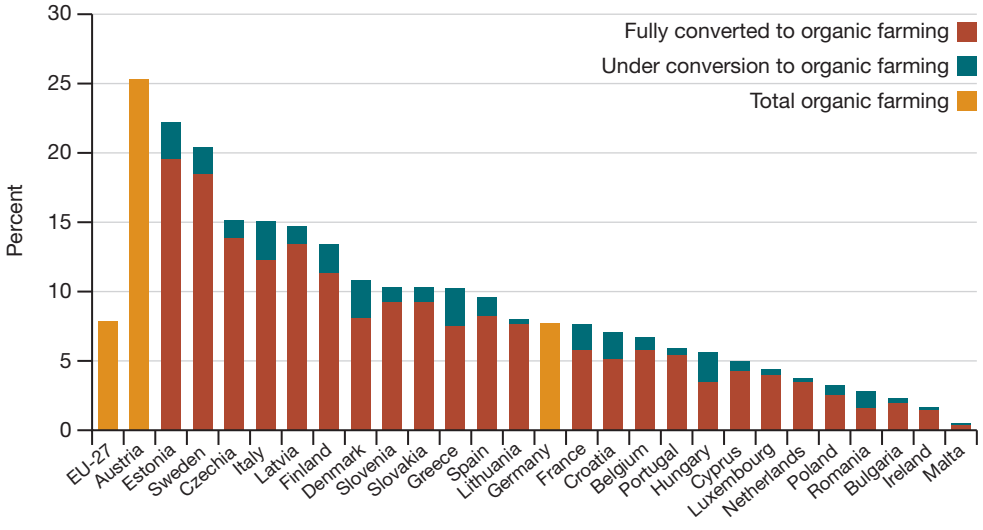

Figure 5: Share of organic area in agricultural area utilised, by country, 2019. (Source Eurostat)

Take-home messages

- There must be a fusion between improved productivity and soil health through regenerative agriculture and the organic farming methods to improve biodiversity and reduce chemical use. Currently organic yield penalty outweighs it numerous other advantages.
- Yield is driver for emissions per unit area of the planet: we must be more productive per hectare with lower emissions.
- Barley growing with cover crops and min till regenerative agriculture can deliver carbon negative cereals for brewers and distillers. .
- Regenerative agriculture is a good focus area for brewers and distillers to become involved in and invest in the supply chain. It is not about paying a premium it is about providing the financial incentives and support to facilitate trials and training that de-risks the future supply of malting barley. It also provides an incentive to farmers to regenerate soil health and potentially sell carbon credits within the supply chain. Ultimately it is about improving margin for farmers by decreasing production costs using a combination of natural pest defence and soil structure improvement to reduce the environmental impact and even go beyond and be a mitigating activity to buy time in the route to net zero whilst industrial processes implement low carbon technologies.

The author Dr Nigel Davies runs Maltdoctor Ltd a specialist sustainability consultancy (*www.maltdoctor.co.uk*) and can be contacted by email at maltdoctor@maltdoctor.co.uk to discuss any issues raised in this article.

The Royal Agriculture Society of England in 2022 published a series of helpful reports on agricultural decarbonisation. The cereals report may be accessed at **bit.ly/BDI_100**

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