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Sustainable distilling

Reducing the carbon footprint of malted barley

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Sustainability is becoming a much-abused word across the brewing and distilling sector, going the same way as 'craft'. At InchDairnie Distillery, a lowland Scotch whisky distillery in Fife, sustainability is defined as 'taking active steps to reduce the distillery's carbon footprint'.

InchDairnie's first single malt may be unveiled as soon as 2029. In our young distillery, carbon offset is not in our vocabulary. The words 'carbon footprint' are often misunderstood, many people think of it as just carbon-based energy consumption, oil, gas, and coal. However, this is not the case; a well-developed carbon footprint calculation will include all the greenhouse gas emissions (GHG) associated with a product or organisation.

Many of these GHG emissions are well hidden and have a greater impact on the climate than carbon dioxide (CO_2). Nitrous oxide (N_2O), for example, has a Global Warming Potential (GWP) 265 times that of CO_2, meaning it is 265 times more potent.

In 2019 the InchDairnie Distillery commissioned Eunomia, a specialist organisation, to carry out a benchmark carbon footprint (CFP) calculation based on the 2018 distillation year. The report is freely available on the distillery's website (bit.ly/BDI_052).

As the distillery had yet to sell any finished goods the scope of the study was restricted to the first year of maturation. Producing this CFP calculation proved to be an excellent tool when it came to developing the high-level sustainability strategy for the distillery.

The report makes use of, where available, verifiable and scientifically robust data, real numbers and not just words. It clearly showed where the effort should be directed.

The contribution of each activity to the overall carbon footprint, detailed in

Malted Barley	56.0%
Gas	35.4%
Electricity	5.0%
Cask Transport	1.0%
Yeast	0.9%
Cask production	0.8%
Wastewater	0.4%
Water	0.3%
Transport	0.2%

Table 1: Contribution to overall distillery carbon footprint

table 1, directed the distillery to examine the feasibility of producing and using green hydrogen on site, but this proved to be unfeasible. Currently, the distillery is examining the use of biomethane from a local anaerobic digestion (AD) plant and the use of green hydrogen delivered in tankers. The distillery now purchases its electricity from a renewable source.

Clearly, however, our main raw material, malted barley, is the greatest contributor to our CFP. This can be broken down further in table 2.

Each GHG can be converted back to CO_2 and then added together to give the equivalent CO_2. This is expressed as CO_2e as in the table above.

The above data was provided by our malt supplier Muntons. The barley values are affected by the choice of reduced GHG efficient fertilisers and the use of sequestering cover crops, while the malting is influenced by the choice of kilning fuel.

Barley growing	240-350kg CO_2e/tonne
Malting	130-300kg CO_2e/tonne

Table 2: Malting barley CFP

Agronomic practices

The growing of the barley has surprisingly a greater CFP than the malting process itself. By separating this footprint into the different crop production activities, the major GHG emission hotspots begin to show (Table 3).

The data in table 3 is continually changing, and it is just a snapshot in time. Fertiliser suppliers are changing their fuel and processes and farming systems are changing.

It's clear from this table that the production and application of nitrogen-based fertilisers are a major element of the barley CFP. The manufacture of nitrogen fertiliser is an energy intensive process which involves the reaction of atmospheric nitrogen with hydrogen, in

Soil N_2O emissions	42.0%
Nitrogen manufacture	22.0%
Fuel	14.0%
Grain drying	7.0%
Liming	7.0%
P & K manufacture	3.0%
Seed	3.0%
Agri chemicals	2.0%

Table 3: Crop production activity contribution to carbon footprint

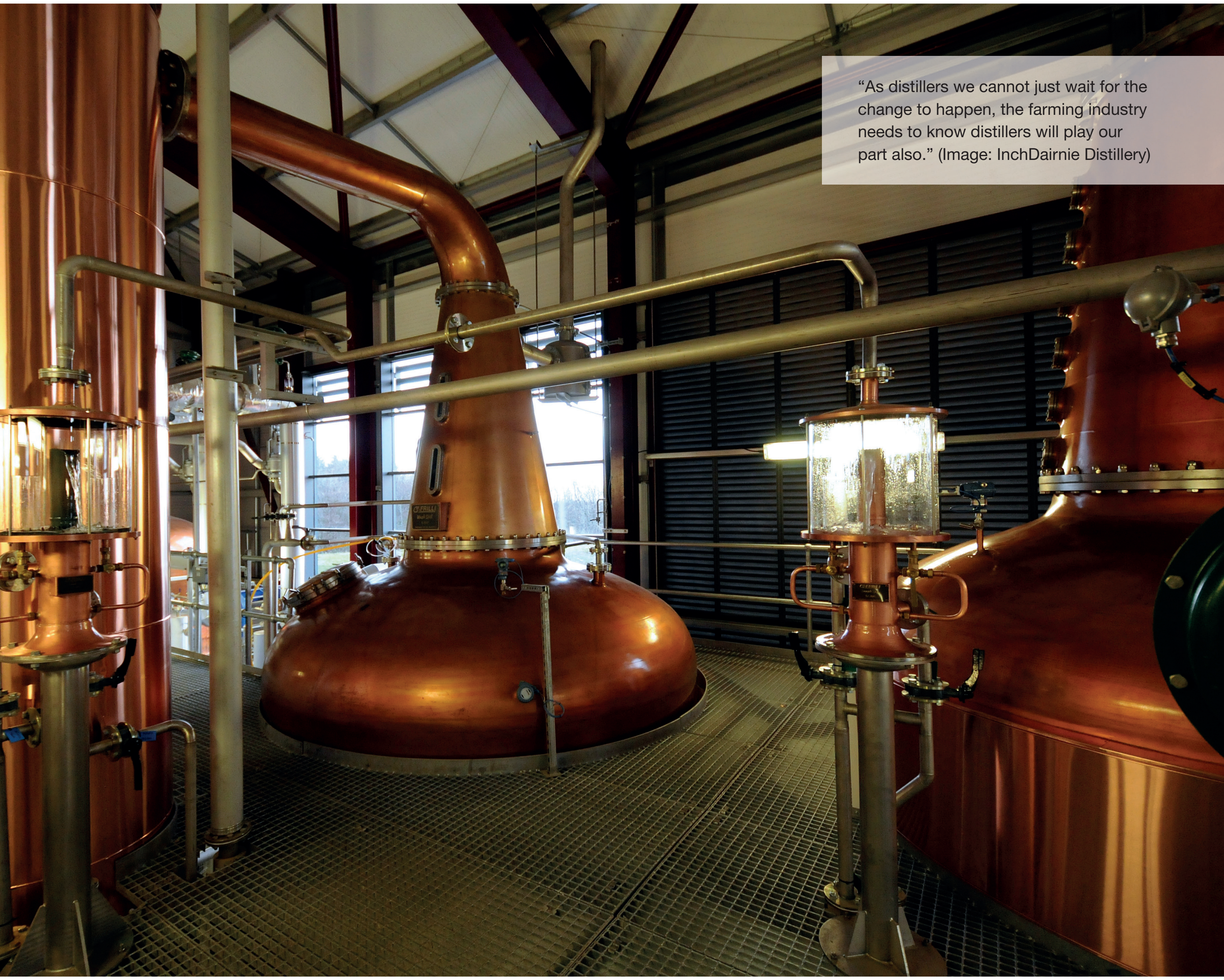
the Haber Bosch process, to produce ammonia (NH_3).

The high energy requirement comes from creating the hydrogen element which is commonly sourced from natural gas or coal. The ammonia produced may then be converted into nitric acid (HNO_3) which can emit significant amounts of N_2O.

However, abatement technology which scrubs out the N_2O emissions associated with nitric acid production is present in EU manufacture plants which can reduce the associated CFP by 90% (with a 40% N reduction in the fertiliser produced).

The application of nitrogen fertiliser results in direct N_2O emissions from the soil, through the microbially mediated processes of nitrification (in aerobic

InchDairnie Distillery's stillhouse in Glenrothes, Scotland



"As distillers we cannot just wait for the change to happen, the farming industry needs to know distillers will play our part also." (Image: InchDairnie Distillery) conditions) and denitrification (in anaerobic conditions).

Fertiliser application is also associated with indirect emissions from ammonia volatilisation and nitrate leaching. Nitrogen lost indirectly from agricultural soils through these routes may become available for loss as N_2O. An additional contributing factor to N_2O emissions is crop residues, both above and below ground crop material left in the field after harvest releases N_2O emissions as it breaks down.

These elements all contribute nearly half of the crop's overall carbon footprint, and when the manufacture of fertiliser is considered this increases to two thirds.

In recent years the farming industry has embraced many new technologies, some of which have led to more targeted use of fertilisers and agriculture chemicals. More effective use and reduction of inputs has already been achieved, but more work needs to be done.

Muntons, who provided the analysis of the malting barley footprint used in this article, has engaged proactively with the supply chain to generate a real step change in malting barley carbon footprint.

A 32% reduction in its barley footprint has been achieved by specifying growers must use abated nitrogen fertilisers which are available without additional cost. This has addressed around half of the contribution to the barley footprint, and more is expected when the fertiliser manufacturers release the new generation almost carbon zero range.

The next most significant element is emissions from soil and use of agronomic practices that minimise GHG during the growing cycle. Through the use of cover crops and intercropping in conjunction with their farmer group, Sustainable Futures, they have recently identified that it is possible to sequester not just the carbon emitted during growing but additional carbon from the atmosphere.

This generates not just carbon zero, but carbon negative barley and could provide an excellent source of offsets within the supply chain and an additional income for farmers working off very tight margins for malting barley.

Further work over the next five years will look at other agronomic practices that build soil organic matter which has the combined effect of reducing leaching and improving water retention. The aim is to deliver a further 30% saving in this contributor to carbon footprint.

Yield enhancement

In 2012 the agricultural consultancy ADAS developed the Yield Enhancement Network (YEN) in response to the wheat yield plateau, with the foundational aim of identifying and supporting arable innovators.

The network, financially supported by industry sponsors, collates on-farm data from farmer entrants to assess how the crop performed over the season and what the potential yield limitations were. The data is reported back to each YEN grower entrant through a benchmark report where their data is benchmarked against others in the competition.

Since originating over eight years ago the cereal YEN has now had over 1,200 grower entrants from across Europe. The YEN has inspired growers to test new yield enhancing ideas on farm, based on the crop analysis provided by the benchmark report. The outcome of these tests are shared back into the network, creating a farm-centric knowledge sharing innovation network.

In 2021 the YEN Zero network was launched, with the objective to create a net zero community for the agricultural industry, to share knowledge, agree key metrics, present ideas, and test what works. The programme is funded by seventeen sponsors, including both Glenmorangie and InchDairnie distilleries, joined by DEFRA, The NFU, AHDB, and other agricultural industry companies.

The output from this programme will be a range of different mitigation strategies for growing lower carbon footprint crops. A one size fits all approach will not work in this scenario given the significant agronomical variation across farms and crops in the UK.

The first year will allow growers to establish a baseline crop carbon footprint benchmark for any possible mitigation strategies to be measured against.

To demonstrate in a practical way the potential impact of these strategies, InchDairnie Distillery will use some of the malted barley, produced by YEN Zero grower entrants, to produce a proportion of its new spirit.

The data collected while using this barley will confirm the distillery yield and carbon footprint. This will also allow any impact on flavour and quality to be measured at a distillery level and not just on a lab bench level.

Of a particular interest to InchDairnie Distillery is the use of AD plant digestate on barley growing land. The distillery supplies both its pot ale and draff to a local AD plant which uses green crop as it main feed stock.

The effort and level of change needed to reduce the carbon footprint of malted barley cannot be understated. The whole supply chain from seed merchant to distiller's malt bin will need to be open to challenge and change.

The YEN Zero programme and the work carried out by Muntons is just the start. As distillers we cannot just wait for the change to happen – the farming industry needs to know distillers will play our part also.