BRIEFING FOR CLA MEMBERS

ENVIRONMENT AND LAND USE

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CLIMATE CHANGE FACTSHEET: LAND USE & NET-ZERO

1. INTRODUCTION

CLA members are committed to helping the UK Government achieve the net-zero greenhouse gas emissions by 2050 target. This document aims to lay out the facts on climate change and land use, relying on the best available, most robust science to cut through the rhetoric and dispel myths. The climate change debate is extremely nuanced, so it is important for CLA members to arm themselves with the facts to make good business decisions, promote the industry and tackle the climate crisis head on.

The vast majority - 81% - of total greenhouse gas emissions in the UK are carbon dioxide, primarily from the use of fossil fuels in the transport, energy and industrial sectors. Agriculture is a slightly different story, contributing 10% to total emissions,[1] but importantly is the only sector with the ability to naturally absorb and store carbon, taking it out of the atmosphere. [2] There is significant potential to reduce agricultural emissions through low-carbon farming practices, however it is important to acknowledge that producing crops and livestock inevitably creates greenhouse gas emissions, some as the result of biological or natural processes, and so within current technology it is not possible to reduce these emissions to zero.

Farmers and landowners can contribute towards the net-zero goal through maintenance of existing carbon stores in soils; enhancement of carbon storage and sequestration through woodland creation and improved management of established woodland; restoration of wetlands and peatlands; and conversion of land to bioenergy crops. In addition, farmers and landowners can reduce greenhouse gas emissions by adopting low-carbon farming practices and techniques, and provide land for renewable energy such as solar and wind, and, in the future, options to capture and store carbon through new technologies.

This document aims to answer the tricky questions on climate change and land use, and demonstrate that there are ways within all farming systems to reduce emissions, improve sequestration and store carbon rather than be prescriptive about any one system.

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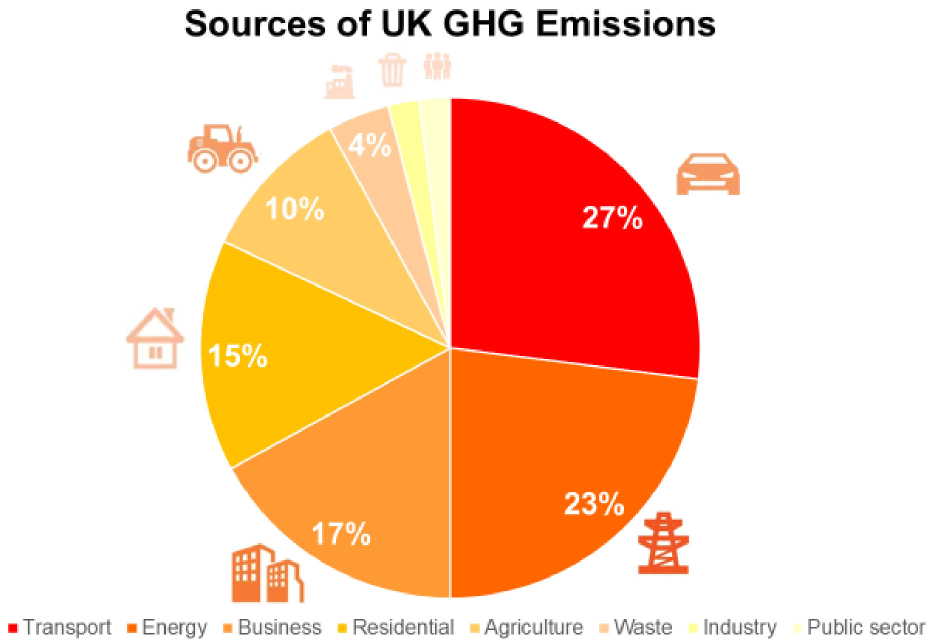
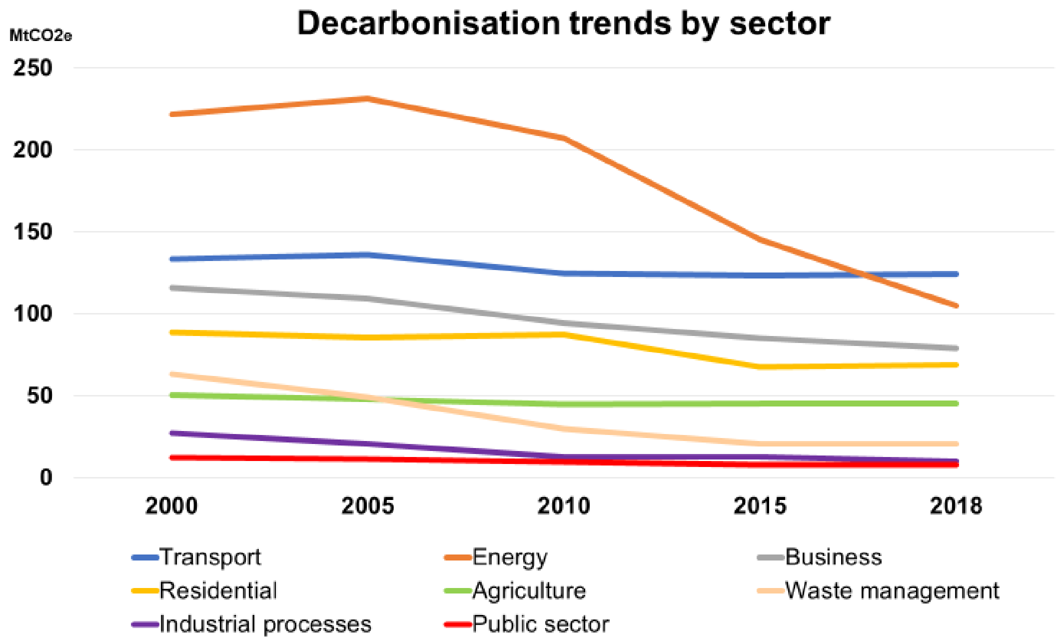
2. AGRICULTURE IN PERSPECTIVE

In the UK, the agriculture sector currently represents 10% of total UK emissions.[3] The breakdown of emissions by sector, sourced from the BEIS 2018 Greenhouse Gas Emissions report, shows transport, energy and business making up the bulk of UK emissions. Emissions from those sectors are primarily carbon dioxide, produced through the burning of fossil fuels. To meet our climate change targets, carbon dioxide emissions must be reduced to as close to zero as possible.



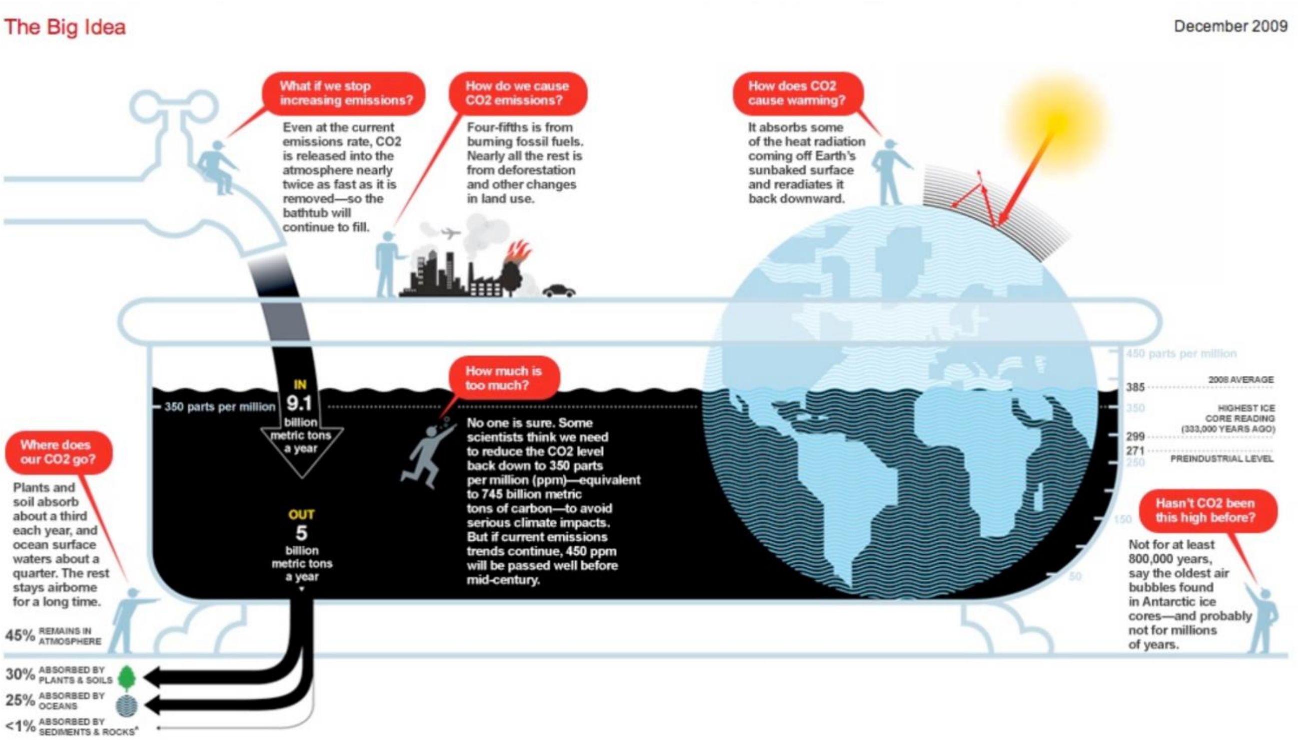
As shown in the graph below, over the past 20 years almost all sectors have reduced their emissions and are decarbonising, albeit some slower than others. Although agricultural emissions decreased by 1% between 2017 and 2018, the overall trend shows agriculture remaining largely static since 2000.

Between 1990 and 2018, agricultural emissions decreased by 16%, however this was due in large part to the reduction in cattle numbers due to foot-and-mouth disease, bovine spongiform encephalopathy, introduction of milk quotas and market volatility rather than measures designed to reduce emissions.



As the graphics show, it is pivotal all sectors play their part to reduce emissions to net-zero. In this respect, a distinction must be made between carbon dioxide emitted by the transport, energy, business and residential sectors, and the methane and nitrous oxide emissions emitted by the agriculture sector. Most agricultural systems essentially cycle existing carbon between plant and animal biomass and atmosphere, however the potency of the methane and nitrous oxide as greenhouse gases and the fact that they are produced as by-products of the carbon cycle, mean that those gases have a disproportionate impact on warming.[4] Further, there are carbon dioxide emissions associated with wide scale land use change such as deforestation to clear land for agriculture.

This is different to the burning of fossil fuels, which takes carbon stored for millions of years underground and places it into the atmosphere as carbon dioxide, where it remains causing warming for thousands of years. The 'Carbon Bathtub' analogy, shown below, is often used to demonstrate how carbon dioxide is being released into the atmosphere much faster than it can be removed through plants, soil and the ocean. For this reason, the Committee on Climate Change has advised the government to make reducing carbon dioxide emissions the priority, and for methane and nitrous oxide emissions to stabilise and slowly decrease.[5]



Source: National Geographic

On a global level, agriculture accounts for 12.56% of total emissions[6], but taking into account the deforestation or degradation of peatlands taking place to clear land for global food production, it contributes around 24% of total greenhouse gas emissions.[7] 14.5% of global emissions are from the livestock supply chain, with almost 80% of global agricultural land used for livestock or the production of feed for livestock.

3. CARBON ACCOUNTING FOR LAND MANAGERS

A ‘farm carbon account’ measures the total amount and source of greenhouse gases emitted as a result of the activities of a farm enterprise as well as the amount of carbon absorbed through activities that sequester carbon, removing it from the atmosphere. From this, a land manager can highlight areas where improvements or changes can be made to reduce total emissions or increase sequestration. Many CLA members have undertaken carbon accounts on their farms to identify priority areas to reduce emissions and sequester carbon, and benchmark progress.

There are three main approaches to carbon accounting for agriculture and land use:

- *Whole holding*: where the overall annual greenhouse gas emissions and sequestration of an entire farm business are measured. This may include farming activities, tourism enterprises and buildings;
- *Per product:* where the emissions associated with a specific product, for example, per kilogram of grain or litre of milk, are measured. This can be effective in demonstrating productivity gains; and
- *By enterprise*: where just one element of a farm business is measured, for example just the livestock enterprise of a wider farm business.

It is also important to establish the boundaries and scope of a carbon account. Emissions are globally defined under three categories, known as ‘scopes.’ Scope 1 refers to the direct emissions from ‘within the farm gate’ while Scopes 2 and 3 take into account purchased emissions, for example electricity, and indirect emissions from the supply chain including all inputs (fertiliser or feed, for example) and up and downstream emissions.

The CLA has produced a Guidance Note to help members who want to get started on carbon accounting and look at ways to reduce their on-farm emissions and increase carbon sequestration, available here. The CLA recommends the Cool Farm Tool and the Farm Carbon Calculator – two free online tools that can be used to measure the carbon account of a holding.

Currently, the emissions from agriculture in the UK, as measured in the National Inventory, greatly outweigh the amount of carbon being sequestered through all UK land use, land use change and forestry (LULUCF). The agriculture industry emits 41.2 million tonnes of carbon dioxide equivalent, or CO2e (a measurement used to compare all greenhouse gases and equate them with a ‘unit’ of carbon dioxide) and LULUCF sequesters 9.8 million tonnes of CO2e in 2017.[8] These numbers do not take into account the significant existing carbon ‘stocks’ in trees and soils in the UK that must also be protected.

4. WHAT DOES NET-ZERO MEAN FOR SHEEP, BEEF & DAIRY?

Key messages:

- Sheep, beef and dairy systems are responsible for the majority of agricultural emissions in the UK as cattle and sheep are ruminant animals, producing methane, a potent greenhouse gas.
- There are also emissions associated with the growing of feed for livestock, so the full supply chain must be looked at to assess the true carbon footprint of sheep, beef and dairy products. Often this means grass-fed animals have a lower footprint, despite producing more methane in their digestive processes.
- There is a large amount of carbon stored in the UK's permanent pastures and rough grazing. In some circumstances, the best way to protect, and even increase, the carbon stored in these soils will be to graze livestock in low stocking densities.
- Methane, the greenhouse gas most associated with cattle and sheep, is a short-lived gas and behaves differently to carbon dioxide in the atmosphere, causing greater warming for a shorter period of time.
- On a global level, beef, sheep and dairy products tend to have a larger carbon footprint than plant-based products, however this fails to take into account a number of nuances around trade, supply chains and nutrition

How do sheep, beef and dairy systems contribute to climate change?

Cattle and sheep are ruminant animals, meaning they produce methane through 'enteric fermentation'. This is the process whereby plant material is digested and methane is produced as a by-product, usually through burping. These methane emissions are responsible for the majority of emissions from agriculture (51.6% in the UK)[9].

There are also significant nitrous oxide emissions associated with the manufacture and application of nitrogen-based fertilisers on soils where animal feed is grown and with the manure and slurry produced by ruminants

What does a low-carbon sheep, beef or dairy system look like?

There is no one 'perfect' system, but instead a range of actions that contribute to carbon efficient farming practices. There are a large number of studies looking into husbandry, livestock diets, vaccines and rumen inhibitors, with varying results. Within existing and widely-available technologies and practices, the only conclusive way to reduce emissions from ruminant livestock is through efficiency improvements and productivity gains that reduce the amount of greenhouse gases emitted per unit of product. The UK currently lags behind other developed countries on total factor productivity and there is scope to reduce emissions by 10 MtCO2e by 2050 across agriculture, including through productivity improvements in sheep, beef and dairy, if we follow international best practice.[10]

A 'low-carbon' sheep or beef system is an efficient system, where measures to improve productivity are utilised. This should include improving animal health and welfare to reduce mortality and improve growth rates, breeding for disease resistance or optimising animal diets.

Ruminant animals grazing permanent pasture can also play a limited role in ensuring the carbon stored in soils is protected, and in some circumstances, increased. This is explored further in the 'grazing management' and 'what does net-zero mean for soils' sections below.

Discussion Points:

Reducing UK ruminant livestock numbers, carbon leakage and trade

UK livestock production is more efficient than the global average, so if the UK reduces livestock numbers but domestic or global consumption of livestock products continues to increase, the net result for climate change will be a global increase in emissions if a less efficient country picks up that demand.[11] This can be described as 'off-shoring' greenhouse gas emissions.

UK-produced beef from dedicated beef herds produce half as much greenhouse gases per kilogram of meat as the global average, with beef from UK dairy herds half of that again. The UK is 80% self-sufficient in beef production. However, due to the amount of 'less efficient' beef that is imported for UK consumption, the carbon footprint of beef *consumed* in the UK is, kilogram for kilogram, higher than the carbon footprint of the beef *produced* in the UK.

This demonstrates that regardless of whether UK consumers change their diets to reduce meat consumption, any policy measures to achieve climate change targets related to meat production will greatly hinge on balancing imports, exports and domestically produced and consumed meat.

Grazing management

As discussed in the 'what does net-zero mean for soils' section, over 10 billion tonnes of carbon are stored in UK soils and over 50% of UK agricultural land is grassland or rough grazing[12]. Many scientific reports suggest that 'good grazing management', where stocking rates are optimised, can help maintain these soil carbon stocks, more so than 'poor grazing management' or conversion to cropland.[13] In certain situations, for example where grazing timing and intensity is optimised, livestock can help the soil sequester more carbon, however in most cases the additional carbon stored only outweighs the methane emitted by the livestock at very low stocking rates (0.5 livestock units per hectare). This does not take into account the amount of existing carbon that may be already stored in soils.

Chapter 3 of the Oxford University Food Climate Research Network Report, *Grazed and Confused*, explains further the science around soil carbon and grazing and analyses the evidence on rotational grazing and the Allan Savory 'holistic grazing' approach. Holistic grazing and rotational grazing are both based around the concept of grazing small areas of land at a high stocking density, forcing cattle to eat everything in the area, including weeds, to trample the soil crust to bury more carbon in soils and to cycle nutrients through manure. While this may work in limited circumstances, the report, along with many other scientific reports, concludes that the benefits of rotational and holistic grazing have been significantly overstated and are based mainly on experimental evidence in semiarid areas that are unlikely to be replicated in the UK.[14]

Is grass-fed or grain-fed better for climate change?

In the UK, cattle are on average fed 70% on grass and 30% on grains or other crops. While fed on grass, cows tend to gain weight more slowly than when fed on grain, so a 100% grass-fed cow will likely have a longer lifespan and thus be producing more methane over that time period. Therefore, looking *strictly at methane emissions*, animals fed a larger percentage of grain tend to have a lower carbon footprint. However, this distinction between grain-fed and grass-fed fails to take into account soil health, biodiversity, carbon storage and animal health and welfare comparisons. It also fails to acknowledge the nitrous oxide and carbon dioxide emissions associated with growing and transporting the crops used to feed the cattle. For this reason, it is difficult to pick one system over the other and it is likely that actual emissions will vary widely between systems.[15]

It is important to note here that much of what cattle and sheep consume, like grass, is unable to be eaten or digested by humans, so livestock provide an important service in turning this unconsumable food source into a consumable one. This allows for large land areas that are unsuitable for crops to be used to produce food.

Health, environmental and cultural benefits of cattle and sheep

It is important not to view ruminant livestock solely through a climate change lens. Livestock provide a number of other benefits and have an extremely important place in English and Welsh societies.

The NHS recommends eating meat (including pork and poultry) as part of a balanced diet, as it provides a good source of high-quality protein. While it is accepted that current consumption levels are higher than the recommended 70g of red meat, it is also acknowledged that vitamins and minerals like iron and B12 are important for human diets and are not readily available in other foods. The NHS considers dairy products to be 'great' sources of protein and calcium and an important part of a healthy diet.[16] The debate around diet change tends to be polarised around 'veganism' vs 'meat', missing the nuance that a healthy, balanced diet looks different for everyone and likely has animal products incorporated.

Environmentally, permanent pastures provide a habitat for many plant and wildlife species. Grazing livestock on pasture at appropriate stocking rates can maintain these habitats and therefore increase biodiversity.[17] However, clearing land for livestock and overstocking can lead to degradation of soils and a decrease in biodiversity.

From a social perspective, there is an intrinsic cultural element to the consumption of livestock products in the UK and much of the landscape that is associated with livestock, for example the uplands, is widely treasured.

*Methane vs carbon dioxide and GWP**

Conventional, internationally agreed methods of greenhouse gas accounting compare methane to CO2 by equating one tonne of methane to 28 tonnes of CO2, as methane is a more potent and 'warming' greenhouse gas. This methodology is known as GWP_{100}. 'GWP' stands for 'Global Warming Potential' and is essentially a measure of how much heat a greenhouse gas traps in the atmosphere. This metric is acknowledged as a crude and slightly inaccurate way to measure the actual warming potential of methane. New research from the University of Oxford aims to more accurately measure methane, naming the new metric 'GWP*'. The science behind it is briefly outlined below.

Methane is a short-lived gas, remaining in the atmosphere for around 12 years before breaking down. CO2 is a long-lived gas, which means that every tonne of CO2 ever emitted by fossil fuels is still in the atmosphere today, and will be for hundreds of years, continuing to cause warming. In comparison, if the methane emitted today is the same amount as the methane emitted 12 years ago, there is no more methane in the atmosphere today than there was 12 years ago, and therefore no more warming. There is an initial 'pulse' of warming when the methane is first emitted, but if the overall methane emission levels remain static, this does not increase.

This means that if the UK national cattle herd stays the same size, the cattle themselves will not be contributing to any new 'warming'. However, as methane is so potent, even a small increase in herd numbers can have a big impact on temperatures, equivalent to a large amount of CO2. Additionally, any reduction in herd numbers reduces the amount of methane in the atmosphere producing a net-cooling effect, similar to carbon sequestration.

This research is focused specifically on methane, so does not take into account the greenhouse gas emissions associated with the crops used to feed them, transport, packaging, supply chain etc.

A briefing note on this is available here: https://www.oxfordmartin.ox.ac.uk/downloads/reports/Climate-metrics-for-ruminant-livestock.pdf

Consumer diet trends and 'less but better'

Much of the rhetoric around climate change and ruminant livestock centres around diet change and consumer choices as the key driver to reduce livestock numbers and therefore methane emissions. The Committee on Climate Change has advocated for a reduction in meat and dairy consumption of 20% per person.[18] This is a modest reduction in comparison to the reduction supported by Public Health England in its 'Eatwell Guide' which calls for a reduction of 89% for beef and 63% for lamb due to health concerns. Recent Defra figures show that between 2014 and 2018, consumption of meat rose by 0.2% (note this is what is being consumed by UK households, not what is being produced by farmers).[19]

When focusing on climate change specifically, as opposed to health, these conversations tend to miss the more nuanced elements of the debate and instead equate livestock as 'bad' for climate change and plant-based foods as 'good'. Plant-based foods tend to have a significantly lower carbon footprint than animal products, even when the supply chain, transport emissions and fertiliser use are taken into consideration.[20] However there are other environmental and nutrition concerns that must be considered, and in some instances the transport emissions of a product can be significant.

Comparing almond and dairy milk provides an example of this: a litre of dairy milk produces 1.67kg of CO2e and a litre of almond milk just 360g of CO2e, but this equation is 'pre-shipping' and so fails to acknowledge the carbon emissions associated with then shipping that litre of almond milk from California to the UK, for example, while the dairy milk will likely have just travelled a small distance within the country. Further, it takes around 400 litres of water to produce 1 litre of almond milk, causing widespread environmental degradation in some areas experiencing extreme drought. A UK dairy system uses between 685-1000 litres of water for one litre of milk, but in a country where, for the most part, water is in plentiful supply.[21] From a nutritional standpoint, dairy milk contains 4 times more protein than almond milk and is high in natural calcium, vitamins and minerals. To achieve a level of nutrition similar to dairy milk, almond milk must be fortified and often contains added sugar.[22]

For this reason, a more palatable and nuanced message should be 'less but better' and 'buy British'. If people want to reduce their meat or dairy consumption for health reasons, the goal should be to buy better meat and dairy, less often, and to ensure it is as local as possible.

It is also worth noting that while NHS guidelines and Committee on Climate Change recommendations push for a decrease in meat consumption, they counter this by recommending an 86% increase in vegetable consumption. This could be positive for the horticulture sector in the UK.

5. WHAT DOES NET-ZERO MEAN FOR CROPS?

Key messages:

- Crop systems emit nitrous oxide through the manufacture and application of nitrogen-based fertilisers, and carbon dioxide through loss of soil carbon. Nitrous oxide is 298 times more potent, or 'warming', than carbon dioxide.
- While organic systems emit significantly less nitrous oxide due to the absence of artificial fertilisers, the consequent drop in average yields in organic systems demonstrates the difficulties the UK would face in producing enough food if nitrogen fertiliser use was curtailed.
- A large amount of the crops grown in the UK are fed to livestock, so any reduction in livestock numbers would have a large impact on the arable sector.

How do cropping systems contribute to climate change?

Despite livestock systems often being the focus when it comes to climate change, crops are also significant sources of greenhouse gas emissions. This is primarily from the use of artificial nitrogen fertilisers and through the loss of soil carbon through cultivations.

The rough breakdown of greenhouse gas emissions from arable cropping in the UK is:

- 60-70% from artificial nitrogen fertilisers production and application;
- 10-20% from fuel use and field operations;
- 10-15% from P and K fertilisers, organic manures and liming;
- 5-10% from sown seeds (emissions associated with growing, processing); and
- 1% from crop protection chemicals.[23]

What does a low-carbon cropping system look like?

The most significant greenhouse gas emissions from arable cropping in the UK are nitrous oxide emissions associated with the manufacture and application of nitrogen-based fertilisers. Therefore, any reduction or removal of artificial nitrogen fertilisers will result in lower greenhouse gas emissions. The other significant greenhouse gas associated with crops is carbon dioxide, released from soils through cultivation. For this reason, arable systems with frequent and intense cultivations will be emitting more greenhouse gases than those engaging in precision agriculture or min till practices.

Discussion points:

The potency of nitrous oxide

Nitrous oxide is an extremely potent greenhouse gas: one tonne of nitrous oxide creates as much 'warming' as 298 tonnes of CO_2, which is roughly equivalent to flying London-Los Angeles return 185 times. While methane stays in the atmosphere for just a decade, nitrous oxide instead has a lifetime of around 110 years. Further, nitrous oxide depletes the ozone layer. However, it's estimated that without nitrogen fertilisers over 50% of the world's population would not be fed – it is crucial for food production globally.[24]

50% of the nitrous oxide emissions associated with agriculture are from the manufacture of fertiliser, and 50% is from the application of the fertilisers. Research is underway to tackle both aspects, with new technologies deployed at manufacturing plants aiming to reduce 'leakage' and precision agriculture and crop management techniques used to improve efficiency at application.

The role of organic systems

Organic systems optimise nutrient and energy flows in agro-ecosystems and produce less greenhouse gas emissions per hectare of land than conventional systems, by confining productivity to natural system limits (through N-fixation or livestock incorporation) instead of relying on artificial fertilisers.[25] Organic systems in the UK clearly have a role to play in reducing the overall nitrous oxide emissions from agriculture, and there are a number of other benefits of organic farming, including to soil carbon, biodiversity and soil health.

However, a recent study done by Cranfield University looked at an extreme example of what would happen if all of England and Wales shifted entirely to organic. In this scenario, greenhouse gas emissions (including methane) from livestock reduced by 5% and from crops by 20% but yields were reduced by 40%, meaning the greenhouse gases emitted per *unit of product* were higher.[26] This would mean the UK would have to rely greatly on imports from overseas to feed the country.

The extra land required to grow organic crops would also have to be converted from grassland or land that could be used for trees, resulting in reduced capacity for sequestration.[27] The full report is available here. The implication of this report is not necessarily that organic does not have a role to play in the UK, but it does use an extreme example to demonstrate that the argument for or against organic farm systems may not be so cut and dried.

How a change in diets away from meat would impact crop production

The NHS guidelines push for a decrease in meat consumption but an increase in fruit and vegetable consumption. While this will likely increase demand in the horticulture (fruit and vegetable) sector, currently 82% of crops grown in the UK are cereals and oilseeds, grown mainly for animal feed. The UK also imports additional feed from Europe and South America, accounting for 50% of total animal feed. From a land area perspective, 3.9 million hectares are used for cereals and oilseed crops and 140,000 hectares are currently used to grow fruit and vegetables.

If the UK population followed the NHS guidelines, there would still be an overall decrease in cropland in the UK as the amount needed for animal feed reduced. Interestingly, with a reduction in livestock numbers and a subsequent reduction in cropland for animal feed, studies have shown the 'freed up' land would allow for the UK to achieve full self-sufficiency, if combined with diets in which people ate seasonal food and more fruit and vegetables.[28]

6. WHAT DOES NET-ZERO MEAN FOR PIGS & POULTRY?

Key messages:

- Pigs and chickens do not produce methane, so their contribution to UK emissions are low. However, this does not reflect the large amount of feed required to raise these animals, which may be imported, and the nitrous oxide emissions associated with growing it.

How do pigs and poultry contribute to climate change?

Pigs and poultry differ significantly from cattle and sheep as they are not 'ruminant' animals, meaning they do not process their feed through enteric fermentation and produce methane emissions. The emissions associated with these systems are nitrous oxide from the crops grown to feed them, methane and nitrous oxide from slurry/manure management and carbon dioxide from the energy needed to house them, if housed.

Pork production produces around half the greenhouse gases per kilogram compared with beef or lamb. Poultry and eggs produce half the greenhouse gas emissions of pork, with nearly half of those emissions associated with the growing, processing and transporting of feeds.

What does a UK low-carbon pig or poultry system look like?

Feed efficiency is the primary way to improve productivity and reduce emissions in pig and poultry systems. This may involve looking at diet, minimising waste and looking into animal husbandry. For housing, good insulation, equipment maintenance and measuring energy use can help reduce carbon dioxide emissions.

As explained below, the production of feed for pigs and chickens is a large proportion of the total carbon footprint, so sourcing sustainably produced feed will make a significant difference to the total footprint.

Discussion Points:

If pigs and poultry have a lower emissions intensity, are they the answer to reducing our emissions?

In a report published in November 2018, the Committee on Climate Change called for a decrease in consumption of beef, lamb and dairy, with at least 20% of that reduction being replaced by an increase in the consumption of pork and poultry.[29] While this would lead to lower domestic emissions, there are other concerns that have been left out of this analysis. For both pork and poultry, feed contributes approximately 78% of the total carbon footprint, mainly nitrous oxide from artificial fertilisers.[30]

Soya is considered one of the most important protein sources for poultry and pigs. The UK imports 2 million tonnes of soya meal annually and 90% of that is used to feed poultry, pigs and fish. The vast majority comes from South America (Brazil, Argentina and Paraguay) and, despite supply chain action to address it, may be associated with unsustainable practices including deforestation in the Amazon basin.[31] This is an extremely important consideration when looking at the whole supply chain and the greenhouse gas emissions associated with pork and poultry.

Further, to compensate for the increased demand, there is potential for the most intensive form of pork and poultry farming to take place which may result in animal welfare trade-offs or an increase in energy use and subsequently carbon dioxide emissions for animal housing.

There have been calls recently for the UK government to roll back the legislation that prevents pigs and chickens being fed surplus food, or ‘food waste’. This practice was banned following the 2001 foot-and-mouth outbreak, however there are significant environmental and economic benefits to allowing for the practice and it has been independently reviewed and deemed likely safe. This could be an area to explore further in the future to improve the carbon footprint of the pork and poultry sector.[32]

7. WHAT DOES NET-ZERO MEAN FOR SOILS?

Key messages:

- Soils are a significant carbon store, second only to oceans, and are extremely important for food production.
- Farming impacts soil health and thus soil carbon stores in both positive and negative ways, so it will be increasingly important for climate change mitigation that we farm in a way that increases soil carbon.

How can agricultural soils help mitigate climate change?

Over 10 billion tonnes of carbon are stored in UK soils, including grassland, arable, peatland and forest soils, roughly equal to 80 years of annual UK greenhouse gas emissions.[33] The Food and Agriculture Organisation of the United Nations (FAO) estimates that the top 30cm of the world's soil contain twice as much carbon as the entire atmosphere, making it the largest terrestrial carbon sink.[34]

Soil organic matter is primarily made up of carbon and is extremely important for soil health, fertility, water infiltration and retention and food production. Healthy soils with high soil organic matter content can underpin whole farm systems. The CLA Guidance Note on carbon accounting contains a guide to measuring and improving the soil organic matter of farm soils, increasing the amount of carbon stored. The FAO has estimated that sustainable soil management could help the world produce up to 58% more food.

Climate change is impacting soils, with warming temperatures and extreme weather events reducing the capability of the soil to sequester and store carbon. It is likely this will also have a negative impact on yield.

Discussion points:

Can grazing livestock help soils sequester more carbon?

Grazing livestock can have a positive or a negative impact on the carbon stores. Livestock can help increase the carbon stored in soils by cycling nutrients back into soils through manure, grazing and stimulating plant growth, when at low stocking densities and well-managed. However, more intensive grazing practices and overstocking can contribute to soil degradation, depleting the amount of carbon stored by allowing the soil carbon to oxidise and leak back into the atmosphere as carbon dioxide.

Can soils continue to sequester carbon indefinitely?

Soil carbon is also vulnerable to drought, flood and erosion so should not be considered a permanent carbon store.[35] Depending on the condition of the soils, at some point they will reach equilibrium and begin leaking carbon – very healthy soils with a high soil carbon content will be unlikely to continue to sequester more.

Increasing the soil organic matter content of soils, and thus the amount of carbon stored, will rely on careful balancing of inputs (plant and animal residues) with losses (decomposition, erosion). The maximum capacity of soil to store carbon is determined by the soil type, with coarse, well-aerated soils, such as sandy soils, having a lower capacity to store carbon and soils with a high clay content having a greater capacity to store carbon.

Mechanical cultivations of soils, particularly in cropping systems, disturb the soil organic matter, allowing the carbon to oxidise and release into the atmosphere as carbon dioxide. Land under continual cultivation will be continually losing soil carbon, so measures to reduce the frequency, depth and intensity of cultivations will reduce this soil carbon loss.

8. WHAT DOES NET-ZERO MEAN FOR FORESTRY & WOODLAND?

Key messages:

- Trees are rising rapidly up the government's agenda, as a crucial part of the 'net-zero' picture. A farm system with forestry and woodland incorporated could include commercial forestry, small copses, agro-forestry, shelter belts and hedgerows. All types of tree planting can be fed into carbon accounts.
- Trees are much more efficient than soils at sequestering carbon.

How can forestry and woodland mitigate climate change?

Trees absorb carbon through photosynthesis and release it through respiration, creating biomass that is stored in soil or in the wood, branches and roots of the tree. For that reason, forestry and woodland are crucial to reducing the amount of carbon dioxide in the atmosphere and landowners can play a large role here by offsetting their and other sectors' emissions through tree planting.

Currently around 3,781 million tonnes of carbon are stored in the UK's forests and woodland, 75% of it in forest soils, and tree cover accounts for up to 13% of total land use.[36] For context, the annual emissions of the UK in 2017 were 460.2 million tonnes of carbon dioxide equivalent. Ambitious government targets and recommendations from the Committee on Climate Change would see tree cover increase to 17-19% of total land use.

What does a farm system with forestry and woodland incorporated look like?

'Forestry and woodland' in the broadest sense can cover commercial forestry, amenity woodland, small copses, trees for biomass, agro-forestry, hedgerows and shelter belts. Many CLA members are engaged in forestry and woodland in one way or another and by incorporating trees on farms we can help achieve the Committee on Climate Change's large targets and contribute to the net-zero goal.

Discussion points:

Which sequesters more carbon – trees or soils?

Trees sequester more carbon than soils, however the picture changes slightly when looking at the difference between *sequestration* of carbon and *storage* of carbon. A young, fast-growing forest has *high sequestration potential* as it will continue to sequester carbon as it grows, but *low levels of carbon storage,* given that it has not had enough time to build significant stocks of carbon. An old, mature forest that is no longer growing at a rapid rate has *low sequestration potential* as it is unlikely to continue to absorb large amounts of new carbon, but *high levels of carbon storage* given that it has been absorbing and storing carbon for a long period of time.

Soils are similar – if they are currently degraded and have *low levels of stored carbon*, good management can increase their *sequestration potential*. Soils in good health have a *low level of sequestration potential*, as they will be close to reaching equilibrium. They have *high levels of stored carbon*, however, and so should be protected.

While soils currently *store* more carbon than trees in the UK, on a hectare by hectare basis trees will always have far greater *sequestration potential* than soils, particularly new planting and young forests. In 2017, woodland in the UK sequestered, on average, 5.66 tonnes of CO_2e per hectare, while permanent pasture sequestered 0.78 tonnes of CO_2e per hectare.[37] Comparably, cropland emitted, on average, 1.87 tonnes of CO_2e per hectare.

The concept that permanent grassland would have to be 'ploughed up' for trees and lead to large soil carbon losses is not necessarily accurate, as widely accepted woodland planting techniques require little soil disturbance, and ultimately any soil carbon lost will eventually be replaced through the tree's natural sequestration processes. Soil disturbance is taken into account when assessing the carbon sequestered and stored in trees through the Woodland Carbon Code.

What does 'right tree, right place, right time' actually mean?

This phrase is often wheeled out to make the point that trees can't necessarily be planted everywhere, that provenance and species mix must be carefully considered, and that thought should be given to future land use and resilience in light of a changing climate. Naturally, it will mean something different depending on the geographical situation and farm system or type. It should arguably be extended to include 'and for the right reasons.' Different woodland plantings will deliver different environmental benefits – the right woodland for carbon sequestration may not be the right woodland for biodiversity, or landscape value or flood alleviation.

Wood in construction

The end use of harvested forestry and woodland is of critical importance to reach net-zero. Sawn timber produced in sawmills for construction is considered to be the most carbon-efficient end use of timber as it both substitutes high embodied carbon products such as concrete and steel, as well as providing long-term storage of the carbon sequestered while the tree was growing.[38] When looking at afforestation targets, it will be important to consider the end use of commercial forestry and prioritise high-quality timber for construction over bioenergy.

9. WHAT DOES NET-ZERO MEAN FOR PEATLAND?

Key messages:

- Peatland covers 12% of the UK in upland and lowland situations. It stores 20 times as much carbon as the UK's forests and has the capability to continually sequester and store carbon perpetually, however, due to the degradation of the soil and draining for agriculture it is currently a net-emitter of greenhouse gases.
- In many areas of the UK, lowland peat is highly productive agricultural land, so it is important that if re-wetting is considered an option, the risks and benefits are fully explored. In many areas, it will not be feasible to rewet peatland or it will come at the expense of food production.
- More research and development into paludiculture in the UK is necessary to find ways to both restore peatland and maintain production levels.

Peatland is an extremely important asset to the UK from a carbon storage perspective, but also for biodiversity, flood risk management, water quality and agricultural productivity.[39] Peat takes thousands of years to form as plant material decays slowly in wet conditions and is compressed into peat. Waterlogged soils prevent carbon binding to oxygen and thus escaping into the atmosphere as carbon dioxide. 80% of the UK's peatlands have been drained to allow crops to grow and livestock to graze. This has led to a large amount of degradation and has turned peatland into a carbon emitter, as opposed to a carbon sink.[40] The Committee on Climate Change pathways for peatland involve restoring between 50-75% of upland peat and 25-50% of lowland peat, in an effort to reverse this.[41]

There are large differences in the costs of restoration for upland and lowland peat, with land value and historic practices making upland peat cheaper to restore, by comparison.[42] The UK has also developed the Peatland Code, a voluntary certification standard setting aiming to quantify the carbon benefits of restoring peatland to allow access to carbon markets.[43] The Peatland Code is still a relatively new scheme, with just three schemes validated – two in Scotland and one in Wales. A number of projects in Yorkshire are under development.[44]

Lowland peat

Lowland peat in the UK is extremely fertile and profitable agriculture land, used primarily for horticulture and cropping. Widescale restoration of lowland peat would make conventional agriculture no longer viable and would greatly impact food production in the UK, as demonstrated in the 'Farming in the Fens' discussion point. The primary barrier preventing the restoration of farmed peatland is the lack of similarly productive land available elsewhere. Management techniques, including ensuring peatland soils are not left bare and seasonal raising of the water table, can go a significant way to preventing further degradation of lowland peat.

Upland peat

Upland peat is also used for agriculture, dominated by livestock grazing. Upland peat bogs are headwaters for some major drinking water sources, storing fresh water and releasing it in summer, helping to maintain water quality and alleviate flood risk. Healthy peatlands provide much cleaner water than degraded ones. The Committee on Climate Change recommends a ban on rotational burning with immediate effect, to be replaced by practices such as heather cutting to manage vegetation.[45] Currently, rotational burning is used on upland peat areas to manage habitats for grouse, burning off old vegetation and allowing for new growth to come through. There is some scientific uncertainty on the impact of burning on carbon stores, biodiversity and restoration efforts, with the Moorland Association in favour of rotational burning and the IUCN UK Peatland Programme, made up of government and non-government organisations, against rotational burning.[46]

Discussion points:

Farming in the Fens

The Fens in the East of England is an example of where peatland, agriculture and climate change intersect. The Fens account for nearly half of the most productive 'grade 1' agricultural land in England, with nearly 40% of England's vegetables grown there. The productiveness of the land is due in large part to the fertile peatland soils that have been drained for agriculture for hundreds of years. Due to the draining and farming of the Fens, it is estimated that the area emits over 100,000 tonnes of carbon dioxide per year.

While this area is a significant carbon source, it effectively demonstrates the difficulties around peatland and agriculture. For climate change mitigation purposes, the best thing to do would be to rewet the peat and allow it to return to as near-natural a state as possible, sequestering and storing massive amounts of carbon. However, agriculture is extremely important in this area, generating £2.3 billion for the UK economy. The highly-productive soils mean the area produces vast quantities of food and it is unlikely this production could be replicated elsewhere in the country. If the Fens were re-wetted, the UK would have to rely heavily on imports of vegetables, grains and bulbs, potentially contributing to a net increase in carbon emissions globally.

Paludiculture

Paludiculture is the practice of agriculture and forestry on wet land, or peatland. It aims to rewet peatland and transform it into productive agricultural land. Potential paludiculture crops species could provide products spanning food, medicine, insulation, biomass and construction materials. Sphagnum moss is currently being grown as a replacement for peat in composts, and the Great Fen project is looking at growing bulrushes for biomass and home insulation.

10. WHAT DOES NET-ZERO MEAN FOR ENERGY & HOUSING?

Key messages:

- The energy sector contributes 24% to total UK emissions. Landowners can greatly help the energy sector reduce emissions, by providing land for renewable energy construction, including solar PV, wind or hydro-power, or growing biomass feedstocks to displace fossil fuels.
- 'Residential' emissions account for 14-15% of total UK emissions. While these emissions are across the whole of society, not just landowners, for those with traditionally constructed buildings, reducing these emissions can pose a particular challenge.

On-farm renewable energy – wind, solar PV, micro-hydro systems

Many farms and rural businesses have installed renewable energy in recent years encouraged by Government incentives, rising energy costs and the falling cost of technology. Some do so to cover their own energy supplies and others are able to produce more power than they need and can sell it back to the grid.

The Feed-in-Tariff (FIT) scheme, a very popular government programme that aimed to promote the uptake of renewable and low-carbon electricity generation technologies, was available to landowners who installed systems, but closed to new applicants in 2019. A new scheme, the Smart Export Guarantee (SEG), took effect from January 2020 however this scheme has so far not achieved similar levels of uptake, partly due to the fact that there is no minimum floor price and the guidelines on pricing are less clear.

Wind turbines: single wind turbines can be installed on farms with minimal impact on the wider farm business. They require an area of land with a high average wind speed, usually on top of a hill, separation from neighbours as they can be noisy, connection to the grid and planning permission. Given their visibility, they are difficult to gain permissions for in designated areas.[47]

Solar power: solar photovoltaic (PV) panels have reduced in price over the last few years so are still relatively popular for landowners, despite the reduction in subsidies. Installation of solar panels is a permitted development so does not require planning permission. Solar farms, the large-scale application of solar PV panels, can cover between 1 acre and 100 acres and are considered one of the most 'nature friendly' ways of generating power as they make no noise or waste, can be installed within existing farms providing shelter for livestock and support biodiversity. [48]

Micro-hydro systems: for landowners on waterways, there are options to either refurbish or build hydro schemes, for example water mills. These are eligible for the SEG, however landowners require planning permission, an abstraction licence to divert water and connection to the grid. There can be some impacts on aquatic life and the wider environment, however many of these schemes have stood the test of time, with water mills installed in the 1800s still in use today.[49]

Ground source heat pumps: ground source heat pumps harness the heat underground and using it to warm a house. They require significant upfront capital to install (£13,000-£20,000), but last a long time and provide an equal distribution of heat – saving carbon dioxide emissions and money. Ground source heat pumps only provide energy for home heating, so are not eligible for government schemes like FIT or SEG.

Biomass, bioenergy and anaerobic digestion

When managed and harvested in a sustainable way, biomass can directly displace fossil fuel emissions. Biomass feedstocks can include crops grown specifically for energy (e.g. miscanthus), forestry residues from thinnings, agricultural residues (straw, rice husks) and organic wastes (manures, slurry). These feedstocks can be combusted to produce heat and power, or processed into a range of gases or liquid biofuels for use across the energy system through anaerobic digestion. Bioenergy crops can also provide net carbon benefits for soils.

The Committee on Climate Change has recommended for 5-15% of the UK's energy demand to be met by bioenergy by 2050, with an increase in crops from 10,000 hectares to 1.2 million hectares.

There is potential for biomass to deliver negative emissions as it absorbs CO2 from the atmosphere as it grows, so long as the rate of biomass growth exceeds the rate of biomass removed. There is even greater potential when you combine bioenergy with carbon capture and storage (BECCS). BECCS uses biomass to generate energy, captures the CO2 emissions from combustion and permanently sequesters and stores them geologically – that is, underground or in rocks formations.[50] BECCS is often seen as a crucial way we will reach net-zero, however as of yet the technology does not exist for it to be deployed at scale.

Housing

In 2017/18, there were 24 million households in England, with 21% built of traditional construction. These properties pose the greatest energy efficiency challenge and make up the largest proportion of our members' portfolios.

Energy use in homes accounts for about 14-15% of UK greenhouse gas emissions.[51] These emissions need to fall by at least 24% by 2030 from 1990 levels, but are currently off track.

The Government has so far focused regulations on the private rented sector (PRS) through the Minimum Energy Efficiency Standards. This is because the private rented sector has the largest proportion of "inefficient" homes due to being more likely to be off-gas grid.

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Alice Ritchie
Climate Change Lead
alice.ritchie@cla.org.uk

For further information please contact:

CLA 16 Belgrave Square
London SW1X 8PQ

020 7235 0511
www.cla.org.uk