agrecalc

SAC CONSULTING

Q&A:
Farm greenhouse gas emissions

1. Which greenhouse gas should agriculture focus on reducing?

All GHG's should be tackled as part of any climate change reduction plan. There are three main GHG (greenhouse gases) produced by agriculture: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N2O). On farm, carbon dioxide largely comes from fuel and energy use and emissions from creating inputs such as fertilisers. Methane is associated with livestock production (especially enteric fermentation) and how manures are stored and applied. Nitrous oxide is a result of crop residues and fertiliser use. On a whole farm, the emissions from a livestock farm may be largely from methane, compared to an arable farm where they may be mostly from nitrous oxide and carbon dioxide.

To illustrate this, the agricultural greenhouse gas picture for Scotland is different from England, with England having a greater proportion of nitrous oxide emissions (from a larger share of arable land) and Scotland's major source of agricultural emissions from methane (associated with dominance of ruminant livestock production). This therefore influences national and farm-level interventions for greenhouse gas mitigation.

2. There is a lot of talk about 'net-zero' – what would net zero farming look like and is it achievable?

The 'net' in 'net zero' means the balance of sources and sinks of carbon. Given current technology and financial incentives, its not clear how the agricultural sector will be able to reach absolute zero emissions yet. 'Net zero' farming involves reducing emissions as much as possible and continually reducing them as new technologies come in, and then offsetting the remaining emissions. Offsetting emissions may involve planting trees on farm or paying for carbon credits, which will involve a third party removing emissions from the atmosphere through land or other strategies.

For further information on the challenges and options for meeting net zero in agriculture see:
https://www.cielivestock.co.uk/net-zero-carbon-and-uk-livestock/

See question 7 for more detail on reducing emissions on farms.

3. How does an extensive system compare to intensive in relation to carbon? Which is better from an emissions perspective?

There is no single answer to intensive versus extensive emissions with regards to which is best from an emissions perspective, as there are so many influencing factors. Intensive systems may finish livestock faster and enable greater control over efficiencies in production (e.g., feed conversion efficiencies and emissions from enteric fermentation), but must then factor in the carbon costs of production of the feed, land use change associated with that, energy and bedding for housing etc. Intensive livestock systems are likely to have fewer opportunities to sequester carbon in soils or to free up land to plants trees than more extensive ones. Intensive systems may have greater emissions per hectarage, but comparable or lower per kg output (on a liveweight or deadweight basis) in relation to extensive systems, which will have a greater hectarage requirement, lower inputs but given the longer finishing time, stock will be on farm a greater number of days, and will therefore have more days where they are producing methane compared to a more intensively finished animal.

While there is also the question of competition of land use for human edible feed sources (i.e., land used for livestock feed production could be used for human edible food), in general, 85% of Scotland is only suitable for grazing livestock.

It's also important to distinguish between environmental benefits and carbon benefits when discussing carbon footprints; while carbon footprints are part of the picture of environmental impact, there are many aspects of environmental benefits that aren't included in a carbon assessment, therefore a wider evaluation should be considered. In addition, the carbon footprint does not take into account the 'carbon opportunity cost' of land use. For instance, land used for grazing could be used for planting trees (or other land use), which would have different carbon footprint outcomes.

It therefore requires taking an overall picture, with a balance of optimal land uses and efficiencies between and within extensive and intensive systems.

4. What role does soil carbon play in a farm carbon footprint?

On farms, soil carbon can be increased or decreased depending on the use of the land. All soil has existing (resting) carbon stocks, i.e. a natural level of carbon in the soil, which is determined by climatic factors such as temperature, moisture content, as well as mineral composition and soil texture.

Generally, the soil carbon stocks in the UK vary between approximately 80–120 tonnes carbon per hectare to 30cm depth. Changes in the management of the land may affect whether these resting soil carbon stocks are maintained, increased, or depleted.

Agriculture is part of a natural carbon cycle, where carbon in the atmosphere is captured in plants and recycled to the atmosphere through livestock and animal consumption or natural breakdown. Without interference the system is in a carbon balance, with soil carbon stocks being maintained. As this (biogenic) carbon is recycled relatively quickly into the atmosphere the growth of plant material on its own cannot usually be considered as sequestration. Agricultural practices affecting this system can alter the amount of carbon 'recycled', resulting in either carbon sequestration or carbon loss, depending on the practice.

The principle used by IPCC is that changes in agricultural practice that lead to changes in soil carbon stock levels will; if maintained, take effect over a 20-year period. After year 20 it is assumed that the soils have reached a new equilibrium of soil carbon stocks (higher or lower) and that no more soil carbon sequestration will then take place from this change in management practice. In reality, it is accepted that soil carbon changes may not occur evenly over a set time period and the length of time this change occurs may vary widely too. However, in order to make carbon estimates workable at the farm level a simplification of complex soil carbon interactions is considered necessary. For this reason, Agrecalc has adopted the current IPCC methods.

Carbon sequestration is not an infinite process – soil will not keep absorbing carbon indefinitely, no matter how you manage it. All soils will have a natural maximum carbon threshold, based on the soil type, characteristics, structure and management, just as soil organic matter will increase to a point but reach a maximum potential percentage individual to that type of soil. This is described as the soil reaching 'carbon saturation'.

5. Does grassland sequester carbon?

Carbon sequestration is when carbon dioxide is removed from the atmosphere and stored in either a solid or a liquid form. As growing crops including grass use photosynthesis to produce their food, they remove carbon dioxide from the atmosphere and at the same time create the oxygen we need to breathe. Through this chemical process, carbon is sequestered in the soil.

As part of the natural cycle, grass and the carbon stored is removed by grazing animals, who in turn return the carbon back into the atmosphere or soil either as enteric fermentation or as manure. The portion of the grass not eaten by stock or removed by harvesting machinery, together with the roots, will in time decompose, and the carbon will then be stored in the soil.

Therefore the ability for grassland to sequester carbon in the soil depends on grassland management practices, forage utilisation, stocking density, reseeding practices, as well as land use factors such as the length of time it has been in grassland, and the soil type. In some cases management practices may deplete the soil carbon, or the soil may reach a point of carbon balance where soil carbon can no longer be increased without further beneficial management practices.

6. How can farmers and growers influence grassland carbon sequestration?

Starting from the ground up, soil health plays an important role in carbon sequestration because in general soils with a good structure have been found to have higher levels of stored carbon. From a crop perspective, good grassland management will reduce the need for reseeding and will allow more organic matter to build up.

While grazed pastures have the potential to sequester more carbon compared to grass used for silage or hay, it is important to manage grazing fields effectively to maximise grass utilisation, mimimise wastage and to ensure that stock do not poach areas of grassland, thereby reducing its productivity, damaging soil health and ultimately necessitating some form of reseeding. The denser the sward, the greater the capacity for carbon capture and storage.

7. What things can a business look at to reduce its carbon emissions?

The first step a farm can make to reduce its emissions is to measure them with a carbon tool. This will give a baseline from which to monitor progress. The results should then enable the farm to assess its use and emissions from farm energy use and sources, fertiliser use, precision agricultural activities, manure management, livestock performance and efficiency amongst other land and soil-based management activities.

Areas of high emissions and use may identify areas for improvement, and many mitigation strategies increase efficiencies and therefore carry financial as well as environmental benefits. Effective strategies for one farm may not be effective on another farm, so specialist advice from a farm advisor may be helpful to identify actions that are best suited to the individual farm.

Because different farms will have different mitigation opportunities, consultants examine farm-specific opportunities with farmers. **The Farming for a Better Climate website** also provides advice and resources for farmers wishing to assess and improve their carbon footprint.

8. Surely my business's carbon footprint does not matter if I have a lot of trees or plan to plant a lot of trees – can't I just offset the carbon emissions from the farm against the trees?

The answer to this comes down to what we are trying to achieve on a grander scale. While for now the 'net' in 'net zero' is the target, but immediately after net zero is achieved, nations will have to aim for absolute zero emissions (i.e. stop emissions, not just offset them). Given current technology, the agricultural sector will not be able to reach absolute zero emissions yet, so our aim is to get to the point where we've done everything to reduce emissions as much as possible and then offset the remaining emissions; reducing emissions as much as possible is key.

In addition, emission-offsetting strategies such as planting trees are effective but there is the issue of permanence. To truly offset the emissions, the trees must survive for 100+ years (based on science from the IPCC). We cannot guarantee that all trees planted to offset an entire industry's emissions will survive that long (due to disease, forest fires, timber production or land use change). It is therefore more effective to reduce emissions as much as possible before relying on tree planting. Because of this, in the future farmers may be incentivised to reduce emissions rather than just offset emissions. Under IPCC and supply chains standards such as PAS 2050, woodlands are not generally considered part of the agricultural system as their management is unrelated to the production of agricultural products. The main exceptions include; trees and hedges for sheltering crops and livestock and silvo-pastoral or silvo-arable systems where trees are purposefully planted to support agricultural production.

9. Do governments comprehensively/properly account for/attribute the full picture of carbon sequestration and emissions on farms?

Due to how carbon is accounted on a national scale in the UK's Greenhouse Gas Inventory, farm woodlands and renewables are classified as non-agricultural activities. This means that the carbon benefit is attributed to LULUCF (Land Use, Land Use Change and Forestry) and Energy sectors respectively.

Agrecalc calculates whole farm emissions, including calculating the carbon sequestration from woodlands and soil carbon, and energy generated by on-farm renewables. This allows the user to measure and monitor the footprint of these, as part of the whole farm picture. Renewables generated and used on-farm are included in this. As renewables have a lower carbon footprint than grid electricity, emissions from farm energy use associated with enterprises will also be reduced.

While farm woodlands may currently be considered part of the LULUCF, agroforestry is one way in which trees would be considered part of agriculture, according to the GHG Inventory. See question 8 for further information.

10. Is the carbon footprint of organics greater than non-organics?

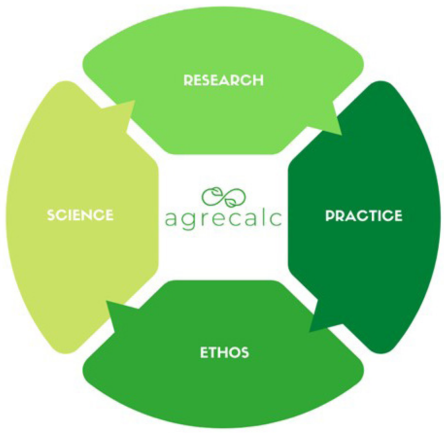
Organic production doesn't necessarily have higher emissions than conventional/non-organic production, and the results depend on whether you look at emissions per unit of output or by the area of the system. For example, some organic crops have lower per kg output emissions due to restrictions on fertiliser and pesticide use and comparable yields to conventional systems. However, other crops, such as potatoes, have higher emissions largely associated with non-organic dehaulming options.

For livestock, beef, sheep and pigs have a greater proportion of extensive rearing and have lower per kg output emissions linked to housing, whereas poultry, dependent on imported organic feeds, has greater per kg output emissions.

The main factor is that due to lower output per ha, which is common in organic systems across most but not all enterprises, a greater area of land is required to produce an equivalent output on a smaller area in a conventional system. As such, due to the land use change factor, Smith et al, 2019 found that in a scenario where all farming systems switched to organic across the country, national emissions from farming would increase.

For further information see:
Smith et al, 2019: http://centaur.reading.ac.uk/86974/1/s41467-019-12622-7.pdf

11. How much of carbon footprinting is science-based, and how much is down to the interpretation of the footprinting tool? Do tools factor in the most recent science or rely on established, consensus-based science?

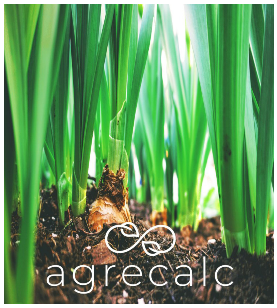


Agrecalc, and other footprinting tools, use standard farm data such as livestock numbers, types of feed, fertiliser use and technical performance etc. as data inputs to calculate the carbon footprint of a business. This data is used in calculations that are based on consensus-based science and where available the findings of recent scientific research projects. Agrecalc is continually being revised and updated/improved to increase its accuracy and reliability based on the most recent science and guidance from the IPCC (Intergovernmental Panel on Climate Change) and other research bodies. This ensures the calculated carbon footprints are comparable with other tools using consensus-based science. If benchmarking year-on-year, however, it is recommended to use the same tool to ensure consistency in the assessment and maximum benefit in evaluating results.

The set of calculations behind SRUCs Agrecalc are complex, reflecting the complexity of interactions of farm inputs, processes and outputs. Data going into Agrecalc is usually entered by the farmer (or their chosen consultant) from their farm records. Where individual farm data is not currently available, Agrecalc can use industry standards to ensure that the carbon audit can be completed, although the more detailed and accurate data is entered, the more accurate the assessment will be.

The new platform of Agrecalc, due for release in 2021, will indicate the level of accuracy of the footprint of the farm based on the data that has been entered versus the use of industry standard data points and empty cells during data entry.

12. What are the benefits of using Agrecalc, over other tools?



Agrecalc provides emissions for the whole farm, per enterprise and per unit of saleable product, providing detailed results to enable the user to identify areas for both resource efficiency and enterprise profitability, with potential financial saving as well as emissions reduction.

Agrecalc is also one of the few tools that provides detailed benchmarking, so the user can benchmark their footprint against similar farms to compare business and enterprise strengths, as well as produce year-on-year comparisons for their farm to monitor changes and progress.

Validation of data is built into the tool to ensure the most accurate benchmark data. Once a farm report has been validated by the Agrecalc team, it can be used to create 'What-if?' scenarios to assess options for reducing carbon or resource use, and optimise farm performance.

Agrecalc is PAS 2050 certified, meaning it has been reviewed and verified by a third party on its use of the internationally applicable method for quantifying product carbon footprints. This method is from IPCC guidelines.

For an independent comparison of the key farm greenhouse gas calculators see: **https://www.climatexchange.org.uk/research/projects/comparative-analysis-of-farm-based-carbon-audits/**

13. What improvements is Agrecalc making to the tool, in terms of usability and carbon science?

Agrecalc is continually under review to ensure that the majority of farm sizes, types, farming systems and the wide range of inputs used are catered for, and through continual consultation with farmers and consultants, to ensure ease of use. The Agrecalc tool now has the ability to assess on farm soil carbon sequestration as well as sequestration linked to farm woodlands and forestry.

Given that soil carbon fluxes (emissions and sequestration) depend on many factors and can be calculated / interpreted in ways not recommended by consensus-based science, it is important that carbon emissions and sequestration from agriculture are calculated using consistent, internationally approved methods so that results are comparable and reliable.

Agrecalc continually reviews the consensus in the scientific community to stay up to date as more research helps make carbon footprints more accurate, and is currently developing Agrecalc to incorporate up-to-date research findings as they are published.

Glossary

Greenhouse gas (GHG) = Gases that increase the global warming effect, through trapping more heat within the Earth's atmosphere. These include: carbon dioxide, methane, nitrous oxide, ozone, and various others. A certain level of greenhouse gases in the atmosphere is natural and necessary to maintain human life on Earth, but additional manmade (anthropogenic) greenhouse gas emissions is warming the planet to a dangerous level, and risks affecting entire ecosystems globally. Pre-industrialisation, CO_2 levels were at 280 ppm (parts per million), and are now around 410 ppm.

Carbon dioxide (CO_2) = The most common greenhouse gas and main cause of manmade (anthropogenic) global warming. Unlike other industries where CO_2 is the dominant greenhouse gas, in agriculture methane and nitrous oxide are just as important. One kg of elemental carbon is equivalent to 3.66 kg of CO_2e.

CO_2e = To simplify how we talk about greenhouse gases collectively, the gases are expressed in CO_2 equivalent (CO_2e). Per unit, methane and nitrous oxide have a greater global warming effect than CO_2 (x25 and x298 times respectively), which is accounted for when calculating CO_2e.

Methane = The main greenhouse gas associated with livestock (particularly ruminant) production. Methane is emitted by enteric fermentation (see below) as well as manure storage or deposition and disturbance of anaerobic environments such as peatland. It has around 25 times the global warming effect as CO_2.

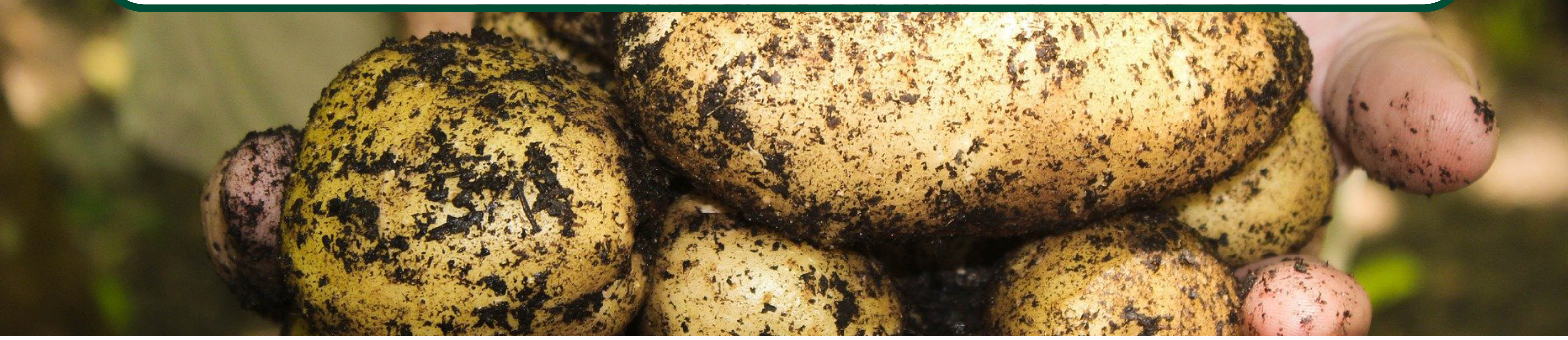
Nitrous oxide (N2O) = The main greenhouse gas associated with crop production, and emitted from practices such as fertiliser and manure application and crop residues. It has around 298 times the global warming effect as CO_2.

'Carbon' footprinting = The practice of estimating the greenhouse gases emitted by a process or system, such as of a whole farm. While the term 'carbon footprinting' is often used due to the predominance of carbon dioxide as a greenhouse gas, most agricultural 'carbon footprints' include methane and nitrous oxide and express emissions in CO_2e.

Enteric fermentation = The digestive process in ruminant livestock used to break down plant materials in the rumen. Enteric methane is a by-product of this process, and emitted from the animal largely through burping. It is one of the major sources of emissions from ruminant livestock production.

Carbon sequestration = The process of storing. 'sinking' or 'capturing' carbon, such as through increasing soil carbon or in woodland planting. By IPCC definition, the process must involve storing the carbon in a long-term solution (standard definition of more than 100 years) to be considered carbon sequestration.

Net-zero/carbon neutral = Where GHG emissions of one activity within a system or industry are balanced by offsetting from another activity, resulting in an overall balance of zero emissions. E.g. emissions from a beef herd being offset by an area of woodland planting within a farm system could be described as net-zero. This is not the same as zero carbon.



Glossary

Zero carbon = Where emissions from an activity or system are eliminated completely. This is much more difficult than net-zero, and arguably impossible in many systems, including agriculture. The current focus is on net-zero as it is technically much more achievable, though zero carbon may be a long-term global goal, beyond achieving net-zero.

IPCC = The Intergovernmental Panel on Climate Change, an independent international body. It is comprised of thousands of the world's leading scientists and experts on climate change, who assess research and identify global standards on climate change.

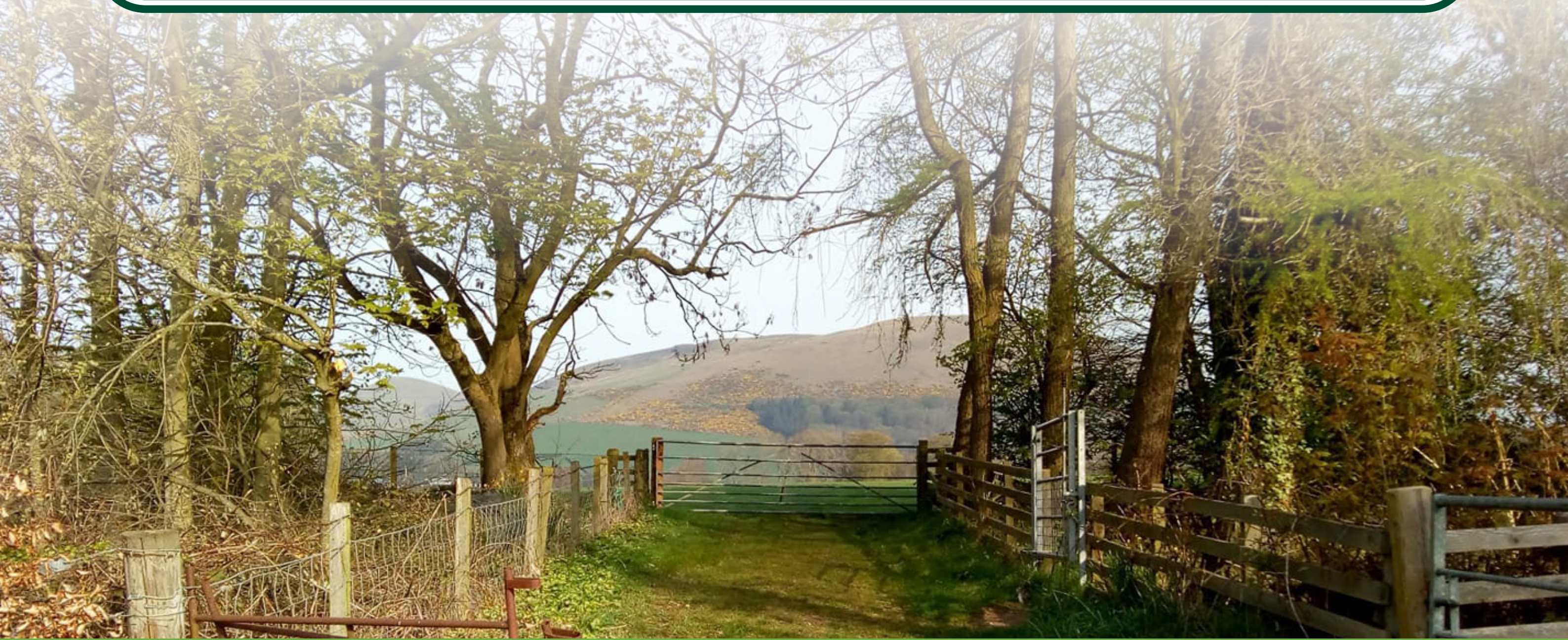
COP26 = The 26th Conference of the Parties, an annual summit on climate change which is held every November to discuss, review and agree global climate targets and strategies. It is due to be held in Glasgow this year, having been postponed from 2020. Previous COPs have seen the signing of international agreements for global GHG emissions reduction targets, such as the Paris Climate Agreement.

PAS 2050 = A supply chain standard, developed by the British Standards Institute, to provide a method for quantifying the carbon footprints of products that is internationally applicable. Most but not all agricultural greenhouse gas footprinting tools comply to PAS 2050 standards. For further information see: **https://ghgprotocol.org/sites/default/files/standards_supporting/GHG%20Protocol%20PAS%202050%20Factsheet.pdf**

GWP100 = Refers to the methodology used for calculating the global warming effect of methane over 100 years, in line with the methodology for assessing carbon dioxide. GWP100 is the standard methodology for most carbon footprinting tools.

GWP* = Refers to a newer methodology than GWP100, which better represents the short term effect of emissions from gases such as methane (which have a greater short-lived effect, but lesser long-term effect), rather than averaging over a 100 year period. For further info see: **https://www.carbonbrief.org/guest-post-a-new-way-to-assess-global-warming-potential-of-short-lived-pollutants**

For definitions of further carbon-related terms, see: **https://www.ipcc.ch/sr15/chapter/glossary/**



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