

Greenhouse Gas Emissions

Practical Guide

Greenhouse gases (GHG) trap heat within the earth's atmosphere. It is widely recognised that these GHG are contributing to changes in the global climate which is also being seen at a local level. For the agricultural sector, there are three main greenhouse gases of concern:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)

A *Global Warming Potential* (GWP) has been calculated for each gas to allow them to be compared. The GWP takes factors such as the length of time the gas lasts in the atmosphere and how much energy it absorbs. This then gives a guide to the warming influence of the gas relative to CO₂ over a 100 year period. The higher the GWP, the greater the warming effect. Generally the gases will remain in the atmosphere anything from a few years to thousands of years.

Emission figures take all the greenhouse gases and combine them into a measurement of emissions, taking into account their individual GWP's. On a national scale, this is often expressed as MtCO₂e and refers to million tonnes of carbon dioxide equivalent.

During 2015, Scotland's emission were estimated at 48.1 MtCO₂e. This represents a 37.6% reduction compared to the baseline year of 1990.

Our Practical Guides cover five useful topics:

1. Use energy and fuels efficiently
2. Renewable energy
3. Lock carbon into soils and vegetation
4. Making the best use of nutrients
5. Optimise livestock management

For more Practical Guides, Case Studies, information on our Focus Farms and ideas to benefit your farm, visit www.farmingforabetterclimate.org

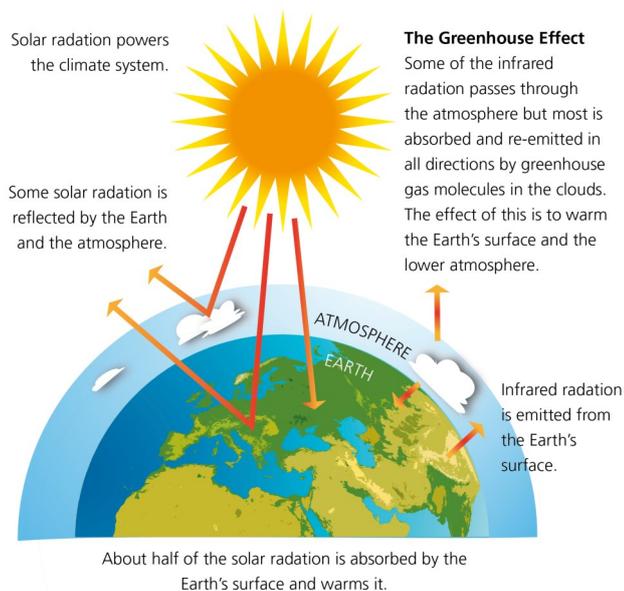
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www.ipcc.ch
www.agrecalc.com
www.soilassociation.org.uk
www.planet4farmers.co.uk
[www.gov.scot/
Publications/2017/06/9986](http://www.gov.scot/Publications/2017/06/9986)

Figure 1: The Greenhouse Effect



This Practical Guide looks at the main agricultural greenhouse gases and how farm emissions might be reduced.

Figure 1 — adapted from design by Gordon Struth, Head of Climate Change & Business Support Branch, Scottish Government, and used at a previous "Castlemains Climate Change Focus Farm" meeting.

Greenhouse Gas Emissions

Carbon Dioxide – CO₂

CO₂ has a GWP value of 1 and is released into the atmosphere through burning fossil fuels, solid wastes, trees and wood products.

In Scotland, the primary contributing sectors to this GHG are transport and electricity production. By increasing the amount of energy we produce from renewable sources such as solar PV, wind and Anaerobic Digesters, we are able to reduce our need to burn fossil fuels, and so reduce emissions.

The proportion of CO₂ produced from agricultural activity is relatively low. Woodland planting and agroforestry can help provide 'carbon sinks' to offset CO₂ emissions from agriculture and other sectors, whilst direct on-farm improvements, such as energy efficiency and use of renewables, can also help to reduce on farm emissions.

Cover crops or conservation tillage, for example min-till can also help reduce the impact of carbon loss through soils whilst providing improved conditions to boost soil organic matter which will continue carbon sequestration.



Climate change and livestock systems

Challenges and opportunities climate change will present for the Scottish livestock industry could include:

- ensuring buildings can cope with extreme weather events
- introduction of new breeds
- possible increased feed costs
- changes in breeding and lactation cycles
- changes in animal appetite and health
- increased veterinary costs due to longer disease seasons



Methane – CH₄

CH₄ has a GWP value of 25 and is the main greenhouse gas produced within the agricultural sector. Methane from agricultural sources accounted for just under three quarters of methane emissions within Scotland during 2015.

Methane can be released from habitats such as wetlands where bacteria release the gas as part of the natural decomposition of organic material. Other sources include gas leaks (natural e.g. volcanos & man made through energy production), waste management / refuse systems and livestock.

Ruminant livestock produce methane as a natural part of their digestive process. Losses also occur from the storage of their manure.

At farm level, improving farm waste management on livestock farms alongside maximum efficiency of production for livestock e.g. reduce the days to finish & maximising our efficiency from inputs are two of the key strategies to reduce the farm carbon footprint. The aim is to make sure each animal is performing at its optimum; maximising the trade off between natural emissions and improved productivity.

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Nitrous Oxide - N₂O

N₂O is the most potent GHG with a GWP of 298. Around 81% of Scottish N₂O emissions are attributed to the agricultural sector. Nitrous oxide molecules stay in the atmosphere for an average of 114 years. Although agriculture is the primary source of N₂O, other sources include waste water management, fuel production and chemical production.

Reduction from the agricultural sector can be achieved through enhanced soil management. N₂O is produced by the microbes within the soil and readily from soils where Nitrogen is available from fertilisers or farm slurry/manure applications.

When applied as an inorganic fertiliser, the N component needs to be converted into an organic form to allow plant uptake. Any N not converted is then susceptible to loss through either water soluble leaching (run-off) or gaseous release as N₂O or ammonia. Correct timing of application is key; N applied over and above the crop requirement, or applications in wet weather are particularly susceptible to loss. This is also a financial cost to the business.

Soil conditions will also have an impact on fertiliser use efficiency. Regular soil sampling, (ideally using GPS) will allow for a more detailed analysis of the soil pH and mineral loading and will allow for more accurate applications. Combining this with historic crop productivity records in different areas of a field will allow the application of N fertiliser to be tailored to those areas where it will have maximum impact to aid crop performance.

Correct soil pH will ensure that the nutrients applied will be accessible to the plants – if the pH is incorrect, the N applied cannot be accessed by the crop and will be lost (Figure 2).

Planting cover crops following harvest will help reduce potential nutrient leaching and soil run off during winter months. The biomass from these crops will also provide a benefit from the organic matter that will be incorporated into the soil. Adopting a min-till approach to cultivations can reduce the overall emissions from the soil due to soil disturbance and exposure to the air. Although the first few years of conversion to min-till systems may see slight reductions in crop production, the general trend shows that

thereafter there is an overall benefit to the crop from the increased soil microbial and organic content. Furthermore, if there is reduced traffic over the field, soil compaction can be reduced, thereby increasing the microbial habitat and reducing the waterlogging potential.

Figure 2: The effect of soil pH on nutrient availability

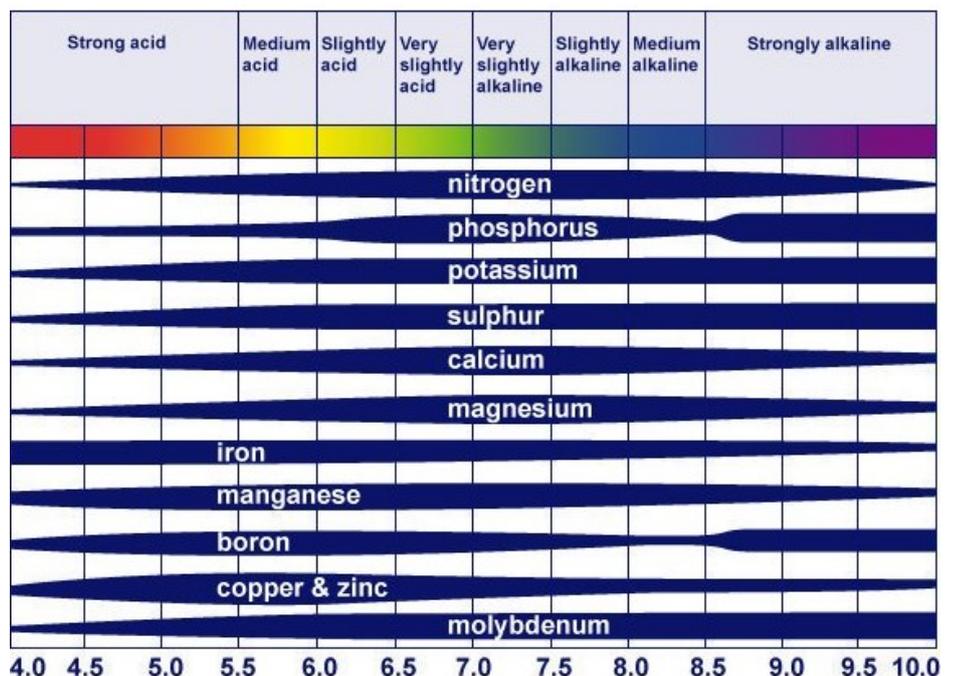


Figure 2 taken from: Rogues, S; Smith, K A; Newell Price, P & Berry, P.M. (2003) *Review of the non-NPKS nutrient requirements of UK cereals and oilseed rape*, HGCA is the cereals and oilseeds division of the Agriculture and Horticulture Development Board. (<https://goo.gl/Unfjm3>)

Greenhouse Gas Emissions

Key measures to reduce emissions on farm

Correct nutrient application management:

- Selection of delayed release fertilisers
- Improved fertiliser placement (close to roots v foliar) & timing (avoid applications to waterlogged soils or prior to forecasted heavy rain; avoid spreading during hot days and in bright sunshine)

Crop management:

- Regular soil sampling to address soil pH and mineral loading to allow for correct N compound selection
- Only apply N in response to crop requirements
- Crop variety - choose low N requirement varieties

Reduce soil compaction

- Use of cover crops to improve general soil health and prevent leaching

Manure management:

- Ensure sufficient & appropriate storage for livestock density
- Method of application – use of splash plate maximises losses whereas direct placement through the use of trailing shoe or injection provides nutrients directly to the crop roots where it is required
- Timing of application – avoid application outside periods of crop requirement, on waterlogged, frozen or snow covered ground and during bright and hot sunny days
- Explore options to export farm manure e.g. anaerobic digesters

Reduce manure N loading:

- Ensure feeding regime accurately meets the animal requirements
- Maximise efficiency of production to minimise losses throughout the system
- Ensure selected livestock breed suits farm location and situation



Carbon Footprints

Measurement of greenhouse gas (GHG) emissions associated with a product or activity is commonly termed a carbon footprint. **Farms with a low carbon footprint are often also most efficient.**

Carrying out a carbon footprint will help you to identify the key sources of emissions on the farm, and therefore which areas to target to improve farm efficiency. Knowing how you compare with other farms and where your key emissions are coming from could help you decide which mitigation measures will have most impact on your farm business.

Funding is available via the Farm Advisory Service (www.fas.scot) or see our website for more information on how to calculate a carbon footprint for your business.

How could reducing emissions benefit your farm business?

Improved farm efficiencies will result in less waste and more profit for the farm business. Taking action as a sector, both to reduce greenhouse gas emissions and to adapt to a changing climate, will secure farm viability for future generations and could also demonstrate positive action, removing the need for future regulations. Along with improving efficiency, identifying and reducing greenhouse gas emissions now could also help you access other markets or gain entry into other schemes.

Farming for a Better Climate (FFBC) provides practical ideas to benefit the farm and help reduce our impact on the climate. Find out more on our website www.farmingforabetterclimate.org, find us on Facebook or follow us on Twitter @SACFarm4Climate

