



Introduction to climate change and agriculture

Information sheet



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The global climate changes naturally over time due to the earth's orbit, variations in solar activity and volcanic eruptions. However, much of the change in climate over the last 100 years can be attributed to human activity and our impact on the greenhouse effect.

The 'greenhouse effect'

The 'greenhouse effect' is a natural process, without which surface temperatures would plummet and life on Earth as we know it would not exist. The living Earth depends on energy from the sun, approximately 30% of sunlight beamed towards Earth is deflected back in to space by the outer atmosphere; the remaining 70% reaches the Earth's surface and is reflected back as slower moving, long-wave radiation known as infrared. 'Greenhouse gases' in the lower atmosphere absorb and re-emit the heat caused by infrared radiation, trapping it within the atmosphere. This warms the lower atmosphere and Earth's surface and regulates the global temperature.

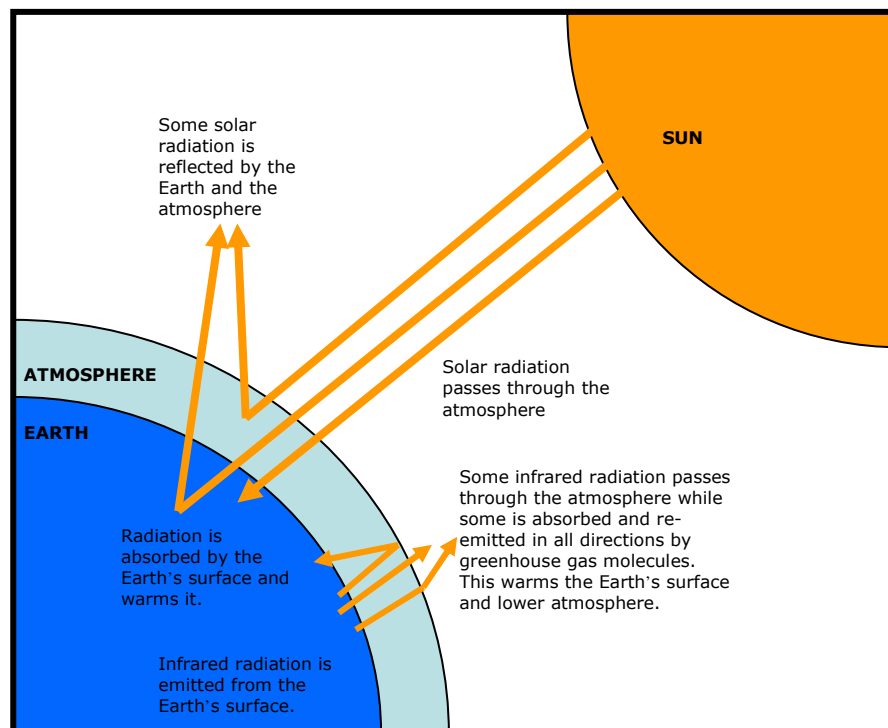


Figure 1: The greenhouse effect

The 'greenhouse effect' is essential in supporting our current ecosystems. Greenhouse gases are released by natural processes on Earth and are required to regulate the planet's climate system; however issues arise when the natural 'greenhouse effect' process is accelerated by higher levels of greenhouse gases in the atmosphere which are caused by human activity – the *anthropogenic greenhouse effect*. Higher levels of greenhouse gases in the atmosphere mean that more heat is trapped than is necessary to maintain an ideal surface temperature. Higher surface temperatures have a knock on effect on a number of other global processes and can lead to significant changes in climate and weather affecting cloud cover, precipitation, wind patterns, the frequency and severity of storms and the duration of seasons.

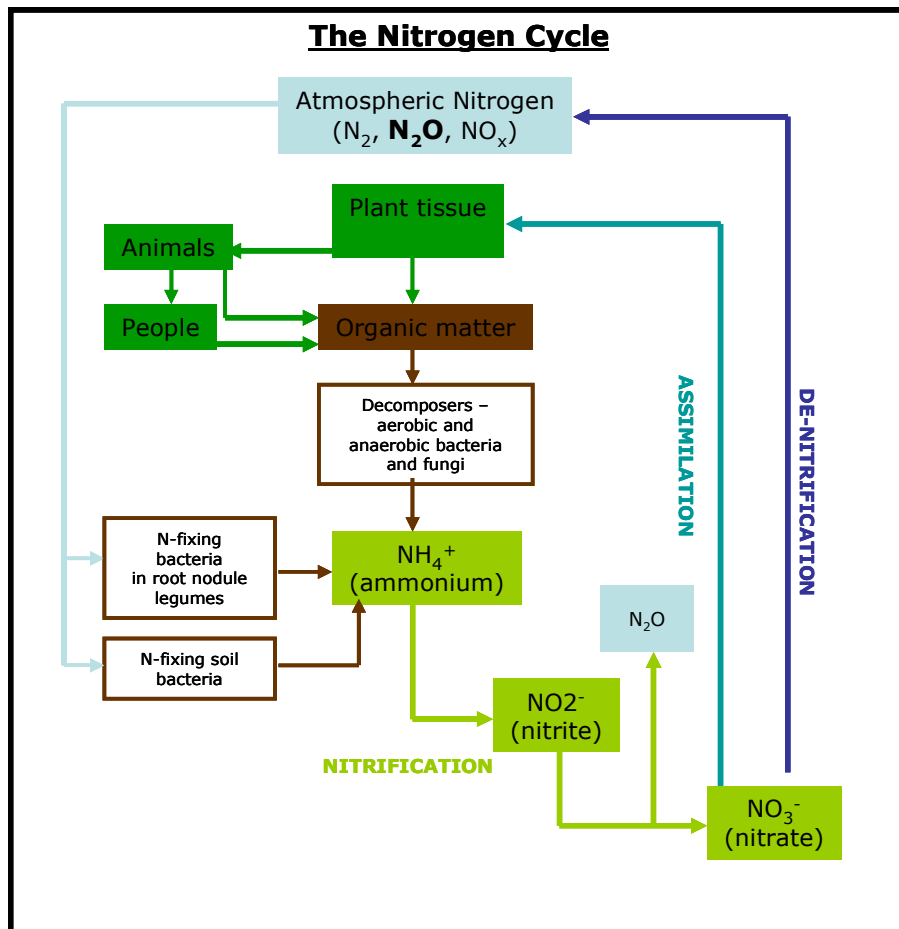
Greenhouse gases and agriculture

In 2008 the agriculture and land use sector was responsible for 48.4 tonnes of carbon dioxide equivalent – about 7.7% of all UK greenhouse gas emissions [1]. The majority of these emissions are caused by enteric fermentation and manure from livestock, and fertiliser and fuel use in farming. The remainder comes from natural carbon and nitrogen cycling which is influenced by the way land is used and managed. The Committee on Climate Change's Fourth Report published in 2010 requires the agricultural sector in England to reduce emissions by three million tonnes CO₂e (about 6%) by 2020 [1].

The main greenhouse gases emitted by the agricultural sector are methane (38%), nitrous oxide (54%) and carbon dioxide (8%). They are measured in relation to their Global Warming Potential (GWP) and expressed as carbon dioxide equivalents (CO₂e) – their potency compared to CO₂. Nitrous oxide and methane emissions from agriculture accounted for 47% of **all** UK non-CO₂ emissions in 2008 [1]. These figures are for the UK only and don't take into account emissions produced outside of the UK – for example emissions from feed production and the associated impacts on climate change.

Nitrous oxide (N₂O) has the capacity to absorb and re-emit approximately 298 times the amount of heat compared to carbon dioxide – it has 298 times the GWP of carbon dioxide. One kilogram of nitrous oxide is therefore 298 kg CO₂e.

Nitrous oxide is released during the production and use of manufactured fertilisers, The diagram below illustrates the chain of events in nitrogen cycling.



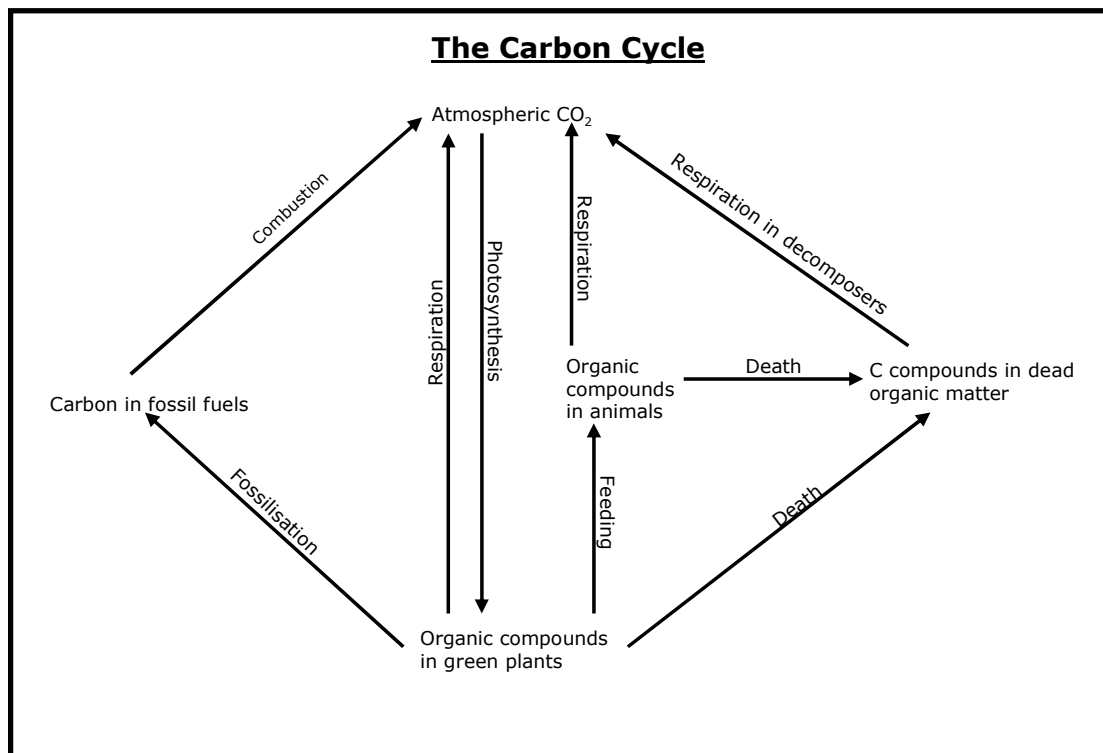
Two chemical reactions in the soil produce nitrous oxide. The process of *nitrification* can take place whereby micro-organisms in the soil transform ammonium (NH₄⁺) to

nitrate (NO_3^-) - nitrous oxide is a by-product of nitrification. A second process, *denitrification*, involves the transformation of nitrate (NO_3^-) (from the nitrification process or from the application of nitrate fertilizers) to nitrogen gas (N_2), and which nitrous oxide is again a by-product

Because nitrogen is such an important part of agricultural systems, the production of nitrous oxide cannot be eliminated from farming systems. However, nitrous oxide production (by nitrification and denitrification) needs to be controlled and reduced. This can be achieved through certain methods of manure and slurry application and storage; attention to accurate nutrient budgeting to achieve better nitrogen utilisation in crop and grassland production systems; and attention to drainage and soil management. High nitrous oxide emissions can occur when clover leys and other crop residues are ploughed in if no growing crop is present to take up the nitrogen that is released, this again needs to be considered and managed carefully.

Methane (CH_4) has 25 times the GWP of carbon dioxide and is therefore 25 CO_2e . It is released from the digestive systems of ruminant livestock by a process known as *enteric fermentation* and from manures and slurries. Similarly to nitrous oxide, it is not possible to eliminate methane production from agriculture but emissions can be reduced through improved livestock health, breed selection and careful modifications to the diet and methods of manure storage and application. Increased production efficiency will mean that less methane is emitted per unit of production so careful management to optimise production will also help reduce emissions.

Carbon dioxide (CO_2) is an inorganic form of carbon cycled through photosynthesis and respiration.



The cycle of photosynthesis and respiration is crucial to sustaining life so it is the other processes which release carbon dioxide which need to be addressed. In agriculture, carbon dioxide is released from the burning of fossil fuels (e.g. fuel in farm vehicles and machinery, electricity production for use on farm and the production of agri-chemicals), and when soils are disturbed following cultivation or land use change.

Levels of carbon dioxide in the atmosphere can also be influenced by carbon sequestration. This is the removal of carbon dioxide from the atmosphere to pools where it is stored securely and not re-emitted for some time.

Woodland, forestry, soils and farm infrastructure such as hedges and margins all sequester carbon. Their removal or disturbance releases carbon dioxide. Agricultural systems have huge potential to sequester carbon which has a significant impact on carbon balances and can counter the impact of emissions from other sectors. The soil carbon store is an aspect of agriculture frequently overlooked, however IPCC advisors suggest that 90% of GHG mitigation potential in global agriculture resides in improving soil carbon levels [2].

Carbon sequestration can be increased by raising levels of soil organic carbon in soils. This can be achieved through soil management practices which add organic matter to the soil, reduce soil disturbance, improve soil structure, enhance soil fauna activity and species diversity, and conserve soil water. A welcome by-product of these soil management practices is higher crop yields and improved production efficiency.

More detailed information and advice on greenhouse gas mitigation can be found on our [website](#).

References

[1] **The Fourth Carbon Budget – Reducing emissions through the 2020's.** 7th December 2010. *Committee on Climate Change*. [online: <http://www.theccc.org.uk/reports/fourth-carbon-budget>]

[2] **Soil carbon and organic farming.** November 2009. *Gundula Azeez, Soil Association*. [online: <http://www.soilassociation.org/LinkClick.aspx?fileticket=SSnOCMoqrXs%3d&tabid=387>]



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