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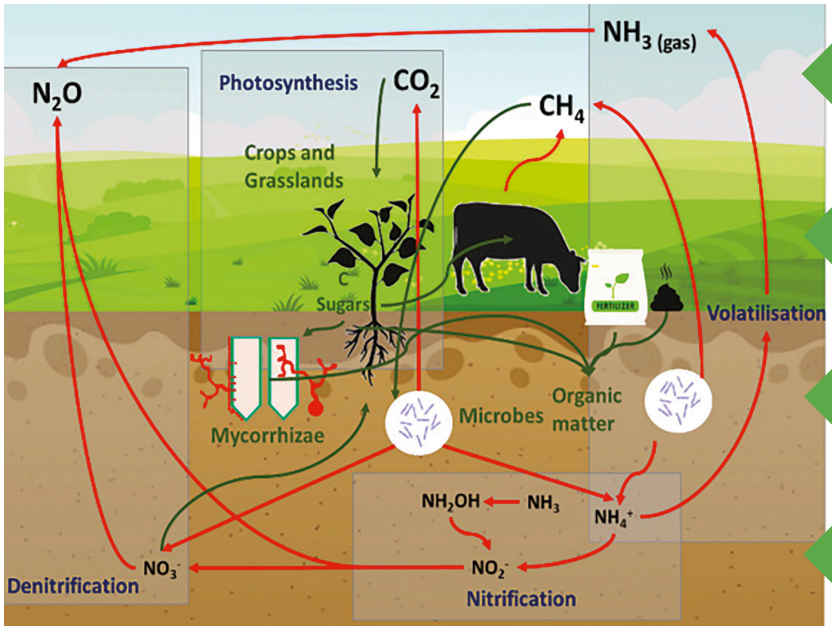
Carbon and nitrogen cycles in agriculture – August 2022

Nitrogen (N) and carbon (C) cycles are essential for life and ecosystem functionality.



C from atmospheric CO^2 provides energy for all plants and animals to live and grow

N is important in making proteins and a lack can limit growth and be detrimental

Soil organic matter (SOM) is a measure of carbon in the soil linked with sequestration

Ideal systems should aim to maximise SOM and minimise N_2O, CO_2 and CH_4 production

CHANGING THE CYCLE

Intensive agricultural **practices** change these cycles

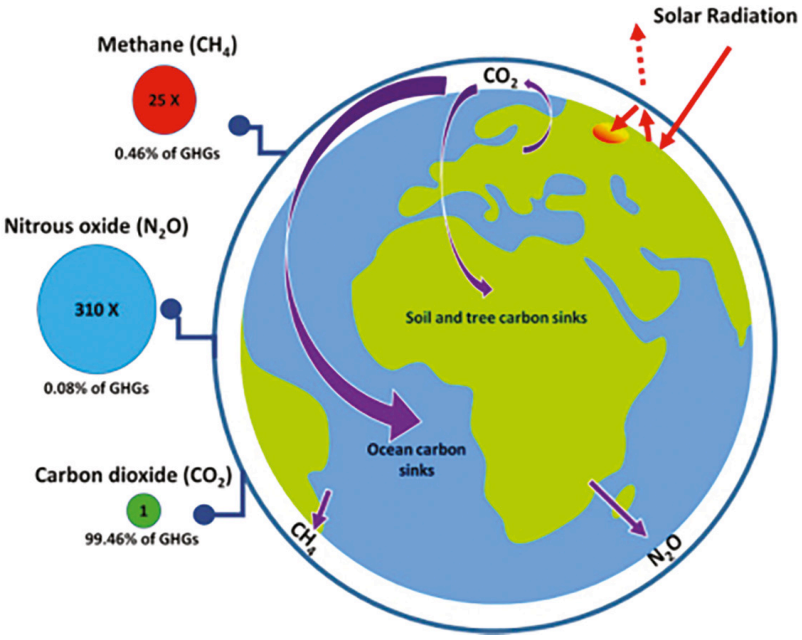
1) **Heavy fertiliser use** boosts plant growth, but delivers more N for **conversion into N_2O** and polluting N in environments
2) High livestock stocking leads to increased **CH_4 production** through enteric fermentation
3) Crops with no, or minimal, mycorrhizal interactions **store less C within SOM**
4) **Ploughing soils** releases stored C as CO_2 and disrupts mycorrhiza/ root systems and ecosystems
5) **Short rotation crops and pastures** don't have long enough to store C and efficiently utilise N

But **traditional and sustainable agricultural practices** try to work by understanding these cycles

1) **Long-term perennial and permanent** plants work better with mycorrhizae, **storing more C** and **needing less N** fertilisation to grow, lowering available N for **microbial N_2O production**
2) Precise **rotational grazing** uses land more effectively, maximising meat/milk production compared to **CH_4 produced**, reducing **N fertiliser use overall**
3) **Biofuel production** can produce C-neutral energy steadying the increase of CO_2 in the C cycle
4) **Precision fertiliser usage**, using what is needed, where it's needed, lowers N for N_2O production
5) **Composting/anaerobic digestion** of wastes cycles N and C back, reducing agricultural emissions

CYCLES AND EMISSIONS

- C and N cycles release **greenhouse gasses (GHG)**
- GHGs trap energy from the sun warming the planet
- **Methane and nitrous oxide trap more energy** than CO_2.
- CO_2 lasts in the atmosphere for **hundreds of years**
- CH_4 and N_2O last between **10 and 100 years in the atmosphere**
- We link all GHGs to CO_2 using their **CO_2 equivalent** environmental impacts
- C and N cycle emissions can be affected by **carbon sinks** and improved **uptake and utilisation efficiency** (for example plant and animal breeding and feeding changes)



CYCLES AND EMISSIONS

Agriculture has **high emissions**, but the **best prospects to improve soil and plant-based carbon sinks**

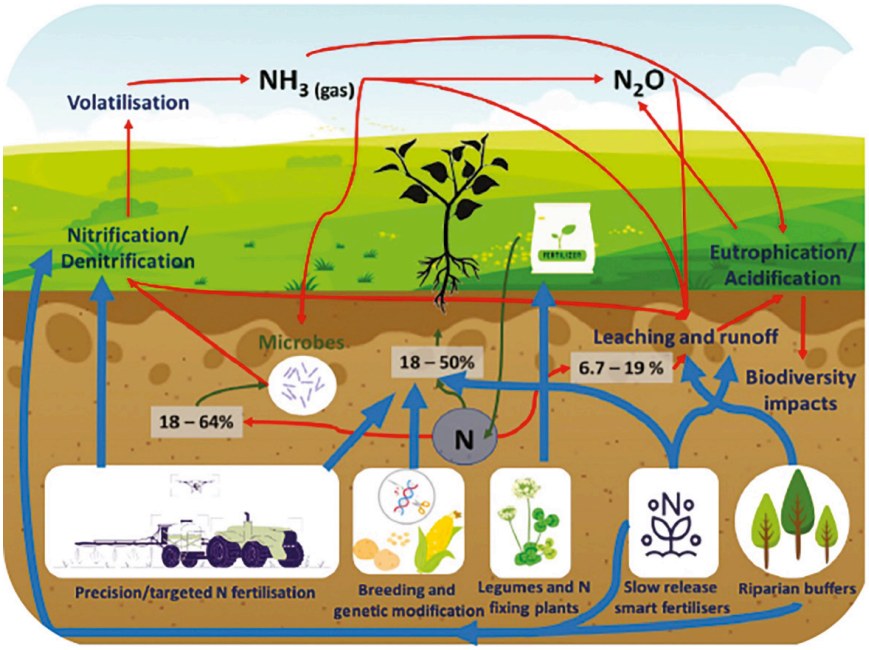
Practices that shift C and N cycles include **species-rich grasslands, riparian buffers, zero/min tillage, cover cropping, agroforestry, legume use** and **recycling farm wastes** to name a few

Improving C and N use/emissions can **help public goods** like **biodiversity, air quality** and **water quality**

Agriculture is a big emitter of N_2O, but reducing fertiliser use could improve this massively

Global **N use efficiency of crops is 18 - 50%**, suggesting huge room for improvements

>50 % of N fertiliser is being cycled back damagingly into systems via **volatilisation, nitrification, denitrification and leaching and runoff**



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