

Is grass-fed beef good or bad for the climate?

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When it comes to climate change, agriculture and the livestock industry often get a bad rap. Around 14.5% of human-related greenhouse gas (GHG) emissions come from livestock. However, both consumers and policymakers have a much looser grasp on the impact of "grass-fed" beef. **Is grass-fed beef good or bad for the climate?**

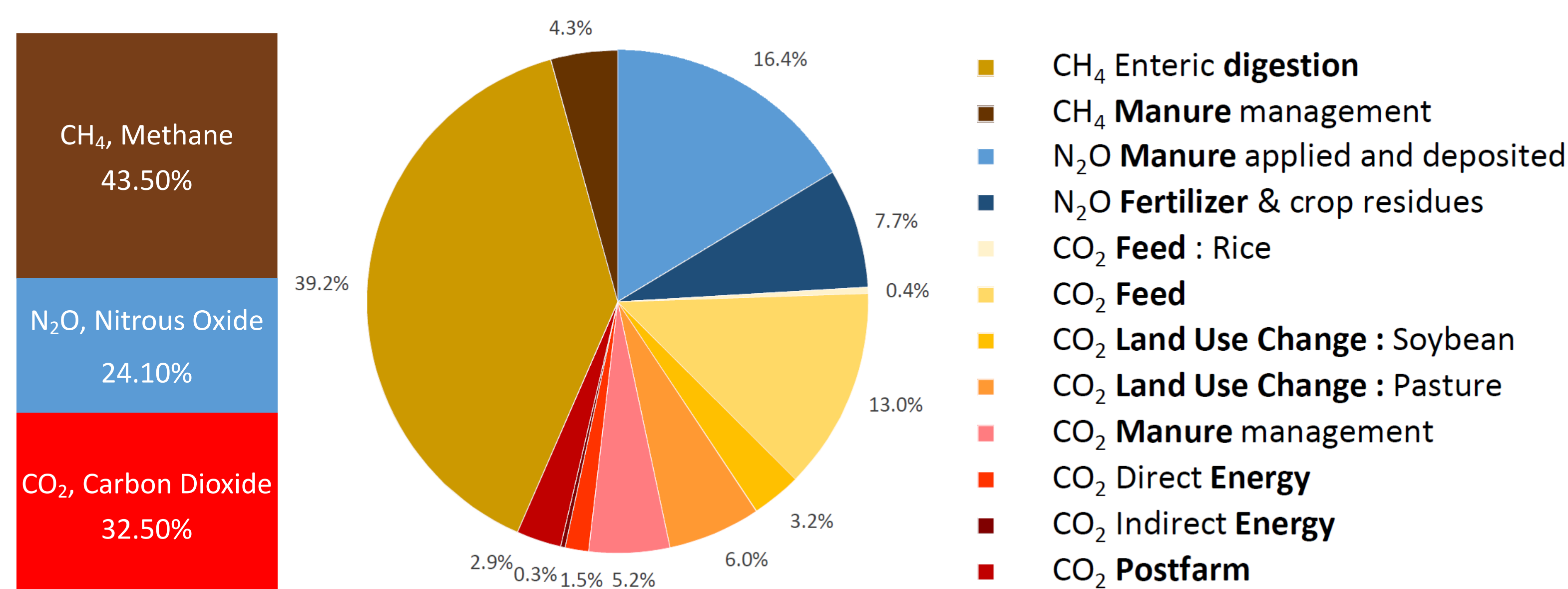


Fig 1: GHG emissions from livestock production by emissions source and gas type. After Gerber et al. (2013).

1) The overall impact of grazing systems depends on the net balance of all GHG emissions and removals

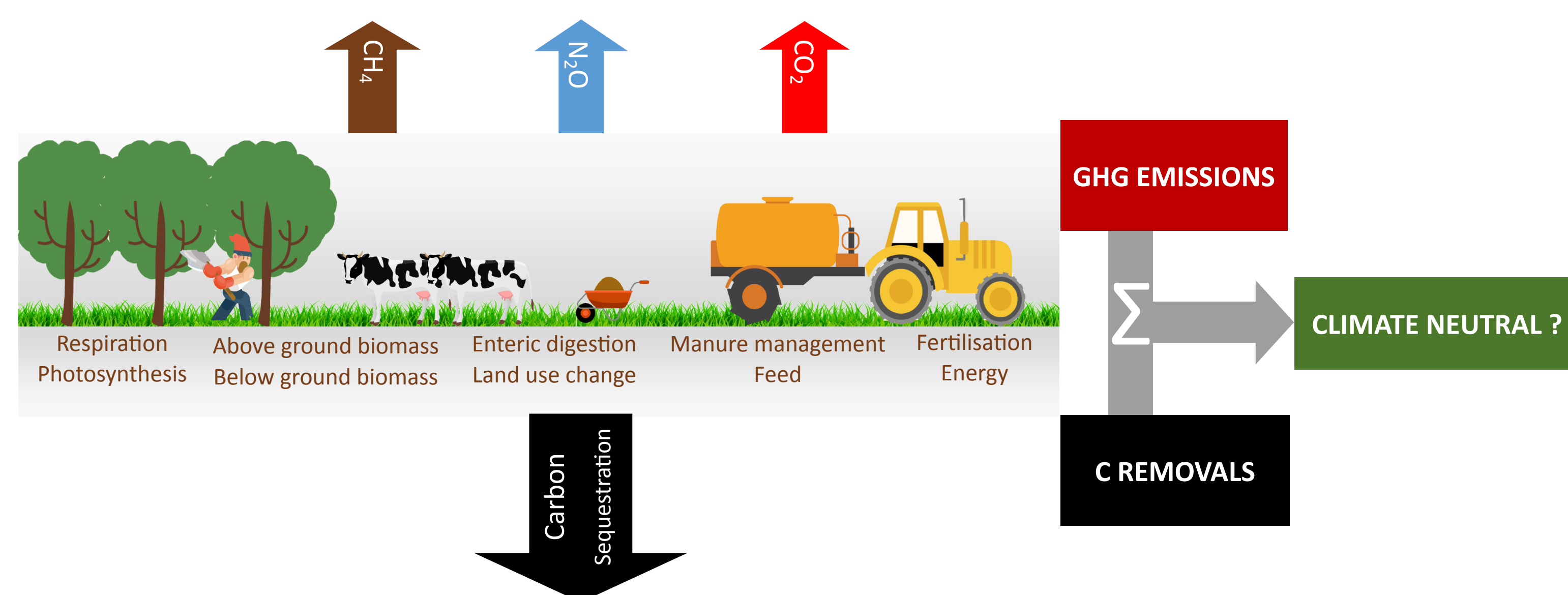


Fig 2: GHG emissions and removals from grazing systems.

2) GHG emissions from grazing systems

Methane CH₄ Ruminants emit CH₄ through enteric fermentation and manure

- CH₄ is a highly potent GHG. Despite having a short atmospheric lifespan (~12 years), warming impacts continue as long as sources of CH₄ exist.
- CH₄ emissions from prehistoric ruminants may have been similar to the one of our farmed animals' today, but the context 11,000 years ago (a tiny human population, no use of fossil fuels) was so different that we cannot ignore current emissions.

Nitrous Oxide N₂O Grazing systems are a source of N₂O through manure and fertilisation

- N₂O is a highly potent GHG with a relatively long atmospheric lifespan (~114 years).
- Efforts to sequester carbon (C) by adding nitrogen (N) to the soil to promote plant growth risk releasing N₂O.
- Ruminants play a role in N cycling by ingesting plant N and returning some of it to soils via their manure. However, they add no new N to the system and can introduce a leaky N cycle (Fig 3).

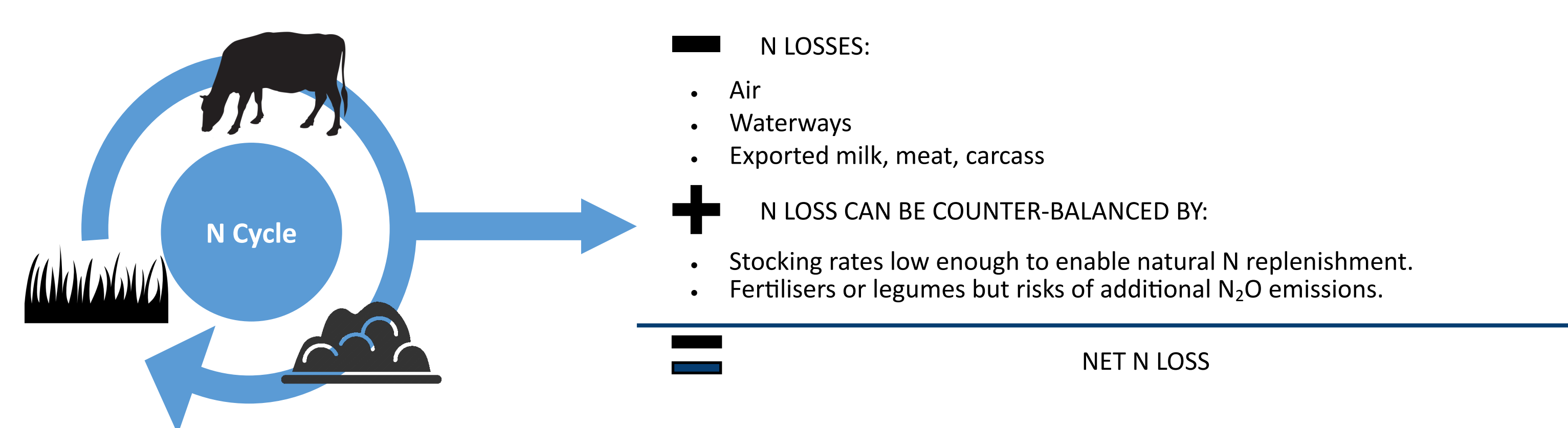


Fig 3: Ruminants can introduce a leaky N cycle.

Carbon Dioxide CO₂ Grazing systems are a source of CO₂ through land-use change, manure, feed production, energy and post-farm processes

- CO₂ is less potent than CH₄ and N₂O but it stays in the atmosphere for 1000's of years (CH₄ ~12 years, N₂O ~114 years).

3) Does carbon sequestration outweigh GHG emissions in grazing systems?

Grazing can boost C sequestration - thus removing CO₂ from the atmosphere - by stimulating plant growth and deeper roots under specific agro-ecological and farming circumstances that certainly do not apply everywhere.

However, the C sequestration that may arise is:

- Time-limited** - Soils reach C equilibrium within a few decades.
- Reversible** - Soil C stocks can be lost through bad management, climatic fluctuations (e.g. drought) or fire.
- Small in aggregate and outweighed by the GHG emissions they generate** - Grazing systems, as all livestock systems, are net emitters of GHGs (Fig 4).

Leaving aside any scope for sequestering C, it is imperative that we "keep C in the ground" by halting grasslands degradation and conversion to croplands, as any released C causes permanent global warming.

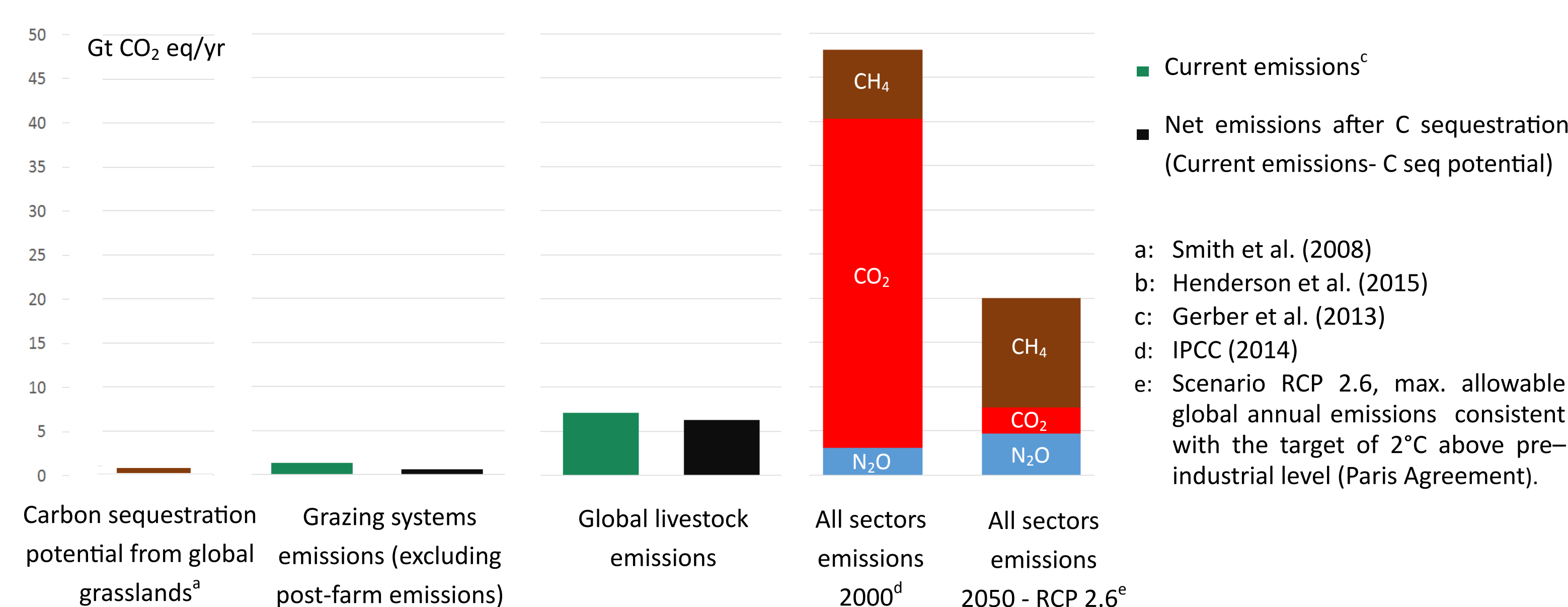


Fig 4: Soil C sequestration in grasslands (295^b-800^a Mt CO₂-eq/yr) could potentially offset 20-60% of grass-fed only sector annual emissions (1.32^c Gt CO₂-eq/yr), 4-11% of livestock emissions (7.1^c Gt CO₂-eq/yr) and 0.6-1.6% of human made emissions (49^d Gt CO₂-eq/yr).

Conclusion: Grazing systems won't save the climate

In aggregate, **grazing systems are net emitters of GHGs and won't save the climate**: potential removals via **carbon sequestration** are substantially **outweighed by existing emissions** and so grazing management's role in helping to mitigate climate change is small, especially when taking a long-term perspective. **'Climate-neutral' grazing systems are rather the exception than the norm.**

Nonetheless, we acknowledge that **improving grazing management** is certainly a worthwhile objective and less intensively reared livestock production methods can offer many **important benefits for overall sustainability.**



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