Mitigate+: Research for Low-Emission Food Systems

Can agriculture reach net zero emissions by 2050?

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Conclusions

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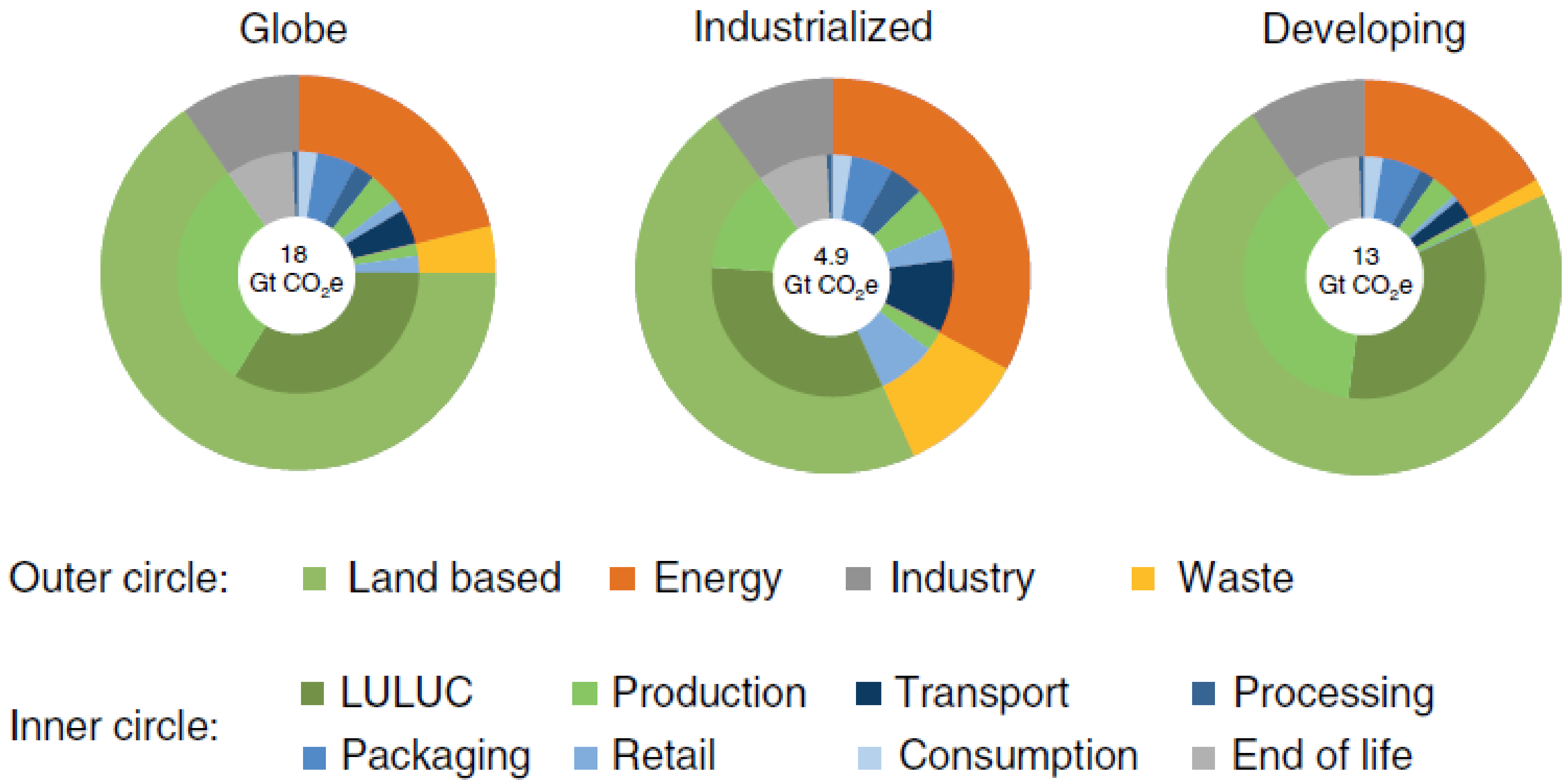
Significant GHG emissions reductions in agriculture are achievable through reducing emission intensity of production, but population growth and dietary changes may offset absolute emissions reductions.

Emission reductions consistent with 2030 targets are achievable in many countries; attaining the 2050 targets will require innovation and systems transformation.

Net zero agriculture cannot be achieved without sinks!

Governance, economics, and sociocultural factors are the keys to food system transformations.

Production is the major source of emissions in food systems



Crippa et al., 2021

Table SPM1. Net anthropogenic emissions due to Agriculture, Forestry, and other Land Use (AFOLU) and non-AFOLU (Panel 1)

		Direct Anthropogenic							
Gas	Units	Net anthropogenic emissions due to Agriculture, Forestry, and Other Land Use (AFOLU)			Non-AFOLU anthropogenic GHG emissions[6]	Total net anthropogenic emissions (AFOLU + non-AFOLU) by gas	AFOLU as a % of total net anthropogenic emissions, by gas	Natural response of land to human-induced environmental change[7]	Net land – atmosphere flux from all lands
Panel 1: Contribution of AFOLU									
		FOLU	Agriculture	Total					
		A	B	C = A + B	D	E = C + D	F = (C/E) *100	G	A + G
CO_2[2]	Gt CO_2 y^{-1}	5.2 ± 2.6	No data[11]	5.2 ± 2.6	33.9 ± 1.8	39.1 ± 3.2	13%	-11.2 ± 2.6	-6.0 ± 3.7
CH_4[3,8]	Mt CH_4 y^{-1}	19.2 ± 5.8	141.6 ± 42.5	160.8 ± 43	201.3 ± 100.6	362 ± 109			
	Gt CO_2e y^{-1}	0.5 ± 0.2	4.0 ± 1.2	4.5 ± 1.2	5.6 ± 2.8	10.1 ± 3.1	44%		
N_2O[3,8]	Mt N_2O y^{-1}	0.3 ± 0.1	8.3 ± 2.5	8.7 ± 2.5	2.0 ± 1.0	10.6 ± 2.7			
	Gt CO_2e y^{-1}	0.09 ± 0.03	2.2 ± 0.7	2.3 ± 0.7	0.5 ± 0.3	2.8 ± 0.7	81%		
Total (GHG)	Gt CO_2e y^{-1}	5.8 ± 2.6	6.2 ± 1.4	12.0 ± 2.9	40.0 ± 3.4	52.0 ± 4.5	23%		

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Agriculture remains an under represented activity in NDC adaptation and mitigation commitments

50-70% of the countries with the highest potential for reducing GHG emissions in livestock and/or soil carbon included mitigation measures in these subsectors.

- Livestock mitigation priorities include manure management (26 countries), feed management (23 countries) and silvopastoralism (15 countries).

- Soil carbon, mitigation priorities included wetland management (35 countries), agroforestry (34 countries) and grassland management (24 countries).

Many of these activities are also proposed as adaptation measures

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Enteric fermentation – Methane

GHG emissions from livestock production vary greatly due to farming practices, animal numbers and type, and food product.

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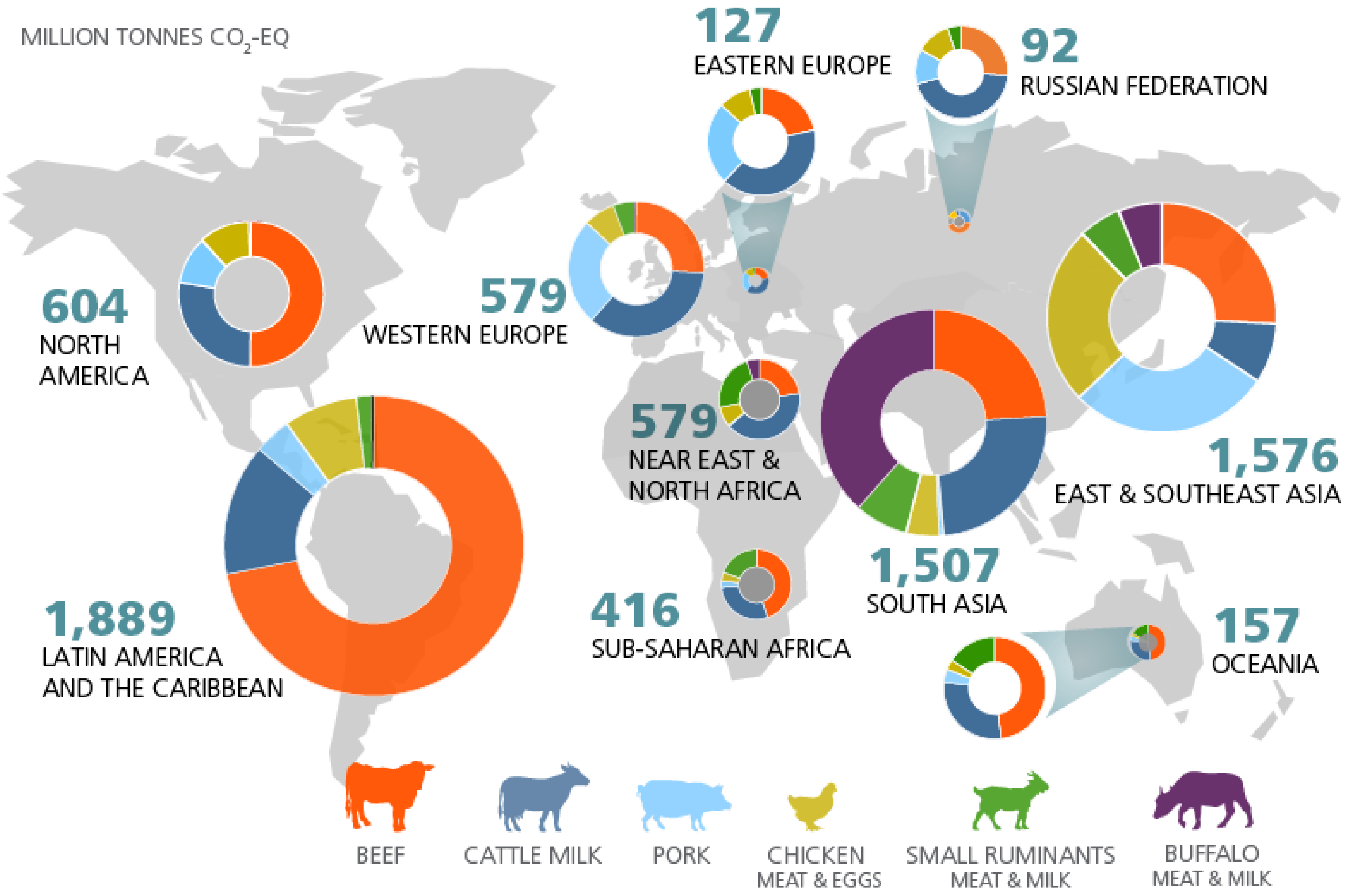

Source: FAO

Three promising enteric fermentation mitigating strategies

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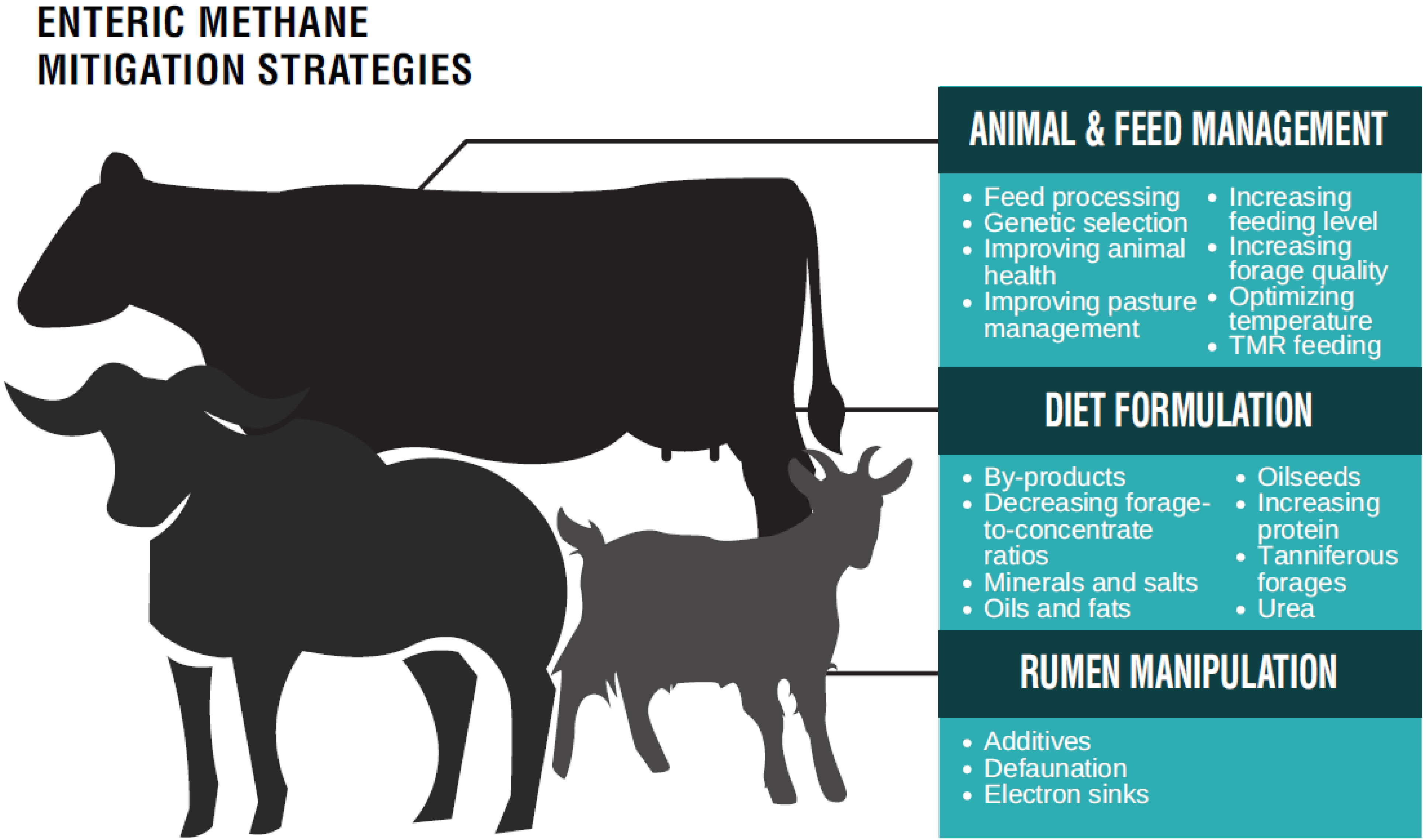

Arndt et al., 2022

Effects of mitigation strategies on CH_4 emission

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	Mitigation strategy	Potential emissions reduction		Relevant production system
Product-Based Reductions	1 Increasing feeding level	CH_4I_M -17% CH_4I_G No Data		Feedlot & mixed systems; Grassland systems
	2 Decreasing grass maturity	CH_4I_M -13% CH_4I_G No Data		Feedlot & mixed systems; Grassland systems
	3 Decreasing dietary forage-to-concentrate ratio	CH_4I_M -9% CH_4I_G -9%		Feedlot & mixed systems
Absolute Reductions	1 CH_4 inhibitors	CH_4I_M -32% CH_4I_G No Data	Daily CH_4 -35% CH_4Y -34%	Feedlot & mixed systems
	2 Tanniferous forages	CH_4I_M -18% CH_4I_G No Data	Daily CH_4 -12% CH_4Y -10%	Feedlot & mixed systems; Grassland systems
	3 Electron sinks	CH_4I_M -13% CH_4I_G -12%	Daily CH_4 -17% CH_4Y -15%	Feedlot & mixed systems
	4 Oils & fats	CH_4I_M -12% CH_4I_G -22%	Daily CH_4 -19% CH_4Y -15%	Feedlot & mixed systems
	5 Oilseeds (Lactating animals only)	CH_4I_M -12% CH_4I_G No Effect	Daily CH_4 -20% CH_4Y -14%	Feedlot & mixed systems

Production system: Feedlot & mixed systems; Grassland systems

Arndt et al., 2022 Scenario analysis conclusions

Agricultural methane emissions must be decreased by 11 to 30% of the 2010 level by 2030 and by 24 to 47% by 2050 to meet the 1.5 °C target.

Globally, only 100% adoption of the most effective product based and absolute CH_4 reduction strategies can meet the 1.5 °C target by 2030 but not 2050.

Mitigation effects are offset by projected increases in CH_4 due to increasing milk and meat demand.

Notably, by 2030 and 2050, low- and middle-income countries may not meet their contribution to the 1.5 °C target for this same reason, whereas high-income countries could meet their contributions due to only a minor projected increase in enteric CH_4 emissions.

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Soils – Nitrous oxide

Regional soil N_2O emissions

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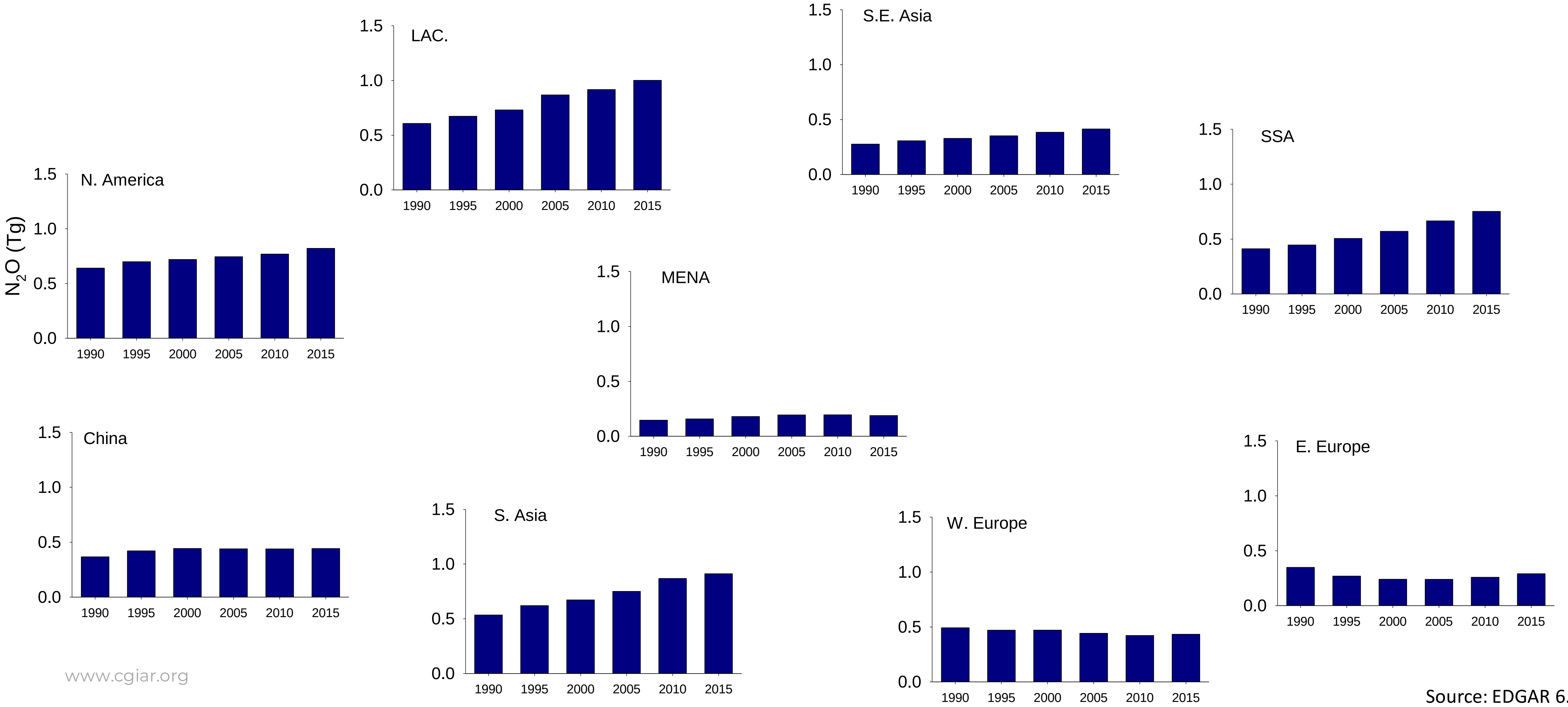

Source: EDGAR 6.0

N_2O emissions are driven by fertilizer application rates and by the levels of N applied in excess of crop demand

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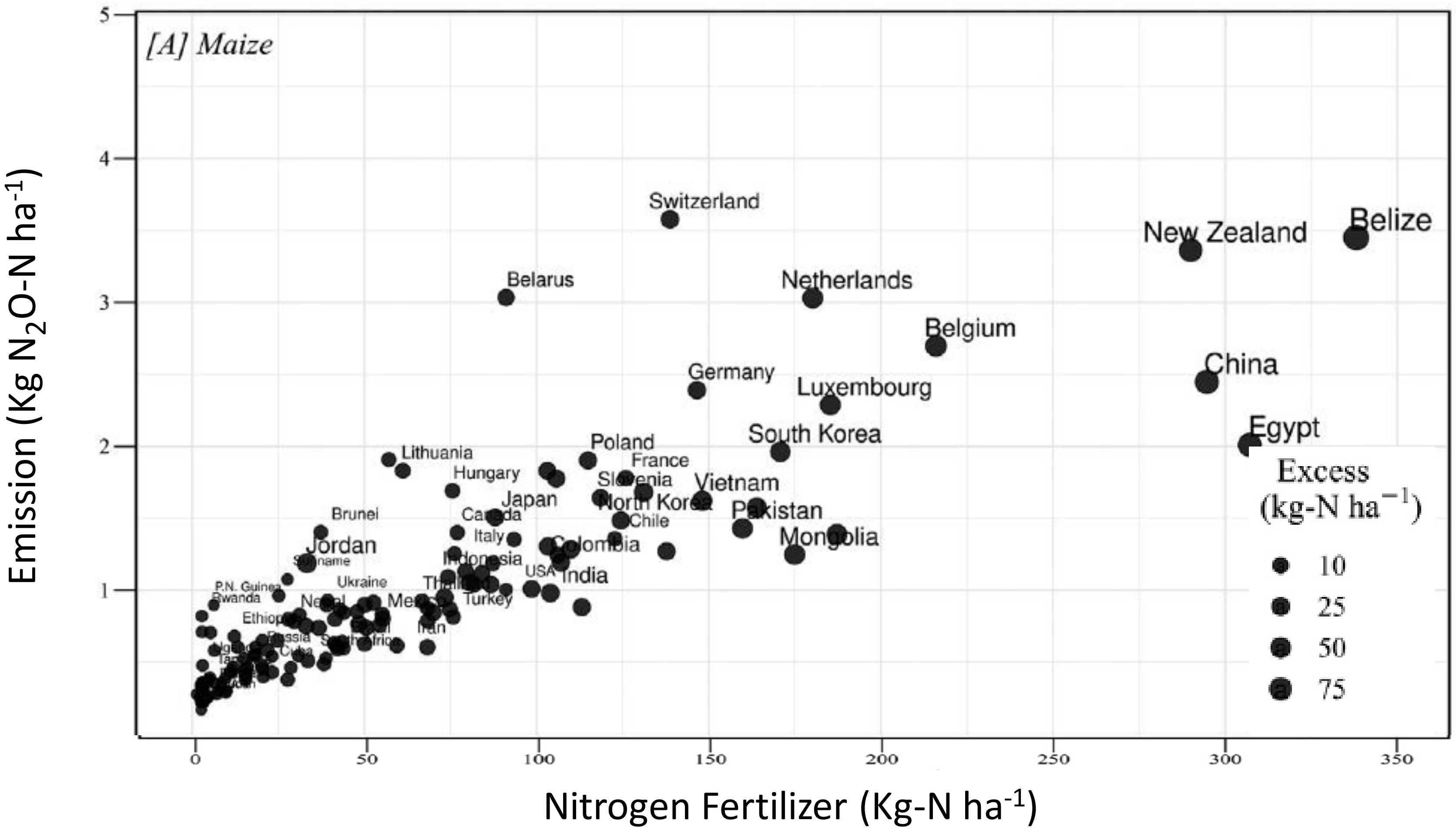

Tesfaye et al., 2021

Improving N use efficiency and reducing excess N by 75% can reduce N_2O emissions by ~35%

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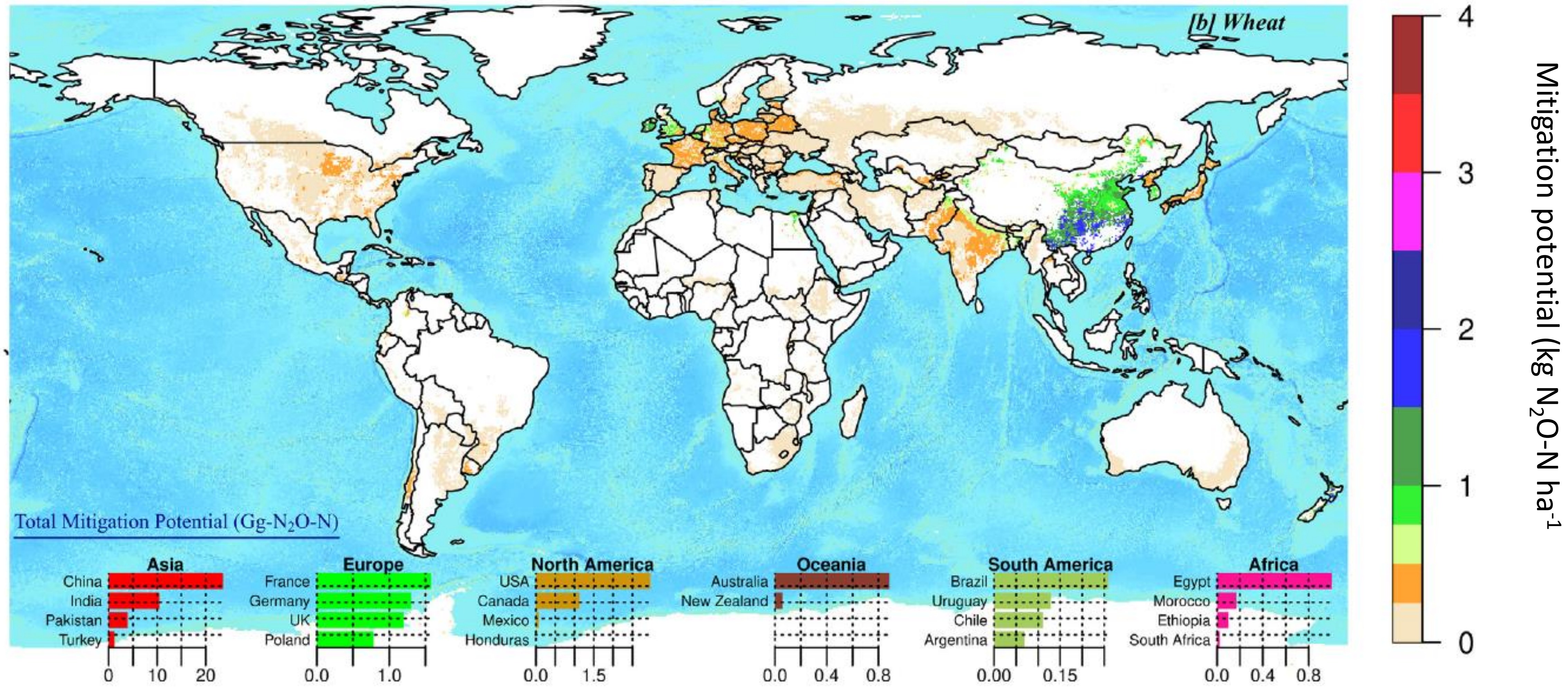

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Sinks in agricultural landacapes

There are a wide range of land-based CO_2 removal opportunities

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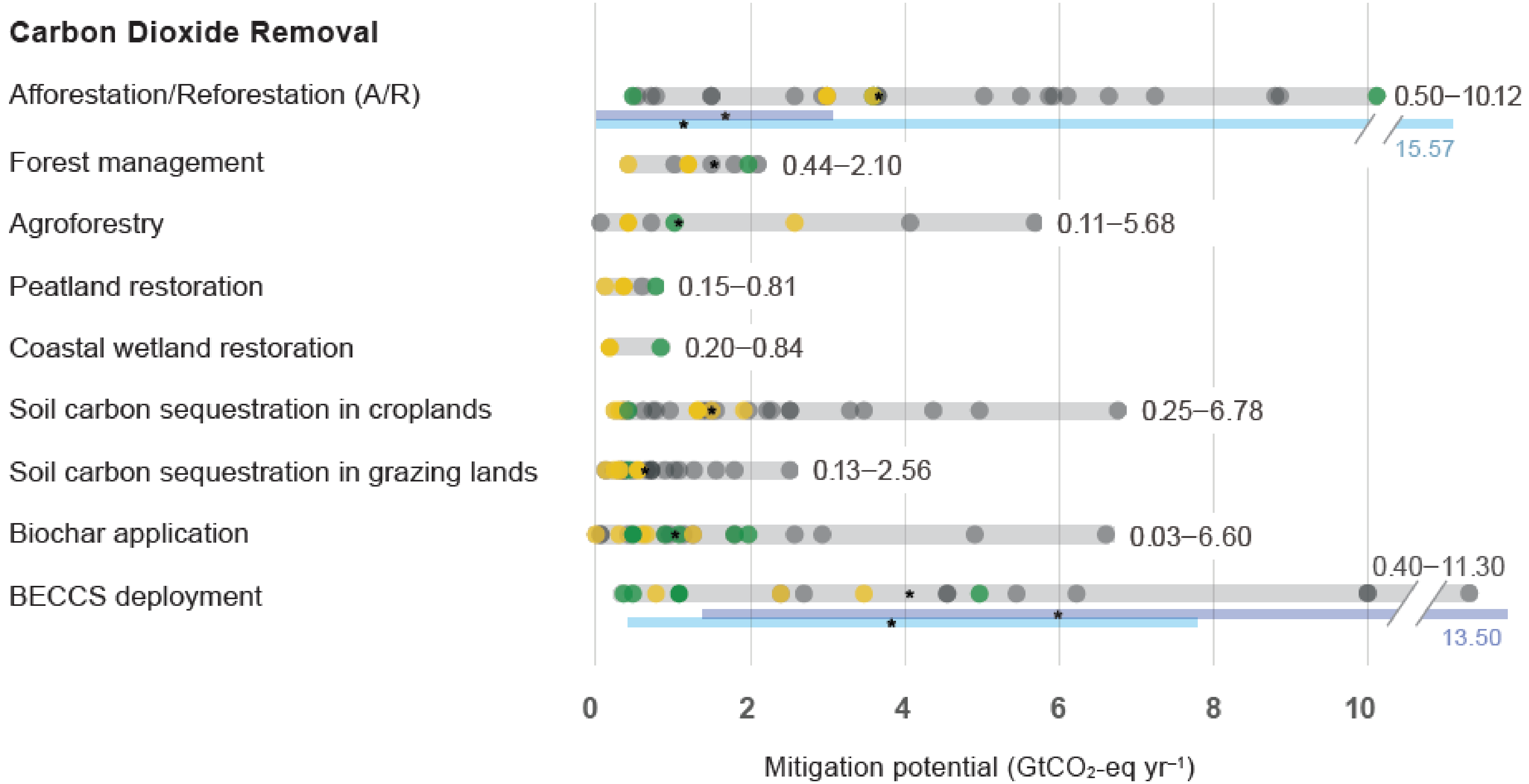

IPCC SRCCL

Soil C sequestration offers significant opportunities across the globe with productivity and soil health benefits

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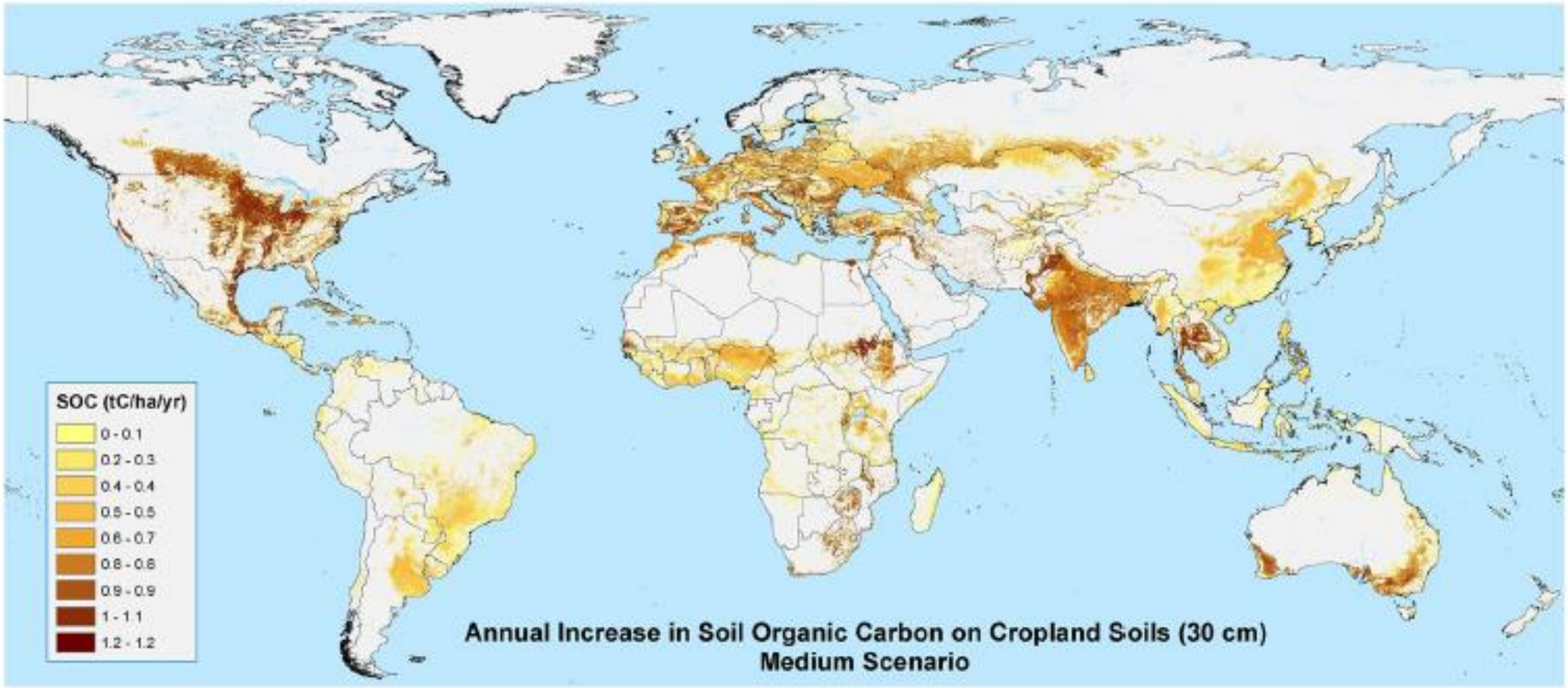

Zomer et al., 2017

Forests are a key part of the net zero equation

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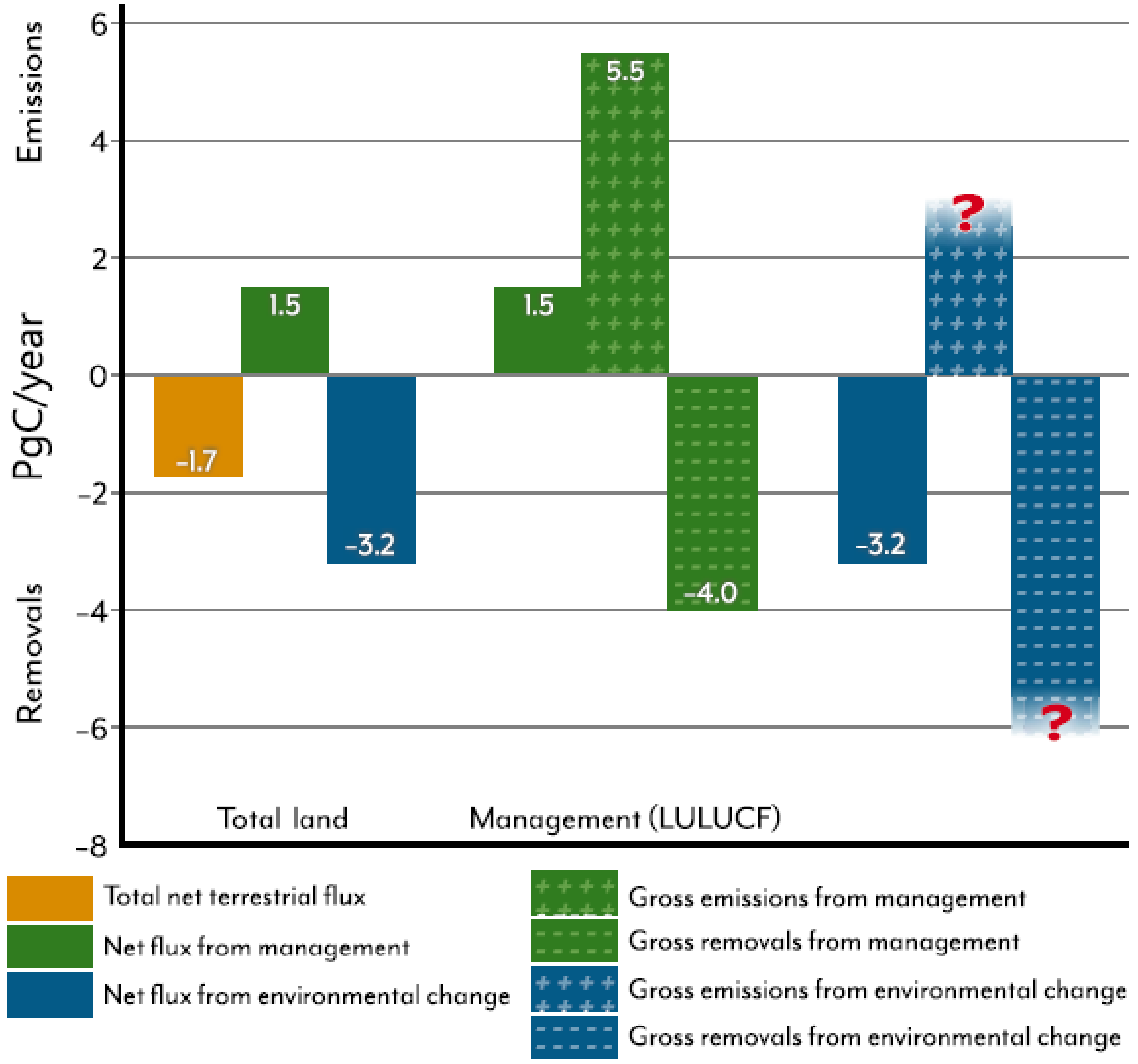

Houghton et al., 2020

Forests provide climate benefits and buffer agaist extreme heat events from ± 50°N/S

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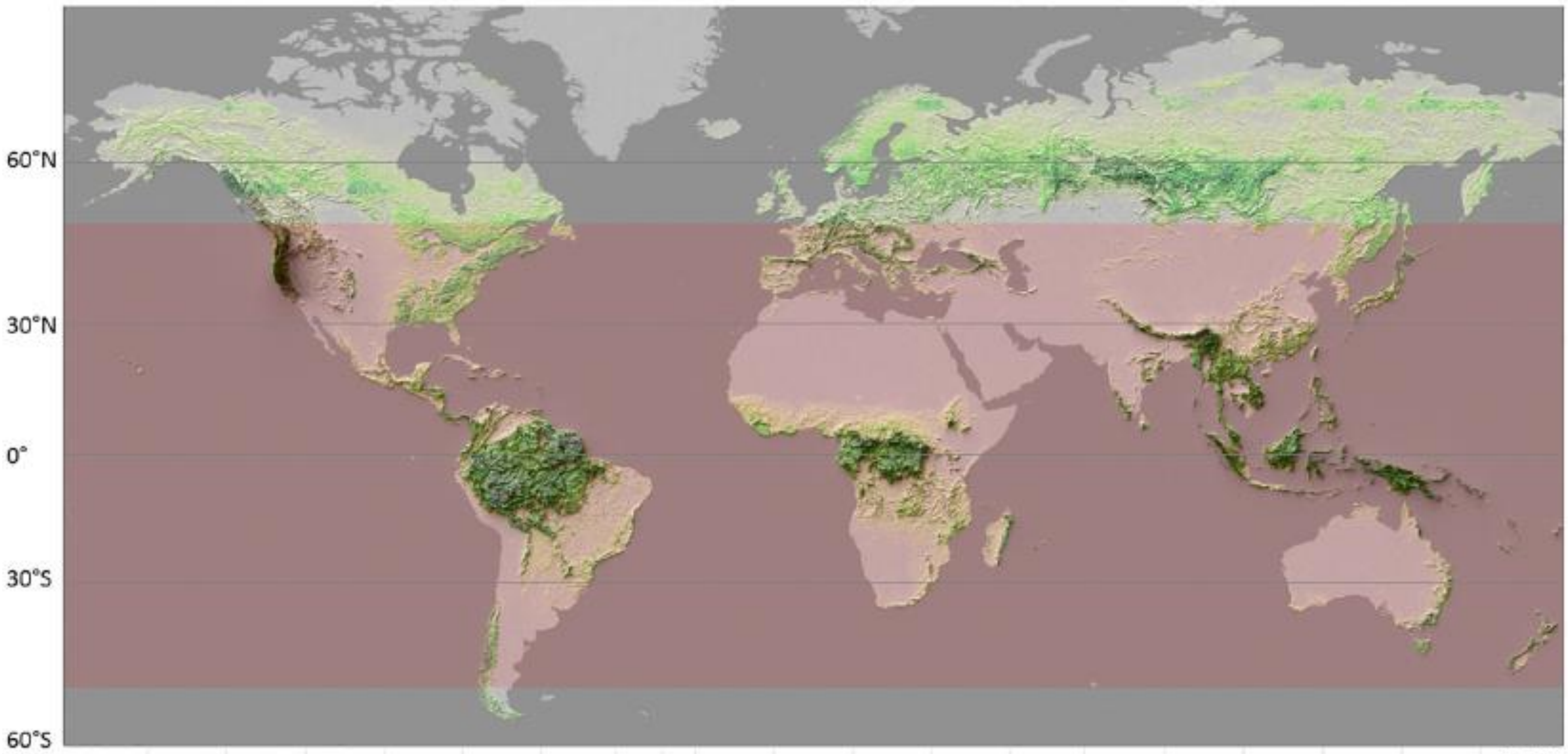

Lawrence et al., 2022

Cost-effective (< \$100/tCO_2eq) land-based mitigation is 8–13.8 GtCO_2eq yr^{-1} between 2020 and 2050

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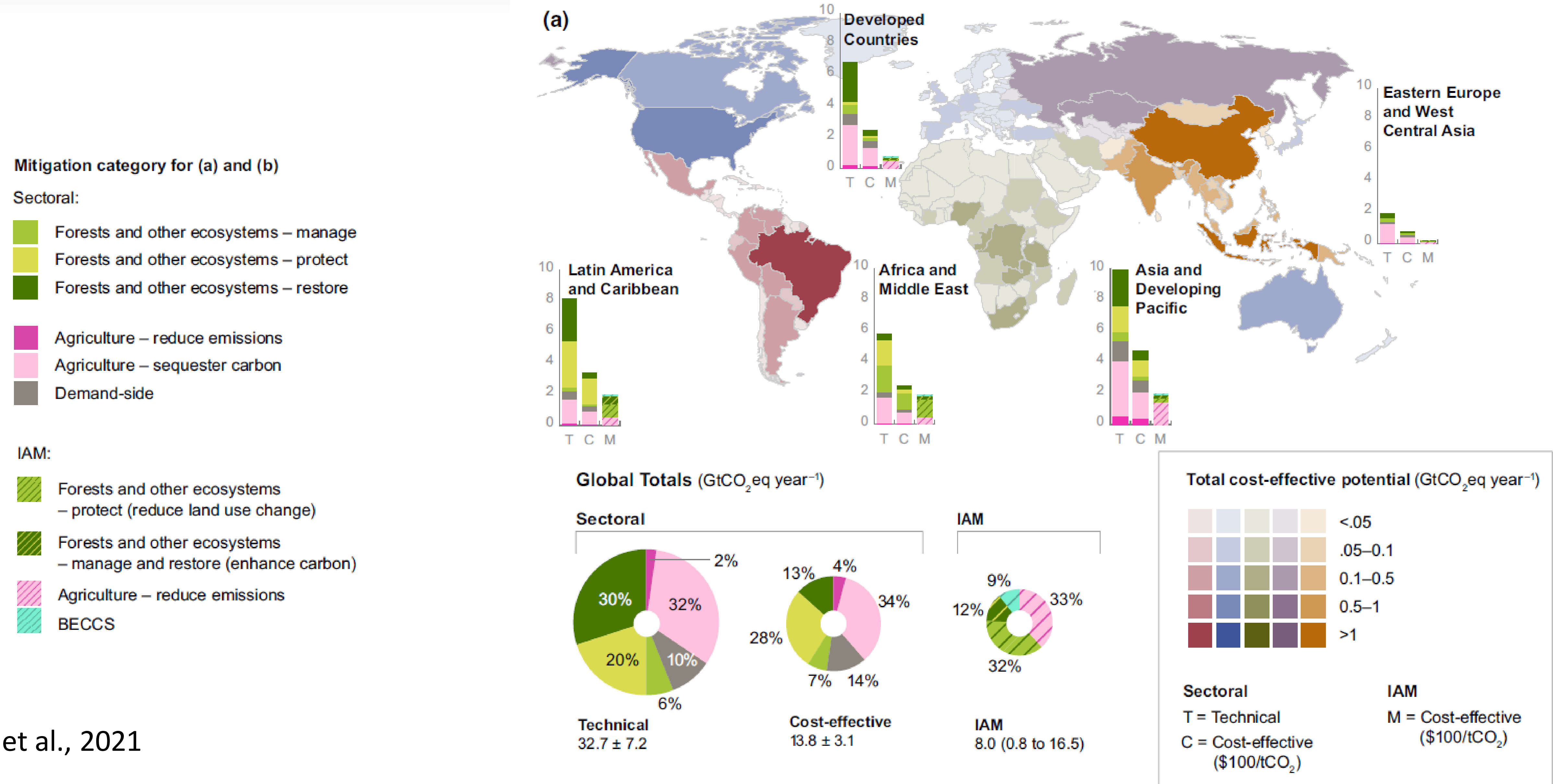


Roe et al., 2021

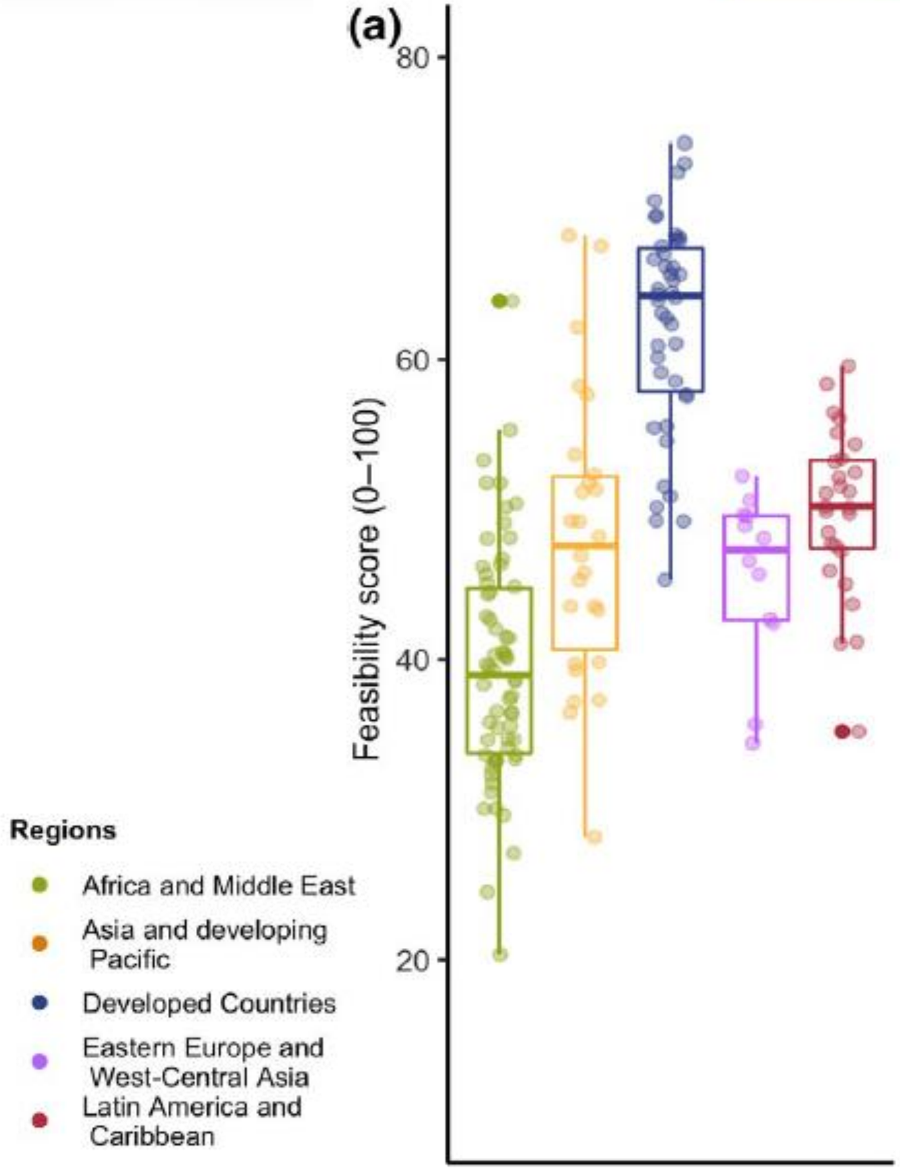
Roe et al., analyzed feasibility of mitigation measures

The cost-effective potential is approximately 50% from forests and other ecosystems, 35% from agriculture, and 15% from demand-side measures.

Opportunities among countries vary widely depending on types of land-based measures available, their potential co-benefits and risks, and their feasibility.

Governance, economic investment, and socio-cultural conditions influence the likelihood that land-based mitigation potentials are realized.

Assisting countries to overcome barriers may result in significant quantities of near-term, low-cost mitigation while locally achieving important climate adaptation and development benefits.



What is the CGIAR doing to support low emissions food system solutions

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The CGIAR is investing ~$300M per year in improving the sustainability of food systems across developing countries and emerging economies.

2 flagship initiatives focused on climate change

- Mitigate+: Research for low-emission food systems focuses on reducing greenhouse gas emissions from food systems and the predicted consequences of climate change on sustainable development and social equity.
- Climber: This Initiative aims to transform the climate adaptation capacity of food, land and water systems to increase the resilience of smallholder production systems to withstand severe climate change effects like drought, flooding and high temperatures.

Climate change concerns are integrated across our whole research

Conclusions

Significant GHG emissions reductions in agriculture are achievable through reducing emission intensity of production, but population growth and dietary changes may offset absolute emissions reductions.

Emission reductions consistent with 2030 targets are achievable in many countries; attaining the 2050 targets will require innovation and systems transformation.

Net zero agriculture cannot be achieved without sinks!

Governance, economics, and sociocultural factors are the keys to food system transformations.

Thank you

For discussion:

Emissions reductions are technically feasible

Some countries can meet some targets some of the times

Innovation is needed

Sinks must be part of the solution

Governance, finance, and enabling conditions are the keys to success

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