Evaluating the Potential of Land-based Climate Change Mitigation Actions in Thailand

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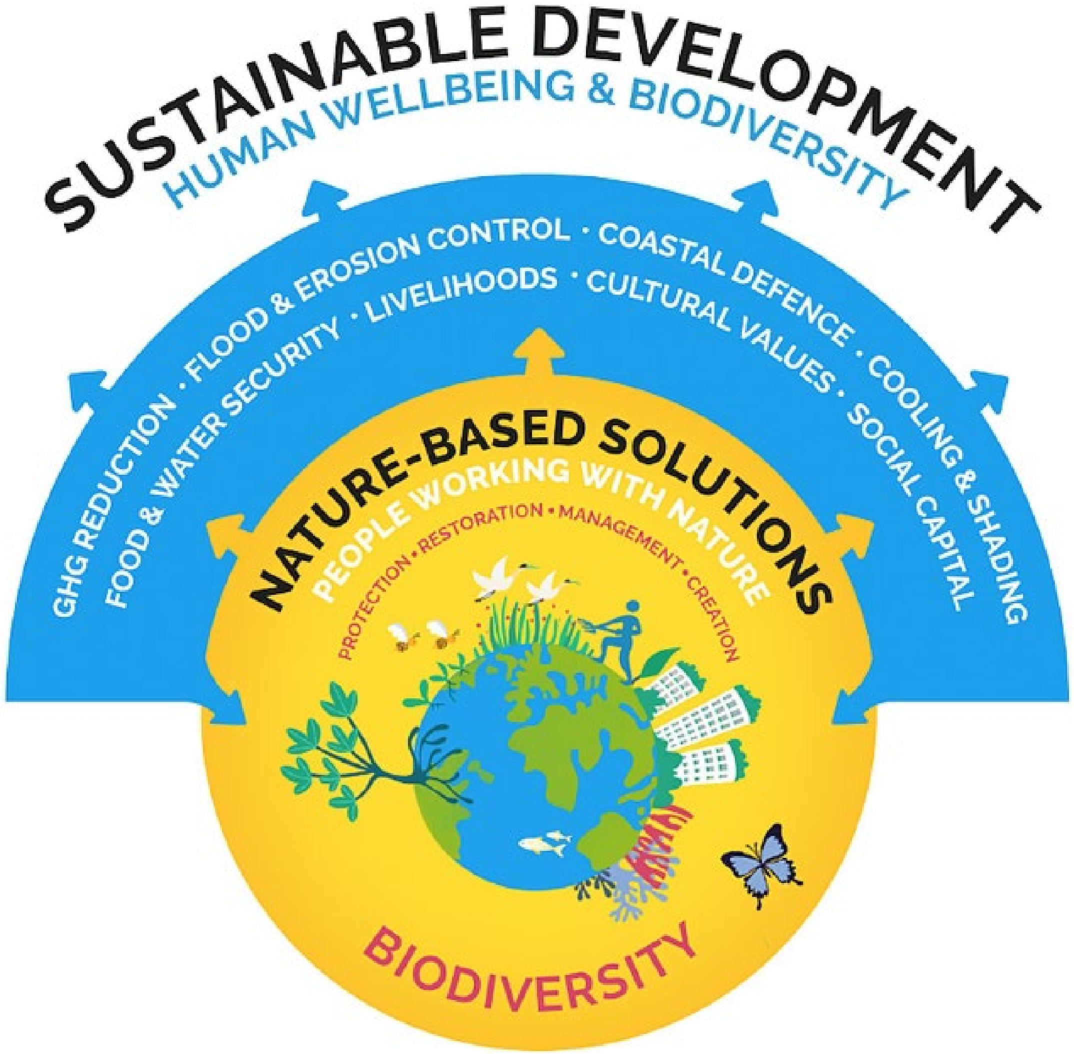
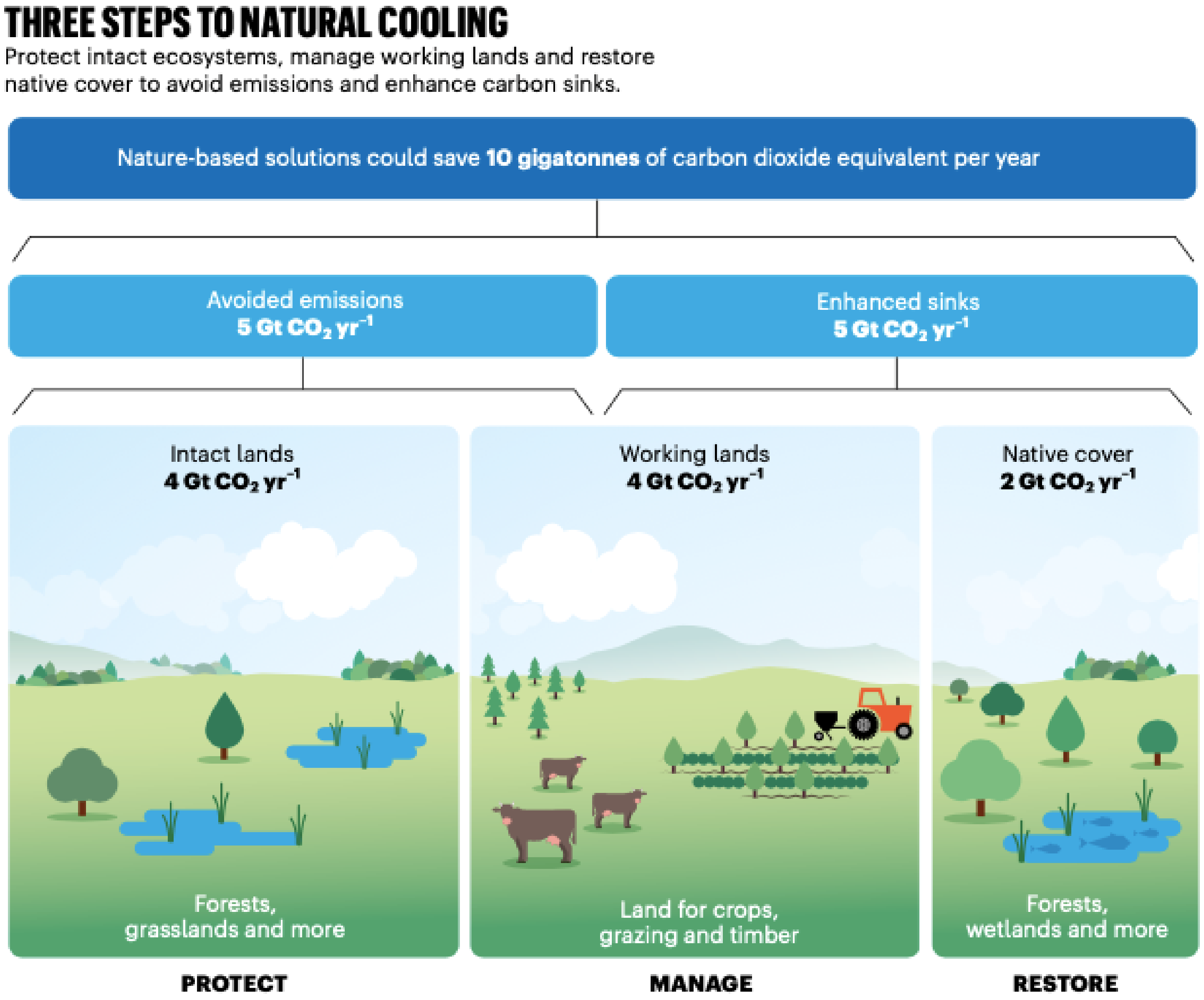
Background of Nature-based Solutions (NbS)



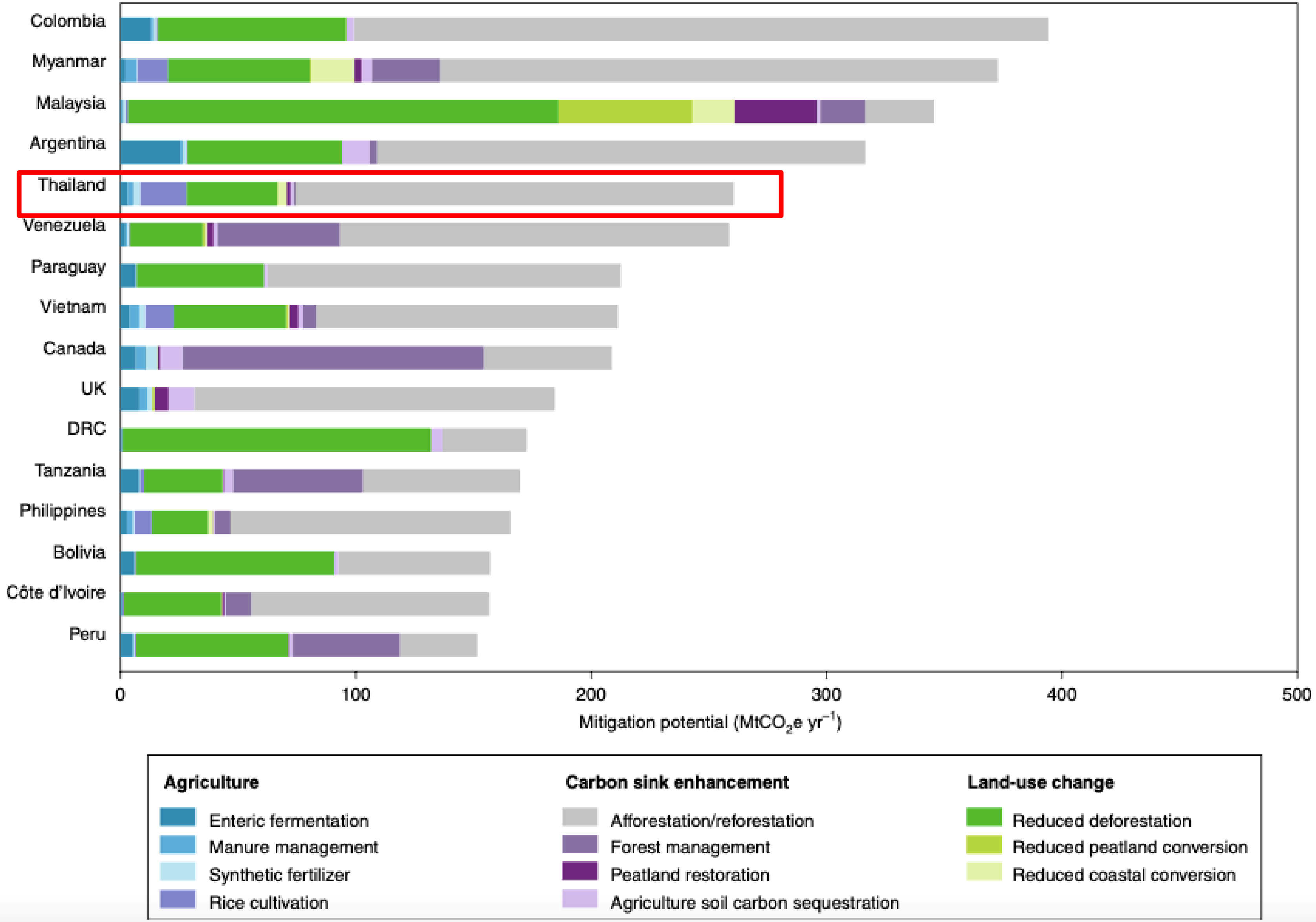
Seddon et al. (2021) Getting the message right on nature-based solutions to climate change. *Global Change Biology*.

The global climate change mitigation potential of NbS



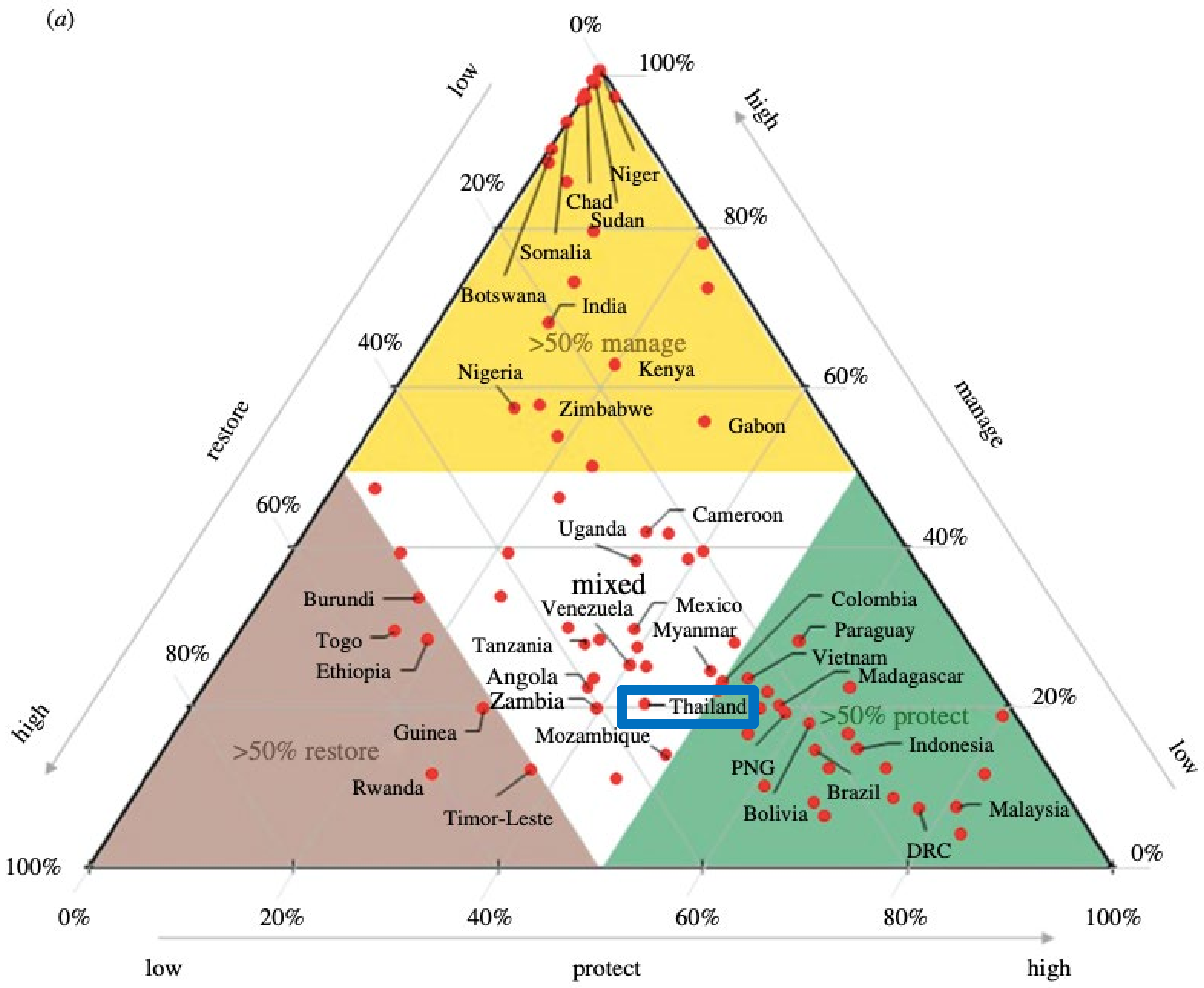
Girardin et al. (2021) Nature-based solutions can help cool the planet – if we act now. *Nature*.

NbS at a national scale – a case study in Thailand



Roe et al. (2019) Contribution of the land sector to a 1.5 C world. *Nature Climate Change*.

NbS at a national scale – a case study in Thailand



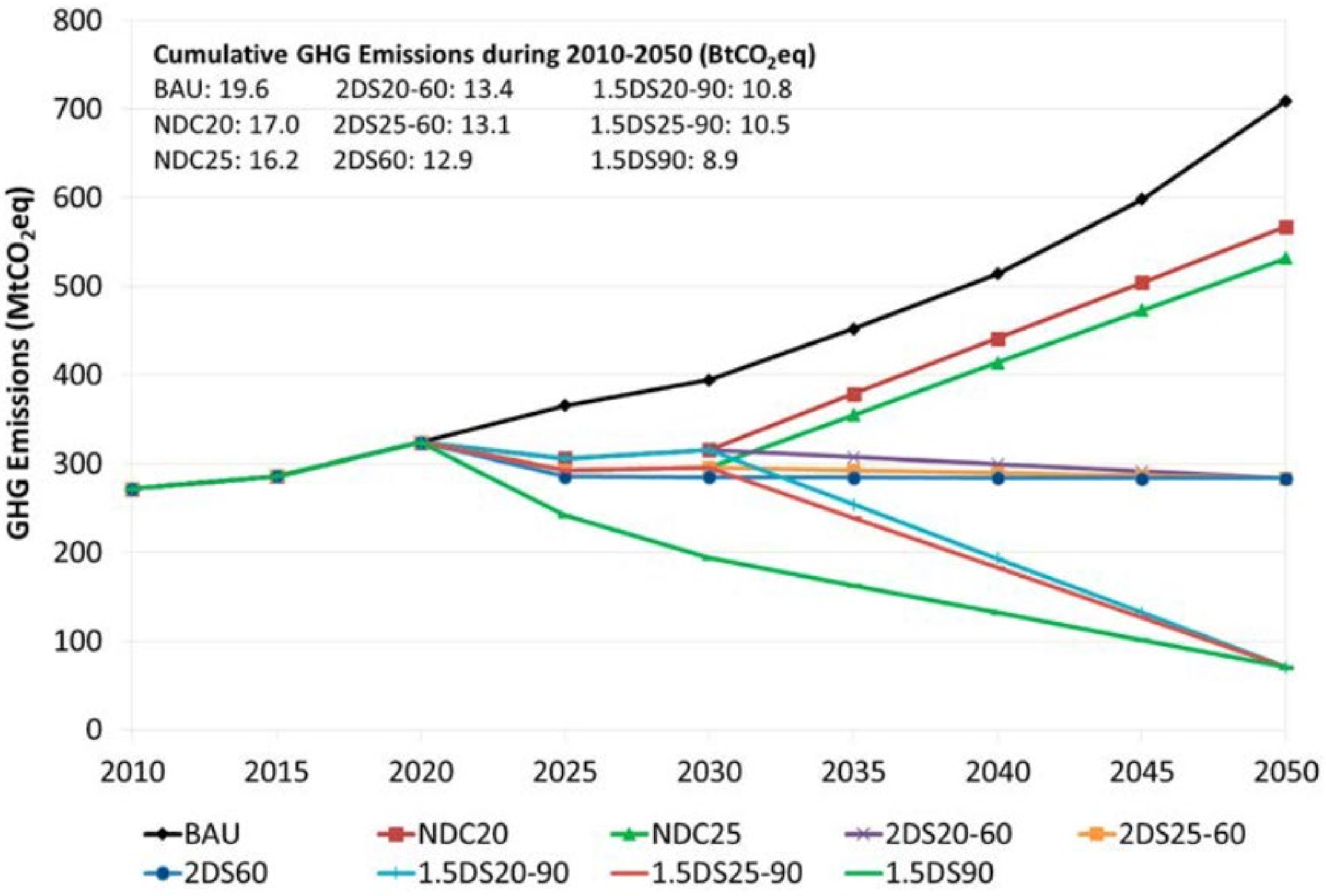
Griscom et al. (2020) National mitigation potential from natural climate solutions in the tropics. *Phil. Trans. R. Soc. B*

Knowledge gap in the mitigation potential of Thailand

Protect	Manage	Restore
Reduce deforestation	Forest management	Afforestation/Reforestation (A/R)
Reduce forest degradation	Agroforestry	Peatland restoration
Reduce conversion, draining, burning of peatlands	Soil carbon sequestration in croplands	Coastal wetland restoration
Reduce conversion of coastal wetlands (mangroves, seagrass and marshes)	Soil carbon sequestration in grazing lands	
	Biochar application	
	BECCS deployment	
	Cropland nutrient management N2O	
	Reduced N2O from manure on pasture	
	Manure management N2O and CH4	
	Improved rice cultivation CH4	
	Reduced enteric fermentation CH4	
	Improved synthetic fertilizer production	
	Urban Green Infrastructure	

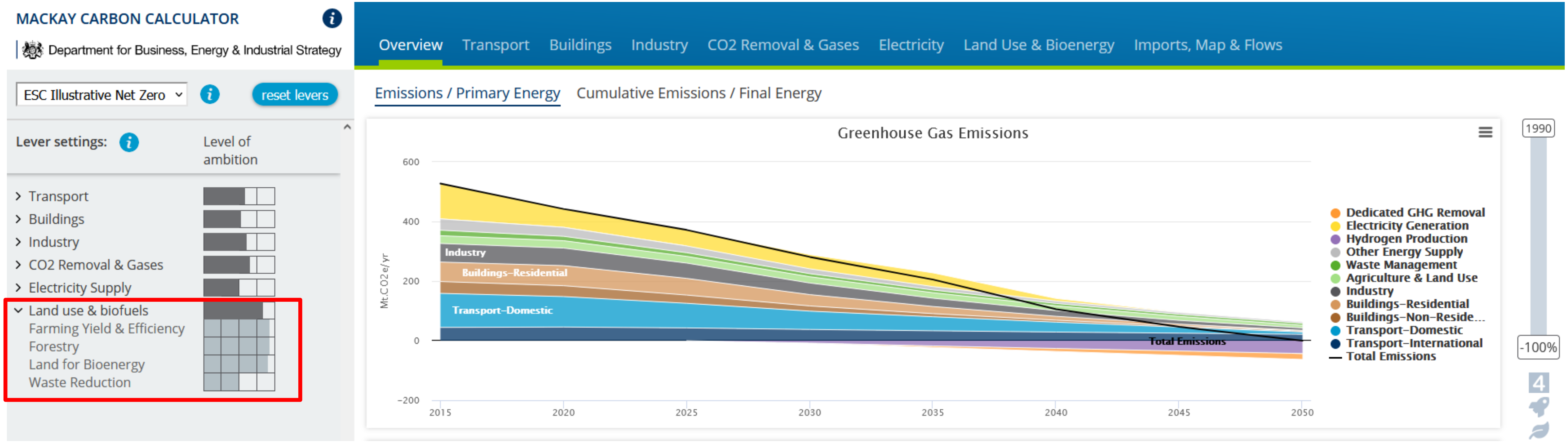
The land-based mitigation options are put together by IPCC (2019) Special Report on Climate Change and Land and Roe et al. (2019) Contribution of the land sector to a 1.5 C world. *Nature Climate Change*.

Thailand's NDC and the more ambitious targets



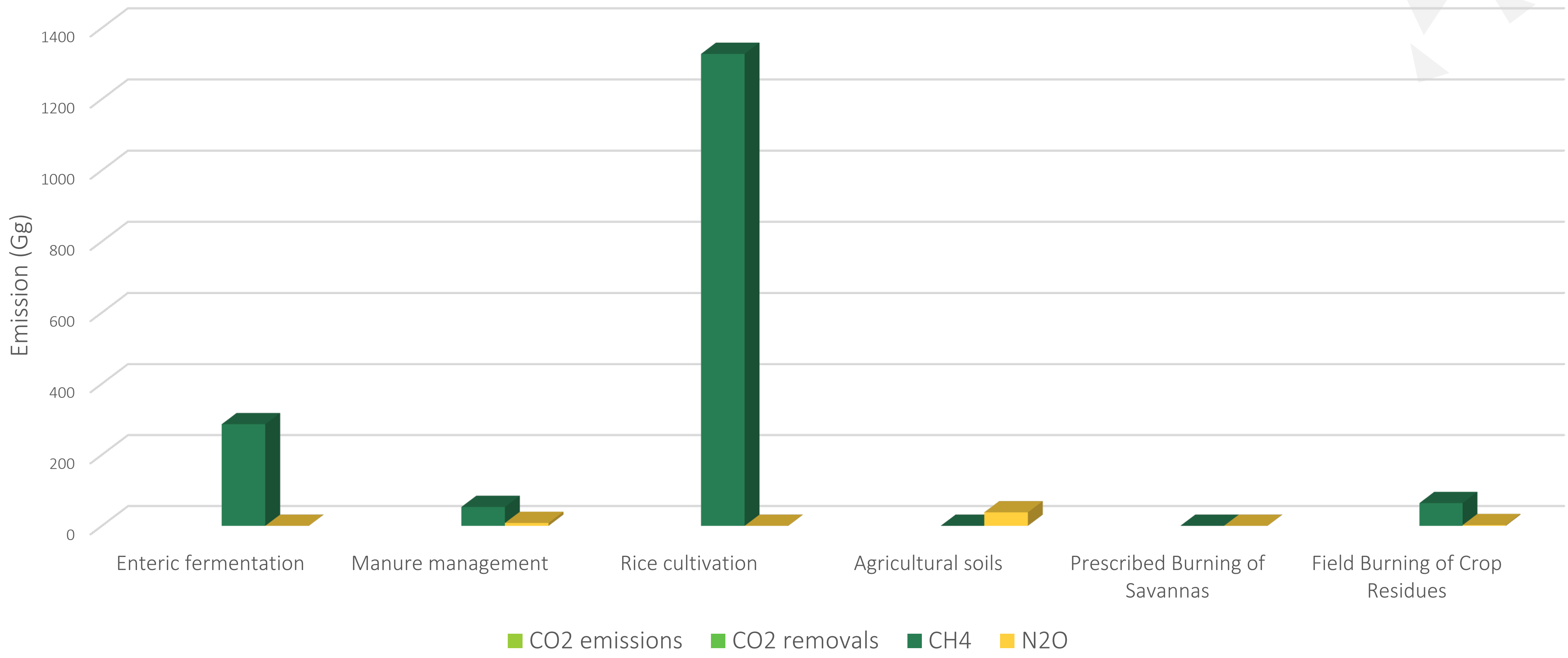
Rajbhandari & Limmeechokchai (2020) Assessment of greenhouse gas mitigation pathways for Thailand towards achievement of the 2 C and 1.5 C Paris Agreement targets. *Climate Policy*.

The Thailand 2050 Calculator and its application in supporting policy-making

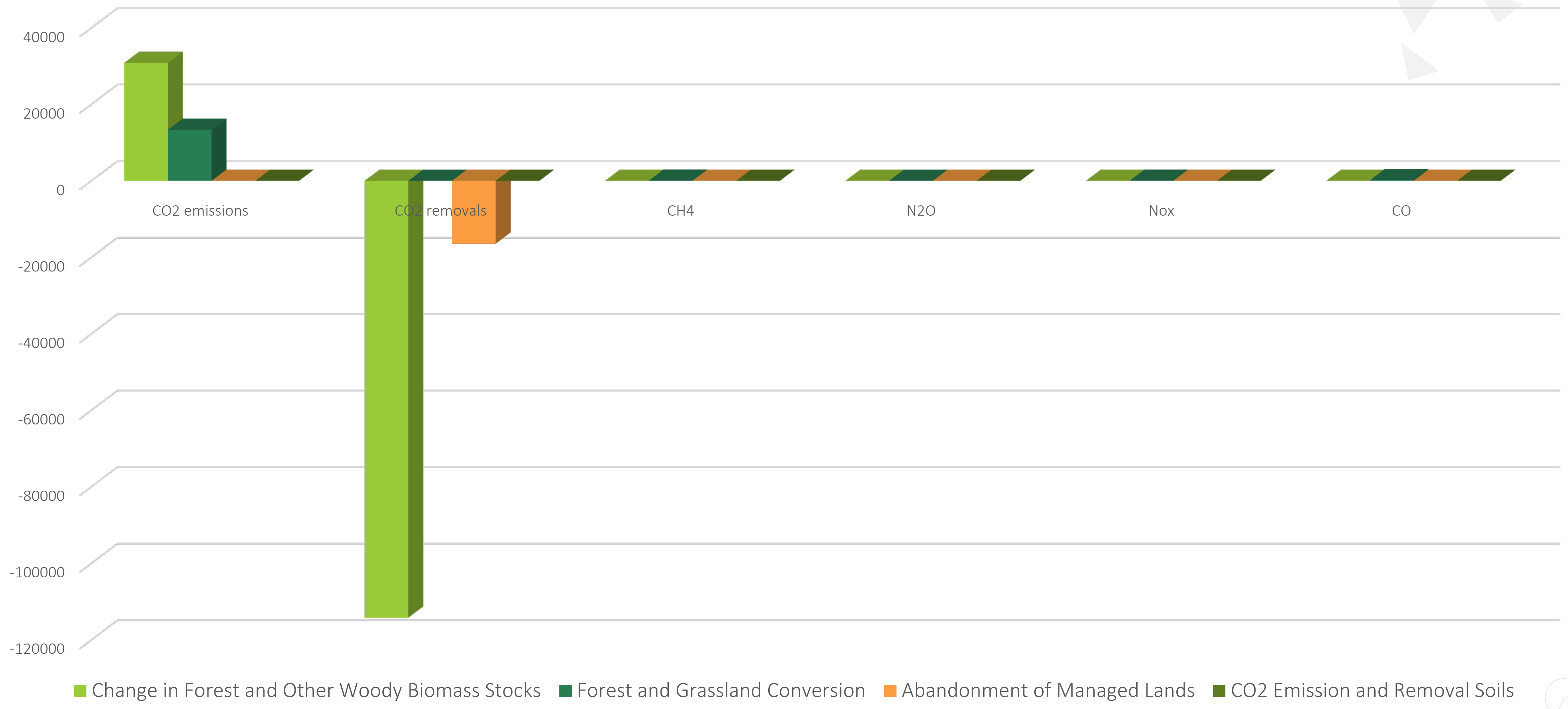


mackaycarboncalculator.beis.gov.uk

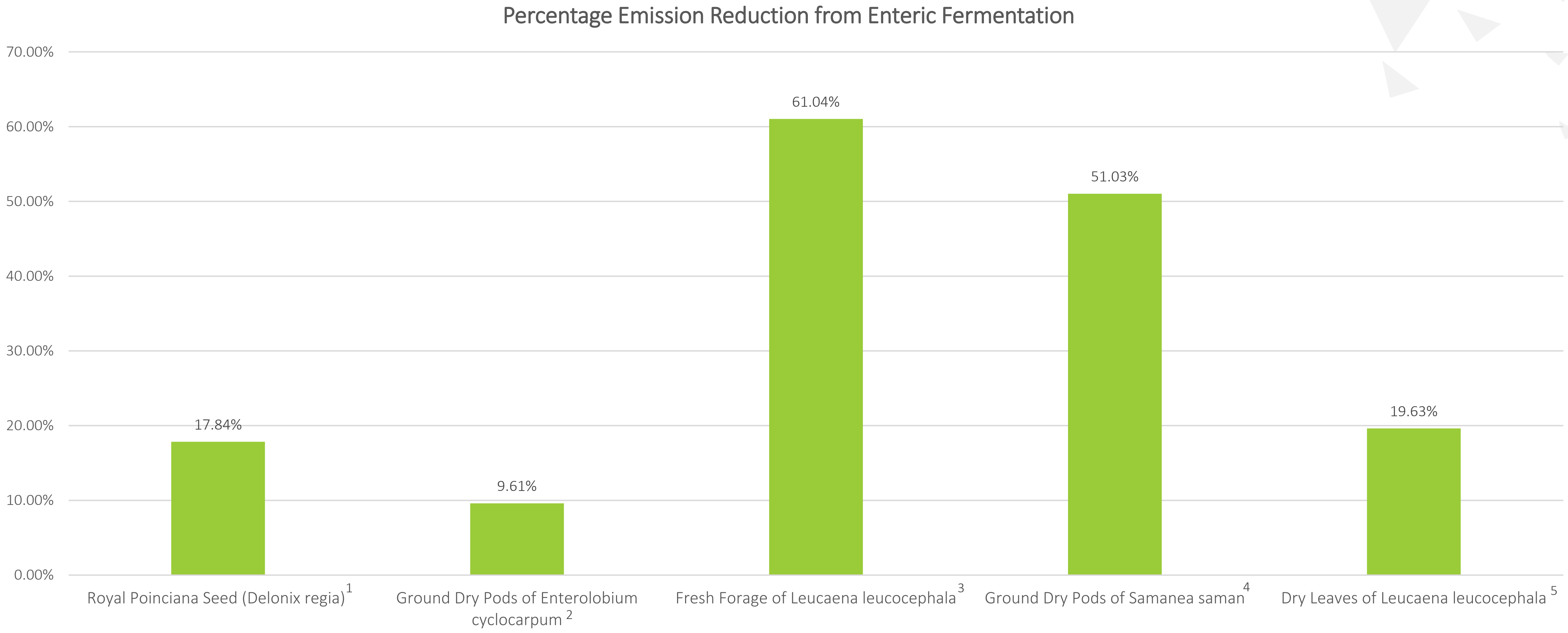
Thailand's AFOLU GHG inventory - Agriculture



Thailand's AFOLU GHG inventory – Forestry and Other Land-use Change

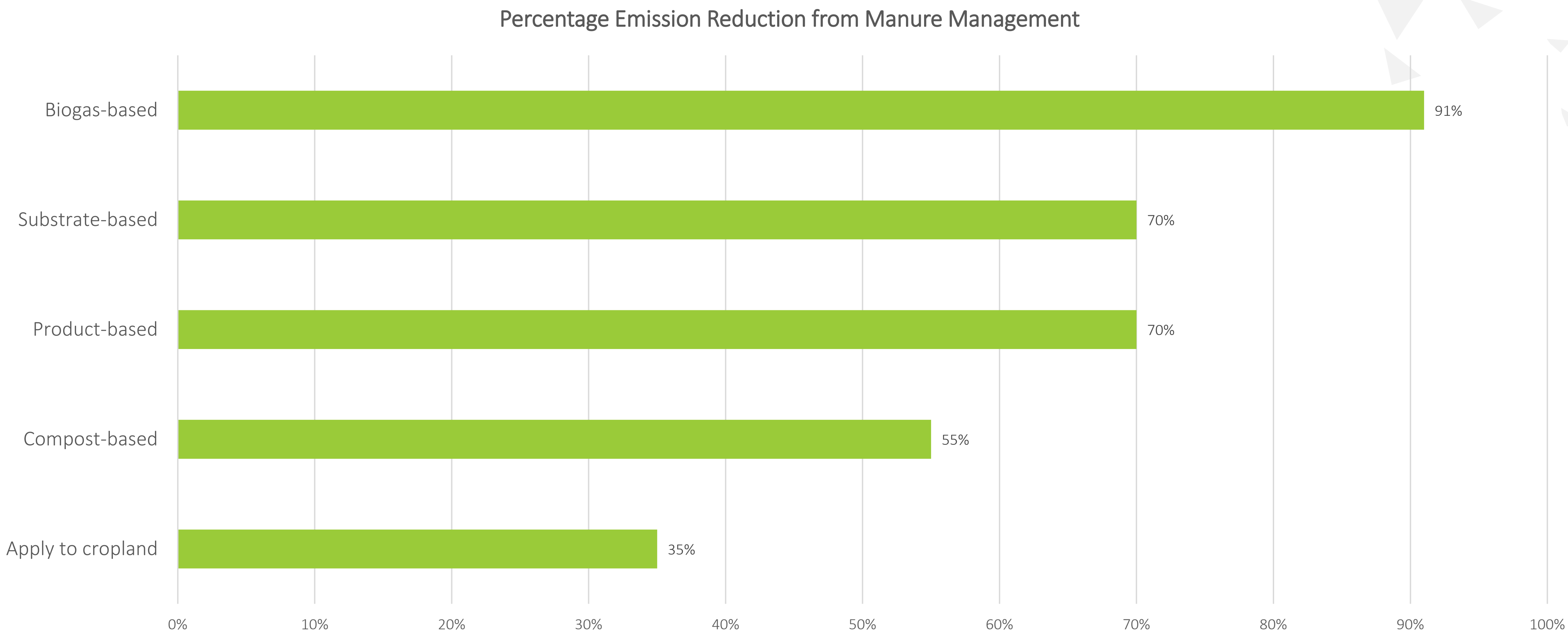


Livestock - Enteric Fermentation



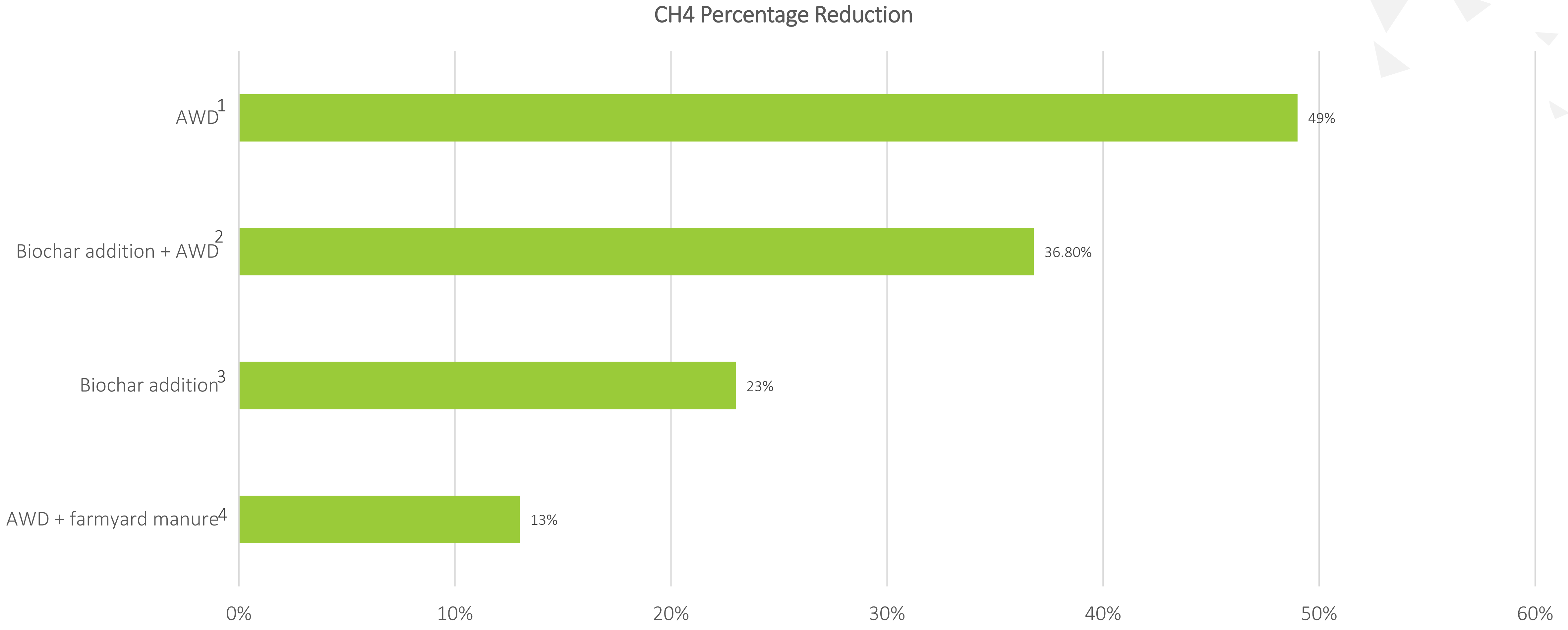
[1]Cherdthong et al. (2019) Effects of Supplementation with Royal Poinciana Seed Meal (Delonix regia) on Ruminal Fermentation Pattern, Microbial Protein Synthesis, Blood Metabolites and Mitigation of Methane Emissions in Native Thai Beef Cattle. *Animals*.
[2]Lazos-Balbuena. (2015) Uso del fruto de Enterolobium cyclocarpum como fuente de saponinas esteroidales para reducir la produccio´ n de metano entérico en bovinos.
[3]Piñeiro-Vázquez et al. (2013) Dry matter intake and digestibility of rations replacing concentrates with graded levels of Enterolobium cyclocarpum in Pelibuey lambs. *Tropical animal health and production.*
[4]Valencia Salazar et al. (2018) Potential of Samanea saman pod meal for enteric methane mitigation in crossbred heifers fed low-quality tropical grass. *Agricultural and forest meteorology.*
[5]Montoya-Flores et al. (2020) Effect of Dried Leaves of Leucaena leucocephala on Rumen Fermentation, Rumen Microbial Population, and Enteric Methane Production in Crossbred Heifers. *Animals.*

Livestock - Manure Management



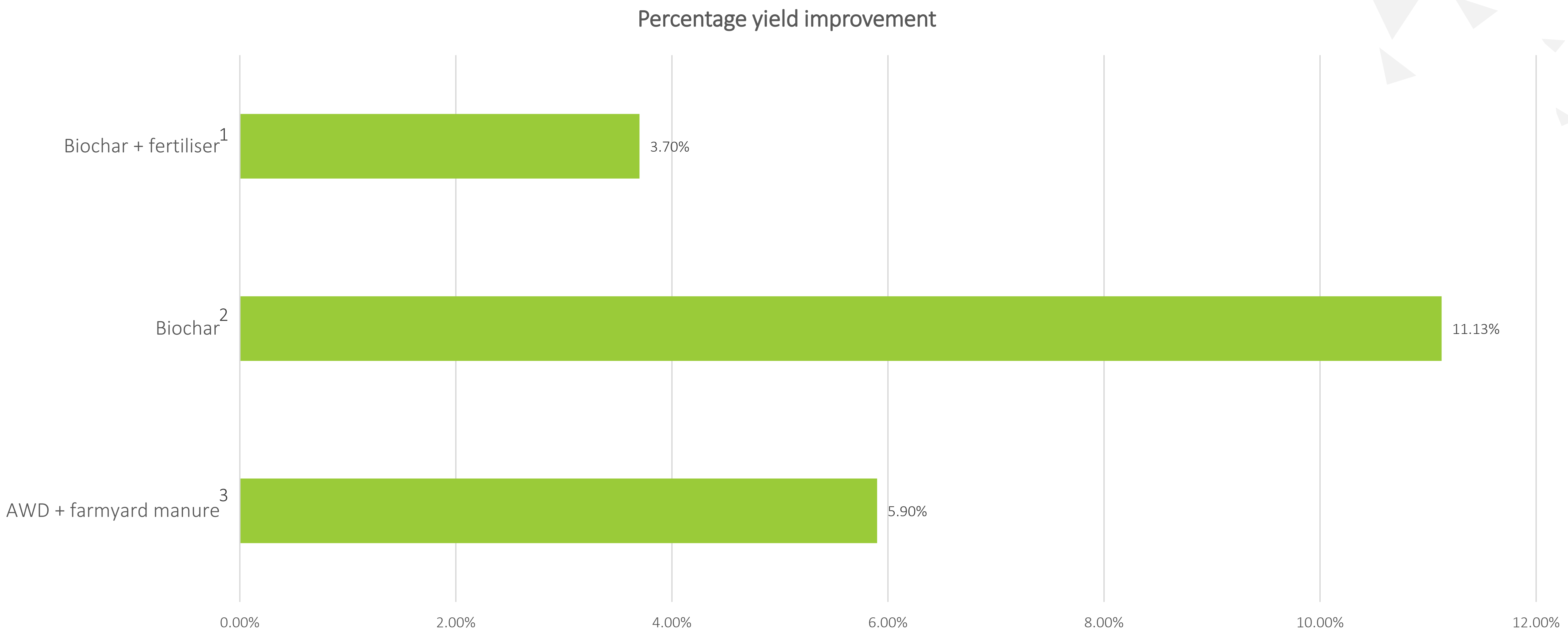
Wang et al. (2021) Alternative Management Systems of Beef Cattle Manure for Reducing Nitrogen Loadings: A Case-Study Approach. *Animals*.

Rice cultivation – CH_4 Emission Reduction



[1]Chidthaisong et al. (2018) Evaluating the effects of alternate wetting and drying (AWD) on methane and nitrous oxide emissions from a paddy field in Thailand. *Soil Science and Plant Nutrition*.
[2]Sriphirom et al. (2020) Evaluation of biochar applications combined with alternate wetting and drying (AWD) water management in rice field as a methane mitigation option for farmers' adoption. *Soil Science and Plant Nutrition*.
[3]Sriphirom et al. (2021) Effects of biochar on methane emission, grain yield, and soil in rice cultivation in Thailand. *Carbon Management*.
[4]Viandari et al. (2020) Alternate wetting and drying system (AWD) combined with farmyard manure to increase rice yield and reduce methane emission and water use. *IOP Conf. Ser.: Mater. Sci. Eng.*

Rice cultivation - Yield Improvement

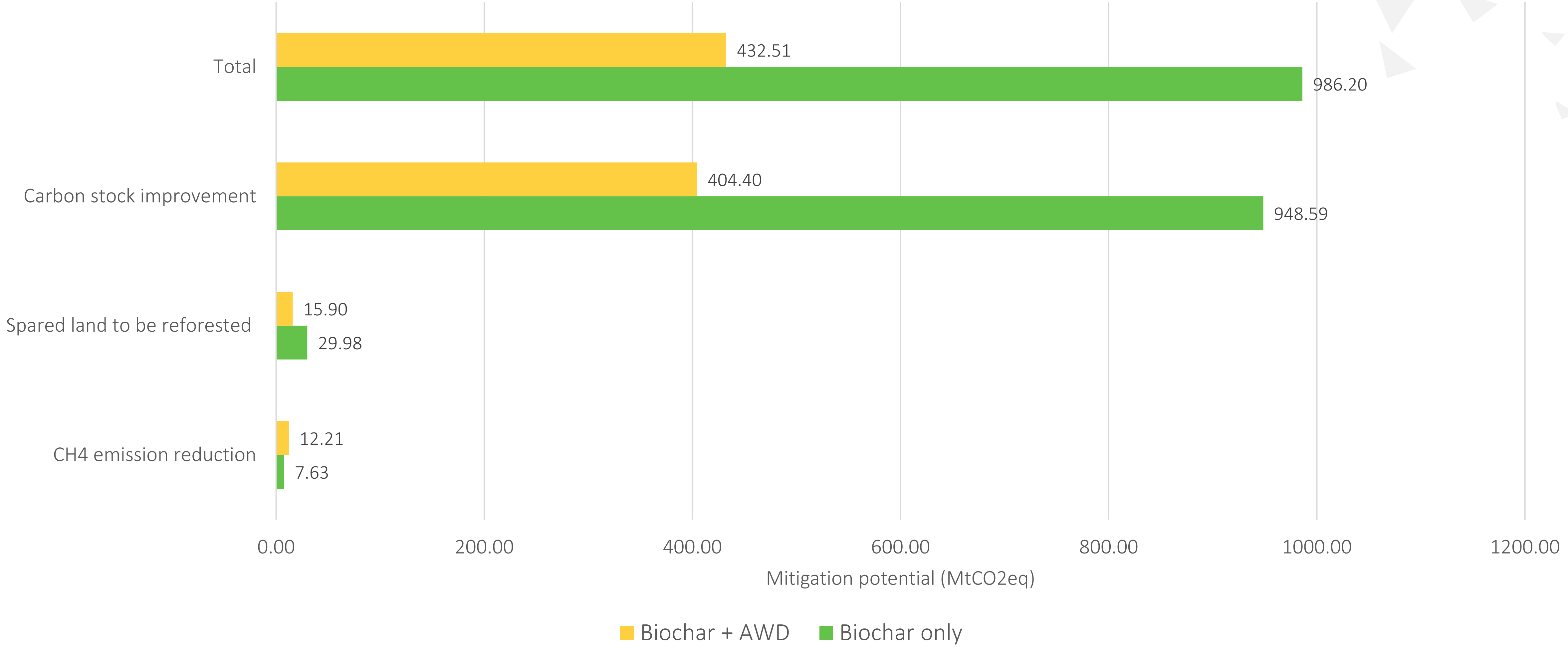


[1]Sriphirom et al. (2020) Evaluation of biochar applications combined with alternate wetting and drying (AWD) water management in rice field as a methane mitigation option for farmers' adoption. *Soil science and plant nutrition.*
[2]Sriphirom et al. (2021) Effects of biochar on methane emission, grain yield, and soil in rice cultivation in Thailand. *Carbon management.*
[3]Viandari et al. (2020) Alternate wetting and drying system (AWD) combined with farmyard manure to increase rice yield and reduce methane emission and water use. *IOP conference series. Materials Science and Engineering*

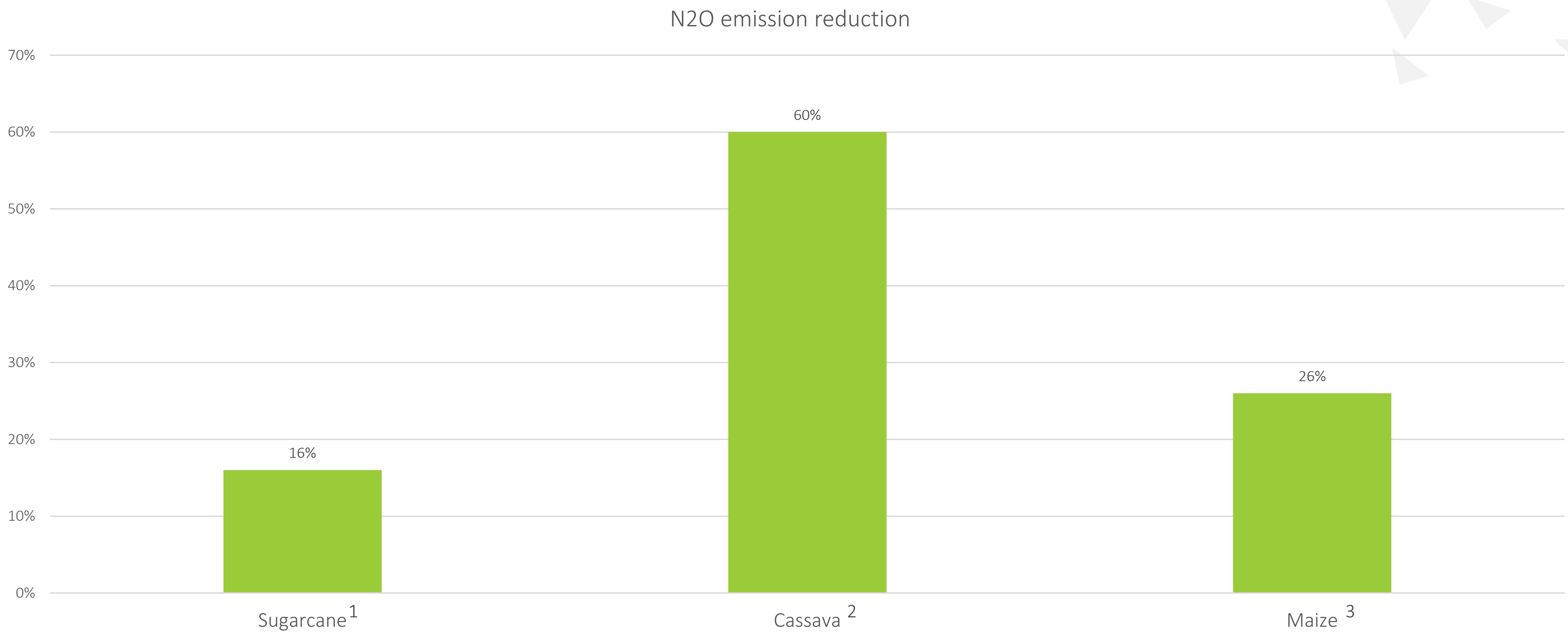
Rice cultivation - Soil Carbon Storage Improvement

[1]Sriphirom et al. (2020) Evaluation of biochar applications combined with alternate wetting and drying (AWD) water management in rice field as a methane mitigation option for farmers' adoption. *Soil science and plant nutrition.*
[2]Sriphirom et al. (2021) Effects of biochar on methane emission, grain yield, and soil in rice cultivation in Thailand. *Carbon management.*

‘Biochar only’ vs ‘Biochar + AWD’



Emission reduction from agricultural soils - Other crops



[1]Kaewpradit et al. (2019) Impact of Eucalyptus biochar application to upland rice-sugarcane cropping systems on enzyme activities and nitrous oxide emissions of soil at sugarcane harvest under incubation experiment. *Journal of plant nutrition*.
[2]Pengthamkeerati et al. (2014) Cassava (Manihot Esculenta Crantz) Yields, Soil Nitrous Oxide Emission, and Soil Nitrogen Transformation Affected by Nitrification Inhibitors in Loamy Sand Soil in Thailand. *Communications in soil science and plant analysis*.
[3]Pengthamkeerati & Modtad. (2016) Nitrification Inhibitor, Fertilizer Rate, and Temperature Effects on Nitrous Oxide Emission and Nitrogen Transformation in Loamy Sand Soil. *Communications in soil science and plant analysis*.

Yield improvement leading to spared land for afforestation/reforestation

Crop	Percentage Yield Improvement	Base Year freed-up land (ha)	Carbon stock gained if changed into forest (tonne C/ha)	Total potential carbon stock gained (tonne C)
Rice	11.13%	1,068,136.858	229.76	245,415,124.40
Rubber	50%	1,810,102.160	94.86	171,706,290.90
Oil Palm	22%	206,910.070	131.05	27,115,564.73
Cassava	8%	103,491.408	229.76	23,778,185.90
Maize	16.5%	182,949.466	229.76	42,034,469.22
Total		**3,371,589.962**		**510,049,635.20**

510 Mtonne C ✖ 44/12 = 1870 Mtonne CO_2 ÷ 30 years[1-3] = 62.33 Mtonne CO_2 year^{-1}

[1]Fukushima et al. (2008) Secondary forest succession after the cessation of swidden cultivation in the montane forest area in Northern Thailand. *Forest Ecology and Management*.
[2]Jha et al. (2020) Forest aboveground biomass stock and resilience in a tropical landscape of Thailand. *Biogeosciences*.
[3]Ueda et al. (2017) Soil properties and gross nitrogen dynamics in old growth and secondary forest in four types of tropical forest in Thailand. *Forest Ecology and Management*.

The potential evaluated so far

Protect	Manage	Restore
Avoided deforestation (**118 $MtCO_2$ $year^{-1}$**)	Rice cultivation (**4.31-12.21 $MtCO_{2eq}$ $year^{-1}$**)	Afforestation/Reforestation (**62.33 $MtCO_2$ $year^{-1}$**)
	Agricultural soil (**1.76 $MtCO_{2eq}$ $year^{-1}$**)	
	Biochar application (**404.40-948.59 $MtCO_{2eq}$ $year^{-1}$**)	
	Enteric fermentation (**0.69-4.36 $MtCO_{2eq}$ $year^{-1}$**)	
	Manure management (**1.30-3.38 $MtCO_{2eq}$ $year^{-1}$**)	
118 $MtCO_2$ $year^{-1}$	**412.46-970.3 $MtCO_2eq$ $year^{-1}$**	**62.33 $MtCO_2$ $year^{-1}$**
To be evaluated		
Reduce forest degradation	Agroforestry	Peatland restoration
Reduce conversion, draining, burning of peatlands	BECCS deployment	Coastal wetland restoration
Reduce conversion of coastal wetlands (mangroves, seagrass and marshes)	Improved synthetic fertilizer production	
	Urban green infrastructure	

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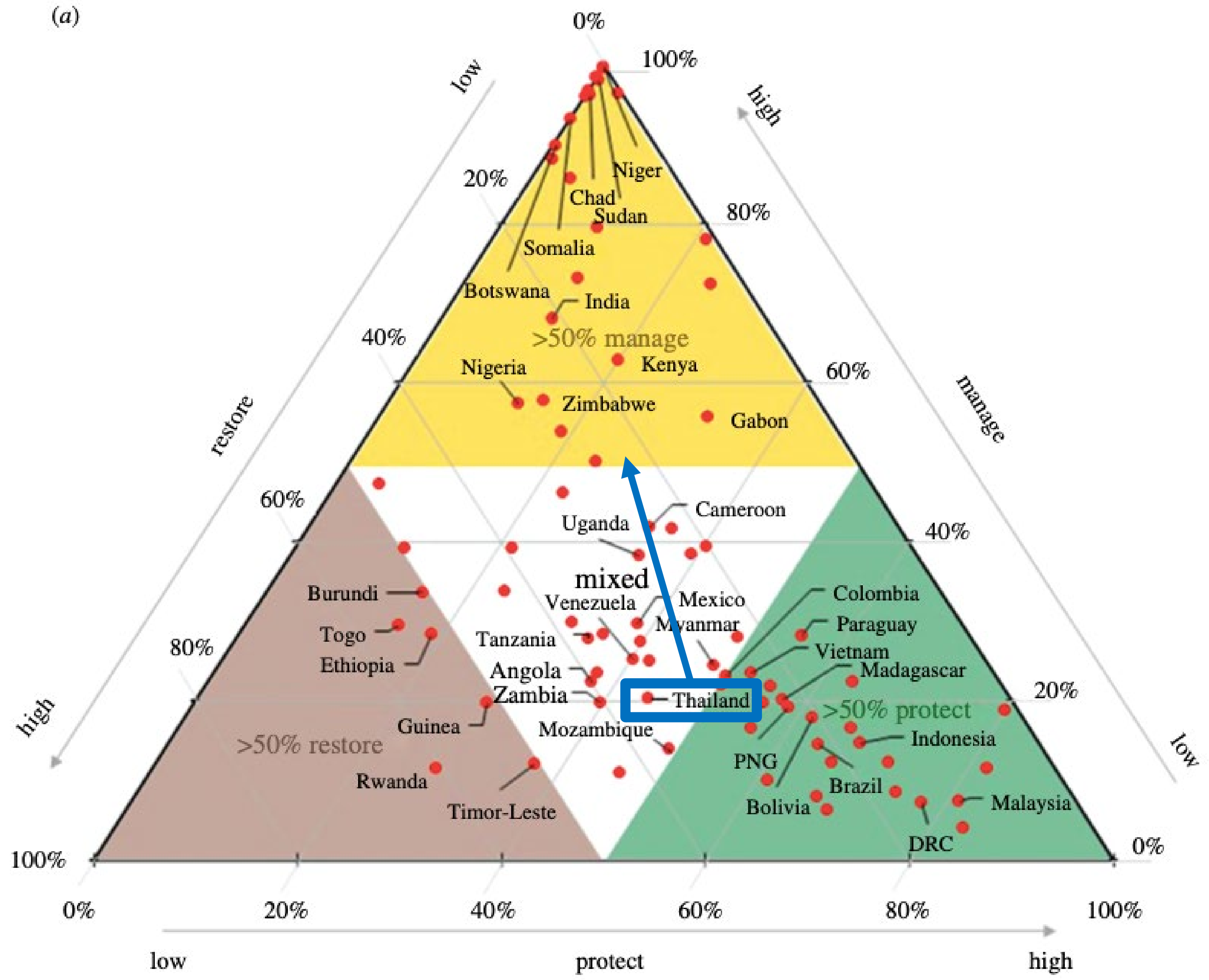

Griscom et al. (2020) National mitigation potential from natural climate solutions in the tropics. *Phil. Trans. R. Soc. B*

Next steps

- Evaluating the potential of the rest of the land-based mitigation actions
- Stakeholder engagement and expert elicitation of the modelling approach & data sourcing
- Working with the modelling team to complete the Thailand 2050 Calculator
- Produce climate change mitigation pathways and study the contribution of the land-based mitigation in the pathways


Thank You
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