Regional Conference on
Sustainable Livestock Transformation
for Latin America and the Caribbean
November 5th to 6th, 2024 - Punta del Este, Uruguay

“Green House Gas Emissions on Livestock – The Importance of Metrics to Estimate Global Warming”

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November, 5th, 2024

Embrapa

MINISTÉRIO DA AGRICULTURA E PECUÁRIA

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- GWP_{100} and GWP*
- Published in 2019
- https://doi.org/10.1038/s41612-019-0086-4
- Different
- long-lived climate pollutants (LLCPs)
- short-lived climate pollutants (SLCPs)

ARTICLE OPEN

Improved calculation of warming-equivalent emissions for short-lived climate pollutants

Michelle Cain[1,2], John Lynch[3], Myles R. Allen[1,3], Jan S. Fuglestvedt[4], David J. Frame[5] and Adrian H Macey[6,7]

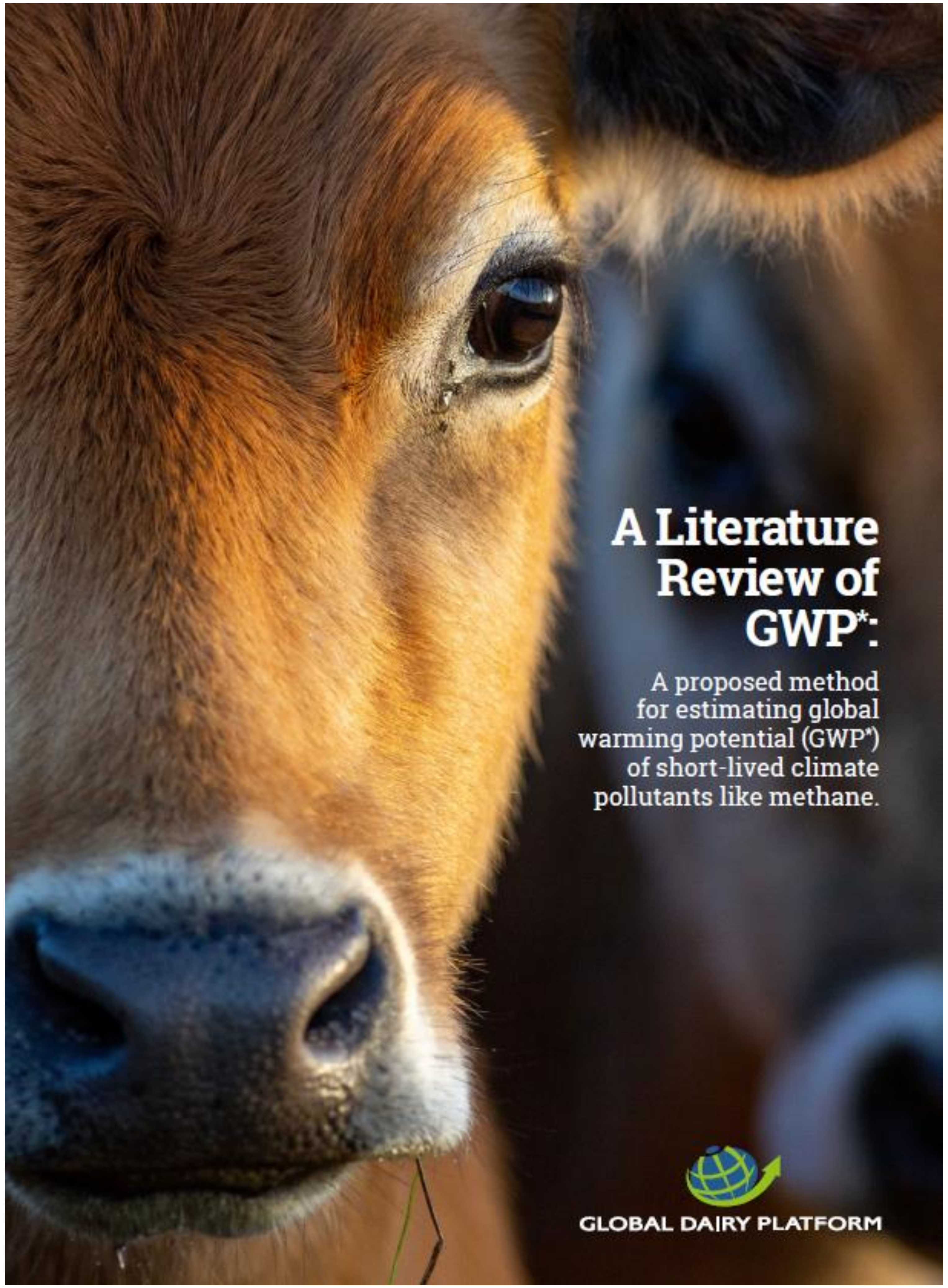
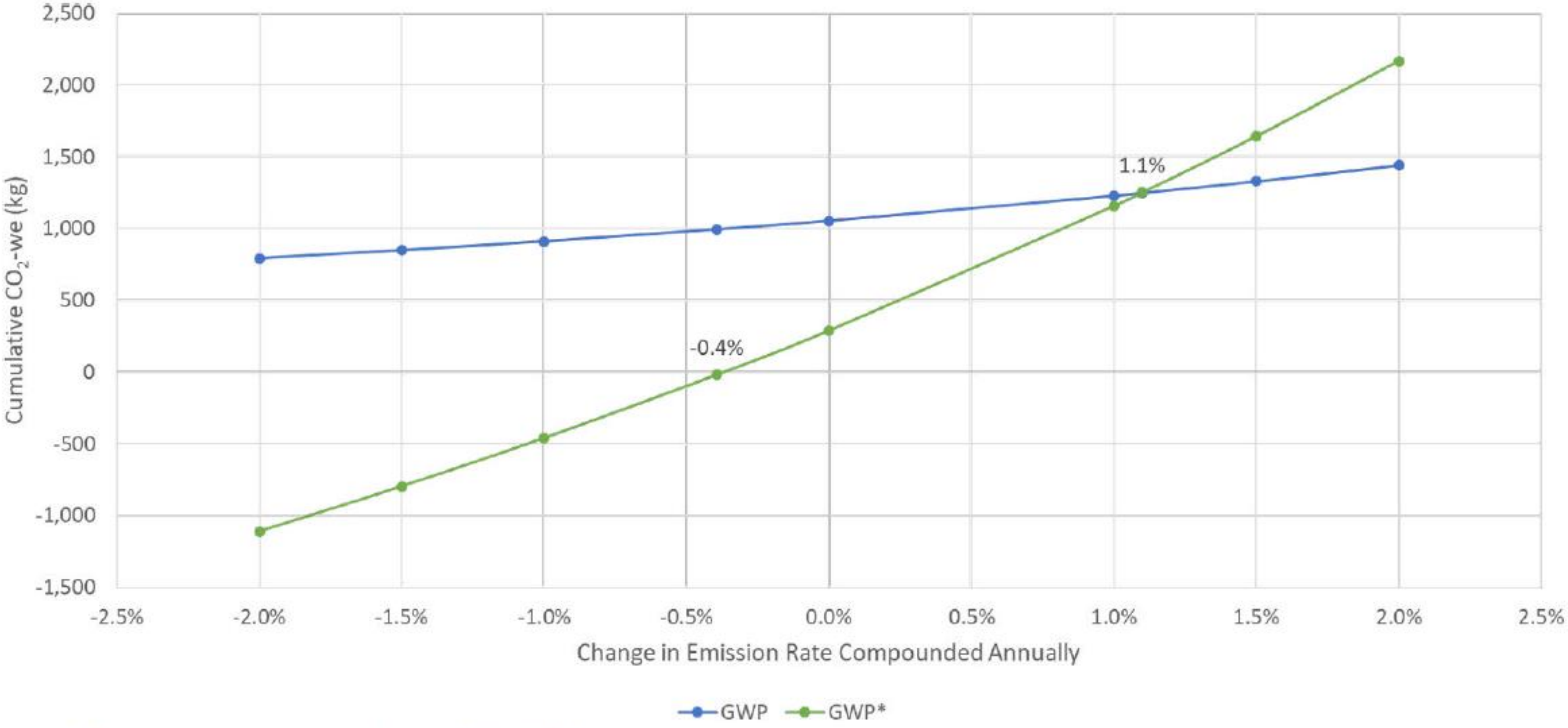
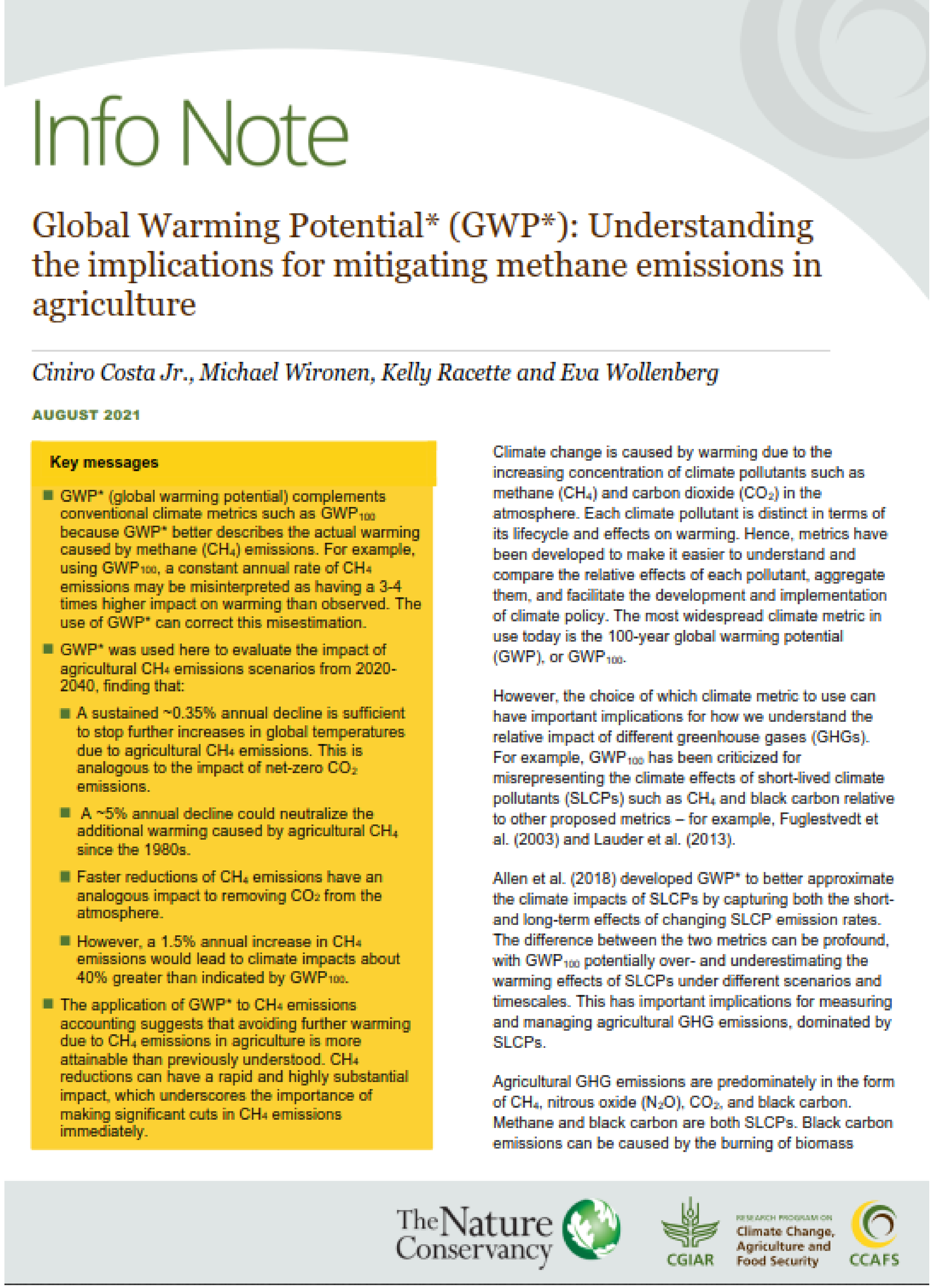

A Literature Review of GWP*:
A proposed method for estimating global warming potential (GWP*) of short-lived climate pollutants like methane.
GLOBAL DAIRY PLATFORM

Figure 8. 30-year Cumulative Methane Warming Estimates Comparing Various GWP_{100} to GWP_{100}* Behaviors#



Note: Initial emission pulse in year-zero is 1 kg, r = 0.75, s = 0.25



Info Note

Global Warming Potential* (GWP*): Understanding the implications for mitigating methane emissions in agriculture

Ciniro Costa Jr., Michael Wironen, Kelly Racette and Eva Wollenberg

AUGUST 2021

Key messages

- GWP* (global warming potential) complements conventional climate metrics such as GWP_{100} because GWP* better describes the actual warming caused by methane (CH_4) emissions. For example, using GWP_{100}, a constant annual rate of CH_4 emissions may be misinterpreted as having a 3-4 times higher impact on warming than observed. The use of GWP* can correct this misestimation.
- GWP* was used here to evaluate the impact of agricultural CH_4 emissions scenarios from 2020-2040, finding that:
  - A sustained ~0.35% annual decline is sufficient to stop further increases in global temperatures due to agricultural CH_4 emissions. This is analogous to the impact of net-zero CO_2 emissions.
  - A ~5% annual decline could neutralize the additional warming caused by agricultural CH_4 since the 1980s.
  - Faster reductions of CH_4 emissions have an analogous impact to removing CO_2 from the atmosphere.
  - However, a 1.5% annual increase in CH_4 emissions would lead to climate impacts about 40% greater than indicated by GWP_{100}.
- The application of GWP* to CH_4 emissions accounting suggests that avoiding further warming due to CH_4 emissions in agriculture is more attainable than previously understood. CH_4 reductions can have a rapid and highly substantial impact, which underscores the importance of making significant cuts in CH_4 emissions immediately.

Climate change is caused by warming due to the increasing concentration of climate pollutants such as methane (CH_4) and carbon dioxide (CO_2) in the atmosphere. Each climate pollutant is distinct in terms of its lifecycle and effects on warming. Hence, metrics have been developed to make it easier to understand and compare the relative effects of each pollutant, aggregate them, and facilitate the development and implementation of climate policy. The most widespread climate metric in use today is the 100-year global warming potential (GWP), or GWP_{100}.

However, the choice of which climate metric to use can have important implications for how we understand the relative impact of different greenhouse gases (GHGs). For example, GWP_{100} has been criticized for misrepresenting the climate effects of short-lived climate pollutants (SLCPs) such as CH_4 and black carbon relative to other proposed metrics – for example, Fuglestvedt et al. (2003) and Lauder et al. (2013).

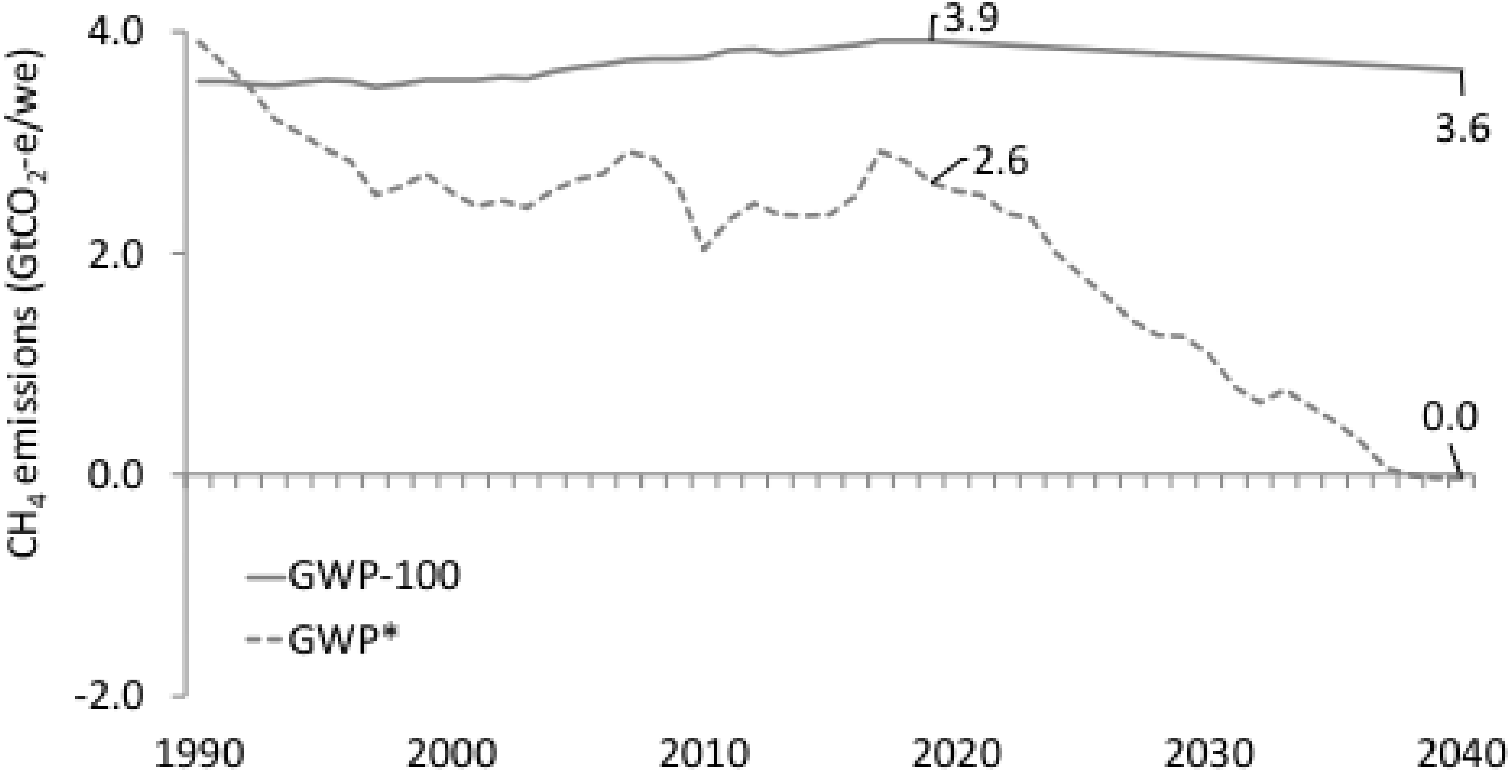
Allen et al. (2018) developed GWP* to better approximate the climate impacts of SLCPs by capturing both the short- and long-term effects of changing SLCP emission rates. The difference between the two metrics can be profound, with GWP_{100} potentially over- and underestimating the warming effects of SLCPs under different scenarios and timescales. This has important implications for measuring and managing agricultural GHG emissions, dominated by SLCPs.

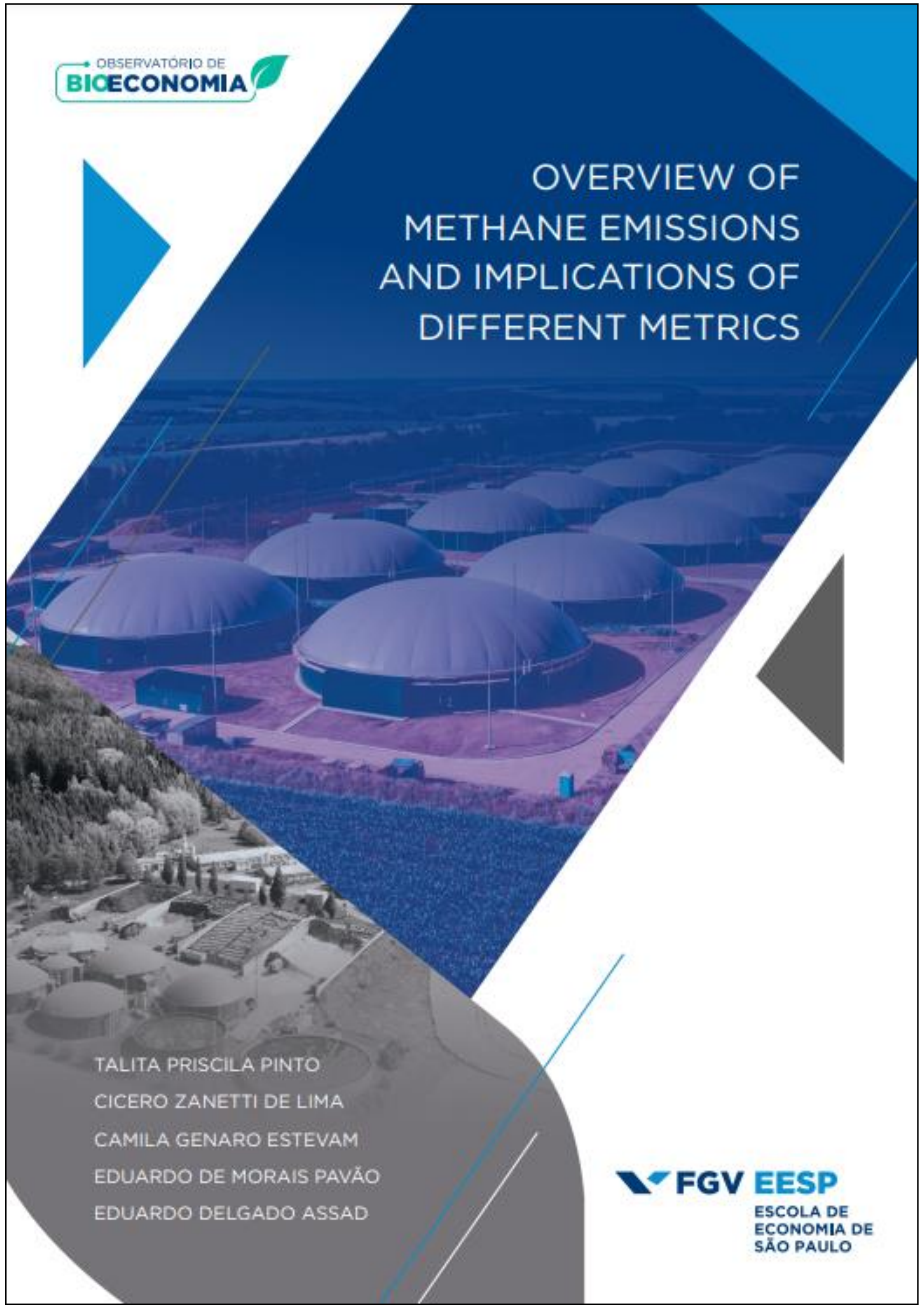
Agricultural GHG emissions are predominately in the form of CH_4, nitrous oxide (N_2O), CO_2, and black carbon. Methane and black carbon are both SLCPs. Black carbon emissions can be caused by the burning of biomass

The Nature Conservancy | CGIAR | Research Program on Climate Change, Agriculture and Food Security | CCAFS

https://cgspace.cgiar.org/items/63284c77-d499-43b3-8541-72ddb35cfd35

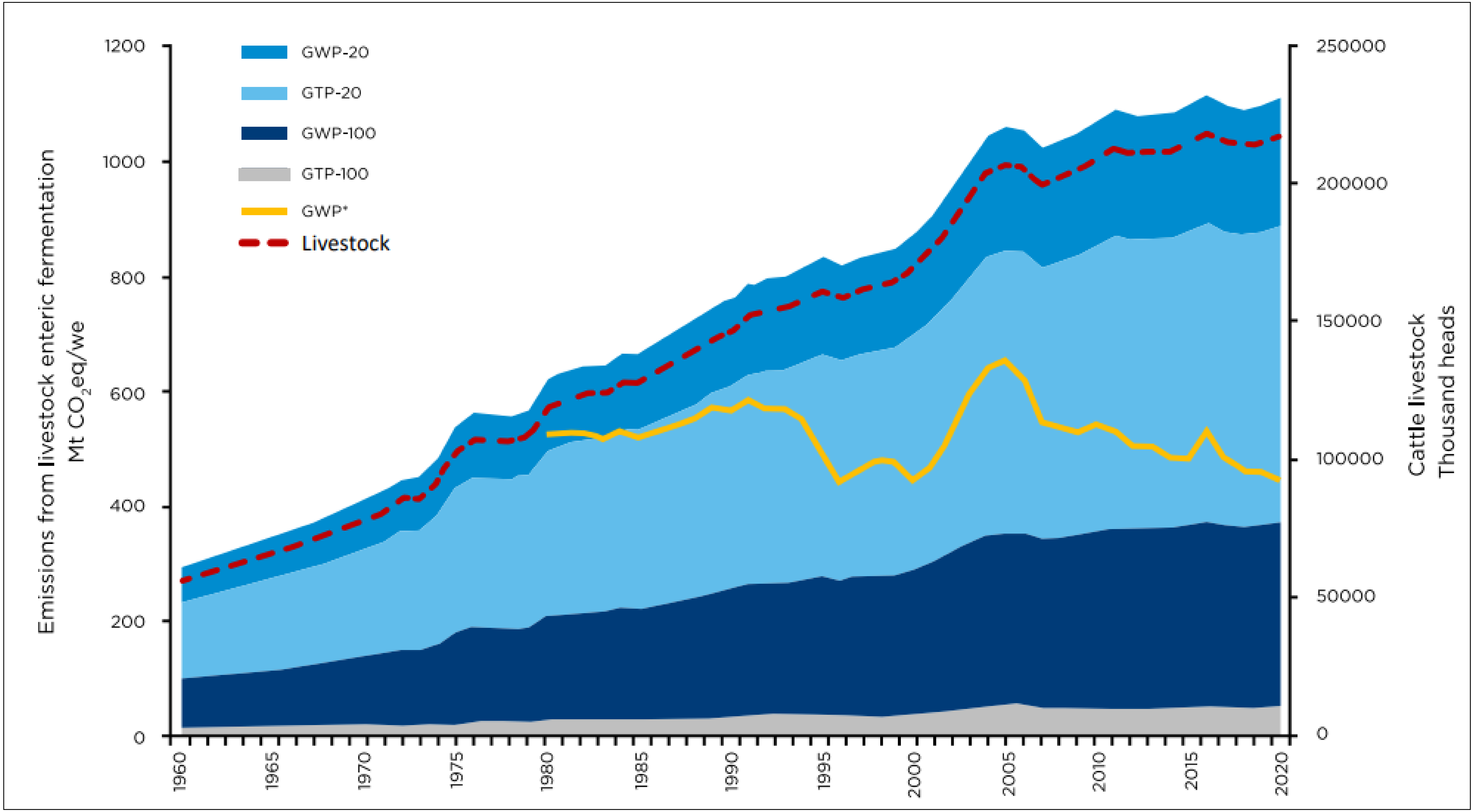
When applying GWP* to future emissions scenarios, we estimate that the agriculture sector could achieve "neutral" CH4 emissions (i.e., no additional temperature increases due to CH4, by reducing emissions ~7% (9.37MtCH4) by 2040). Thus, assuming no changes in other emission sources (e.g., N2O and black carbon) and excluding land conversion and other indirect emissions, the agriculture sector could reduce its direct contribution to ongoing temperature increases by 60% by 2040 (Figure 1) solely by cutting CH4 emissions by ~0.35% per year by 2040 (Figure 3a).


CH$_4$ emissions (GtCO$_2$-e/we)
4.0
2.0
0.0
-2.0
1990
2000
2010
2020
2030
2040
3.9
3.6
2.6
0.0
GWP-100
GWP*
(3a)

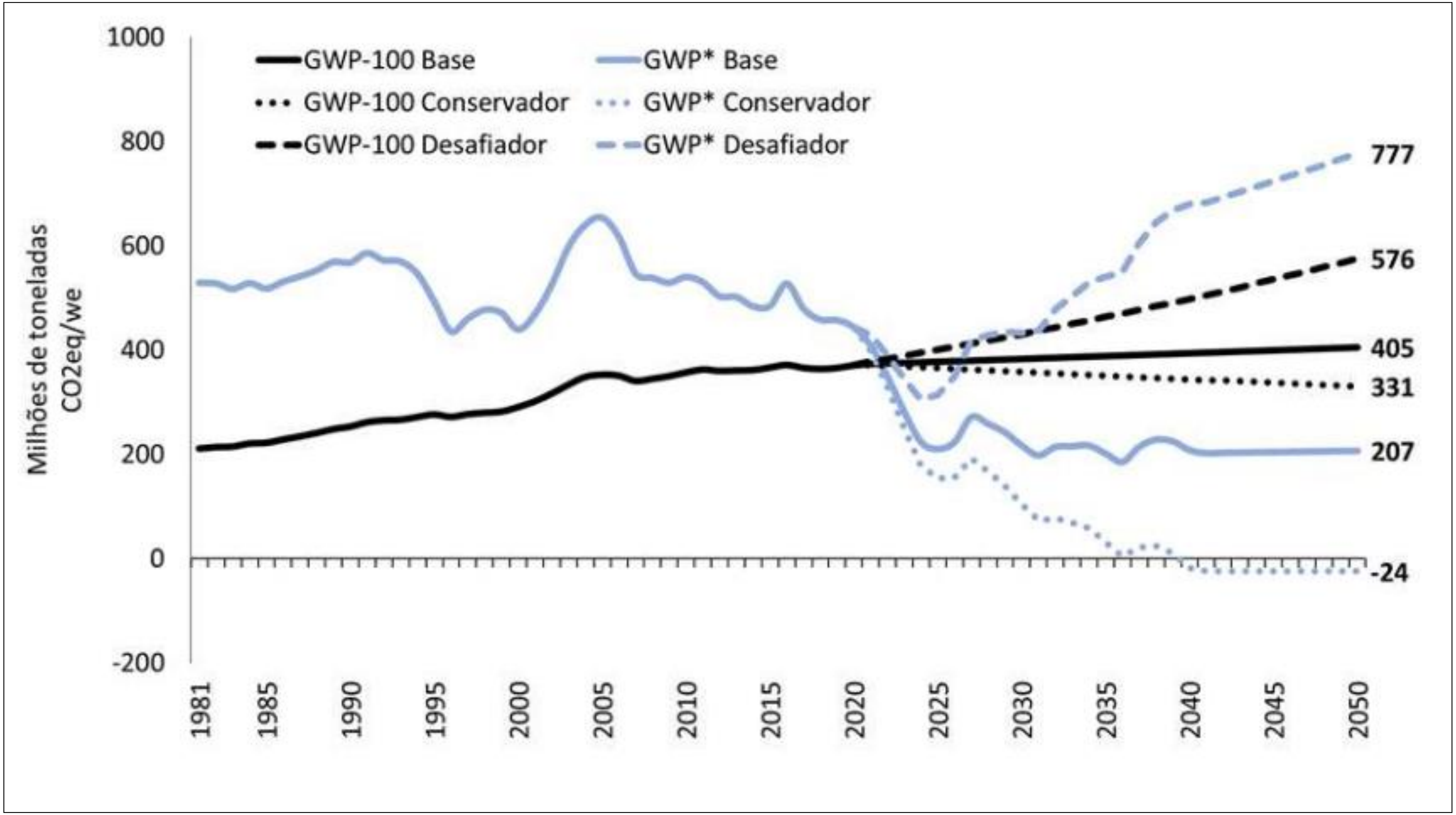


New metrics, such as the GWP*, allow to assess how the trajectory of emissions contributes to global temperature change, something that cannot be derived from traditional metrics such as GWP100, for example (Lesschen, 2021). The GWP* metric reinforces the importance and associated benefits of actions that promote the mitigation of methane emissions in the short and very short term. Even in a stable scenario of emissions, the potential contribution of livestock to reduce global warming is considerably reduced. On the other hand, a scenario with modest emission reductions can deliver a great benefit in terms of stopping climate change, increasing the sector's contribution to delaying the effects of global warming.

https://agro.fgv.br/sites/default/files/2023-02/eesp_relatorio_metano-eng_ap1_v1.pdf



GWP-20
GTP-20
GWP-100
GTP-100
GWP*
Livestock
Emissions from livestock enteric fermentation
Mt CO_2eq/we
Cattle livestock
Thousand heads
0
200
400
600
800
1000
1200
0
50000
100000
150000
200000
250000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020



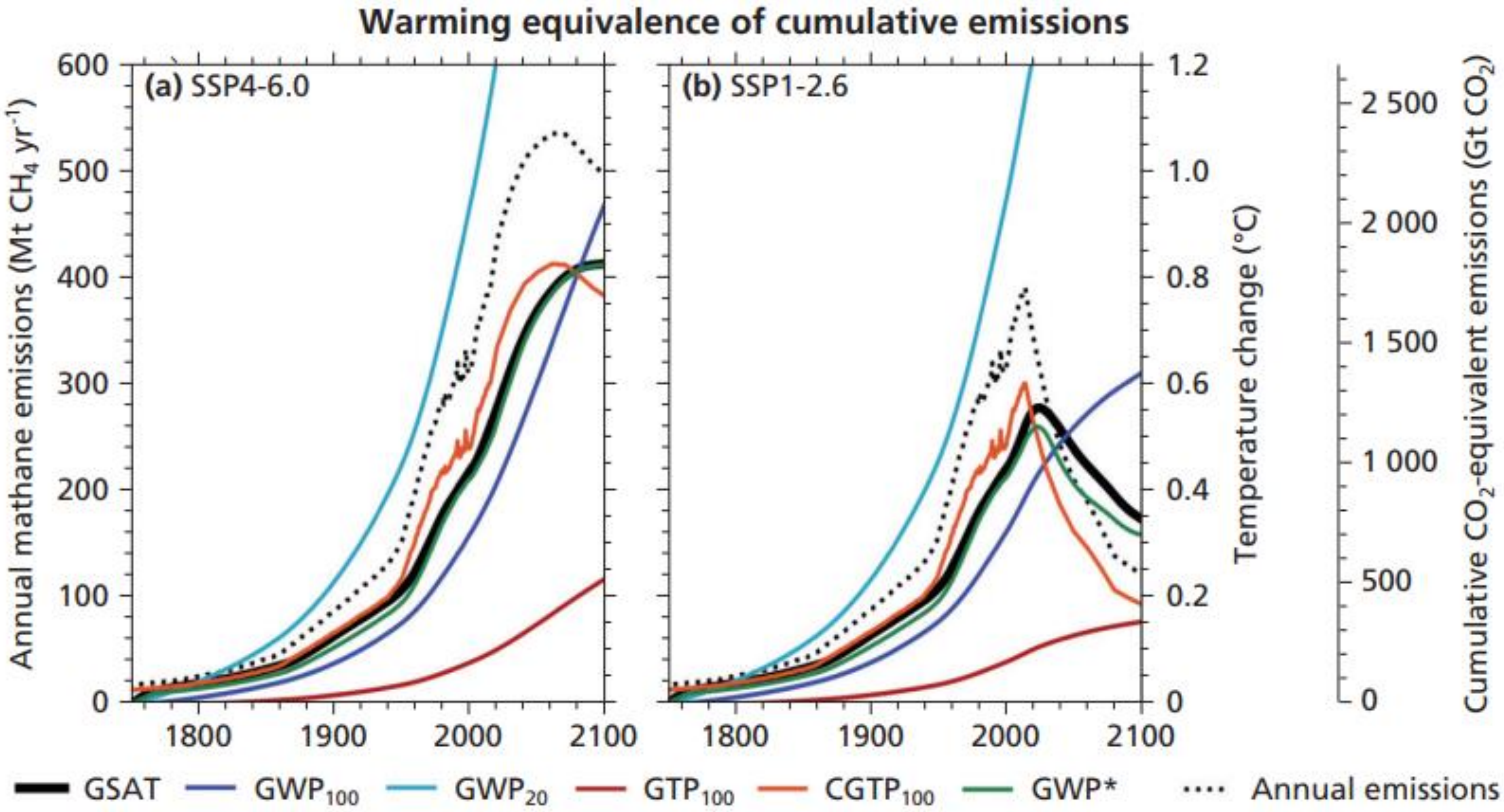
Note: the graph shows the cumulative CO_2eq emissions in the baseline scenario up to 2050 for the GWP100 metric and the cumulative CO_2we emissions in the baseline, challenging and conservative scenarios for the GWP* metric. Base scenario: stable herd growth (+0.33% per year). Challenging scenario: an acceleration of herd growth at a rate of 1.5% per year is considered. Conservative scenario: a reduction in the time to slaughter animals is considered, which would imply a deceleration of herd growth at a rate of -0.35% per year. Methane neutrality would be achieved in the conservative GWP* scenario in 2040.

Methane emissions in livestock and rice systems

Sources, quantification, mitigation and metrics

Figure 9

Cumulative CO_2-equivalent emissions of methane are shown, calculated using different metrics, for two mitigation scenarios named SSP4-6.0 (panel a) and SSP1-2.6 (panel b)



The temperature response from these emissions, calculated using an emulator, is shown with the black line (labelled GSAT for global surface air temperature).

- N_2O and CO_2 units are CO_2-eq
- Carbon removals are in CO_2-eq
- CH_4 GWP unit is CO_2-eq or
- CH_4 GWP* unit is CO_2-we

- How to harmonize metrics?

Appendix

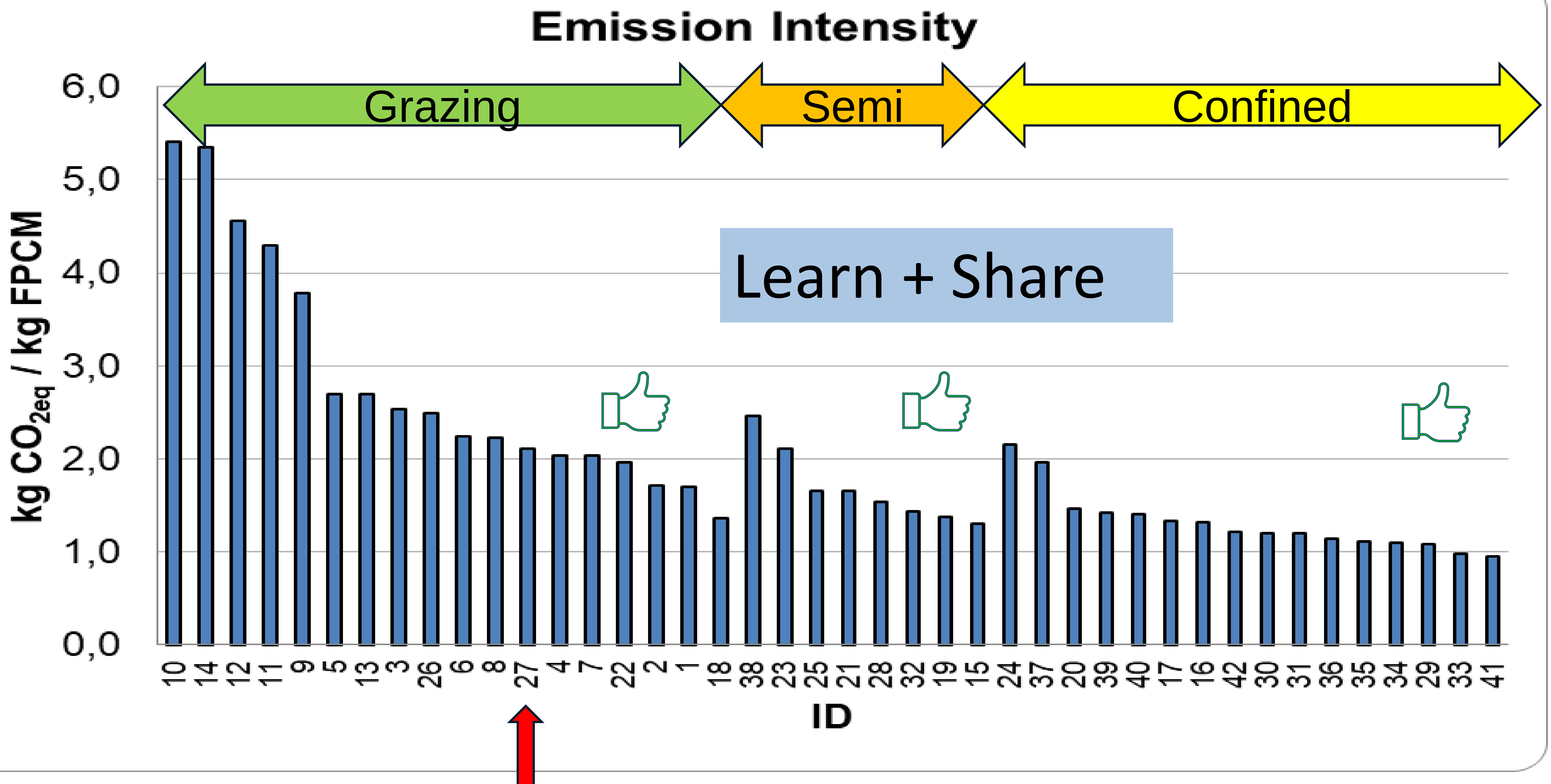
$GWP*_H$ Table of Coefficients ($C_{(t)}$ and $P_{(t-\Delta t)}$) for Δt = 0 to 50

Δt (yr)	$GWP*_{20}$ H=20, GWP_H=86, r=0.75, s=0.25	
	$C_{(t)}$	$P_{(t-\Delta t)}$
0	86.00	0.00
1	1,311.50	1290.00
2	666.50	645.00
3	451.50	430.00
4	344.00	322.50
5	279.50	258.00

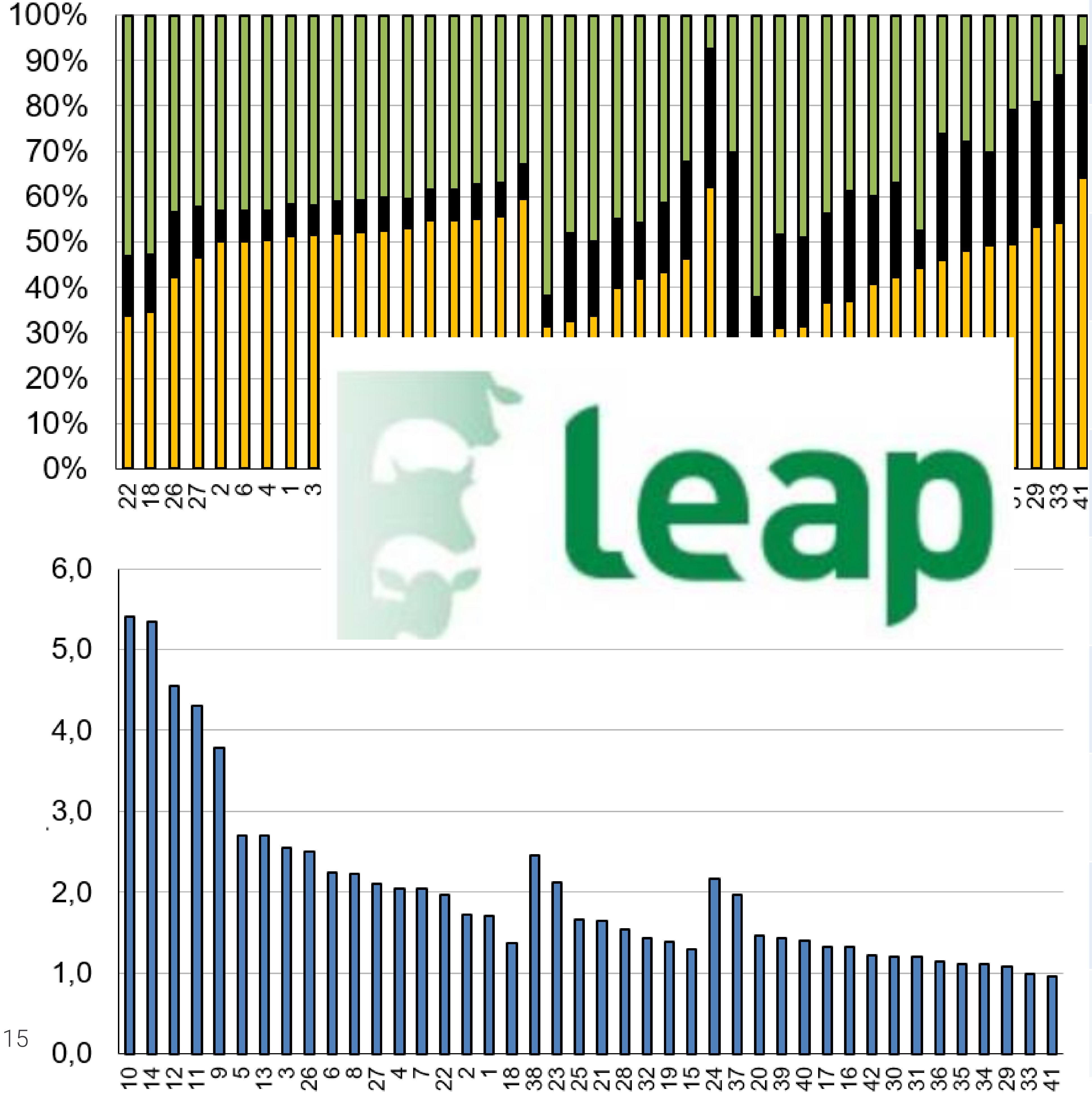
$$E_{CO2\text{-}we\ (SLCP)} = (4 \times E_{SLCP(t)} - 3.75 \times E_{SLCP(t-20)}) \times GWP_{100}$$

- Convention acceptance?

Low Carbon Dairy Platform – Embrapa (LCA)



Reflections:



	Grazing	Semi	Confined
E.Intensity	+	+-	-
Enteric	+	+-	-
Manure	-	+-	++
Water	-	+-	++
Carbon	++	+-	-
Energy	-	+-	++
Feed	-	+-	++
Biodiver/y	+	-	-
Profitabi/y	+	+-	+ or -
Happiness	?	?	?

Thank you!

Embrapa Southeastern Livestock team

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