Implications of methane as a short-living gas when designing global emission mitigation policies in the Agri-Food Sector

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1. Introduction

- Methane (CH_4) is a live-fast, die-young greenhouse gas, unlike carbon dioxide (CO_2).
- After released into the atmosphere, methane traps very large quantities of heat in the first 12 years (atmospheric lifetime), but quickly breaks down.
- For our analysis a simplified computation of the GWP* metric is applied to the analysis of emission mitigation policies in the agri-food sector (time-dynamics in 20 years steps)

CO2

CH_4

2. Main references

ARTICLES
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nature food
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Short- and long-term warming effects of methane may affect the cost-effectiveness of mitigation policies and benefits of low-meat diets

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Effects for global agriculture of country-specific climate policy regimes with a focus on methane

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3. The importance of metrics

- Conventionally, the impact of CH_4 is made comparable to CO_2 via the GWP_{100} metric, describing the integral of the induced radiative forcing over time (100 years) compared to that of CO_2.
- The alternative GWP* metric stresses that:
  - The Short-term (ST) effect of CH_4 (up to 20 years) is about four times higher than in the conventional GWP100 method
  - The Long-term (LT) effect of CH_4 (more than 20 years) is four times lower than in the conventional GWP_{100} method.
- Potentially misleading statements:

"the methane emissions of a cattle herd today are simply replacing the emissions that were first produced when that herd was established by a previous generation of farmers […] ***so there is no ongoing warming from that herd****."*

4. Scenario analysis for the agri-food sector

- Using short-lived methane equivalent factors (MEF) the economic impacts on agricultural commodity markets for two different mitigation policies are computed:
  - Moderate mitigation in year 2070 (consistent with a 2°C - 2.5°C target)
  - Ambitious mitigation in year 2070 (consistent with a 1.5°C – 2°C target)
- Three agro-economic models involved: GLOBIOM, CAPRI, MAGNET

Metric	Moderate mitigation	Ambitious mitigation
MEF-LT*	CP150_LT	CP500_LT
GWP_{100}	CP150	CP500
MEF-ST**	CP150_ST	CP500_ST

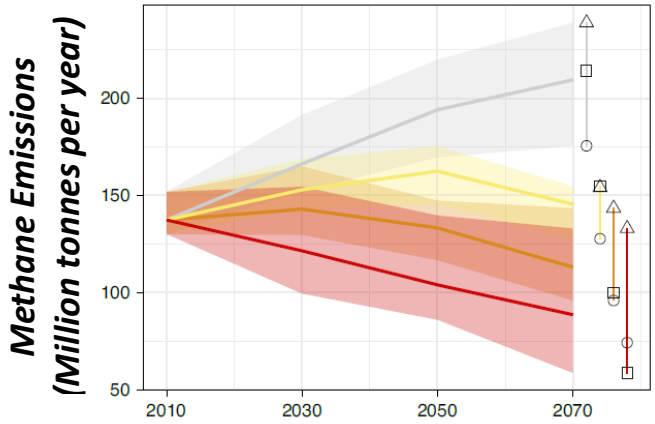
* Methane equivalent factor long term (MEF-LT): 0.25x25 = 6.25.

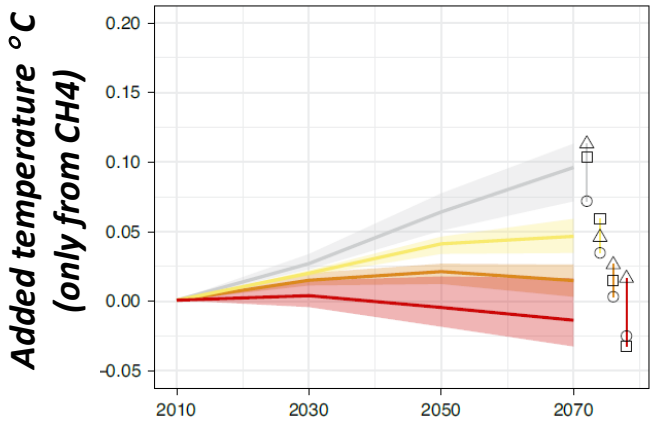
** Methane equivalent factor short term (MEF-ST): 4x25 = 100.

Note: the scenarios do not include residual climate change impacts on yields

Source: Pérez et Al. 2021, Nature Food

5. How effective are mitigation policies?





BASE CP150_LT CP150 CP150_ST □ CAPRI ○ GLOBIOM △ MAGNET

- Global baseline CH4 emissions from agriculture slightly increase between 2010 (reference year) and 2070 (final simulation year) → **grey area**
- Moderate mitigation brings CH4 emissions down the most when considering a "short-term" methane emission factor (**red area**) and brings them to stabilization considering a "long-term" perspective (yellow area).

- Added temperature from agriculture methane emissions in the baseline is about 0.10°C (2070 compared with 2010)
- Moderate mitigation policies can stop added temperature from methane emissions
- Ambitious mitigation policies can contribute to negative added temperature

Source: Pérez-Domínguez et al. 2021, Nature Food

6. What are the main economic impacts?

	Metric used	Moderate mitigation	Ambitious mitigation
Added warming from CH4 emissions	MEF-LT	-51	-88
	GWP100	-85	-117
	MEF-ST	-115	-132
Added warm. from non-CO2 emissions	MEF-LT	-34	-58
	GWP100	-53	-74
	MEF-ST	-70	-84
Crop production index	MEF-LT	-2	-4
	GWP100	-2	-4
	MEF-ST	-2	-4
Non-ruminant production index	MEF-LT	-2	-5
	GWP100	-2	-5
	MEF-ST	-1	-4
Ruminant production index	MEF-LT	-8	-18
	GWP100	-14	-25
	MEF-ST	-24	-36
Producer Price	MEF-LT	5	16
	GWP100	8	24
	MEF-ST	17	51

Indicators for global agriculture by mitigation policy and methane emission factor. Average of models; percentage change relative to baseline in 2070

Source: Pérez-Domínguez et al. 2021, Nature Food

- Large decrease in added temperature from non-CO2 emissions depending on the MEF and mitigation policy:
  - -34% to -70% for moderate
  - -58% to -84% for ambitious
- Mitigation policies imply lower ruminant production, especially in the MEF_{ST} and ambitious mitigation scenario (-36%)
- In general, mitigation efforts induce lower production (from -2% to -36% depending on the activity) and higher producer prices (from +5% to +51%)

7. Discussion

- Methane's short atmospheric life has important implications for the design of global climate change mitigation policies in agriculture.
  - ✓ If CH_4 emissions increase → very high added temperature in the short-term (ST), high in the long-term (LT)
  - ✓ If CH4 emissions stable → high in the ST, no added temperature in the LT
  - ✓ If CH4 emissions decrease → high in the ST (if emissions continue), negative in the LT
- Therefore, the choice of a particular metric for methane's warming potential is key to determine optimal/effective mitigation options (i.e. specific mitigation technologies)
- Policies *based on shorter-term impacts of methane lead to greater overall emission reduction and potentially "negative warming"*.

7. Discussion

- Methane time dynamics are difficult to consider in the post-2020 CAP, even if it is more flexible and results-based… but focusing on actual management practices
- In practice emission mitigation efforts should vary across time for methane emitting activities, in practice:
  - ✓ mitigation incentives (or emission dis-incentives) should be larger in the first years of the emitting activity
  - ✓ They could be potentially phased-out over time or redirected towards the mitigation of long-lived GHGs (e.g. CO_2 and N_2O)
- Most importantly, the use of alternative metrics (GWP* versus GWP_{100}) shall not undermine global emission reduction efforts but better adjust current mitigation policies to actual climate outcomes