GENERAL INTRODUCTION & EFFECTS OF FEED ADDITIVES TO REDUCE GHG EMISSIONS

PETER LUND, GIULIO GIAGNONI, MORTEN MAIGAARD, MARIA H. KJELDSEN, SAMANTHA NOEL, DANA OLIJHOEK, WENJI WANG, MARTIN R. WEISBJERG



Dep. of Animal and Veterinary Sciences
Aarhus University
Peter.Lund@anivet.au.dk

AARHUS UNIVERSITY

CBIO
AARHUS UNIVERSITY CENTRE FOR CIRCULAR BIOECONOMY

iCLIMATE
AARHUS UNIVERSITY INTERDISCIPLINARY CENTRE FOR CLIMATE CHANGE

World Jersey Conference
June 2024
40 min incl. questions

Aviser RejsUd FileSender TinyWow Dyreforsøgstilsynet BUP Brightspace Blackboard YouTube

THE LOCAL dk

NEWS ESSENTIALS LEARN ABOUT DENMARK LANGUAGE HOMES JOBS

Danish expert committee proposes CO2 emissions tax for agriculture

Ritzau/The Local - news@thelocal.dk
Published: 21 Feb, 2024 CET. Updated: Wed 21 Feb 2024 14:58 CET

Recommendations for an emissions tax on agriculture were presented by a Danish expert committee on Tuesday., Photo: Thomas Traasdahl/Ritzau Scanpix

An expert committee on Wednesday presented its proposals for a carbon tax for agriculture, which the Danish government has long sought to

REUTERS® World Business Markets Sustainability Legal Breakingviews Technology Invest

Climate & Energy | Environment | Sustainable Markets | Climate Change | Climate Solutions

Danish farmers concerned carbon tax will lead to lower production

By **Isabelle Yr Carlsson**

February 21, 2024 6:24 PM GMT+1 · Updated 3 months ago

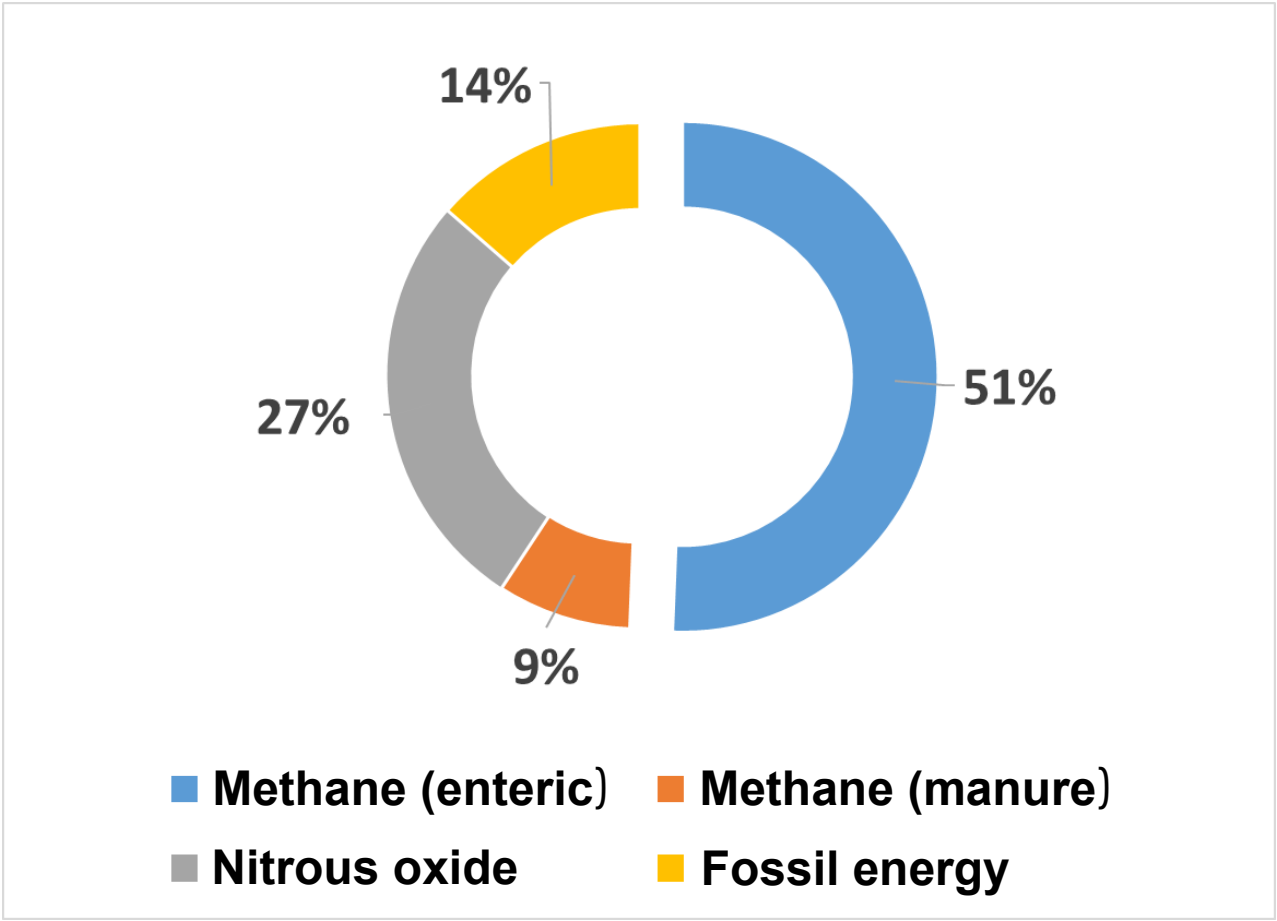
TOP 5 CONTRIBUTORS TO DANISH AGRI GHG

1. Enteric fermentation, mainly from ruminants, CH_4 (33%)

2. Manure management, CH_4 (20%)
3. Inorganic N fertilizer, N_2O (10%)
4. Manure on soil, N_2O (9%)
5. Crop residues, N_2O (8%)

Nielsen et al. (2022)

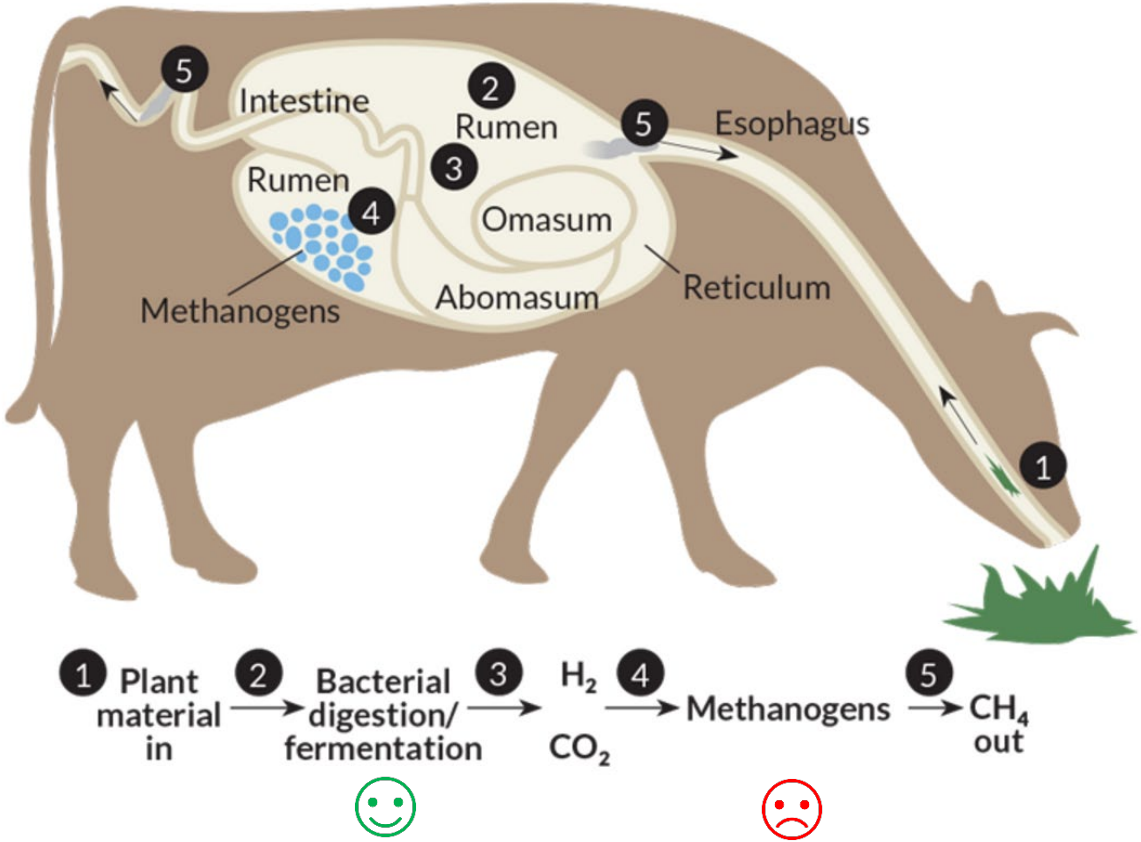
DANISH MILK PRODUCTION (ON FARM)



Kristensen (2019)

WHY DOES A COW PRODUCE METHANE ?

(ACTUALLY IT DOES NOT !)



CO_2-EQUIVALENTS

1 kg CO_2 = 1 kg CO_2-eq.

- Fosile fuels
- Degradation of soil organic matter

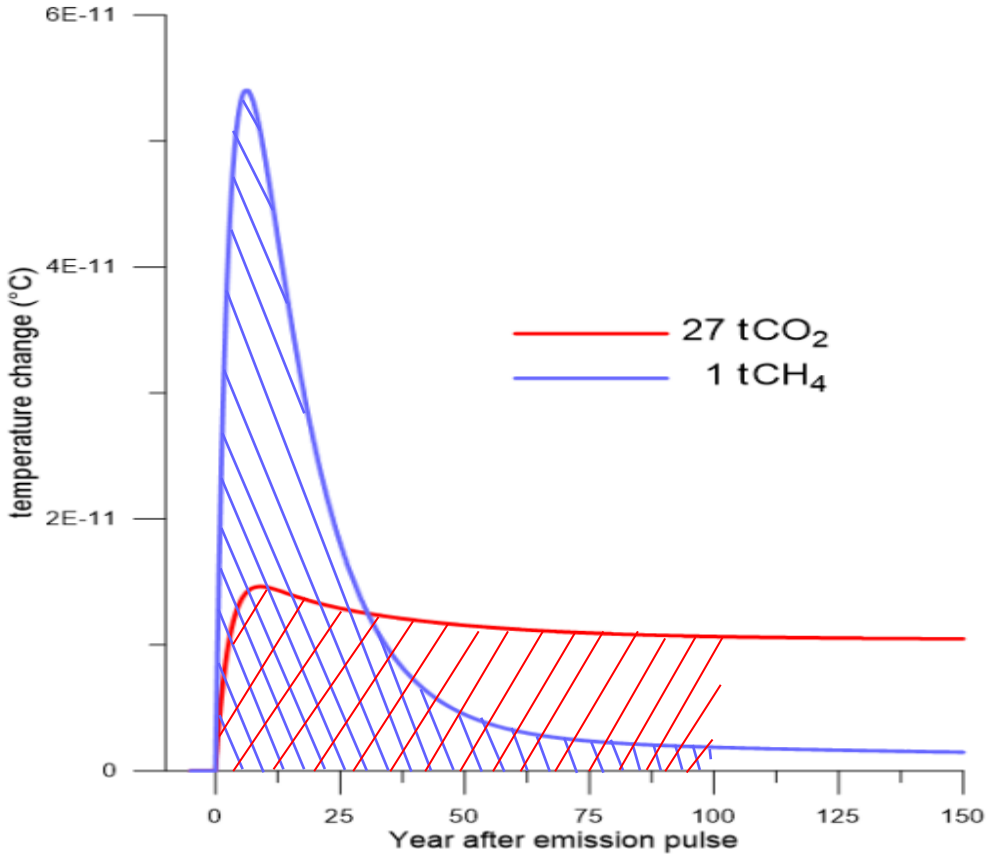
1 kg CH_4 = 27 kg CO_2-eq.

- Digestion
- Manure

1 kg N_2O = 256 kg CO_2-eq.

- N turnover in manure and soil

CO_2 AND CH_4 - 100 YEARS TIMESPAN



Reisinger (2022)

CO_2-EQUIVALENTS

1 kg CO_2 = 1 kg CO_2-eq.

- Fosile fuels
- Degradation of soil organic matter

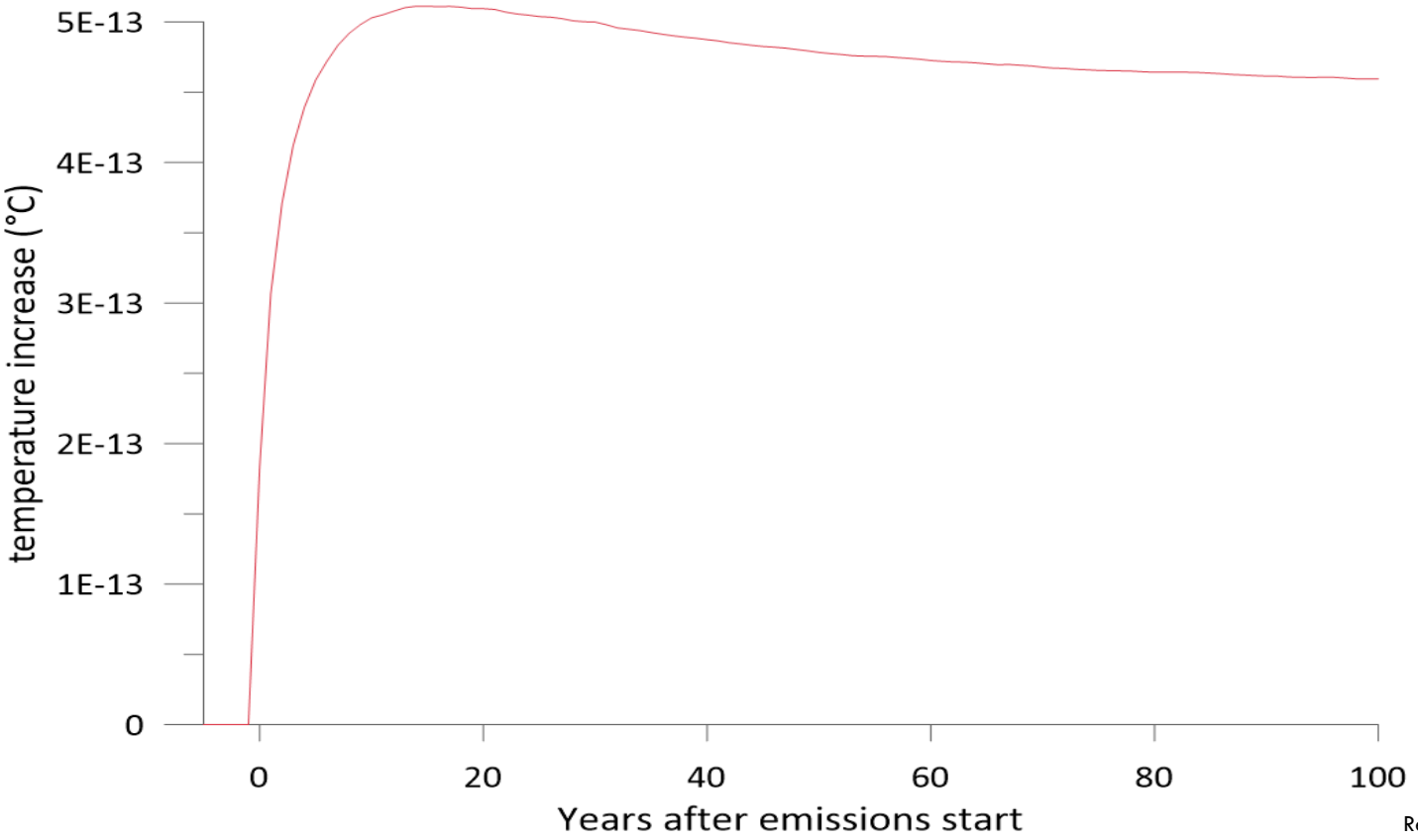
1 kg CH_4 = 27 kg CO_2-eq. (20 years: 86 kg CO_2-eq.; 500 years: 7 kg CO_2-eq.)

- Digestion
- Manure

1 kg N_2O = 256 kg CO_2-eq. (20 years: 289 kg CO2-eq.; 500 years:170 kg CO_2-eq.)

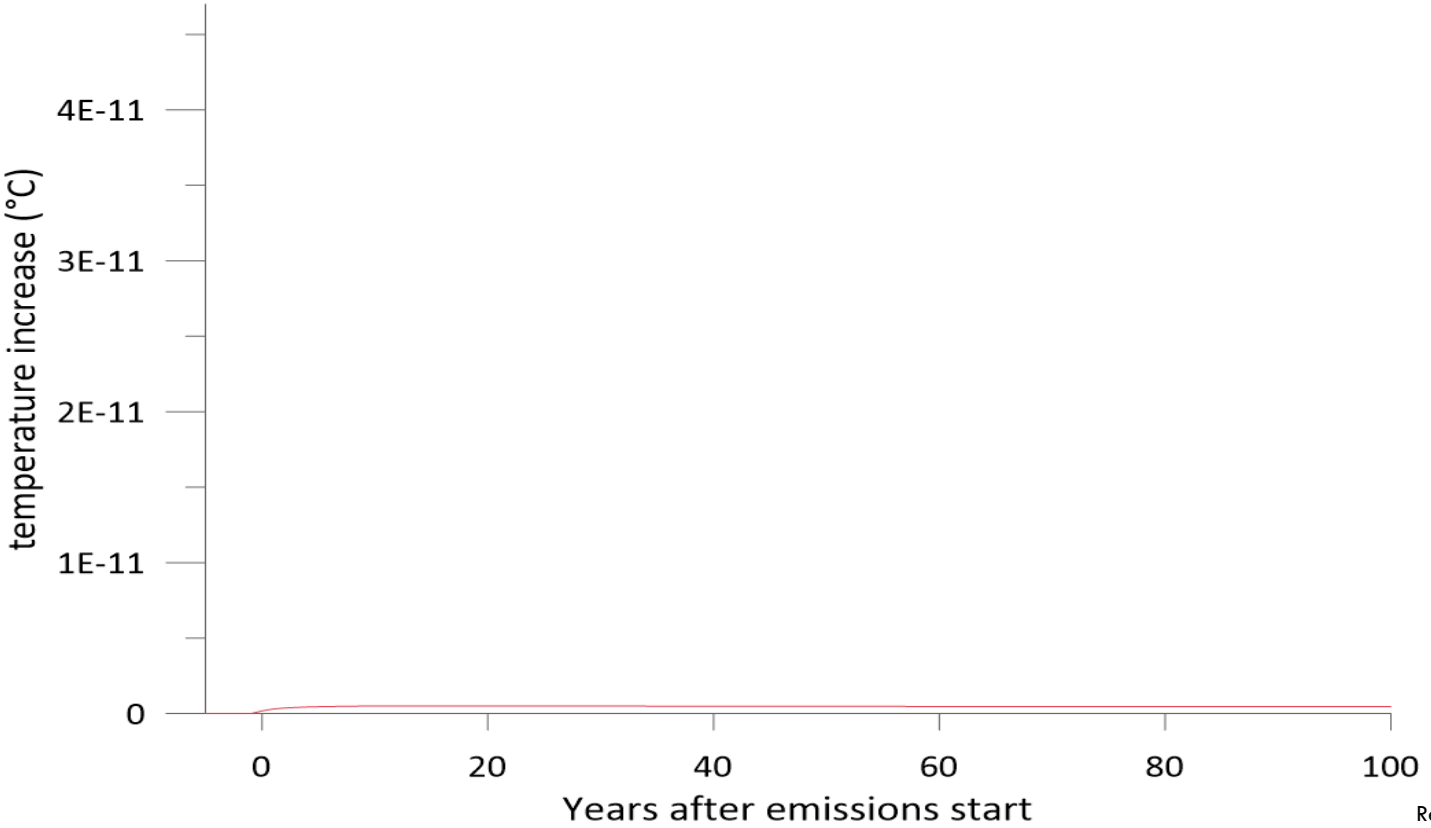
- N turnover in manure and soil

PULSE DOSE OF CO_2



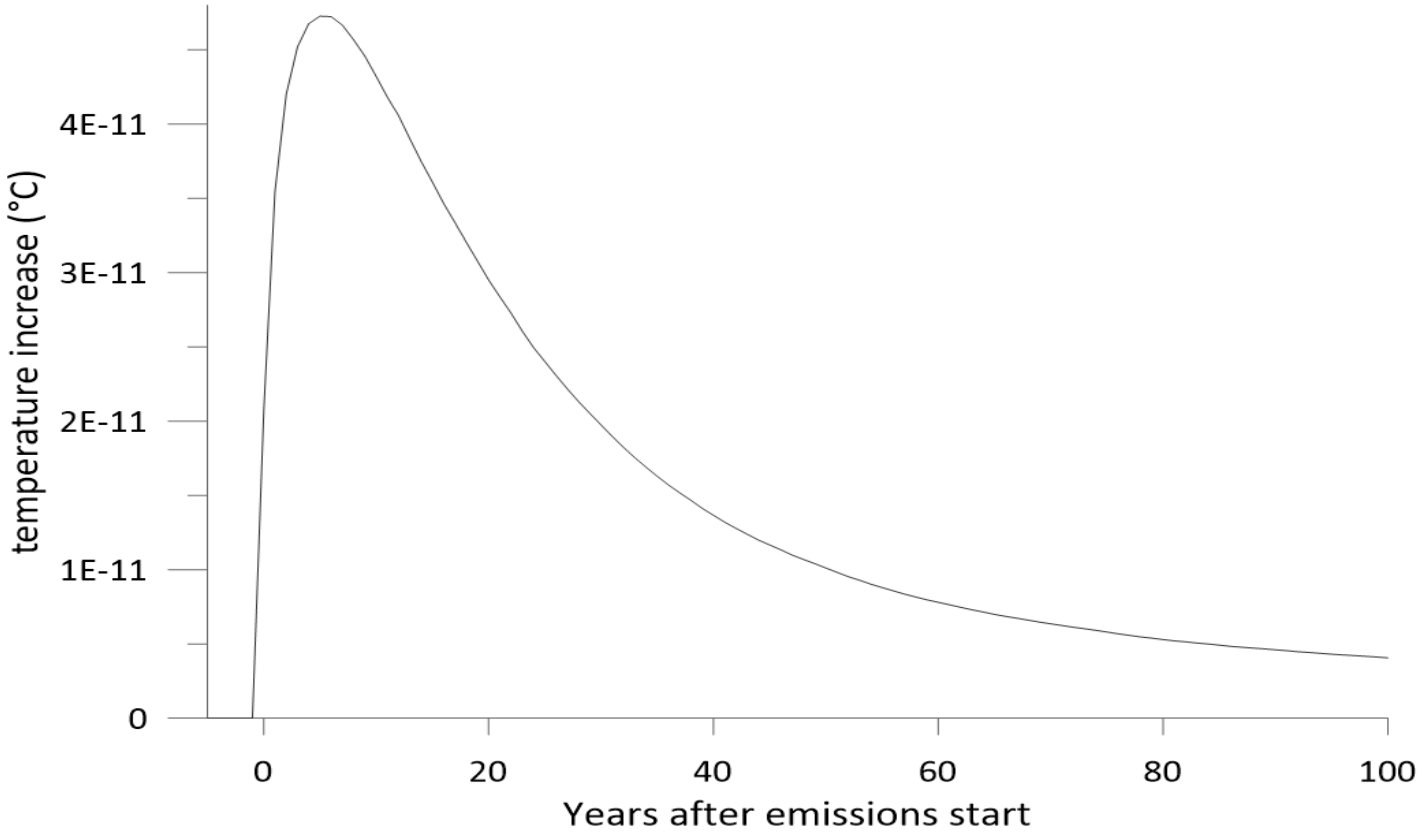
Reisinger (2022)

REPEATED PULSE DOSE OF CO_2



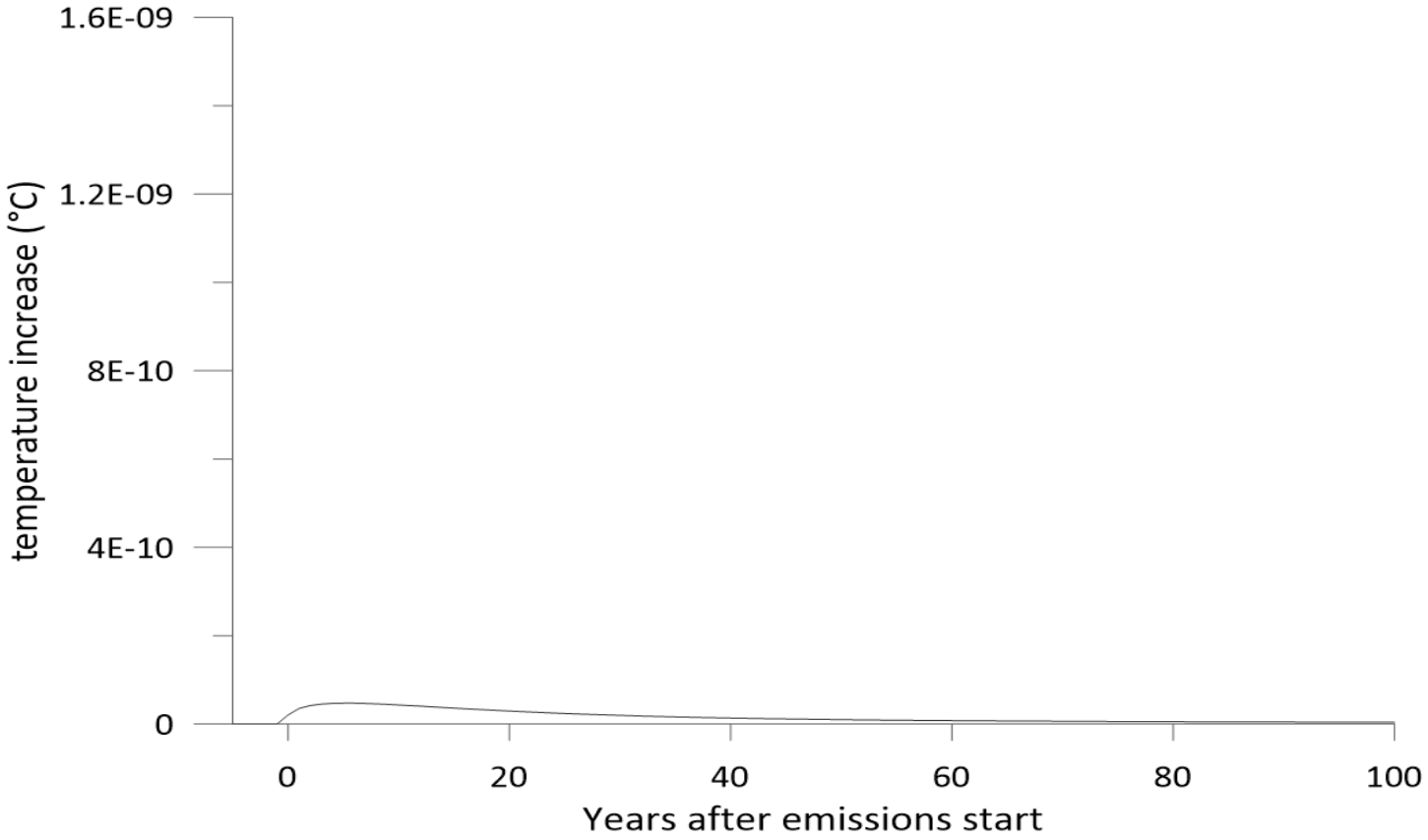
Reisinger (2022)

PULSE DOSE OF CH_4



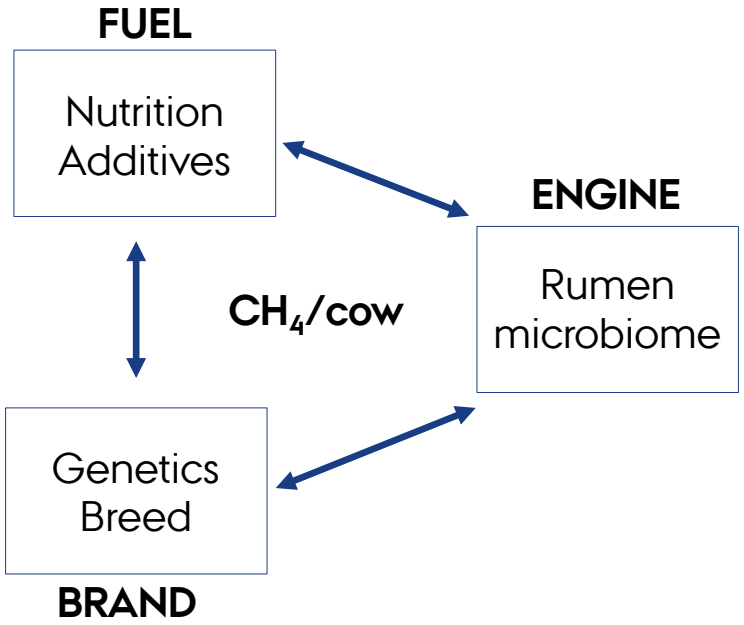
Reisinger (2022)

REPEATED PULSE DOSE OF CH_4



Reisinger (2022)

THE TASK


FUEL
Nutrition
Additives
ENGINE
Rumen
microbiome
CH_4/cow
Genetics
Breed
BRAND

THE LOW HANGING FRUITS

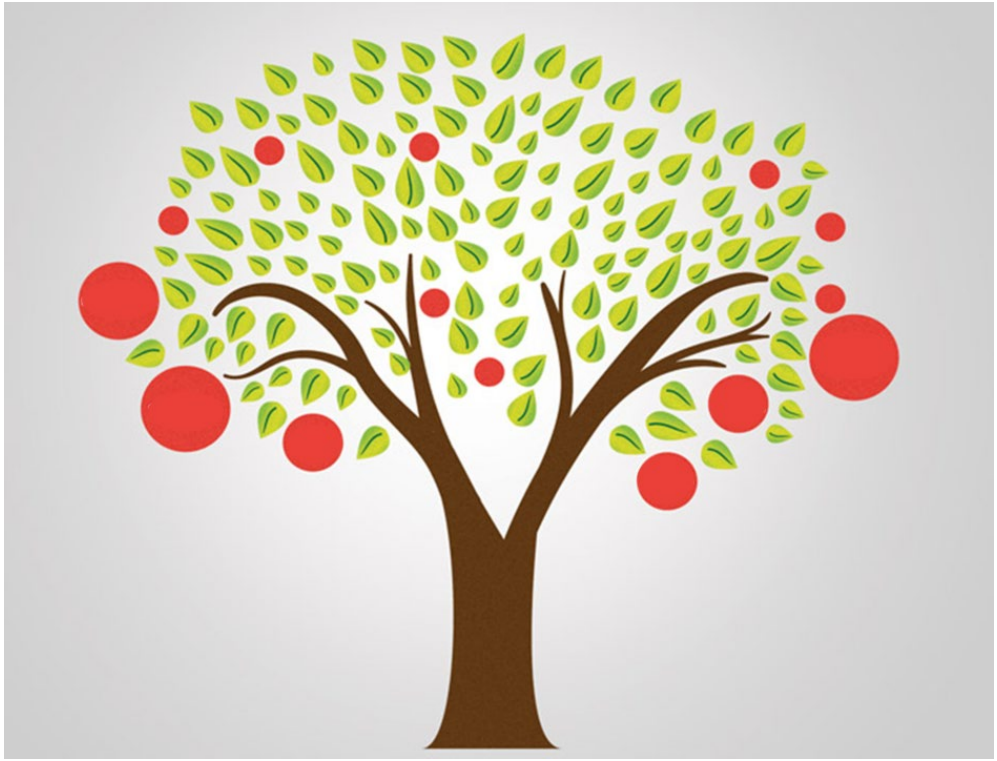
Significant effect

Consistent effect

Persistent effect

High TRL level

Minor neg. trade-offs

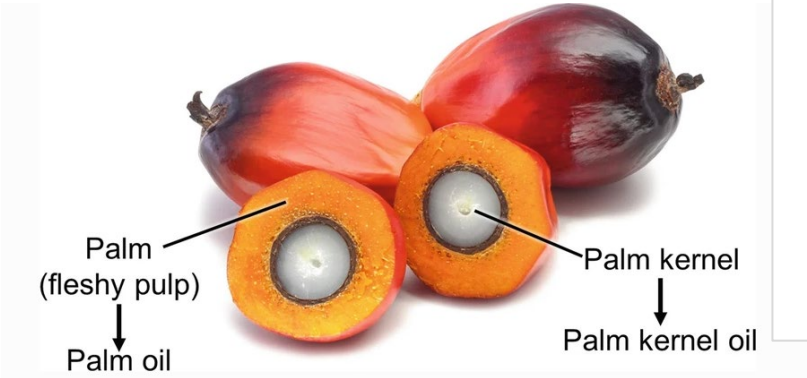


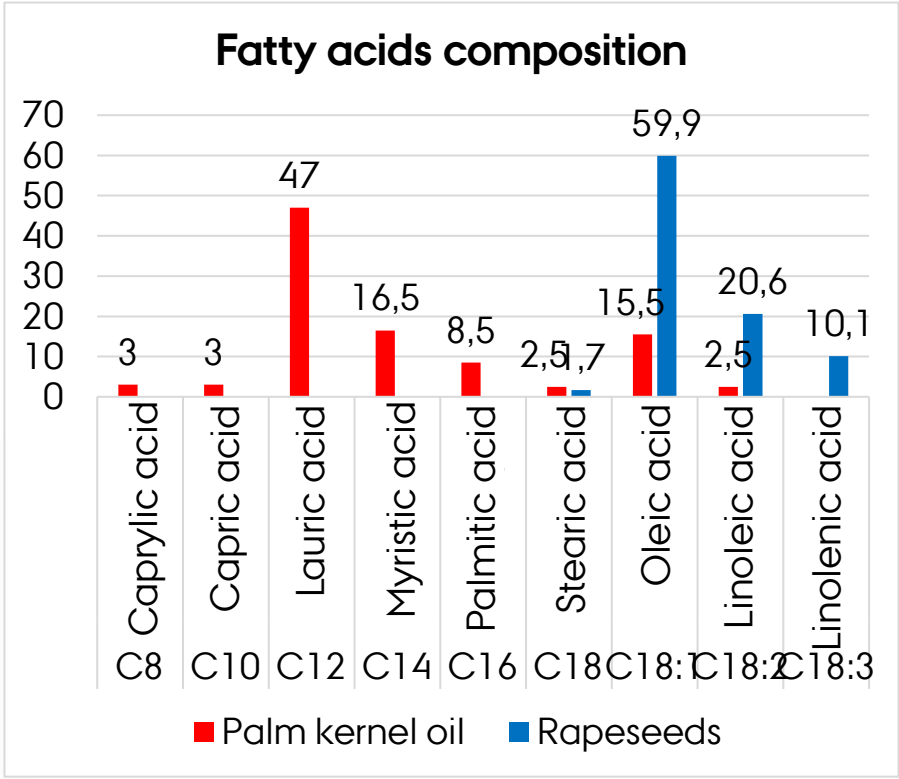
Fat supplementation
10%

Bovaer (3-NOP)
30%

Nitrate
10%

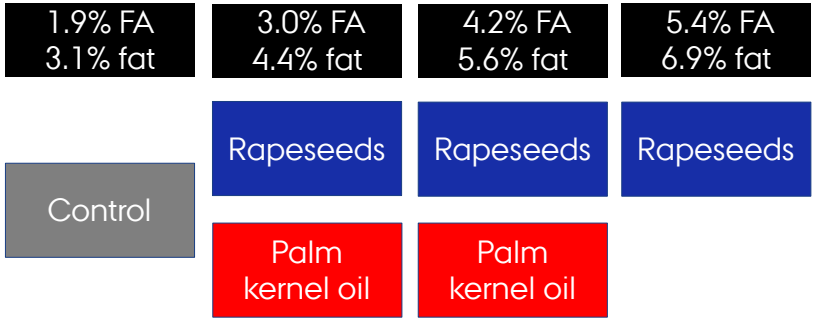
FATTY ACID PROFILE





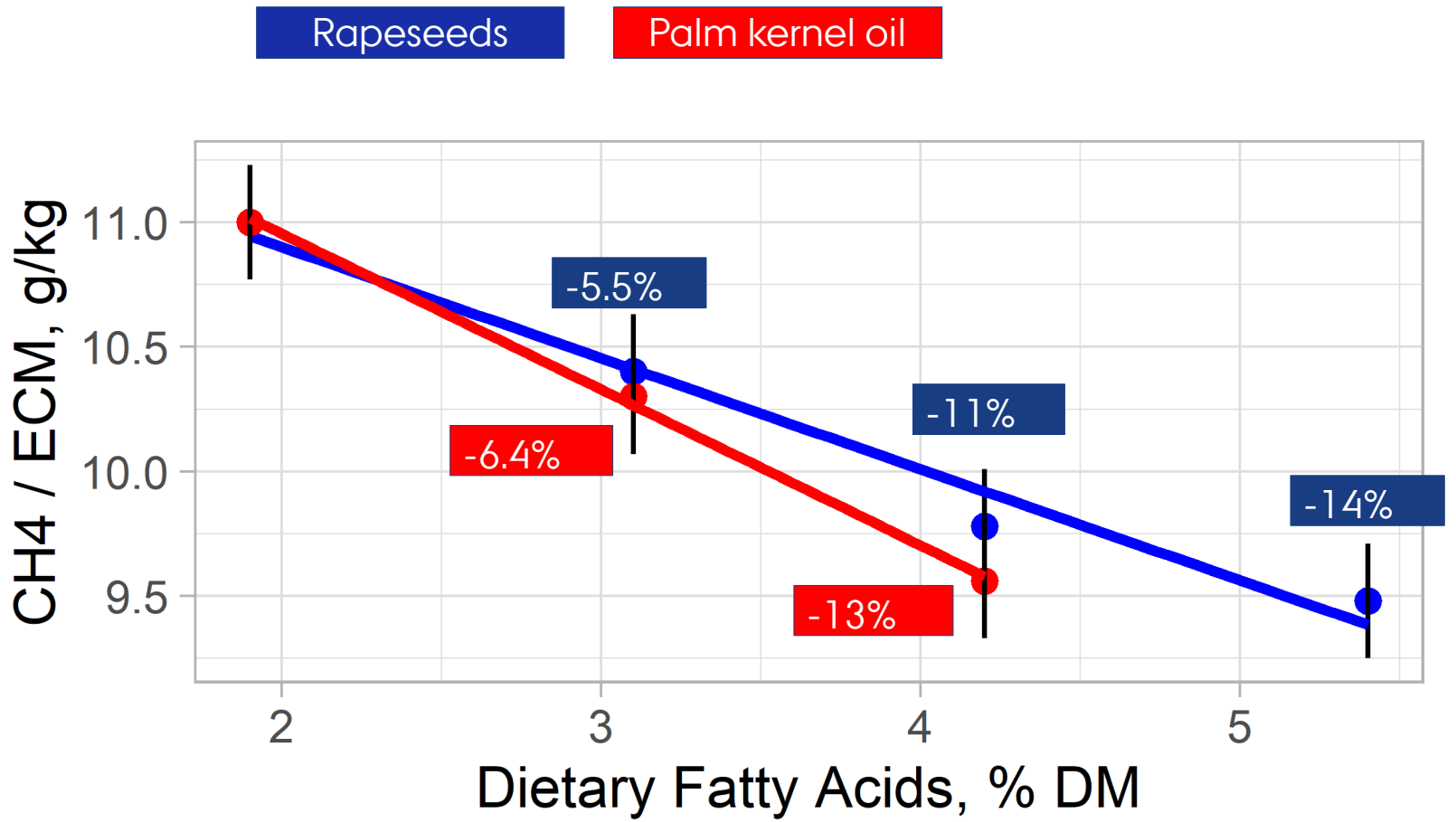
Giagnoni et al. (2022)

DIETS

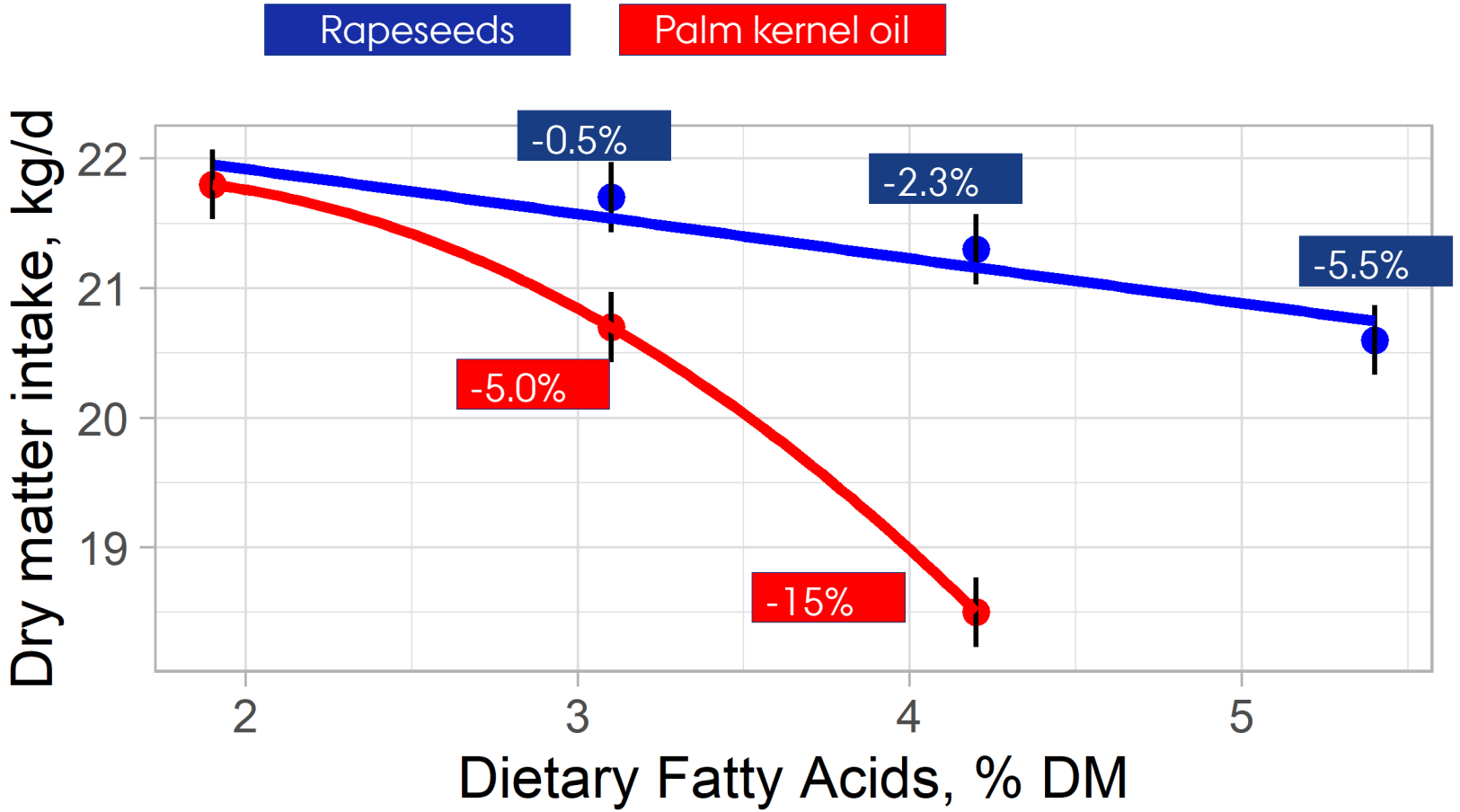


Ingredient, % DM	Basal diet
- Spring barley	19.5
- Grass-clover Silage	39.0
- Maize silage	31.2
- Beet pulp, dried	7.80
- Sodiium bicarbonate	1.63
- Mineral and vitamins	0.65

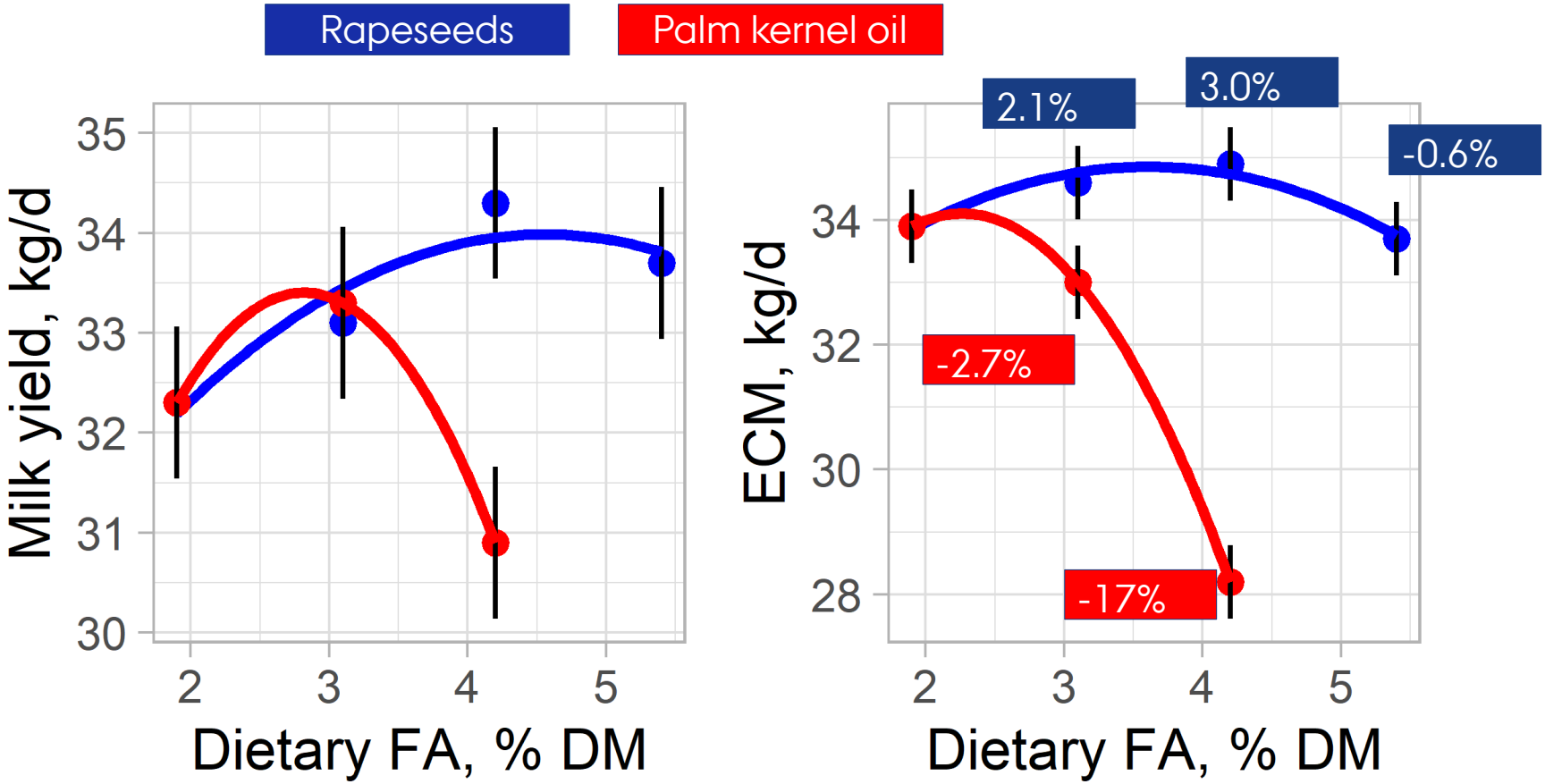
METHANE, G/KG ECM



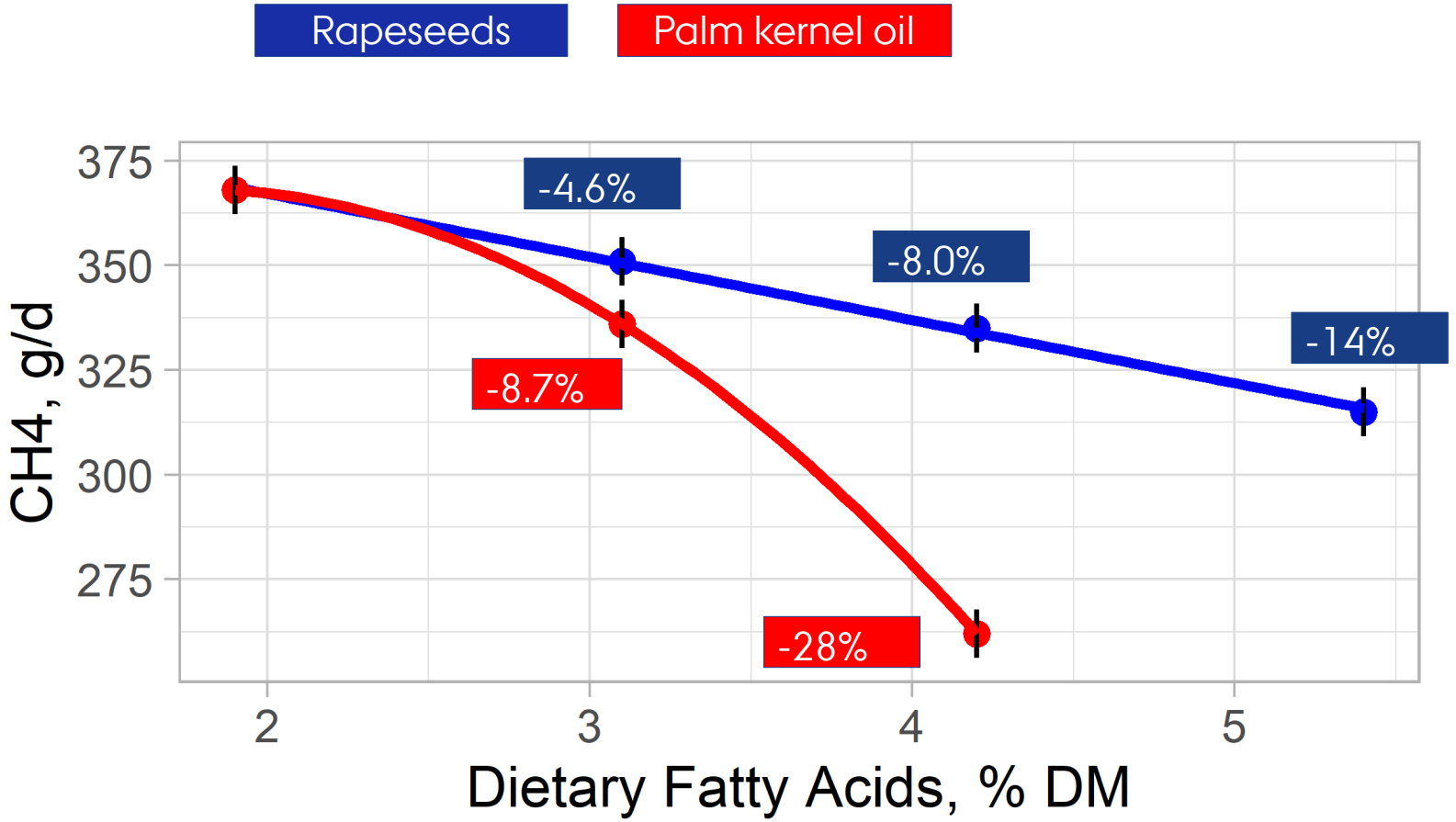
FEED INTAKE


Rapeseeds
Palm kernel oil
-0.5%
-2.3%
-5.5%
-5.0%
-15%
Dry matter intake, kg/d
22
21
20
19
2
3
4
5
Dietary Fatty Acids, % DM

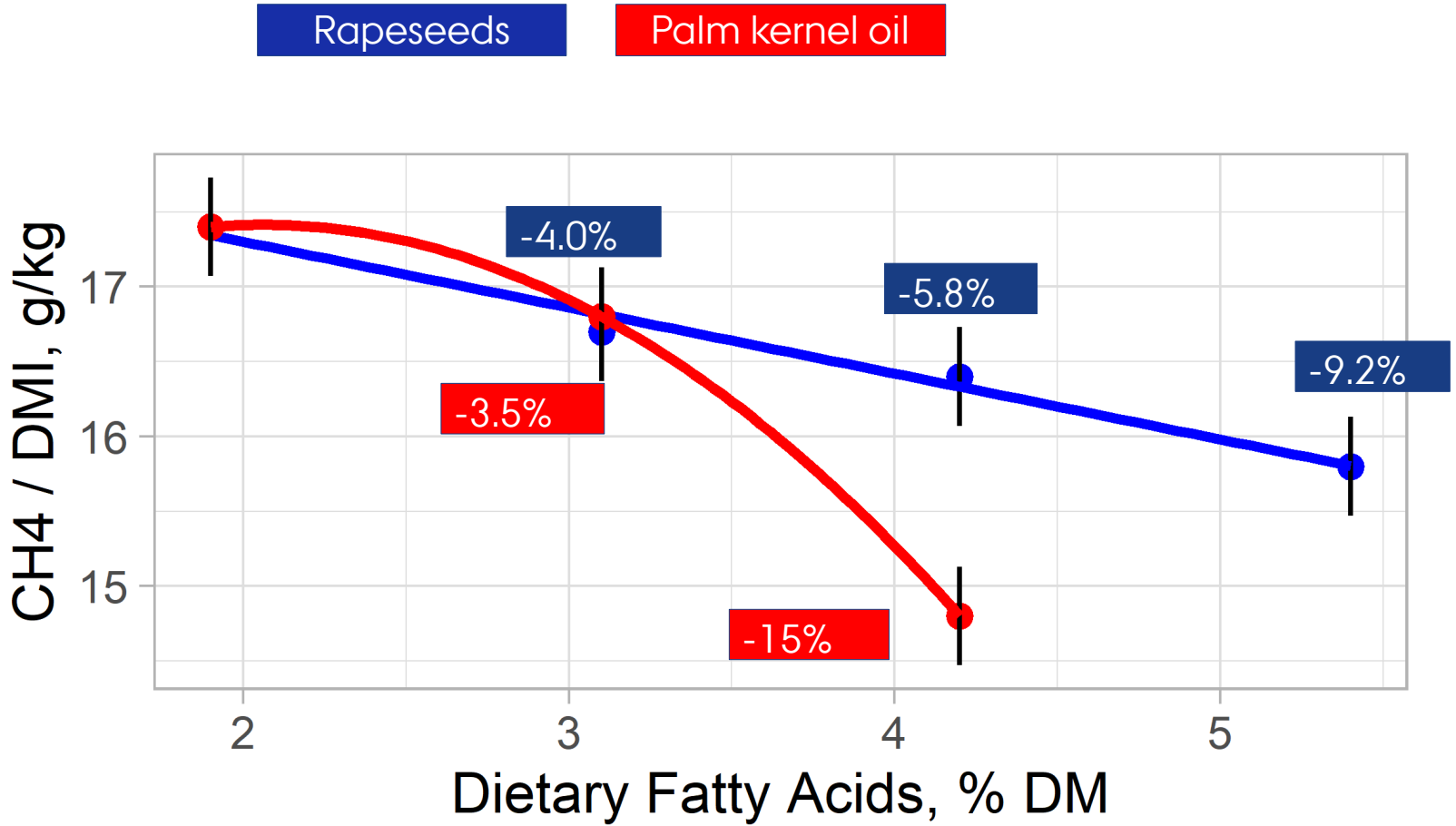
MILK YIELD


Rapeseeds
Palm kernel oil
Milk yield, kg/d
35
34
33
32
31
30
2
3
4
5
Dietary FA, % DM
ECM, kg/d
2.1%
3.0%
-0.6%
-2.7%
-17%
34
32
30
28
2
3
4
5
Dietary FA, % DM

METHANE EMISSION

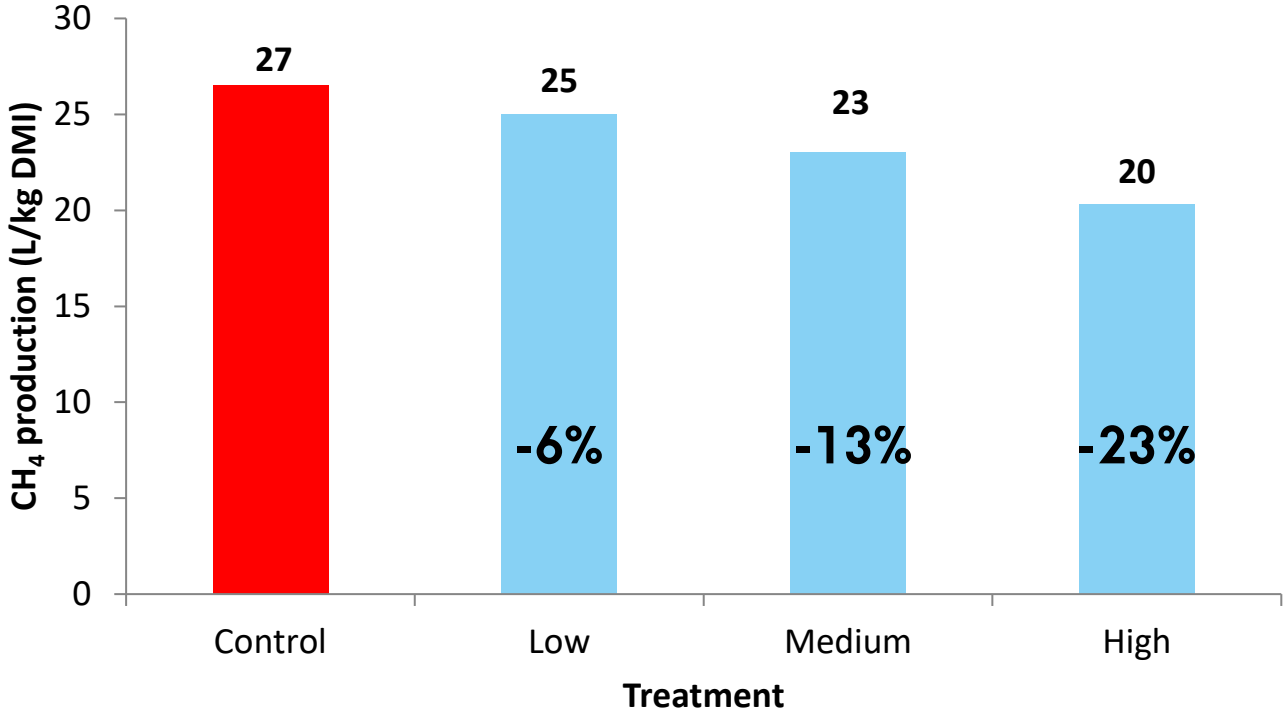


METHANE YIELD, G/KG TS



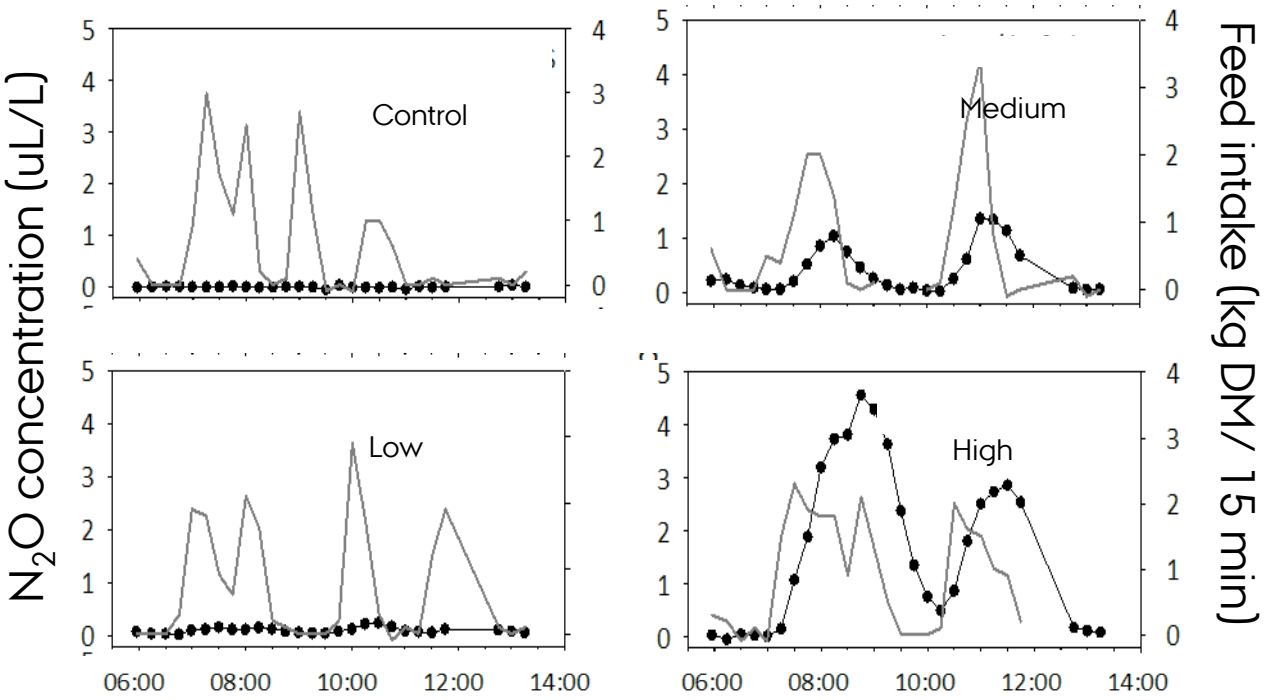
NITRATE – DUAL PURPOSE

$NO_3^- + H_2 + 2H^+ \rightarrow NO_2^- + 2H_2O$ $\quad\quad$ $NO_2^- + 3H_2 + 2H^+ \rightarrow NH_4^+ + 2H_2O$



Olijhoek et al. (2016)

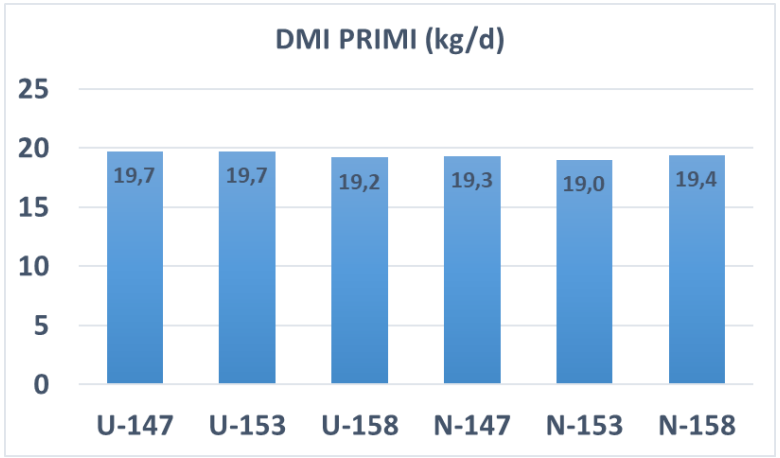
N_2O (256 X CO_2)



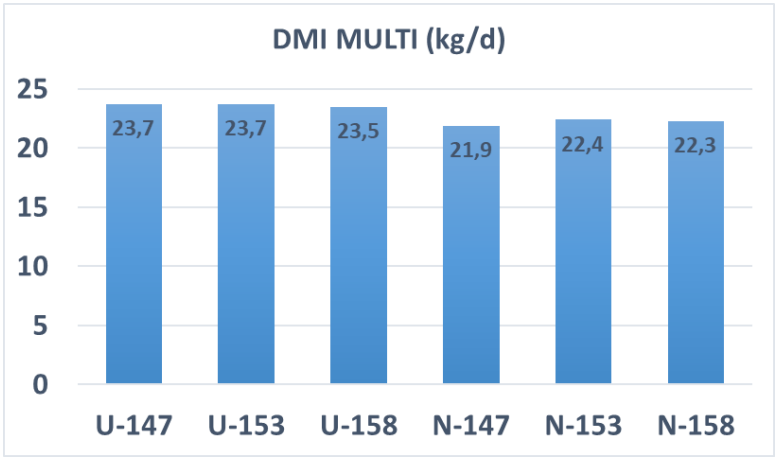
Petersen et al. (2015)

NITRATE – PRODUCTION STUDY

Nitrate: - 1% in DM intake



Nitrate: - 9% in DM intake

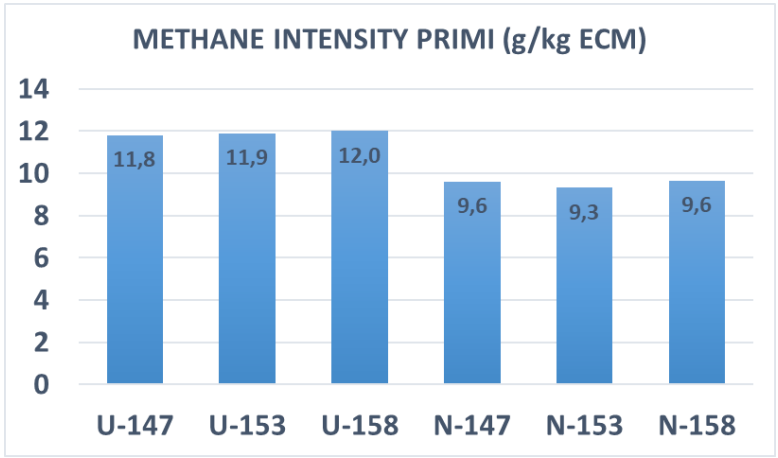


U: Urea
N: Nitrate
147: 147 g CP/kg DM
153: 153 g CP/kg DM
158: 158 g CP/kg DM

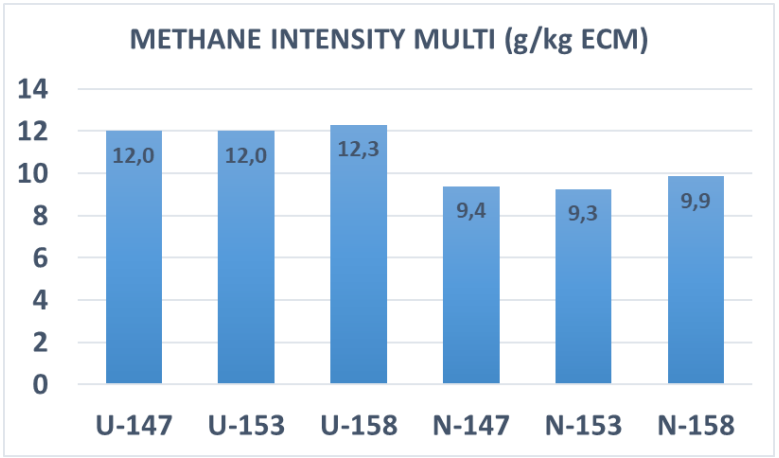
Wang et al. (2022)

NITRATE PRODUCTION STUDY

Nitrate: -20 % in CH_4 yield

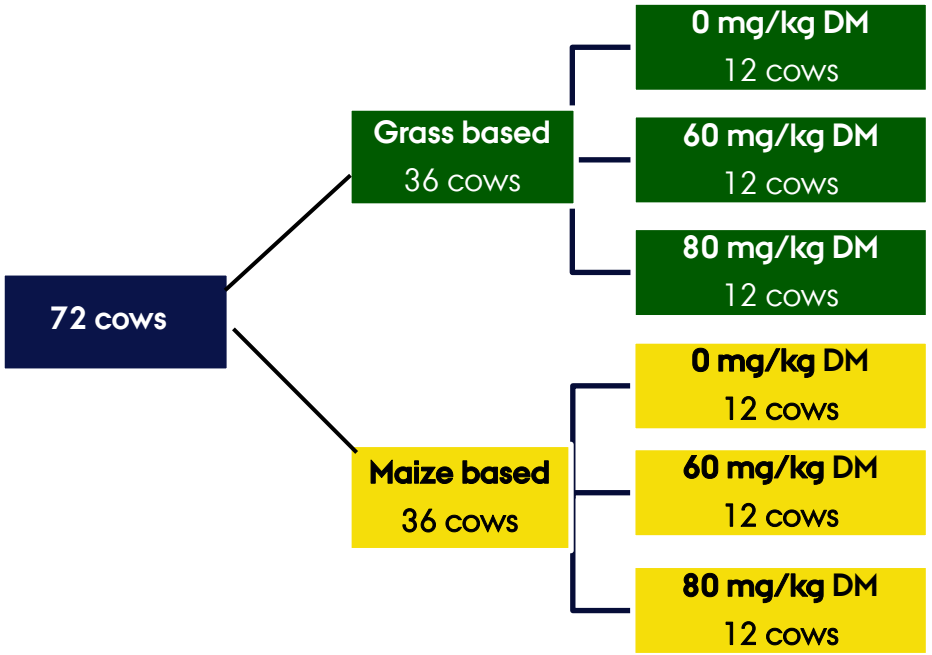


Nitrate: -21 % in CH_4 yield



U: Urea
N: Nitrate
147: 147 g CP/kg DM
153: 153 g CP/kg DM
158: 158 g CP/kg DM

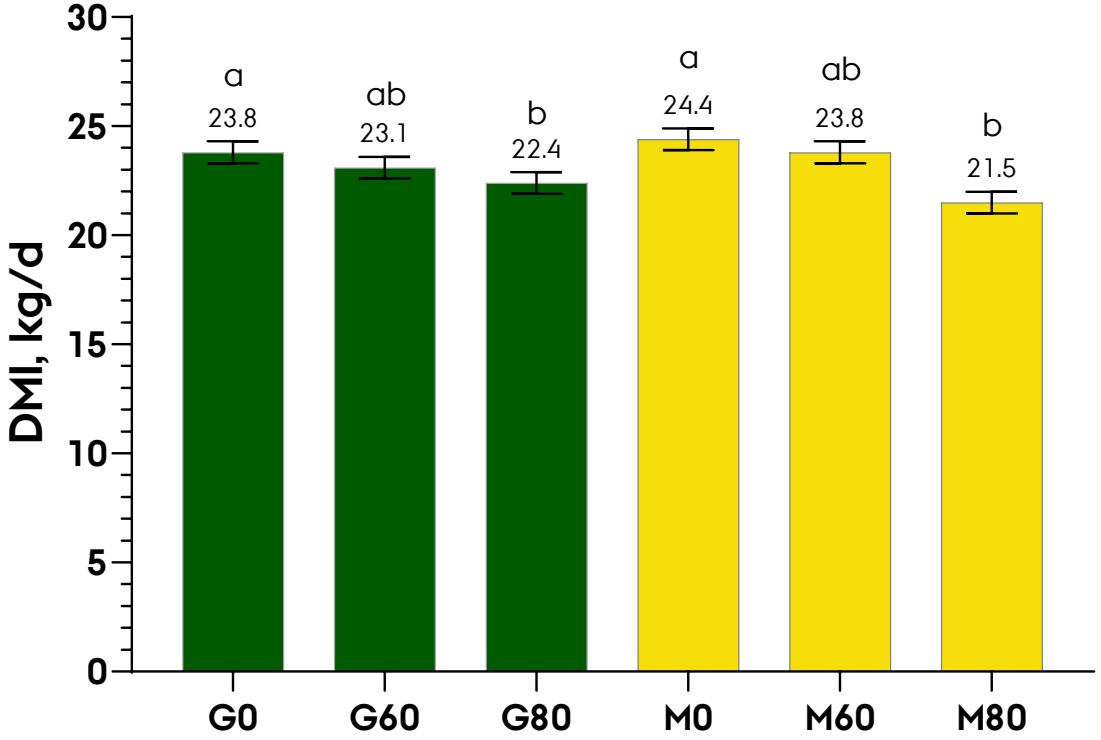
BOVAER X FORAGE TYPE



THE DIETS WERE SIMILAR IN FIBER, STARCH, AND FAT

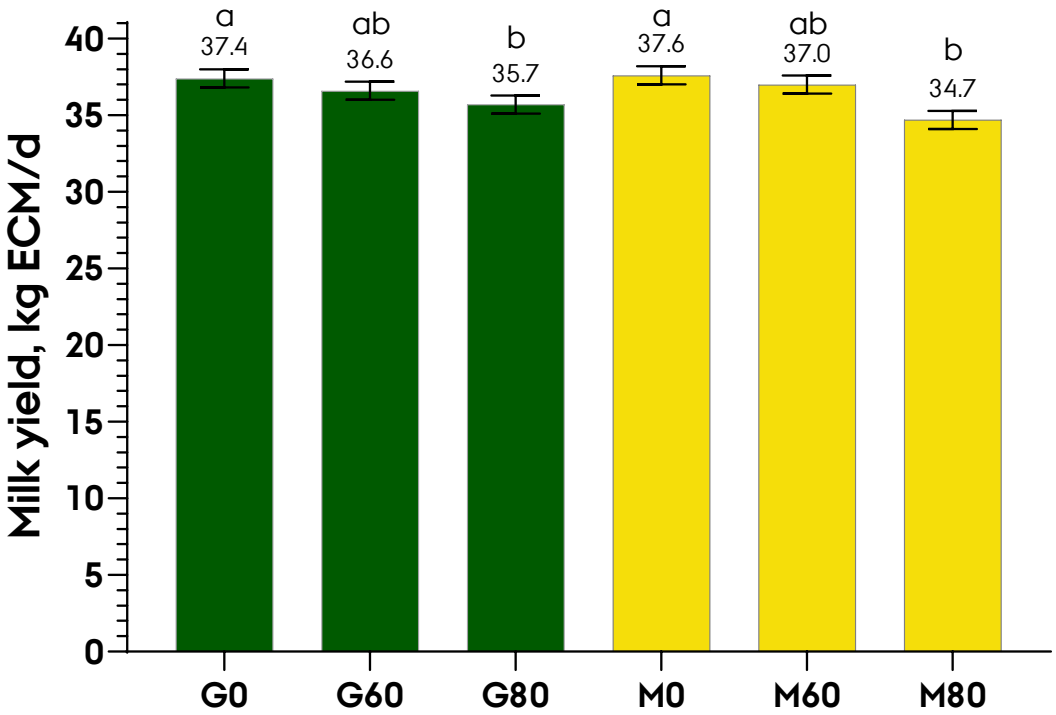
	Grass-based 60:40 Grass:Maize		**Maize-based** 40:60 Grass:Maize
Energy, MJ/kg DM	6.5		6.5
Ash, g/kg DM	69		64
Crude protein, g/kg DM	164		161
NDF, g/kg DM	330		331
Starch, g/kg TS	185		194
Crude fat, g/kg TS	43		39

3-NOP AT 80 mg REDUCED DMI BY 9%
NO EFFECT OF 60 mg



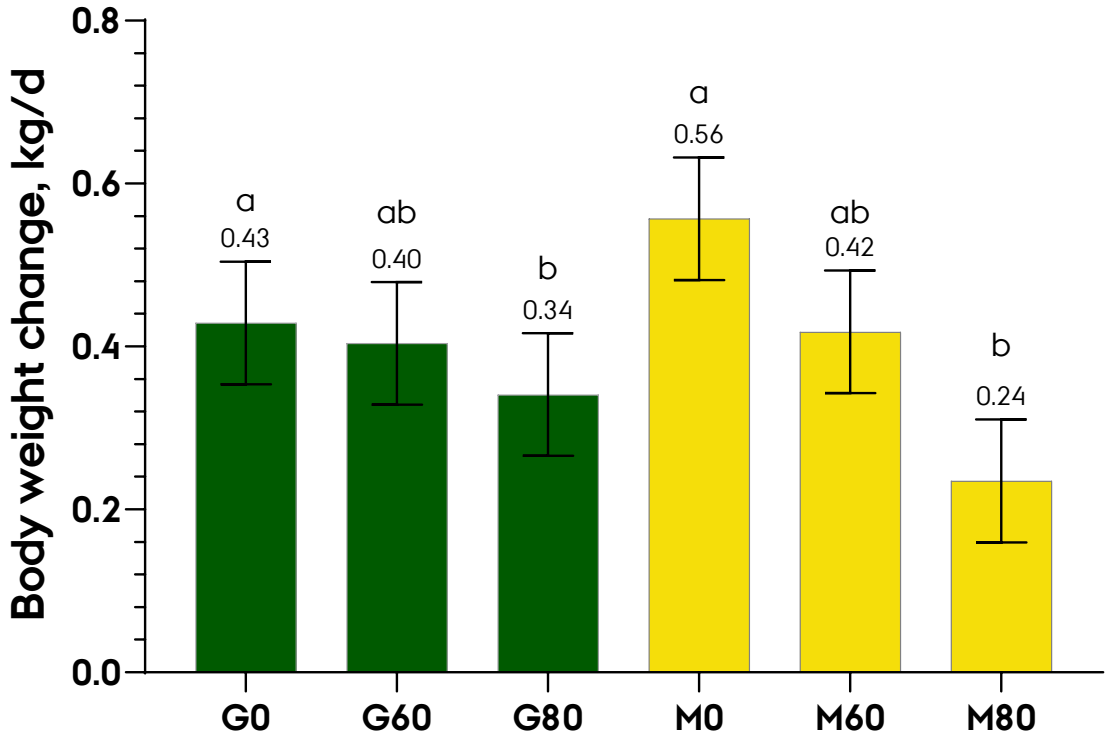
	P-value
Forage type	0.68
3-NOP dose	<0.01
Week	<0.01
Parity	<0.01
Forage type × 3-NOP	0.22
Forage type × 3-NOP × Week	<0.01

MILK PRODUCTION REDUCED BY 5% AT 80 mg NO EFFECT OF 60 mg



	P-value
Forage type	0.81
3-NOP dose	<0.01
Week	<0.01
Parity	<0.01
Forage type × 3-NOP	0.39
Forage type × 3-NOP × Week	0.18

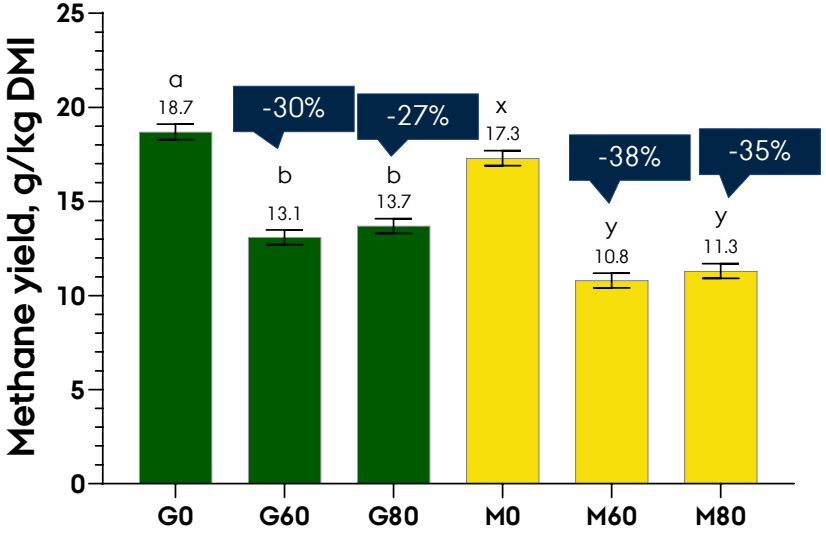
CHANGE OF BW OVER THE 12 WEEKS



	P-value
Forage type	0.84
3-NOP dose	0.02
Parity	0.48
Forage type × 3-NOP	0.26

60 & 80 MG 3-NOP IS EQUALLY EFFICIENT

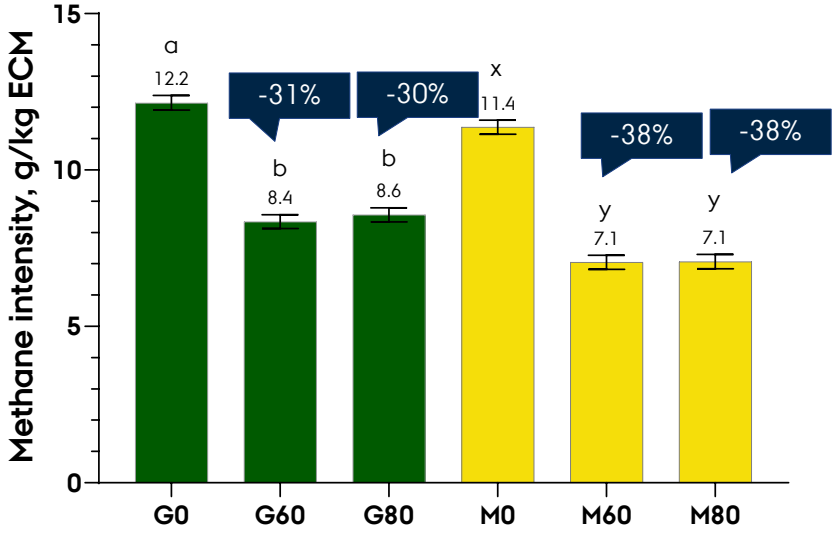
Methane per kg DMI



	P-value
Forage type	<0.01
3-NOP dose	<0.01*
Week	<0.01
Forage type × 3-NOP	0.27

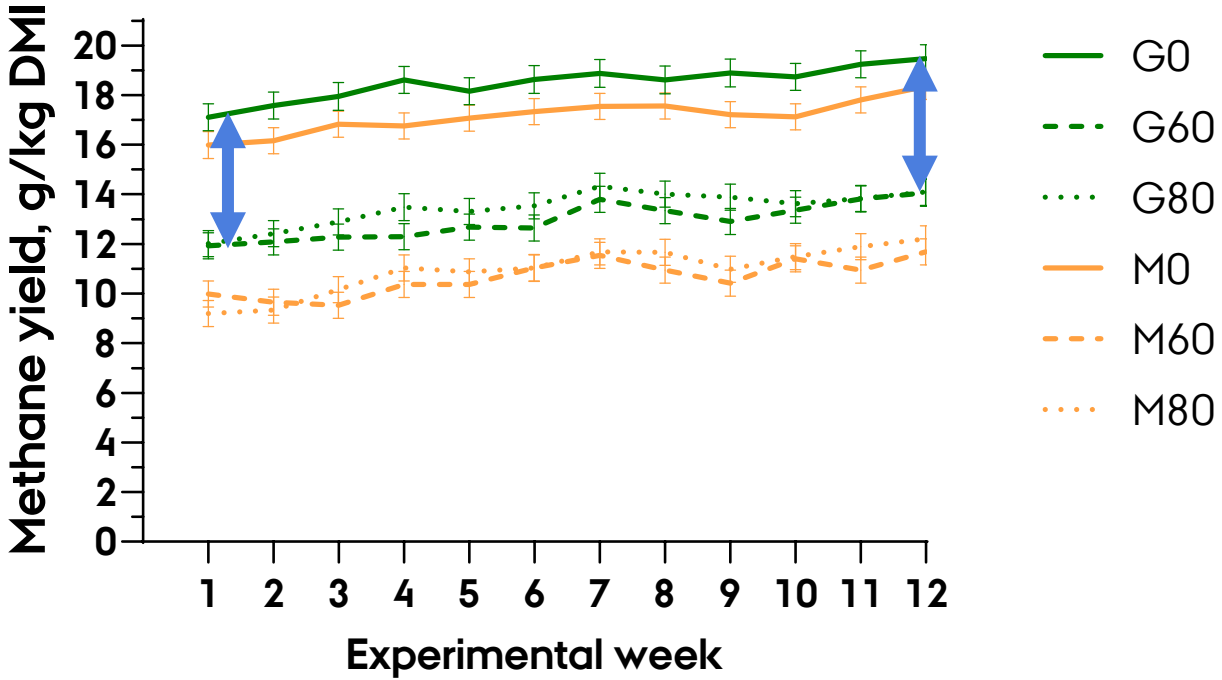
*Greater 3-NOP-effect in multiparous cows

Methane per kg ECM

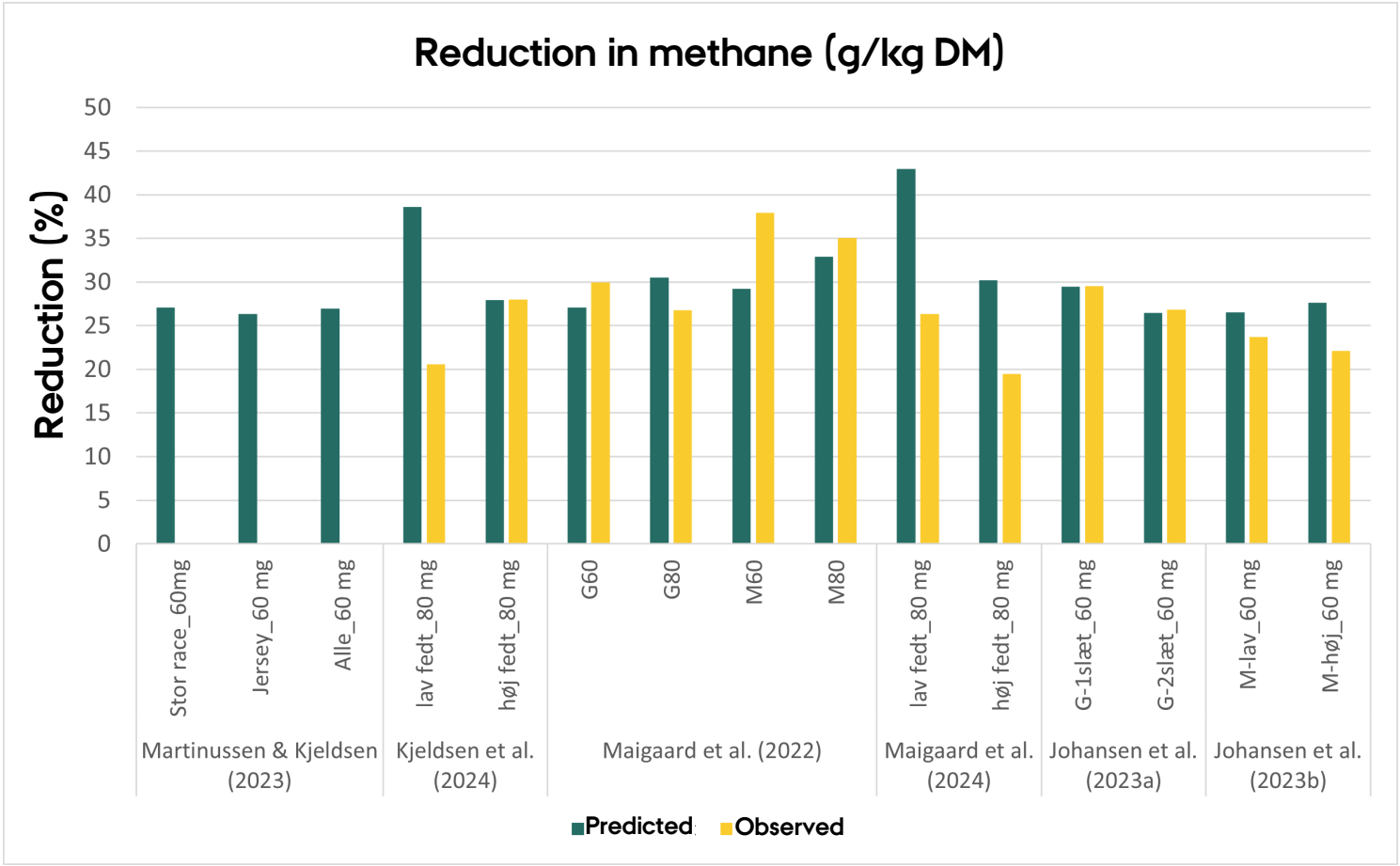


	P-value
Forage type	<0.01
3-NOP	<0.01*
Week	<0.01
Forage type × 3-NOP	0.28

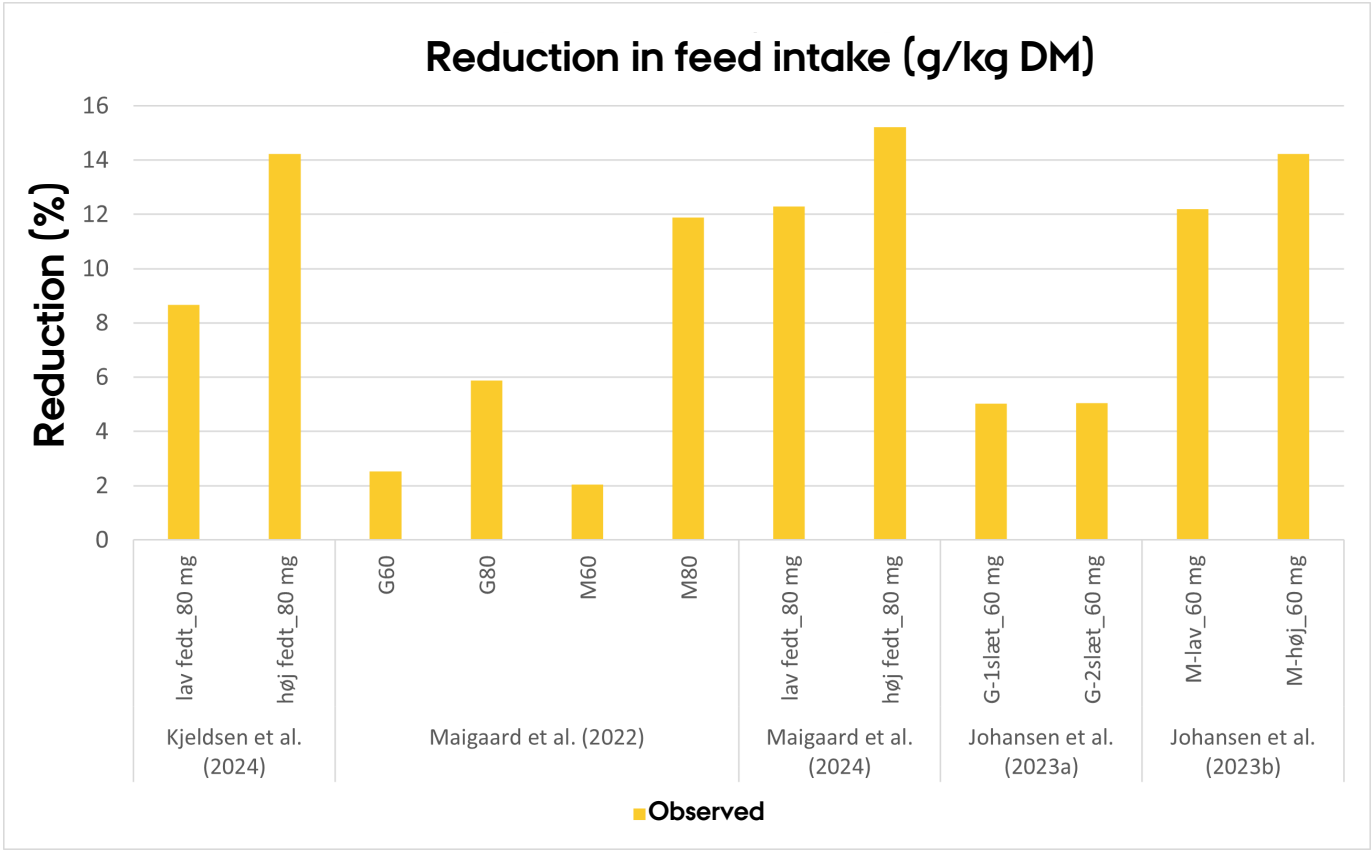
THE EFFECT OF 3-NOP IS PERSISTENT



BOVAER IN AU TRIALS – 27 % REDUCTION



BOVAER IN AU TRIALS – FEED INTAKE



On farm trials (Arla, SEGES): No reduction in feed intake

TREATMENTS

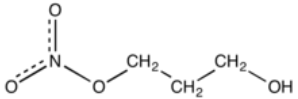
2×2×2 factorial arrangement of treatments

- Low/high fat: 3% crude fat vs. 6% crude fat **(Fat)**
- -/+ Nitrate: 10 g/kg DM **(Nitrate)**
- -/+ 3-NOP: 80 mg/kg DM **(3-NOP)**

= 8 different diets

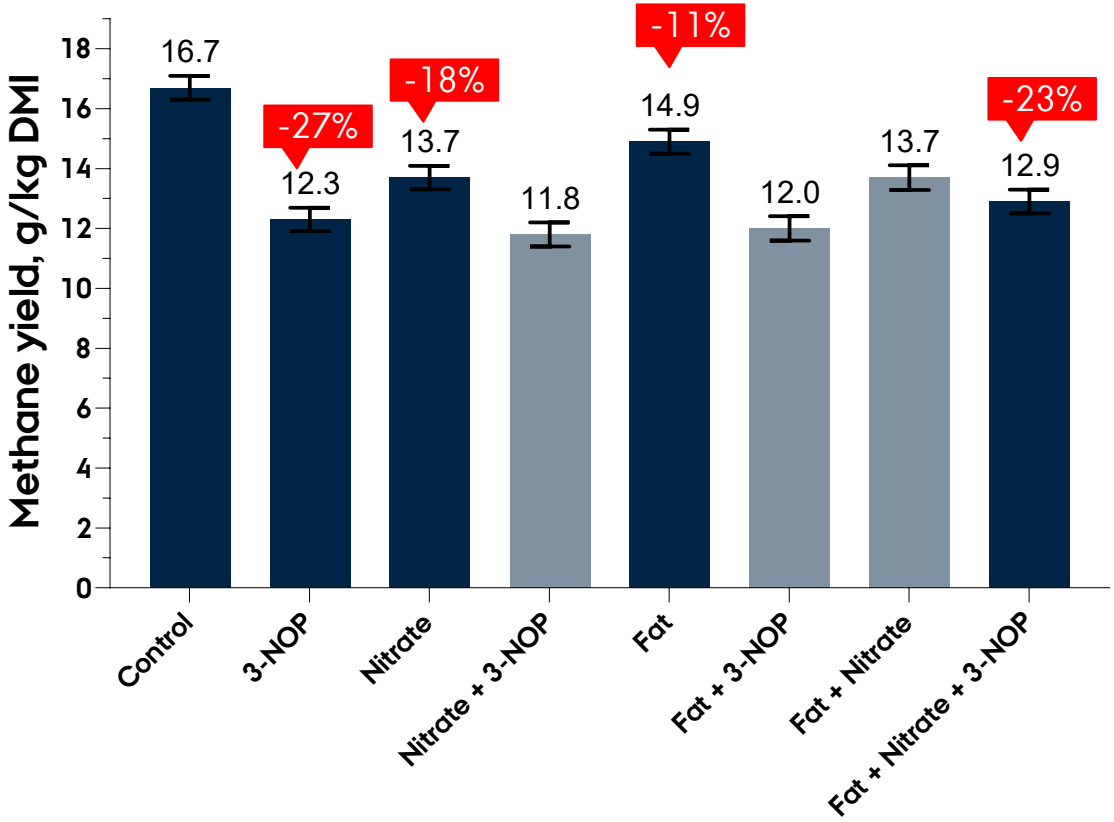
Fat: whole cracked rapeseed

Nitrate: Calcium nitrate; SilvAir ®



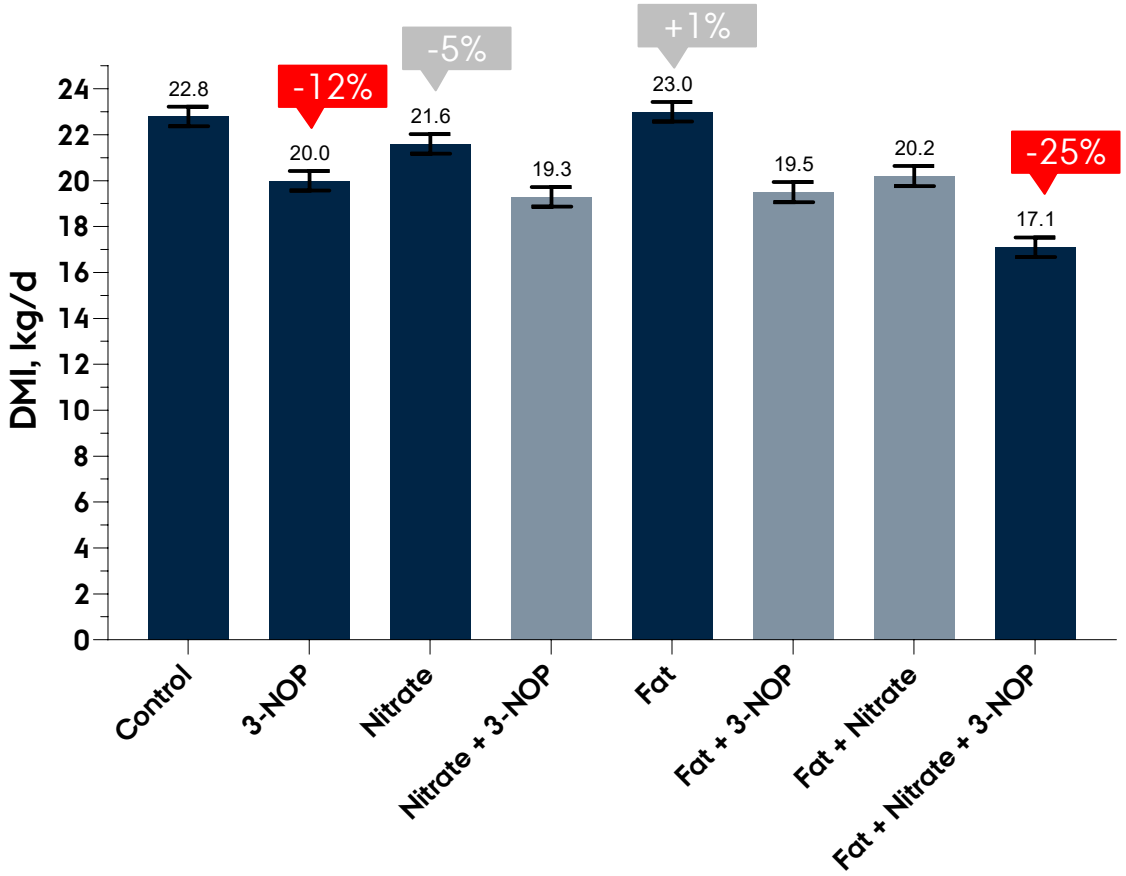
3-NOP: Bovaer ®

METHANE YIELD



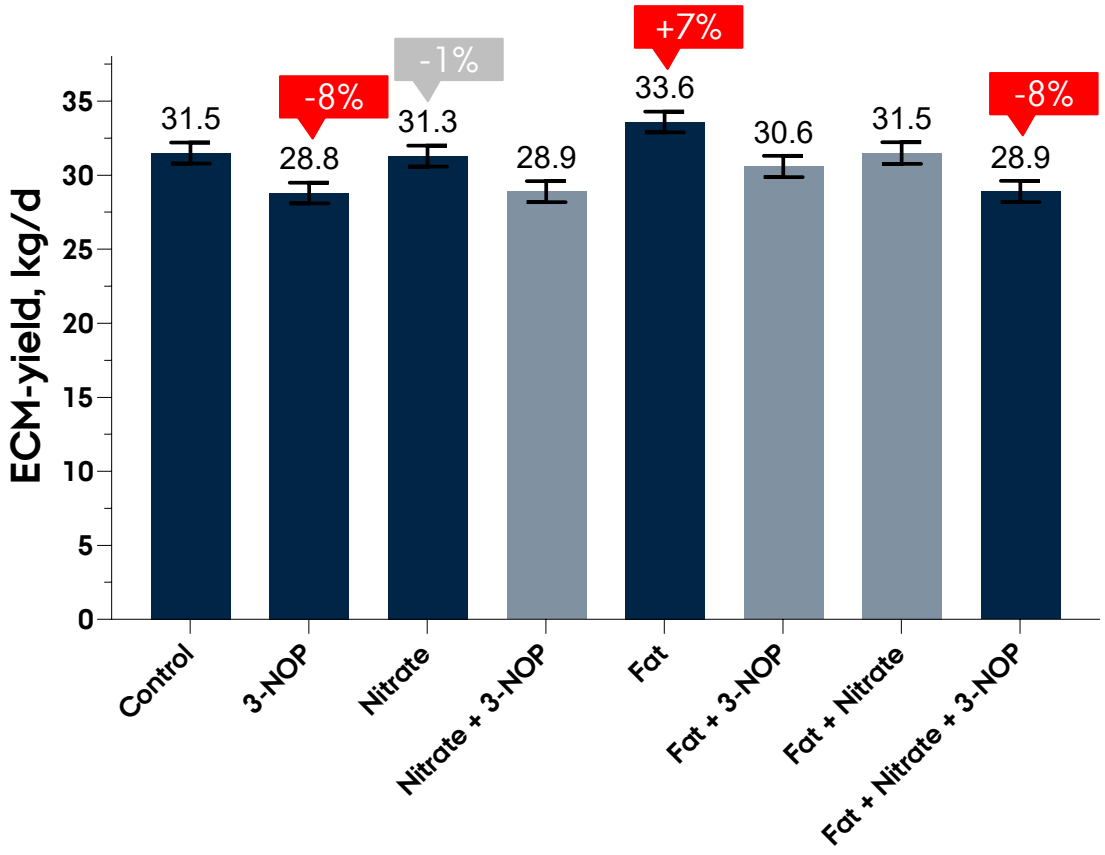
	P-value
Fat	0.35
Nitrate	<0.01
3-NOP	<0.01
Fat x Nitrate	<0.01
Fat x 3-NOP	<0.01
Nitrate x 3-NOP	<0.01
Fat x Nitrate x 3-NOP	0.58

DRY MATTER INTAKE



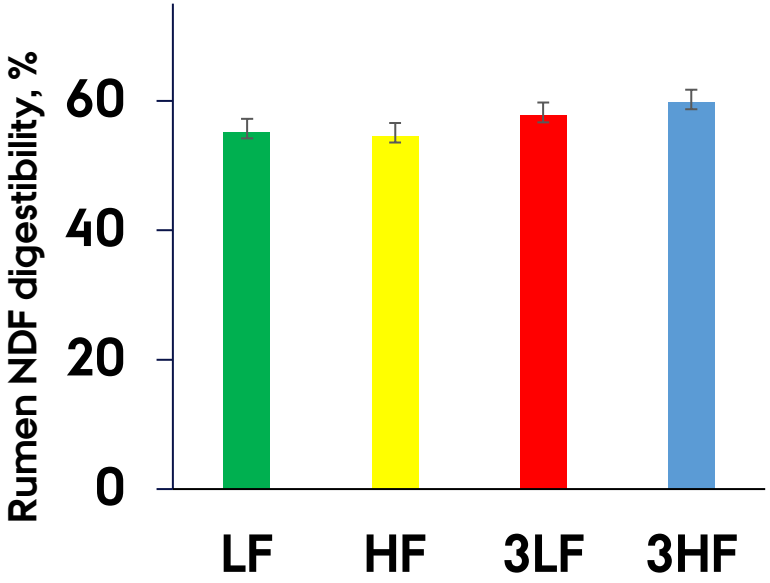
	P-value
Fat	<0.01
Nitrate	<0.01
3-NOP	<0.01
Fat x Nitrate	<0.01
Fat x 3-NOP	0.09
Nitrate x 3-NOP	0.30
Fat x Nitrate x 3-NOP	0.99

MILK PRODUCTION

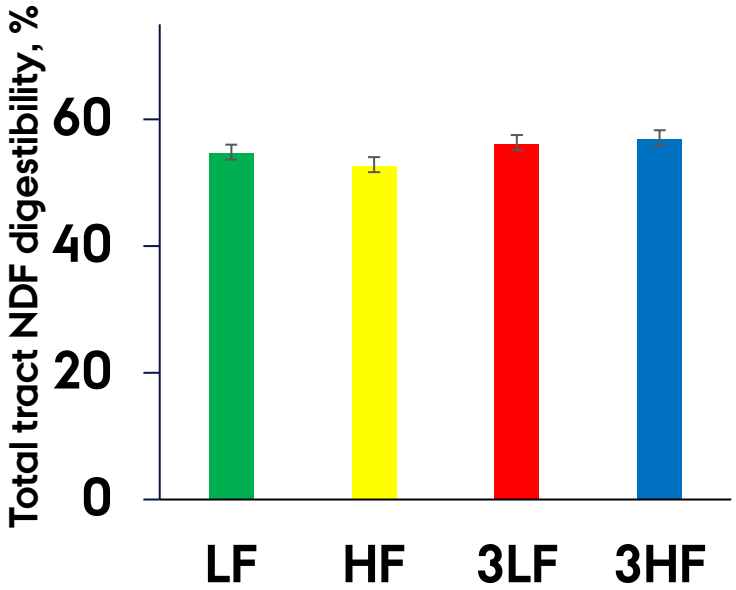


	P-value
Fat	<0.01
Nitrate	<0.01
3-NOP	<0.01
Fat x Nitrate	<0.01
Fat x 3-NOP	0.70
Nitrate x 3-NOP	0.52
Fat x Nitrate x 3-NOP	0.90

NDF DIGESTIBILITY



SE	P-value		
2.1	Fat	3- NOP	Fat x 3- NOP
	0.73	0.09	0.51

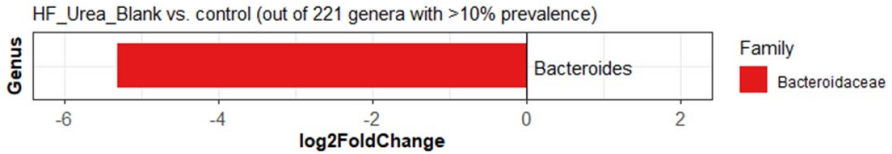


SE	P-value		
1.4	Fat	3- NOP	Fat x 3- NOP
	0.67	0.06	0.34

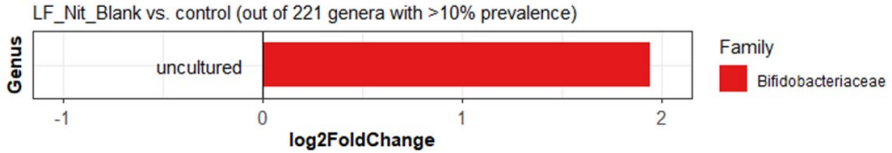
Kjeldsen et al. (2022)

RUMEN MICROBIOME

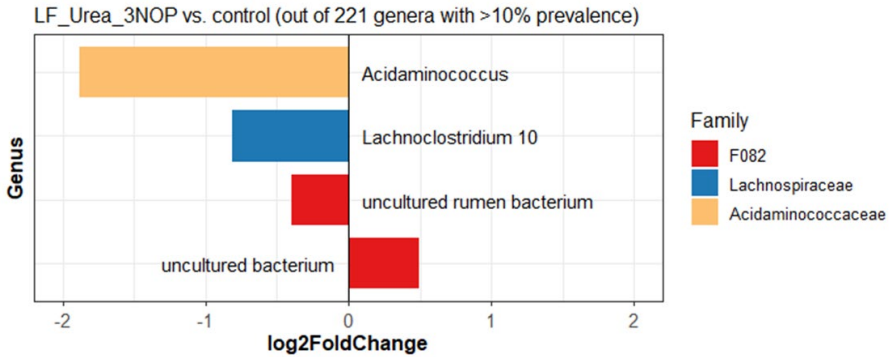
+ FAT



+ NITRATE



+ 3-NOP



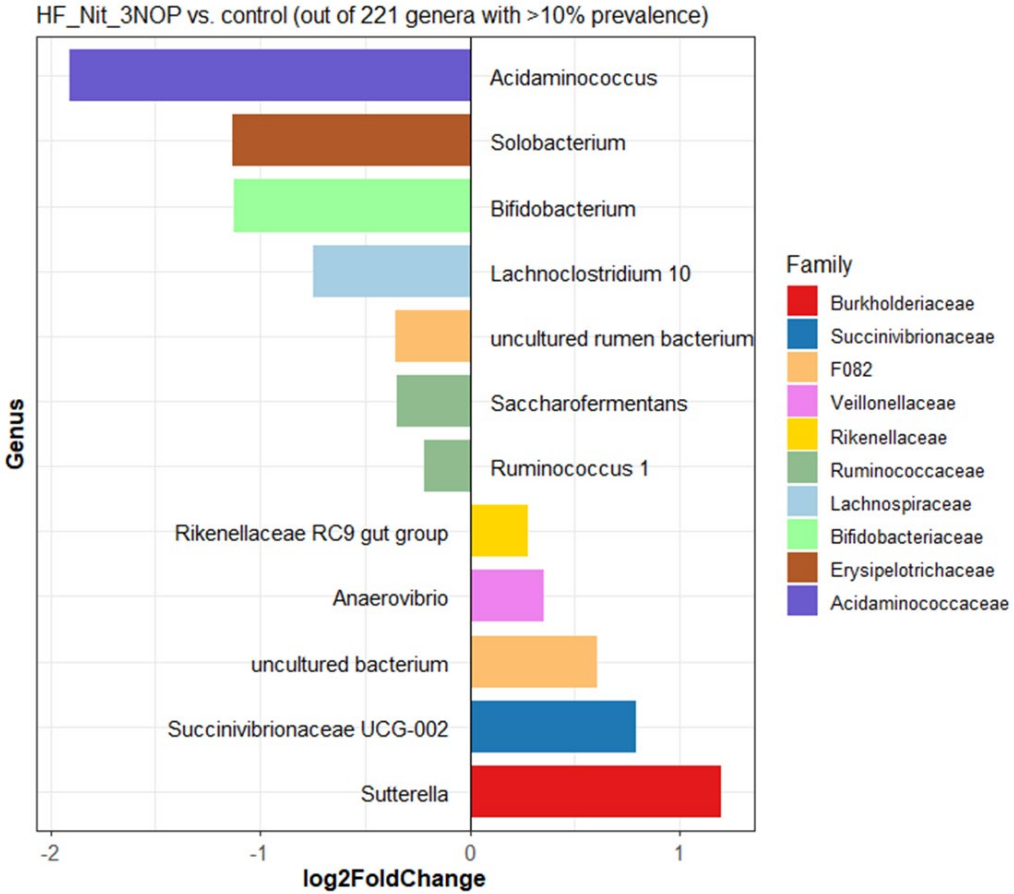
Noel et al. (2022)

RUMEN MICROBIOME

+ NITRATE

+ 3-NOP

+ FAT



Arla

nlm vantinge
sustainable lipids

DSM

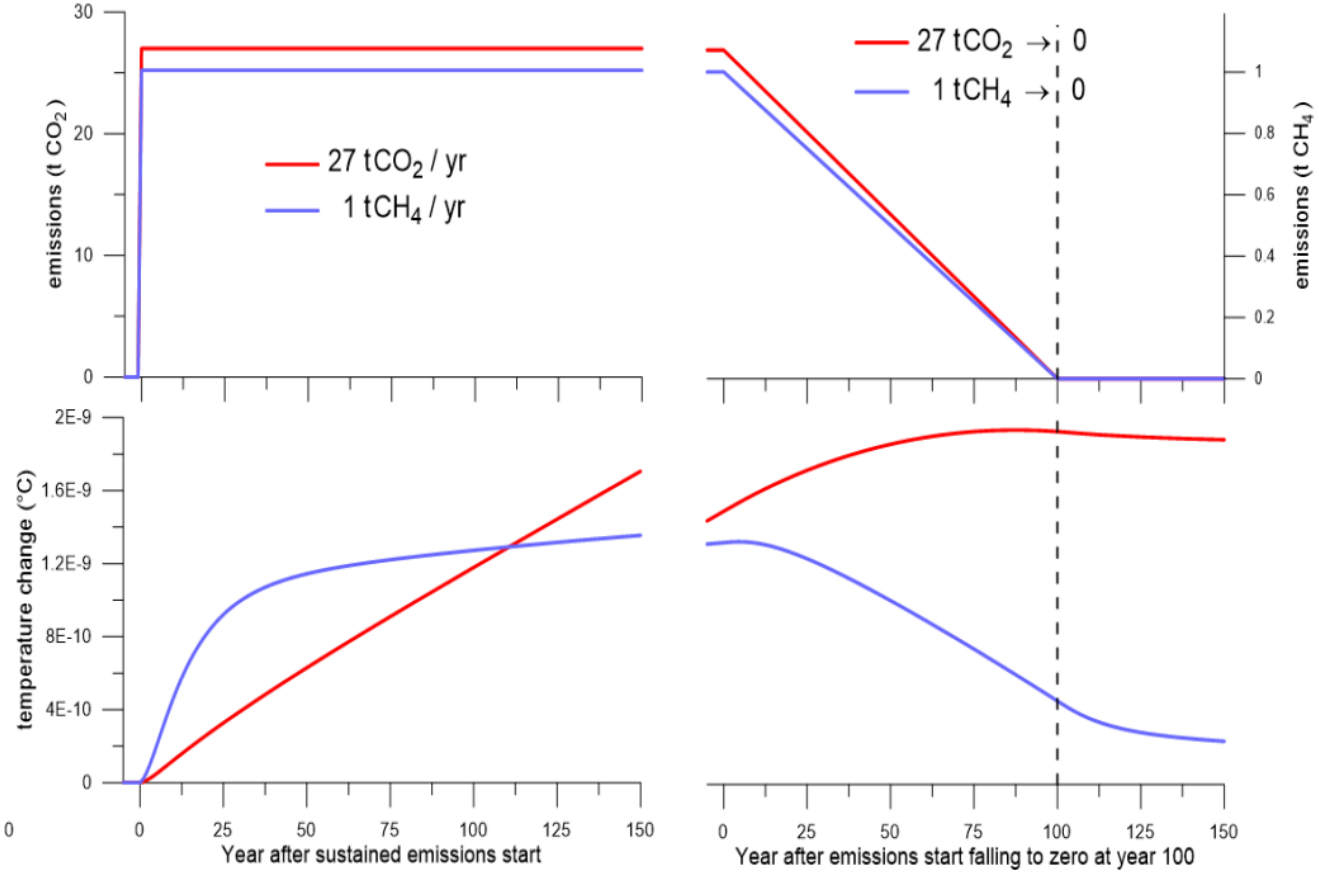
Mælkeafgiftsfonden

Cargill

Ministry of Food, Agriculture and Fisheries of Denmark

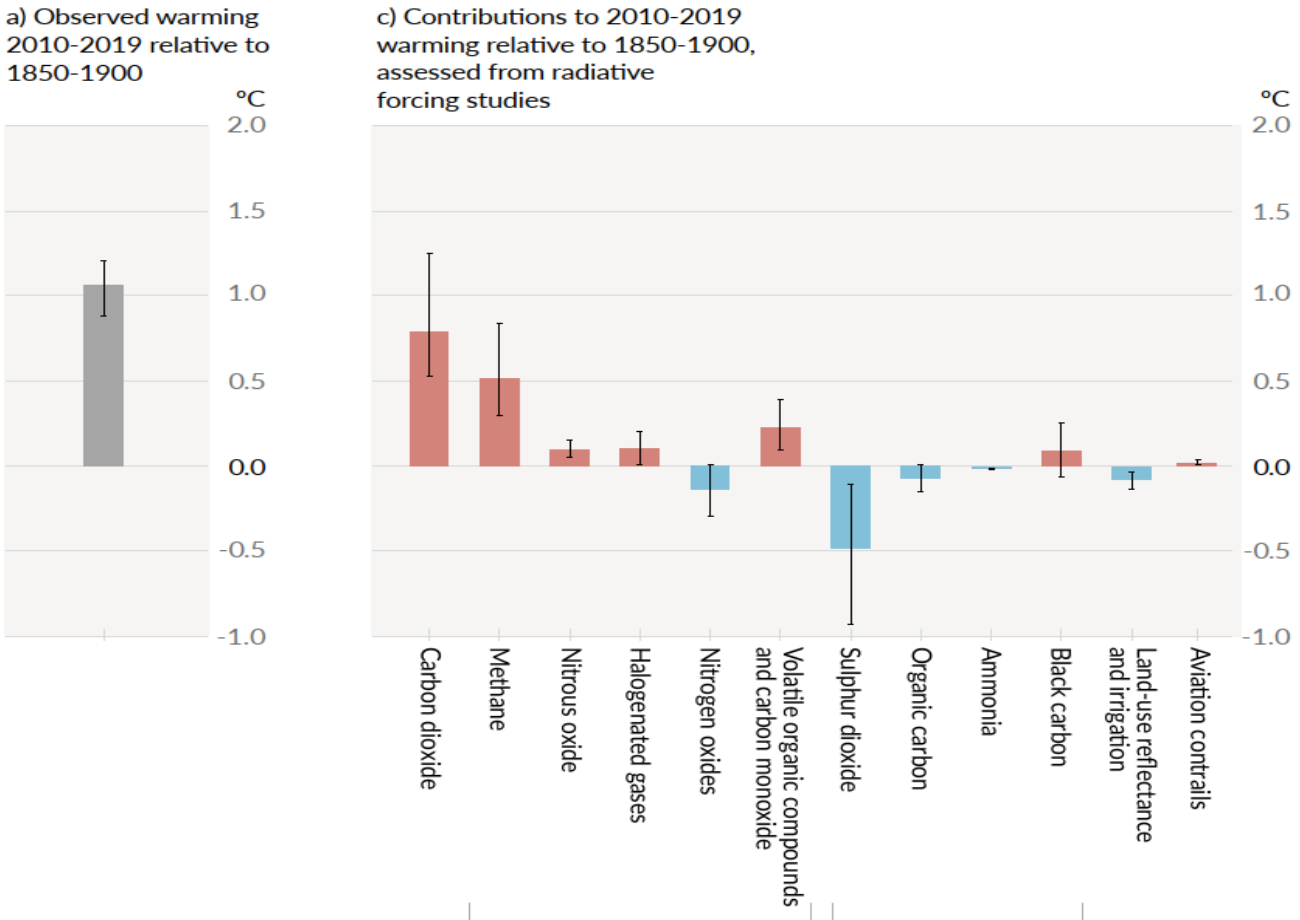
AARHUS
UNIVERSITET

EFFECT OF REDUCTION



Reisinger (2022)

CO_2 AND CH_4 ARE THE MOST IMPORTANT GHG



Reisinger (2022)
IPCC AR6 WGI (2021)
Figure SPM.2