# HOW TO REDUCE ENTERIC METHANE FROM DAIRY COWS

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CPH CATTLE
APR 2026, 30 MIN.

# THE 3 LOW HANGING FRUITS

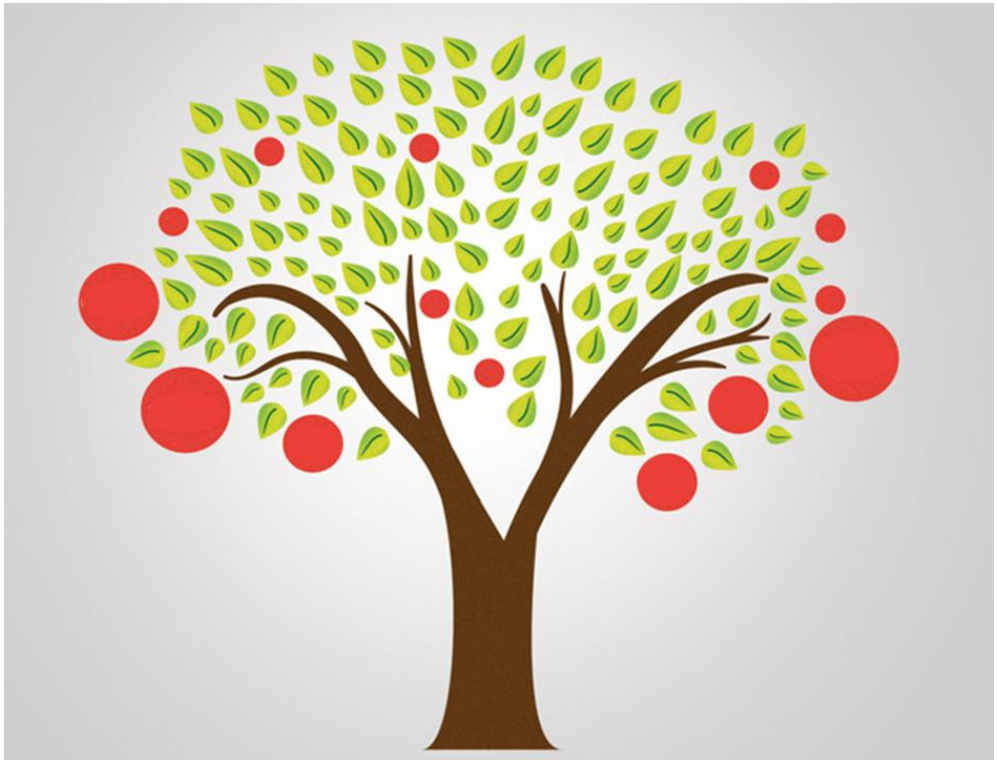
Significant effect

Consistent effect

Persistent effect

High TRL level

Minor neg. trade-offs

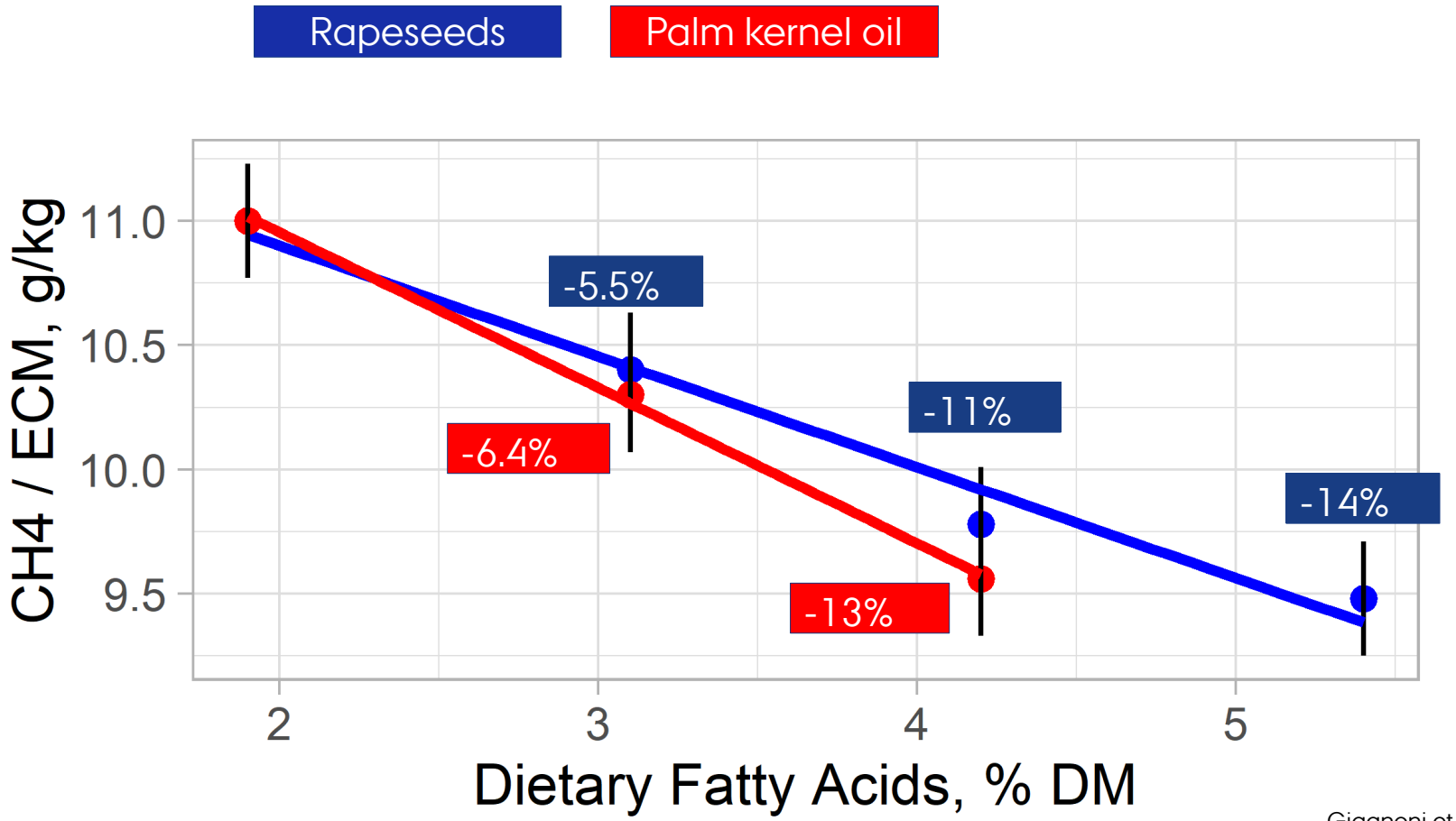


Fat supplementation
10%

Bovaer (3-NOP)
30%

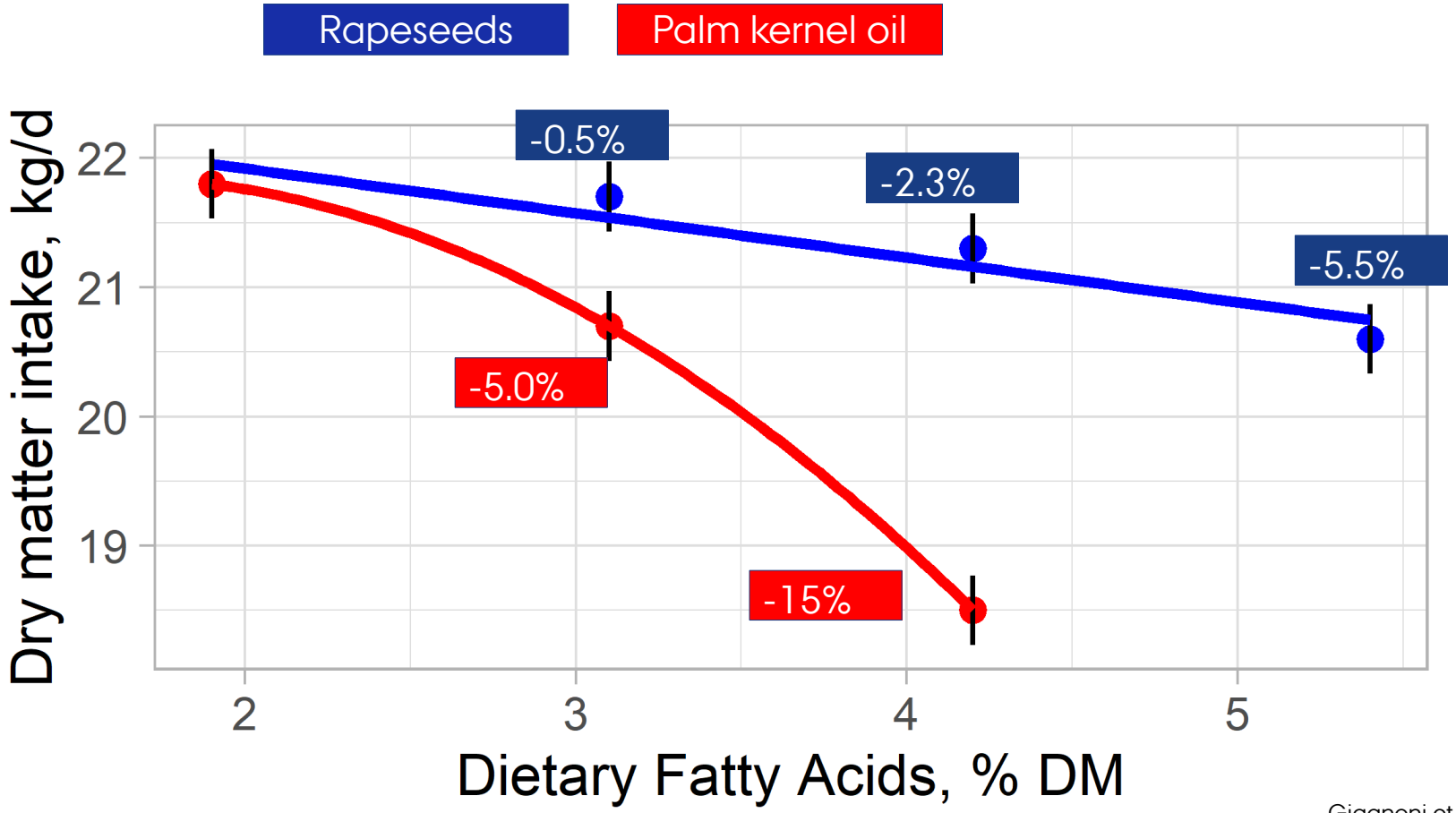
Nitrate
10%

# METHANE, G/KG ECM



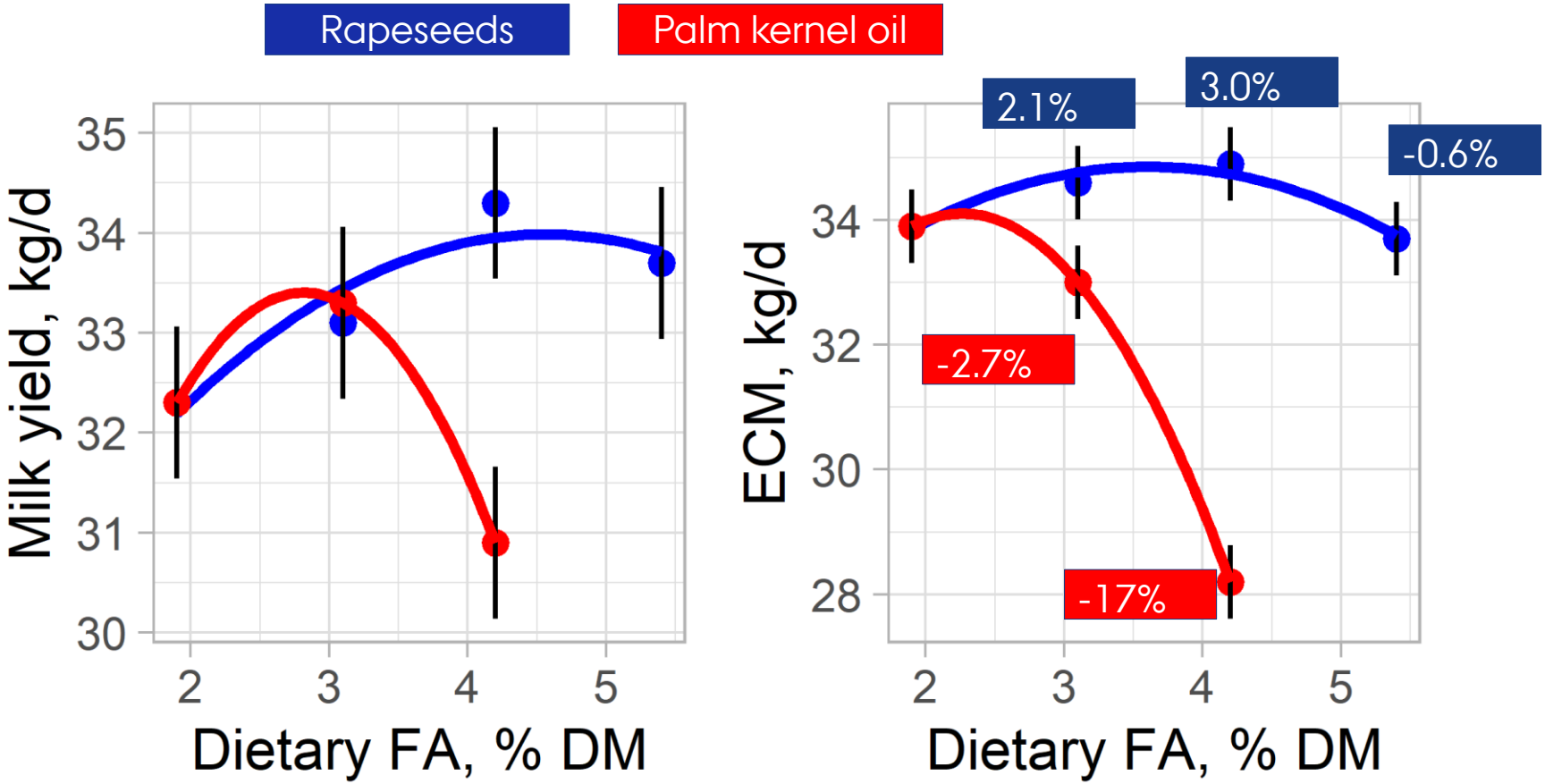

Giagnoni et al. (2022)

# FEED INTAKE



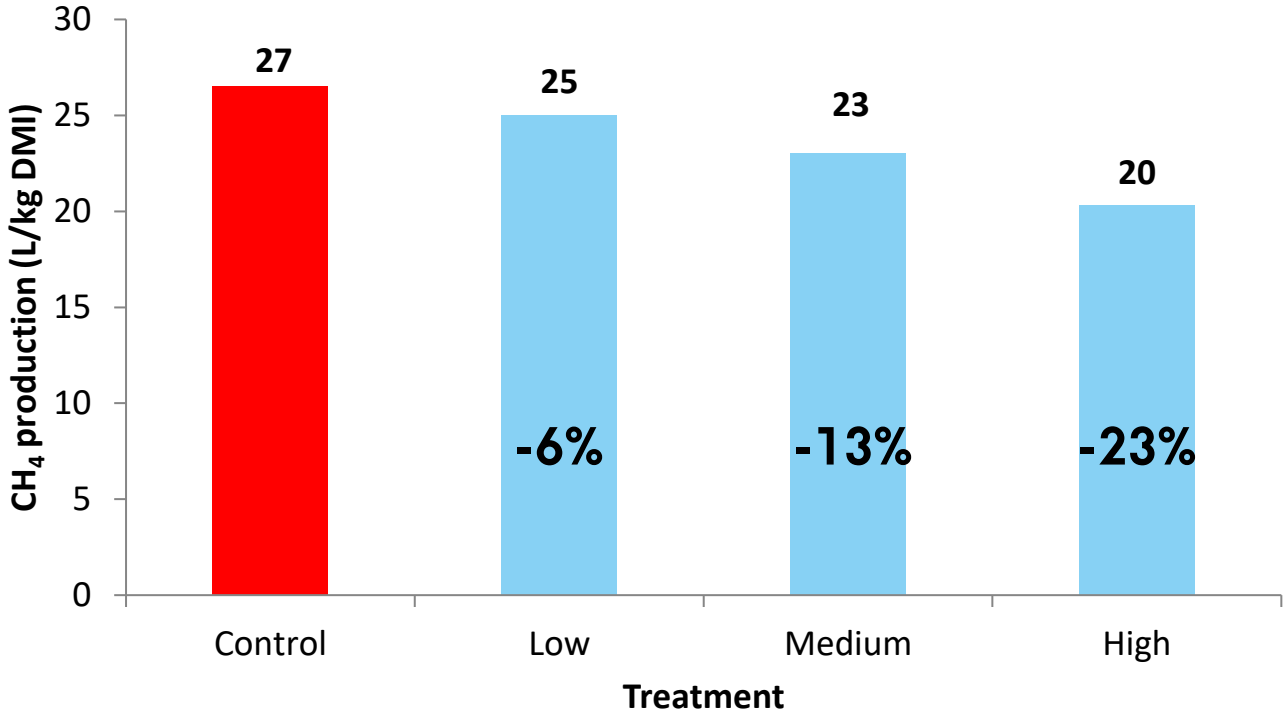

Giagnoni et al. (2022)

# MILK YIELD



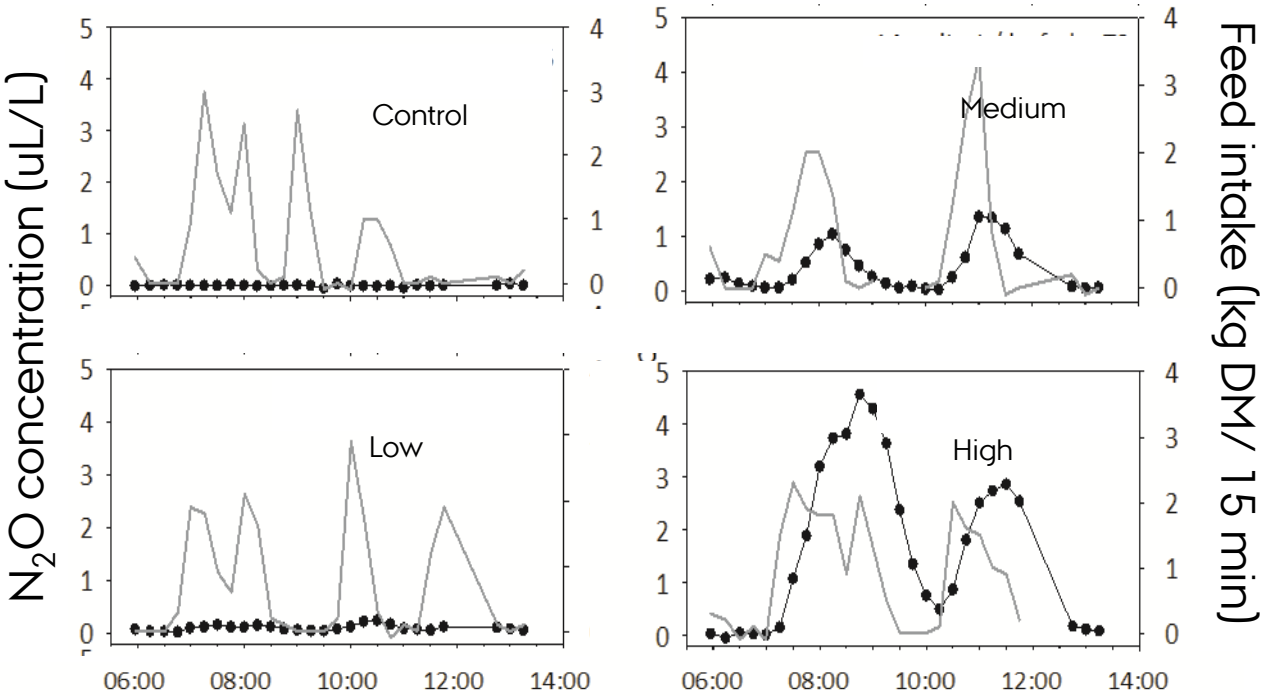

Giagnoni et al. (2022)

# NITRATE – DUAL PURPOSE ADDITIVE




Olijhoek et al. (2016)

# $N_2O$ (256 X $CO_2$)



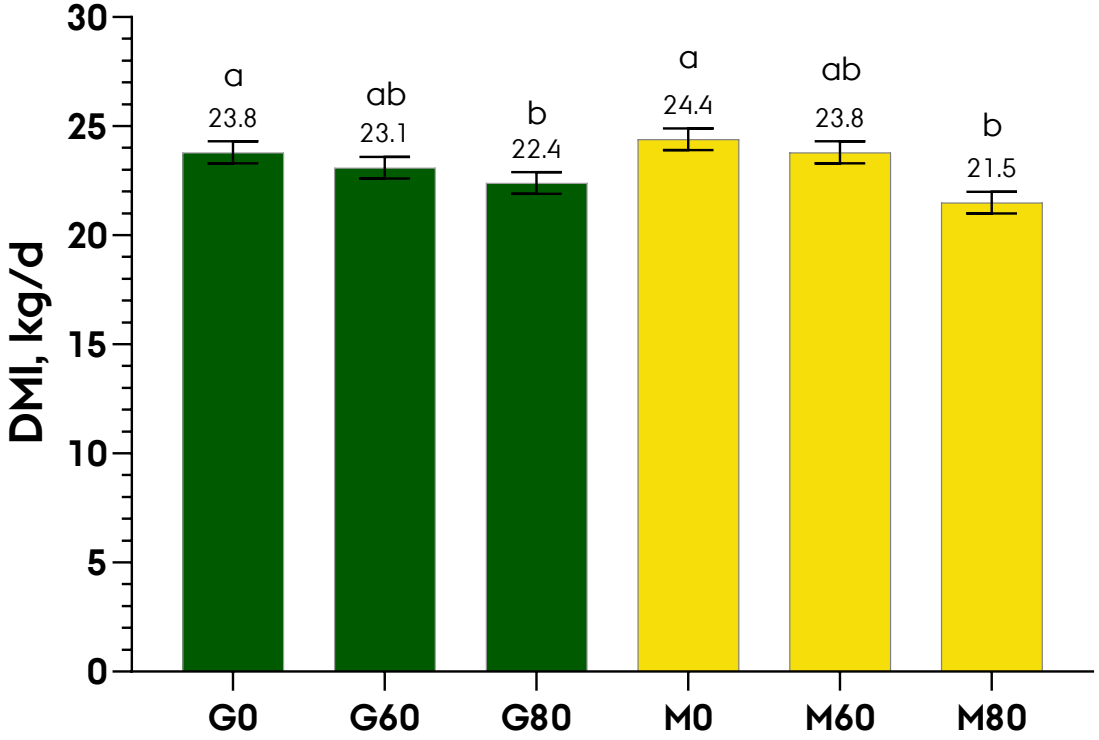

Petersen et al. (2015)

# BOVAER – 3-NITROOXYPROPANOL

Methyl coenzyme M reductase enzymesystem (MCR) (unique for methanogens)

Last step in methane production

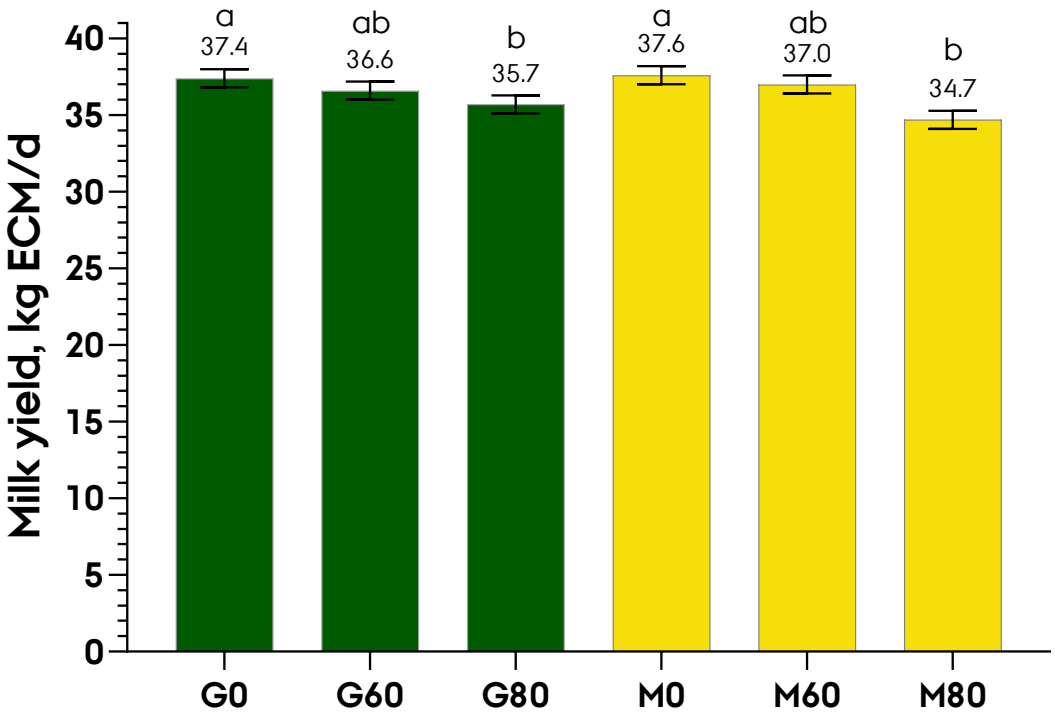
# 3-NOP AT 80 MG REDUCED DMI BY 9%
# NO EFFECT OF 60 MG




| | 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 |

Maigaard et al. (2024)

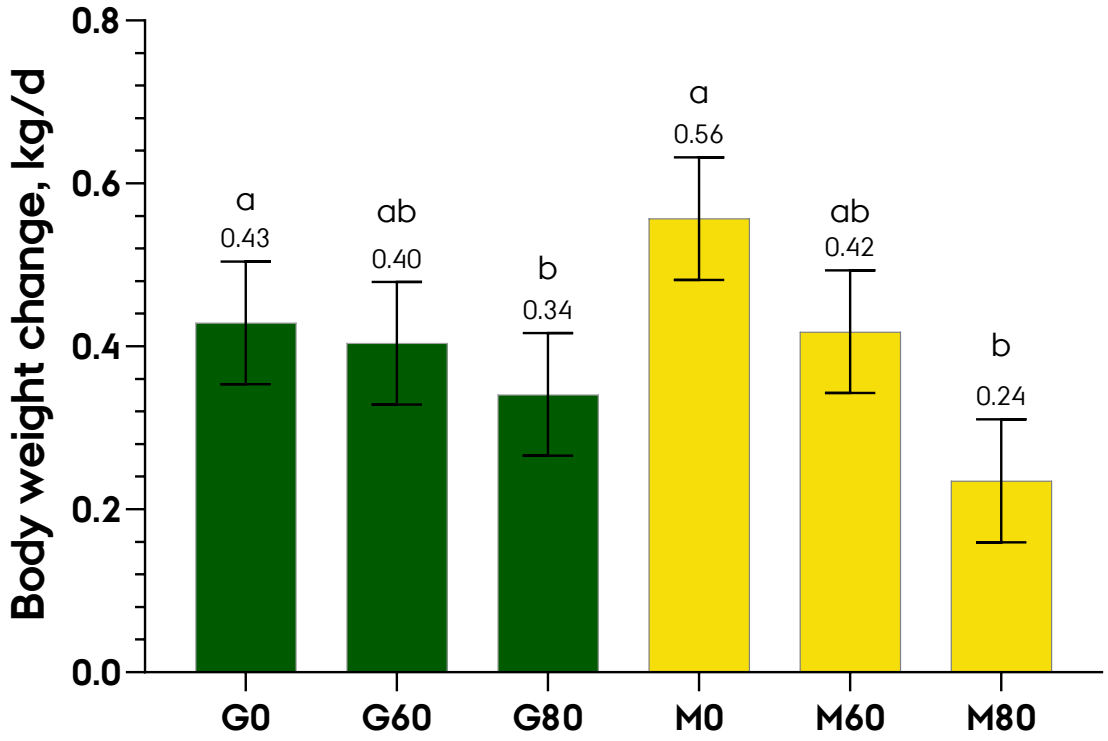
# MILK PRODUCTION REDUCED BY 5% AT 80 MG NO EFFECT OF 60 MG




| | 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 |

Maigaard et al. (2024)

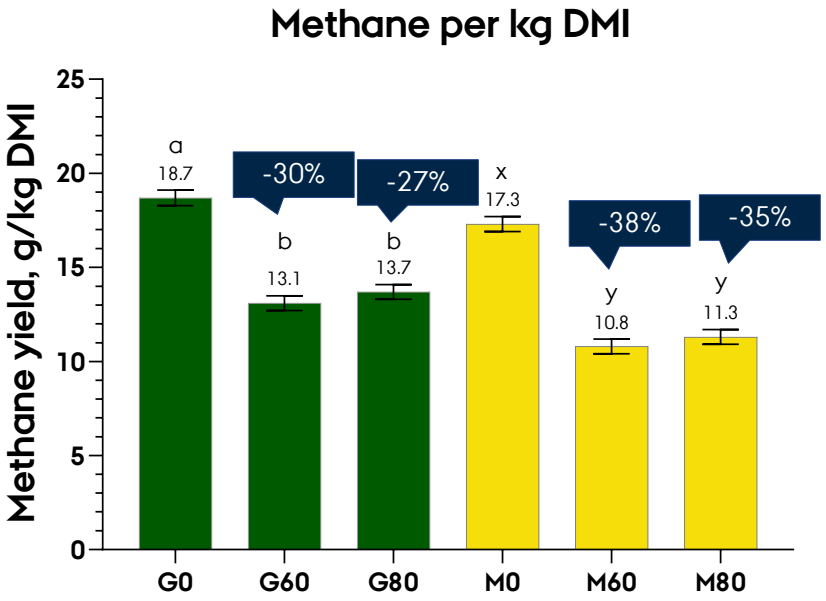
# CHANGE OF BW OVER THE 12 WEEKS

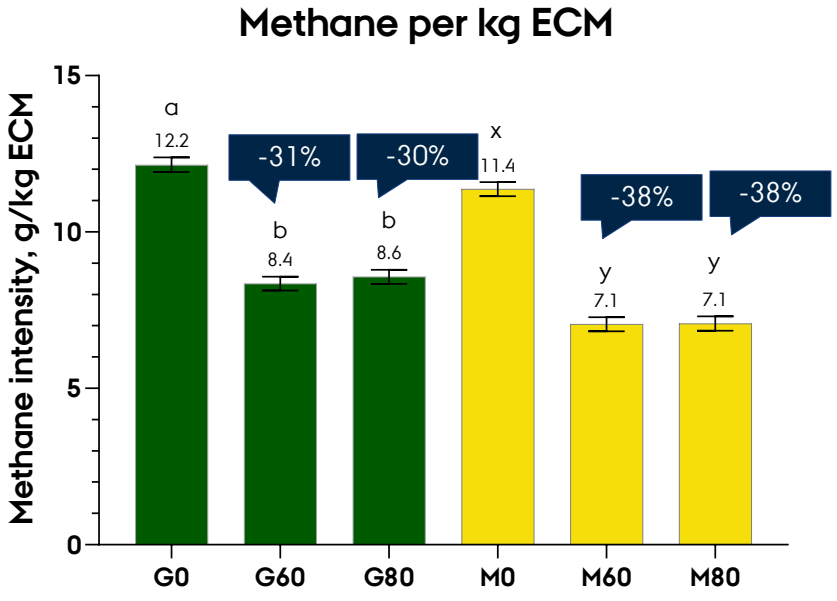



| | P-value |
|---|---|
| Forage type | 0.84 |
| 3-NOP dose | 0.02 |
| Parity | 0.48 |
| Forage type × 3-NOP | 0.26 |

Maigaard et al. (2024)

# 60 & 80 MG 3-NOP ARE EQUALLY EFFICIENT



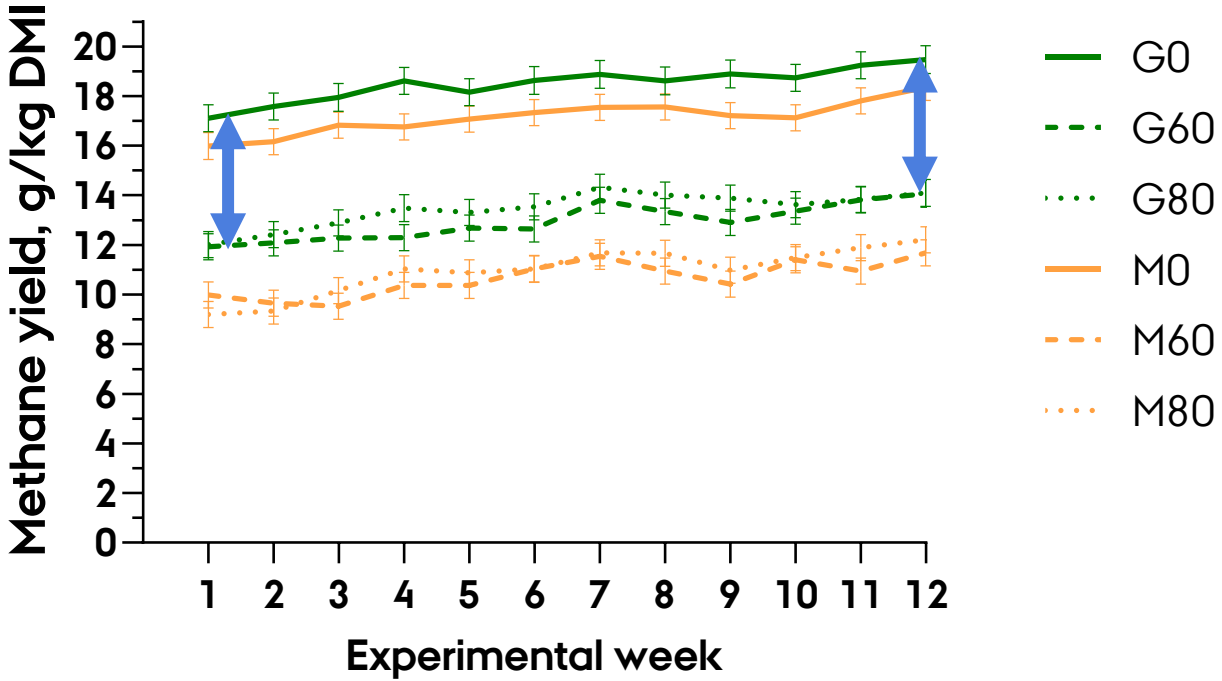

| | P-value |
|---|---|
| Forage type | <0.01 |
| 3-NOP dose | <0.01* |
| Week | <0.01 |
| Forage type × 3-NOP | 0.27 |

*Greater 3-NOP-effect in multiparous cows

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

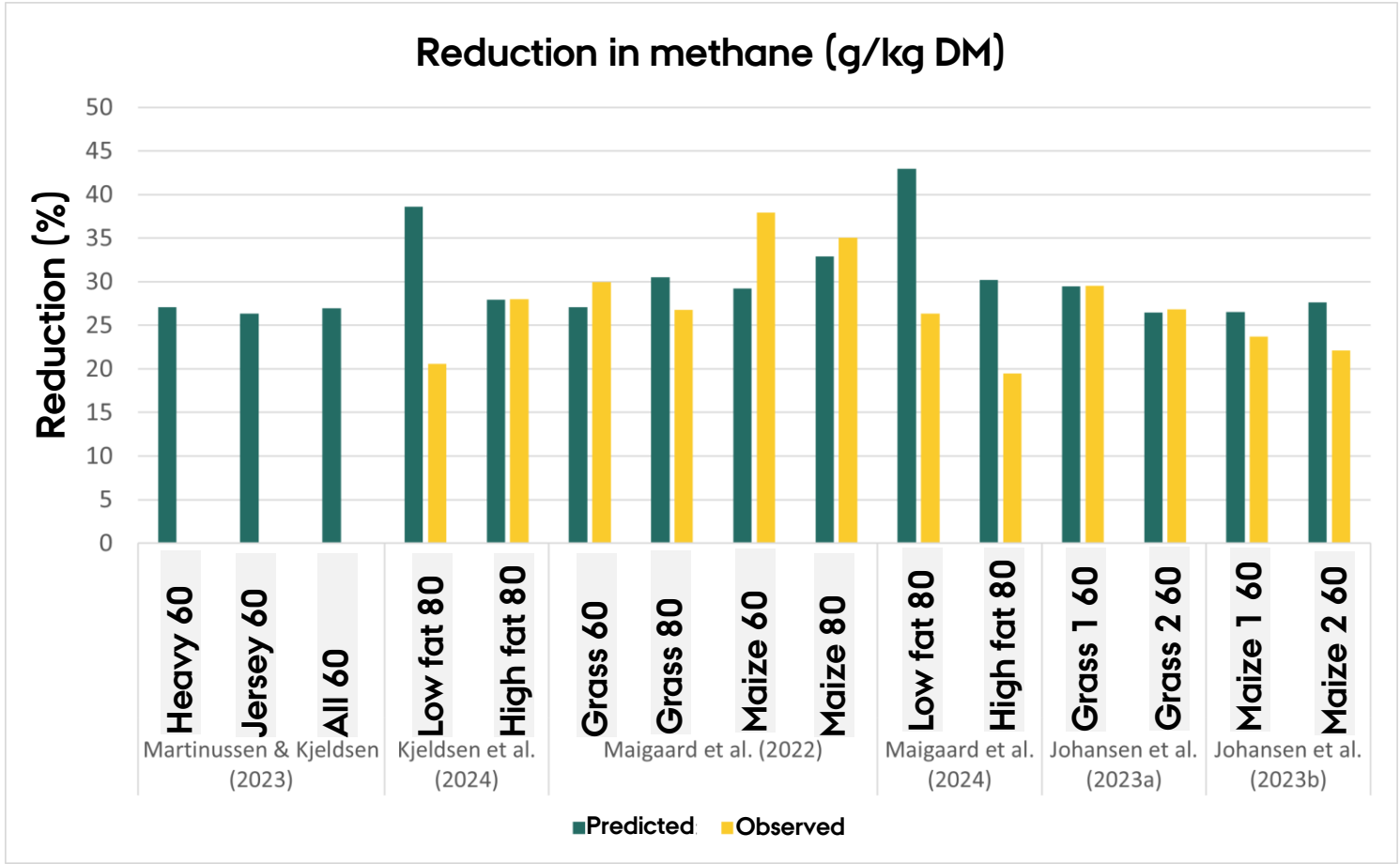
Maigaard et al. (2024)

# THE EFFECT OF 3-NOP IS PERSISTENT

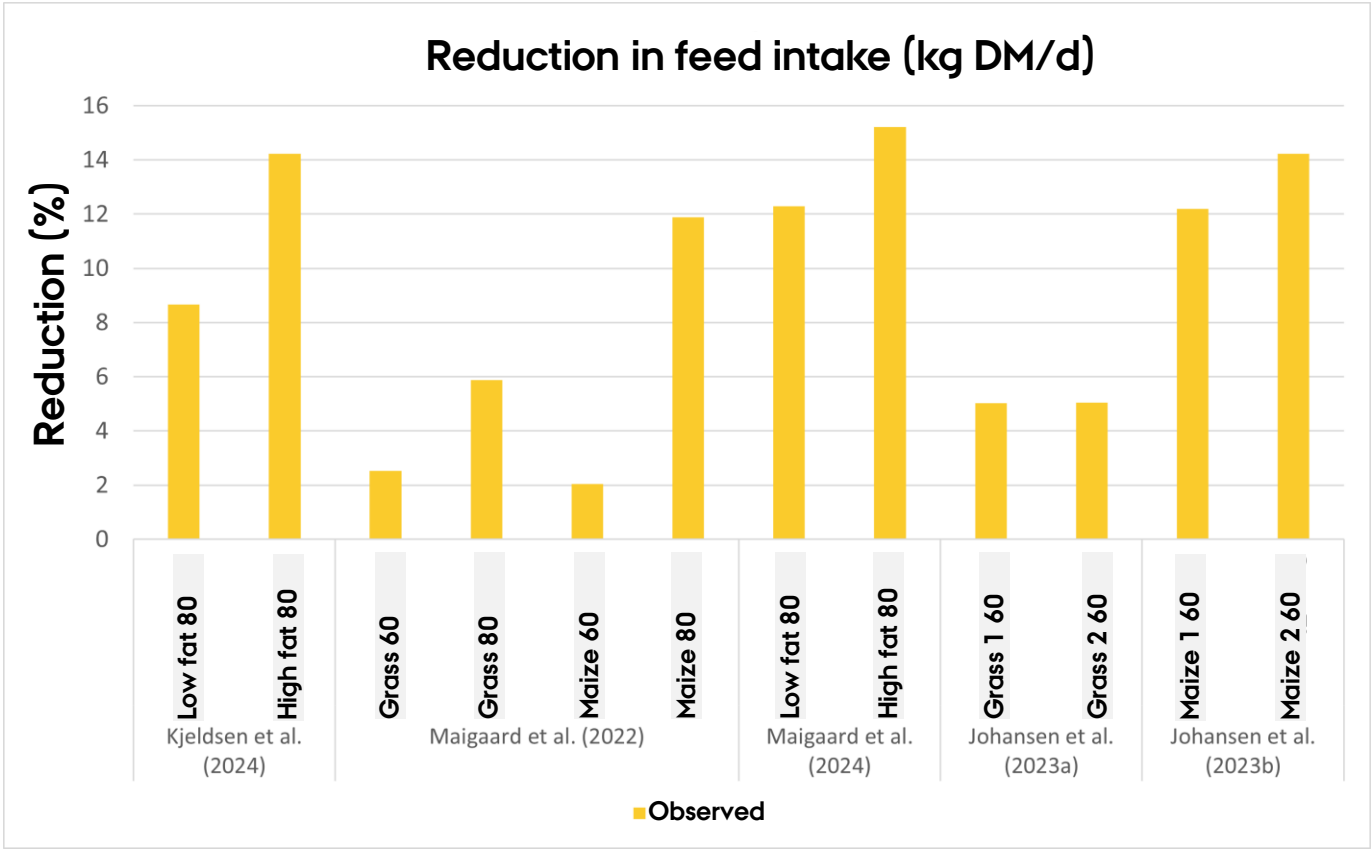



Maigaard et al. (2024)

# BOVAER IN AU TRIALS – 27 % REDUCTION



# BOVAER IN AU TRIALS – FEED INTAKE




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

Maigaard et al. (2024)

# DK TRIALS IN AN INTERNATIONAL CONTEXT

- Meta analysis shows reduction in DM intake across trials
- Dose-dependent effect on DM intake

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https://doi.org/10.3168/jds.2024-25653


**Lactational performance effects of 3-nitrooxypropanol supplementation to dairy cows: A meta-regression**

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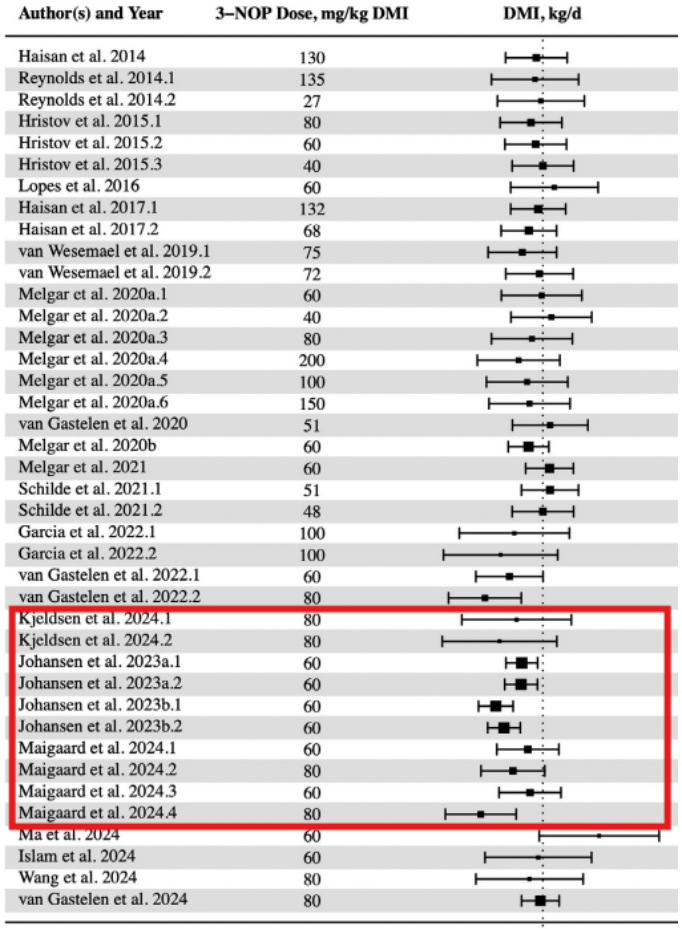
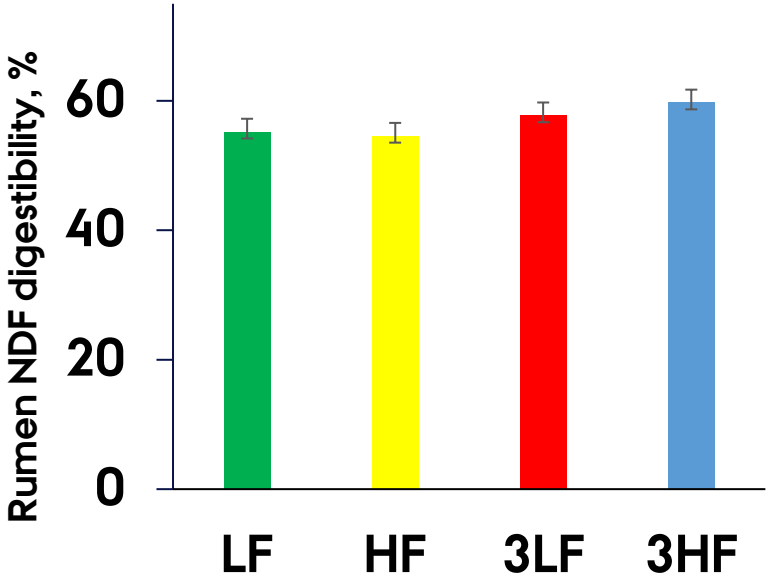
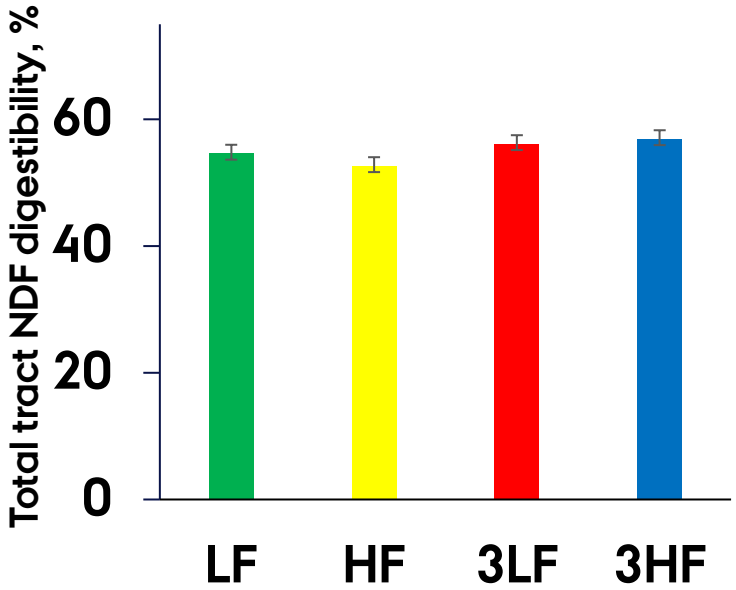


No higher incidence of sick cows in these experiments at AU related to Bovaer.
Why the decline in feed intake and milk production?
What are the underlying physiological mechanisms?

# NDF DIGESTIBILITY



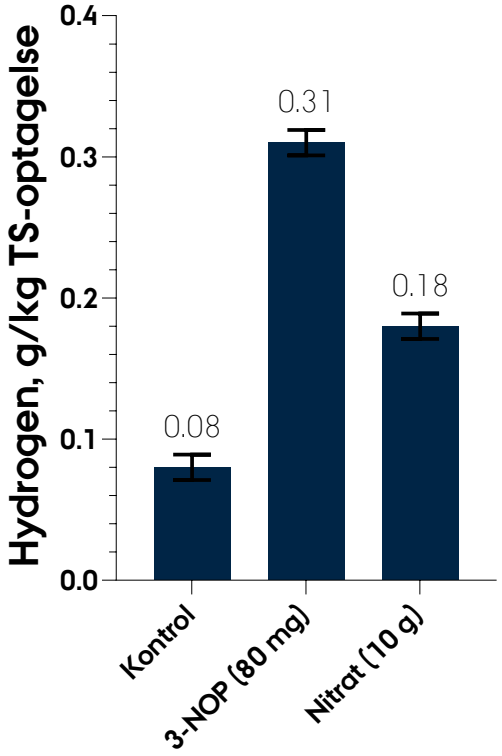

| SE | P-value | | |
|---|---|---|---|
| 2.1 | Fat | 3- NOP | Fat x 3- NOP |
| | 0.73 | 0.09 | 0.51 |




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

Kjeldsen et al. (2022)

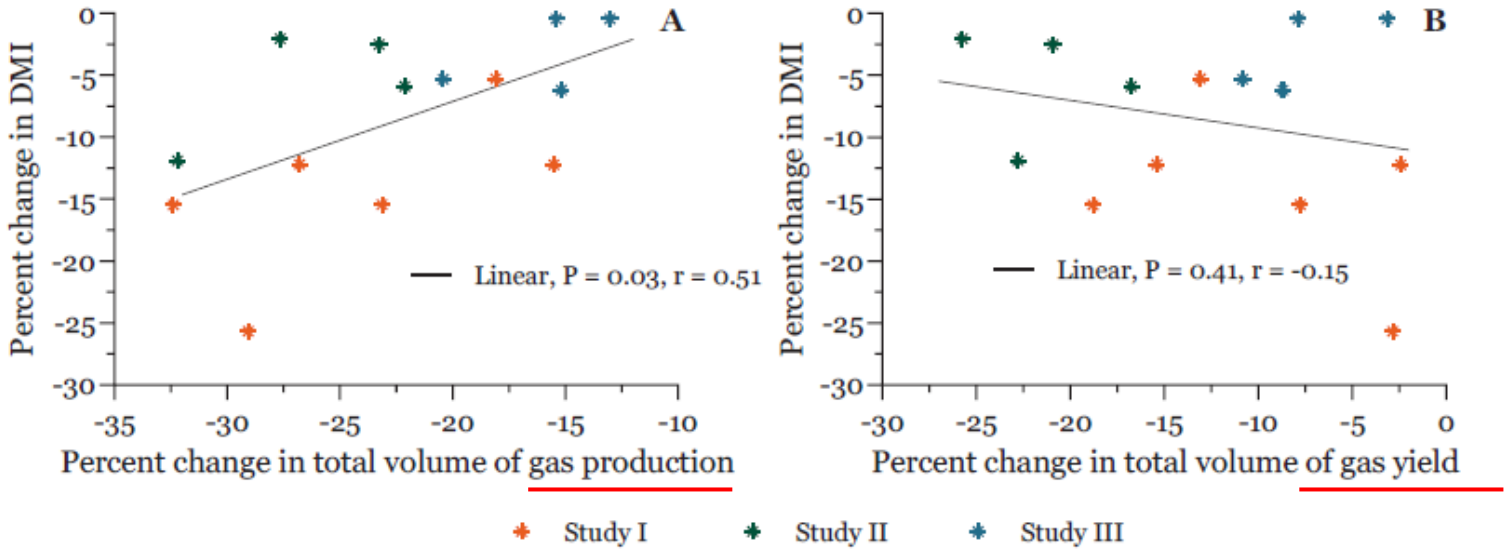
# HYDROGEN EMISSIONS INCREASE WHEN METHANE IS INHIBITED




$$CO_2 + 4H_2 \not\rightarrow CH_4 + 2H_2O$$

# ACCUMULATION OF GAS?

$$CO_2 + 4H_2 \not\rightarrow CH_4 + 2H_2O$$

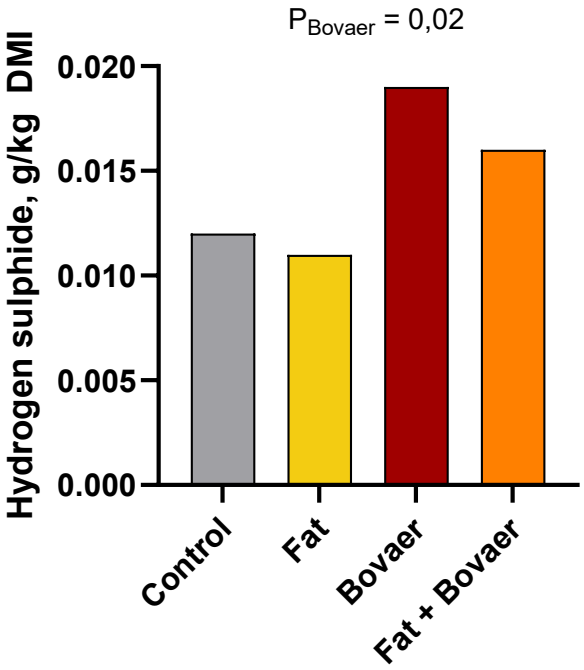



**None of these relationships show increased total gas volume when feed intake is decreased**

- But, little is known about acute effects around eating events...

Maigaard (2024)

# $H_2S$: AN EXAMPLE OF AN EFFECT OF INCREASED HYDROGEN




**Hydrogen sulphide concentration in chambers**
In cows fed 80 mg 3-NOP, the concentration of hydrogen sulphide increased by 0.08 ppm from the "normal" level.

**Humans and working environment**
Hygienic limit value per day: 5 ppm

**What does this mean for the cow?**
Supposedly significantly higher concentration in the rumen

Kjeldsen et al. (2024)

# THE COCKTAIL TRIAL

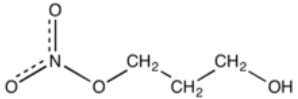
**2×2×2 factorial arrangement of treatments**

- 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

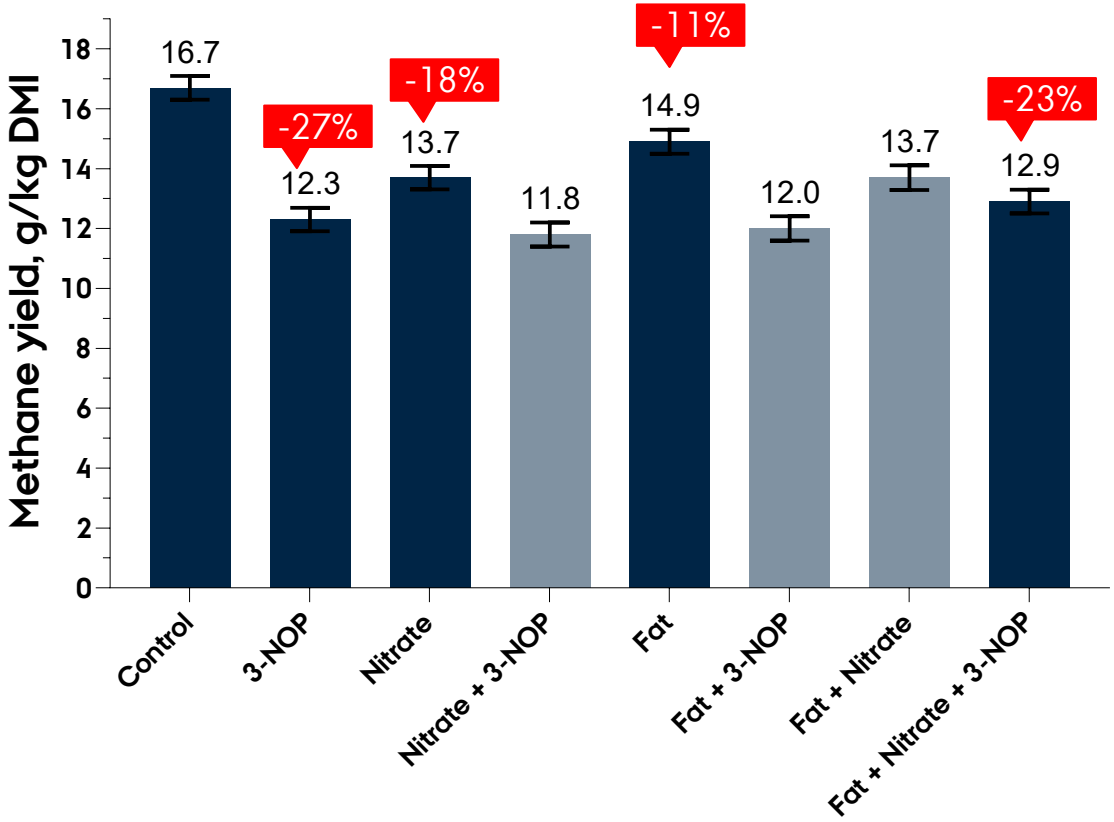
Nitrate: Calcium nitrate; SilvAir ®




3-NOP: Bovaer ®

Maigaard et al. (2024)

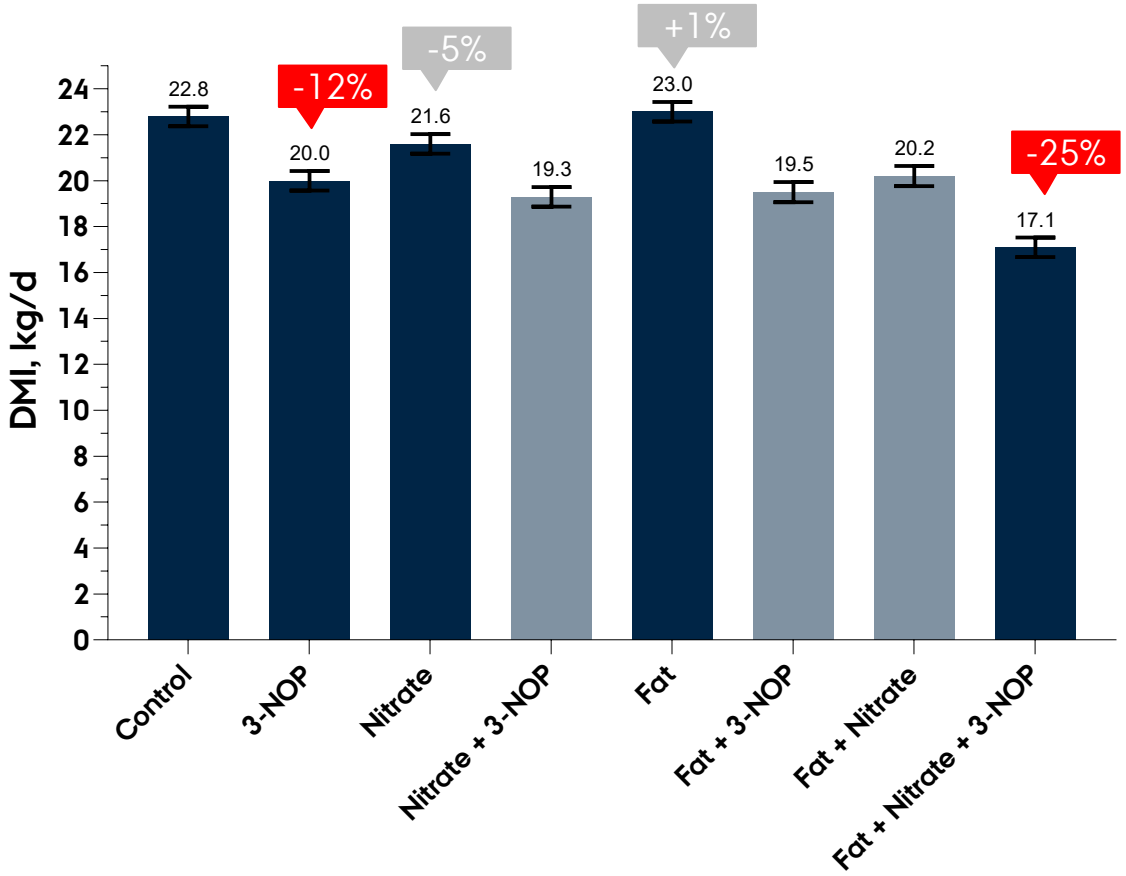
# METHANE YIELD




| | 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 |

Maigaard et al. (2024)

# DRY MATTER INTAKE

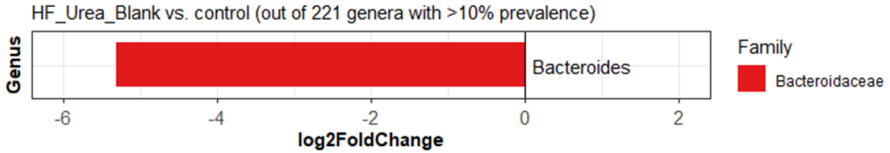



| | P-value |
|---|---|
| Fat | <0.01 |
| Nitrate | <0.01 |
| 3-NOP | <0.01 |
| Fat x Nitrate | <0.01 |
| Fat x 3-NOP | 0.09 |
| Nitrate x 3-NOP | 0.30 |
| Fat x Nitrate x 3-NOP | 0.99 |

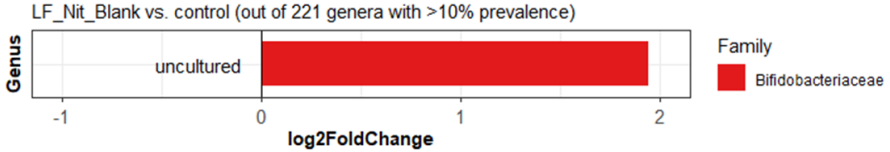
Maigaard et al. (2024)

# RUMEN MICROBIOME

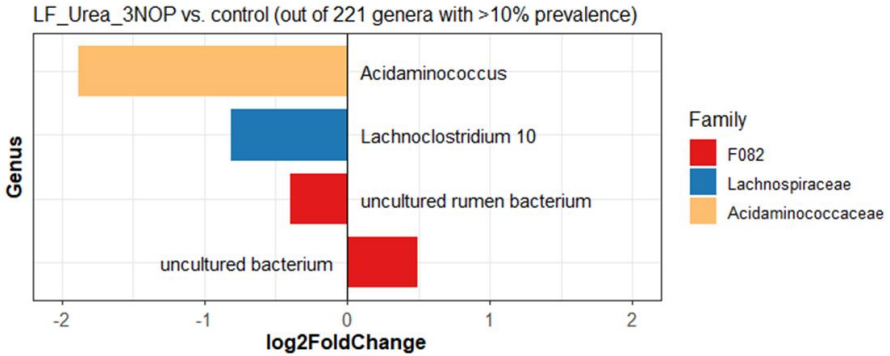
+ FAT




+ NITRATE




+ 3-NOP



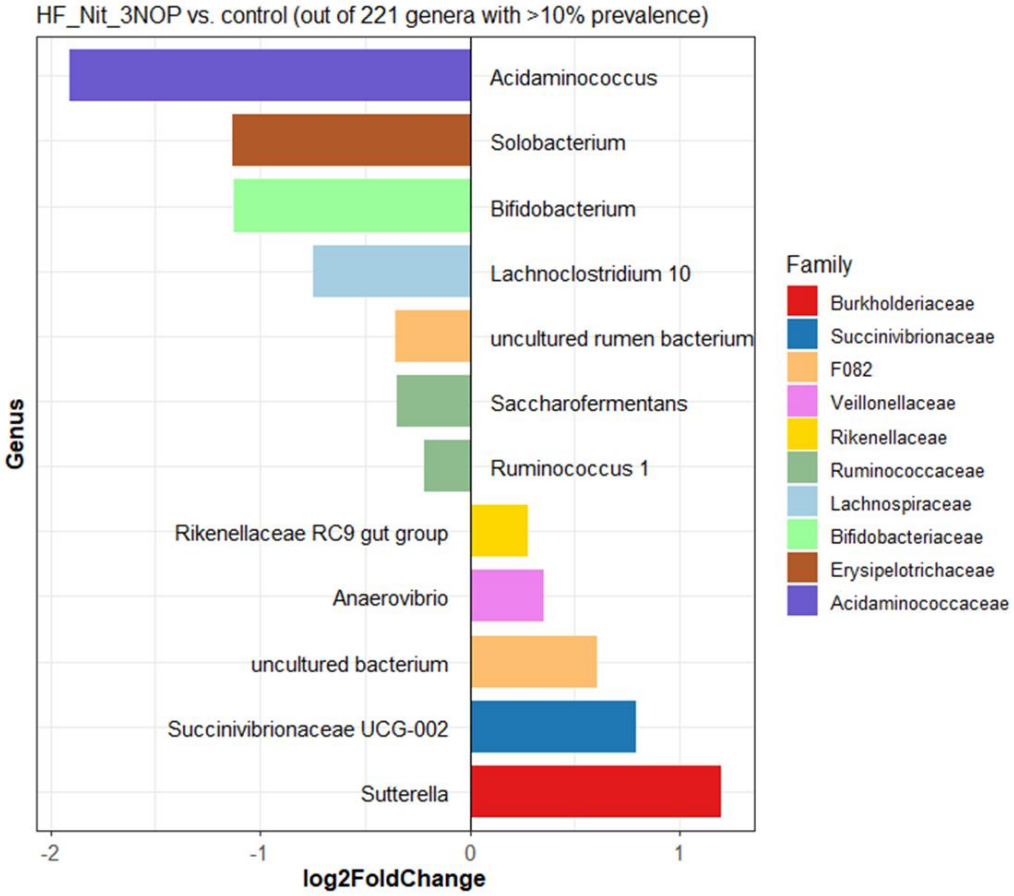

Noel et al. (2022)

# RUMEN MICROBIOME

+ NITRATE

+ 3-NOP

+ FAT




Noel et al. (2022)

Arla

nlm vantinge
sustainable lipids

DSM

Mælkeafgiftsfonden

Ministeriet for Fødevarer, Landbrug og Fiskeri
gudp

Cargill

Ministry of Food, Agriculture and Fisheries of Denmark



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