

Update on feed additives research in pasture-based dairy systems in Ireland



**Funded by
the European Union**



Update on Feed Additives Research in Pasture Based Dairy Systems in Ireland

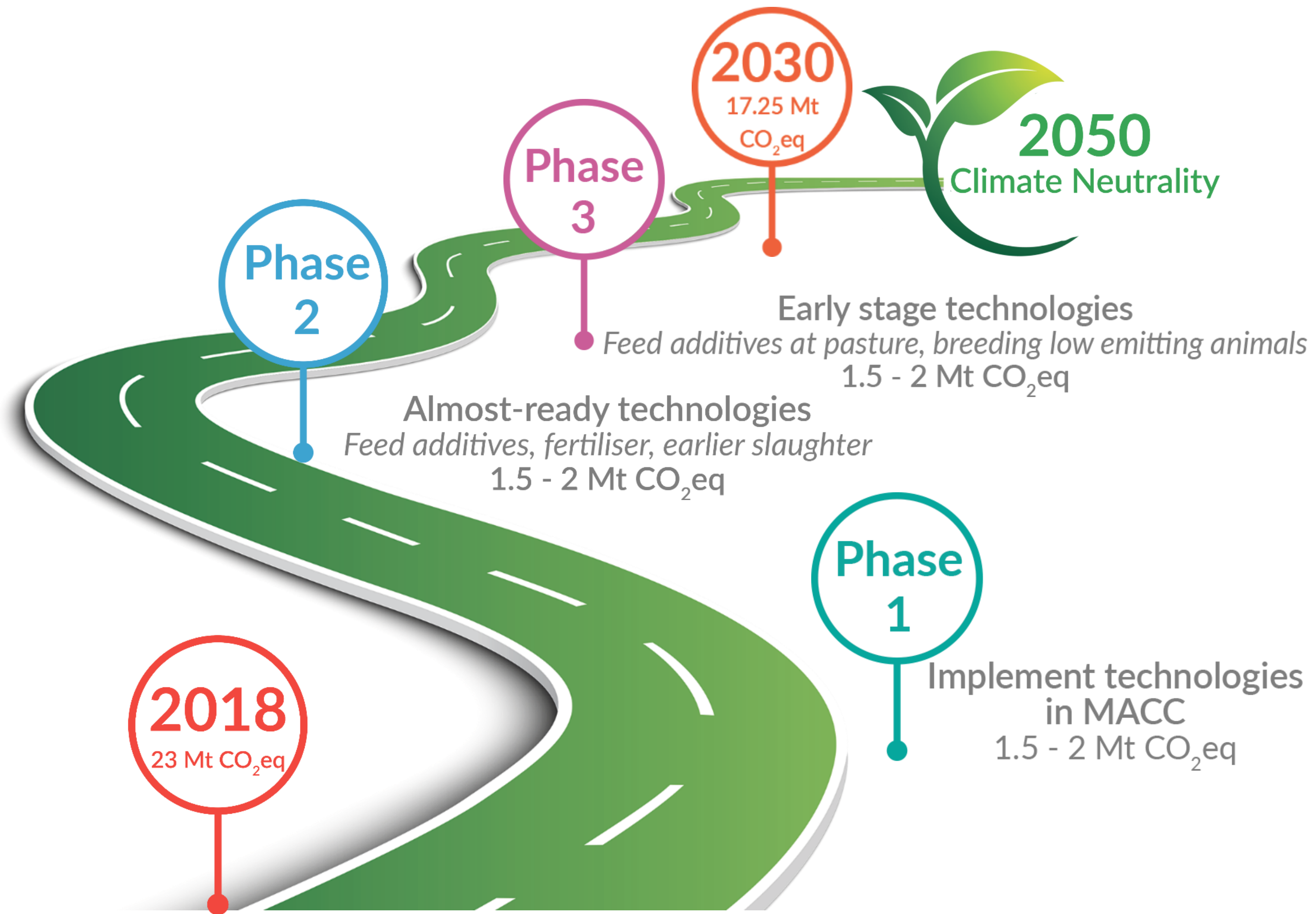
Ben Lahart and Hazel Costigan

Teagasc, AGRIC, Moorepark, Fermoy, Co Cork.

Email: Ben.Lahart@Teagasc.ie and hazel.costigan@teagasc.ie

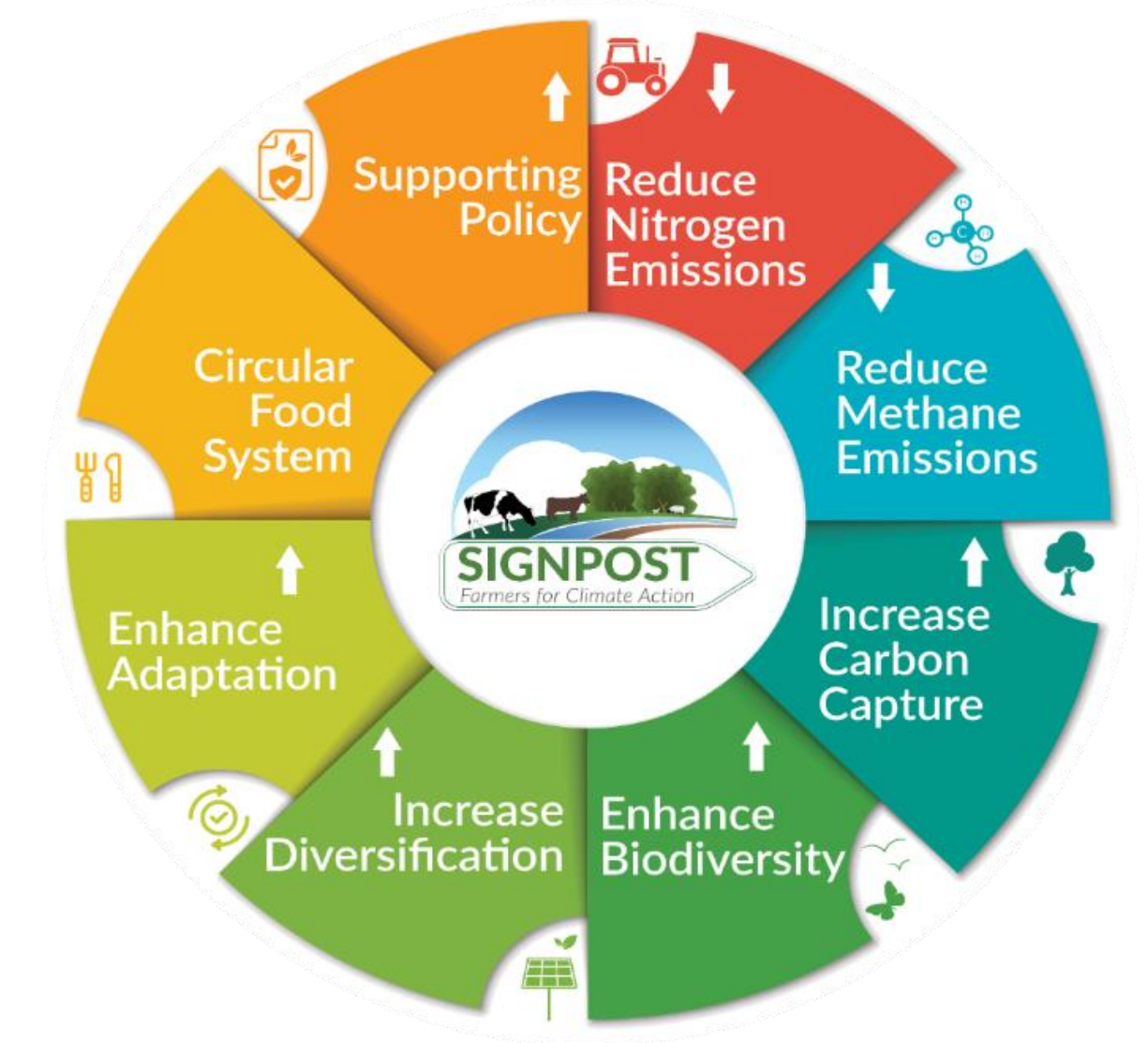
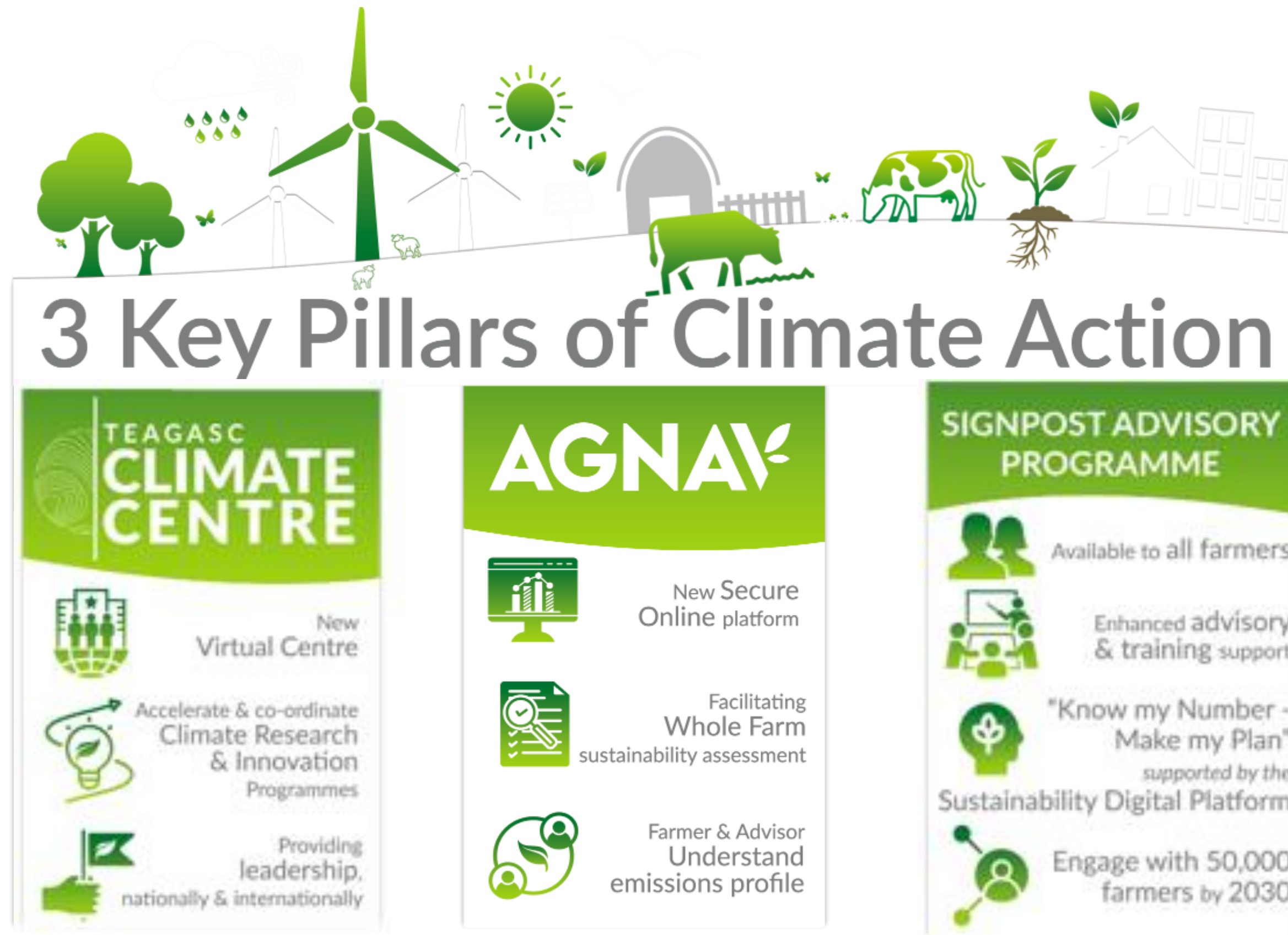


Roadmap to 2030



Teagasc Climate Strategy

Teagasc Climate Centre

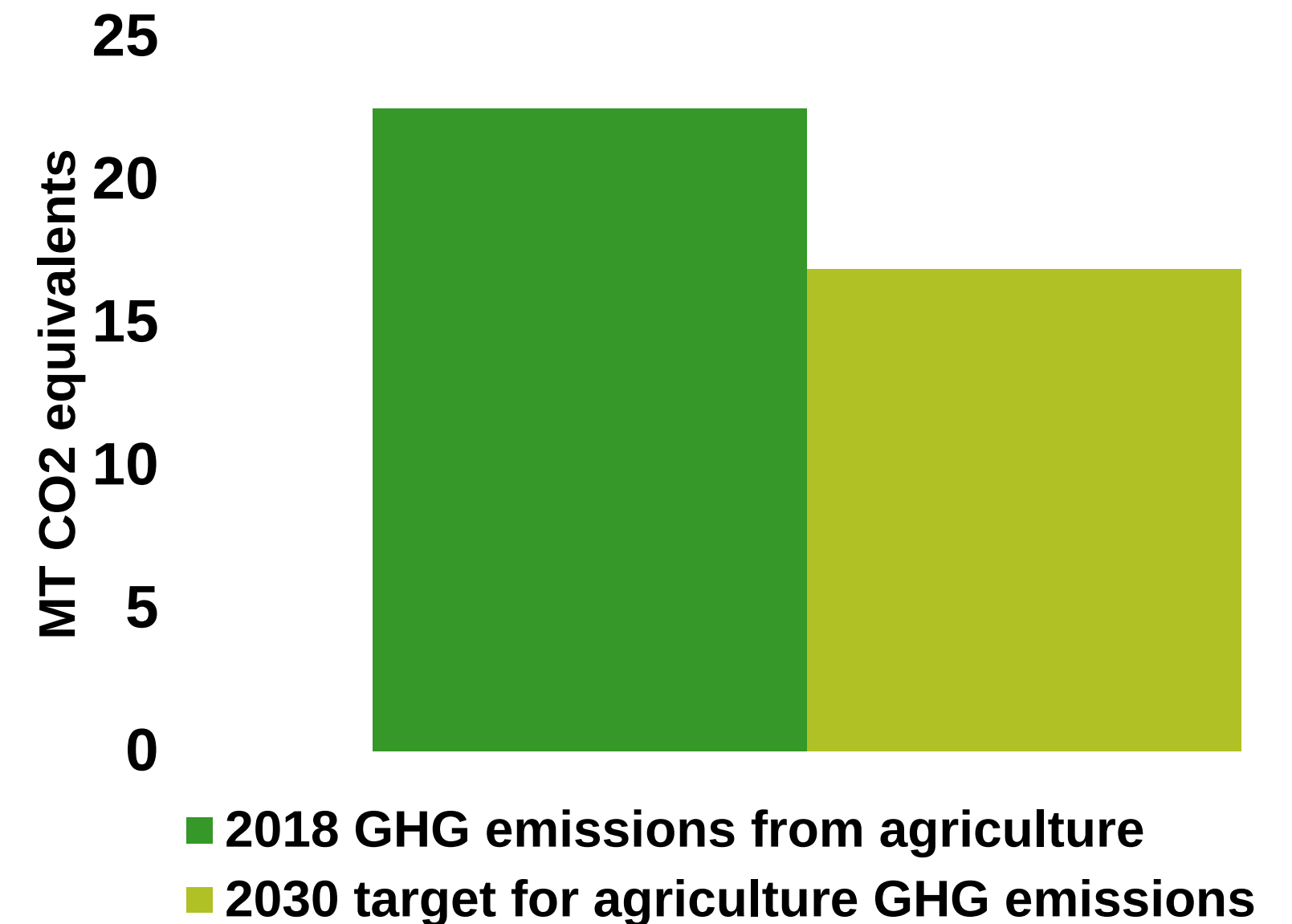


Agricultural Emissions

- Enteric methane emissions account for ~65 % of agricultural greenhouse gas emissions
- 25% reduction in emissions by 2030, relative to 2018

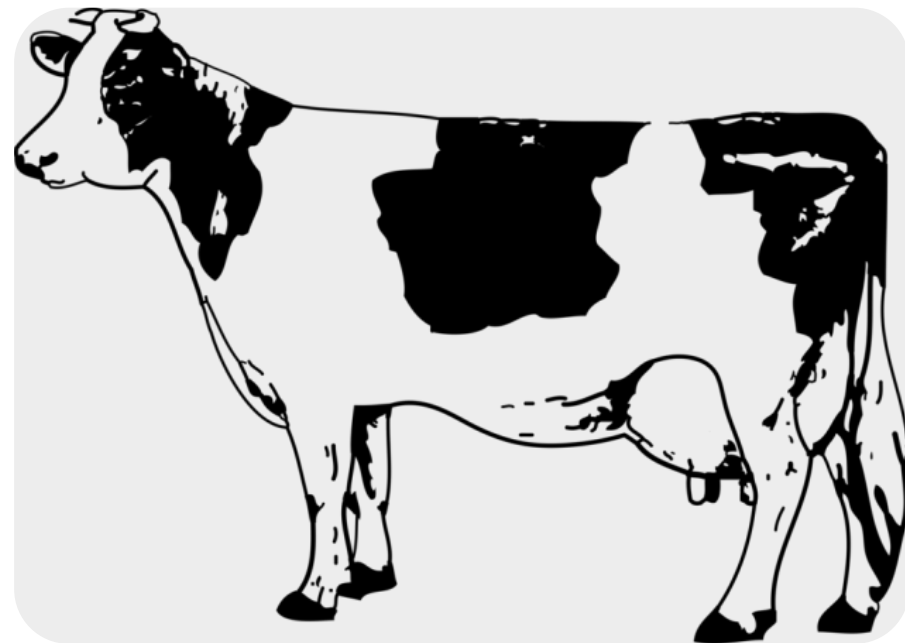
Objectives:

- ☐ To improve the understanding of enteric methane emissions in grazing dairy systems
- ☐ Develop solutions to reduce methane output



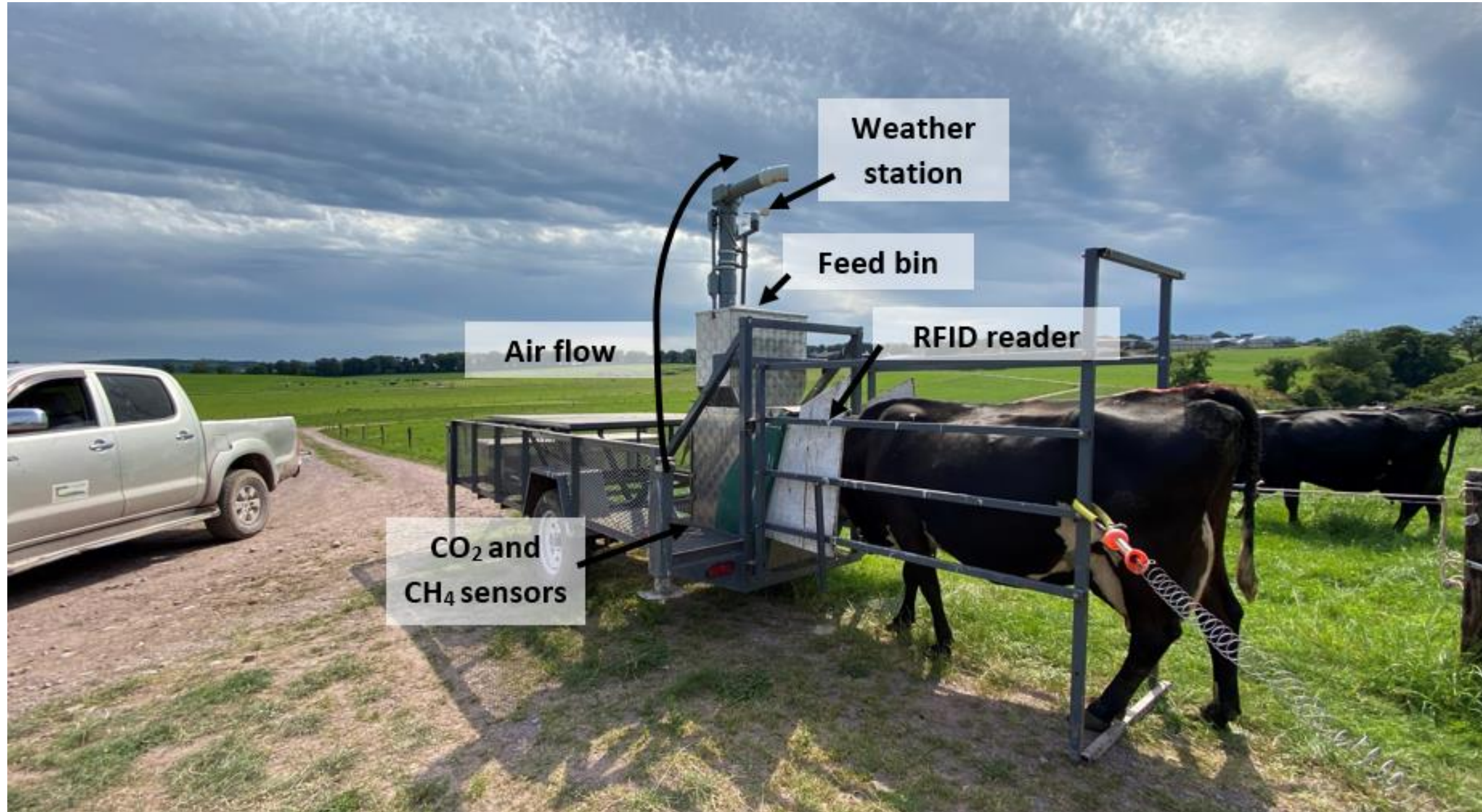
Methane calculation

Current methane conversion factors used to calculate methane in the national inventory is derived across a number of countries (*IPCC, 2019*)

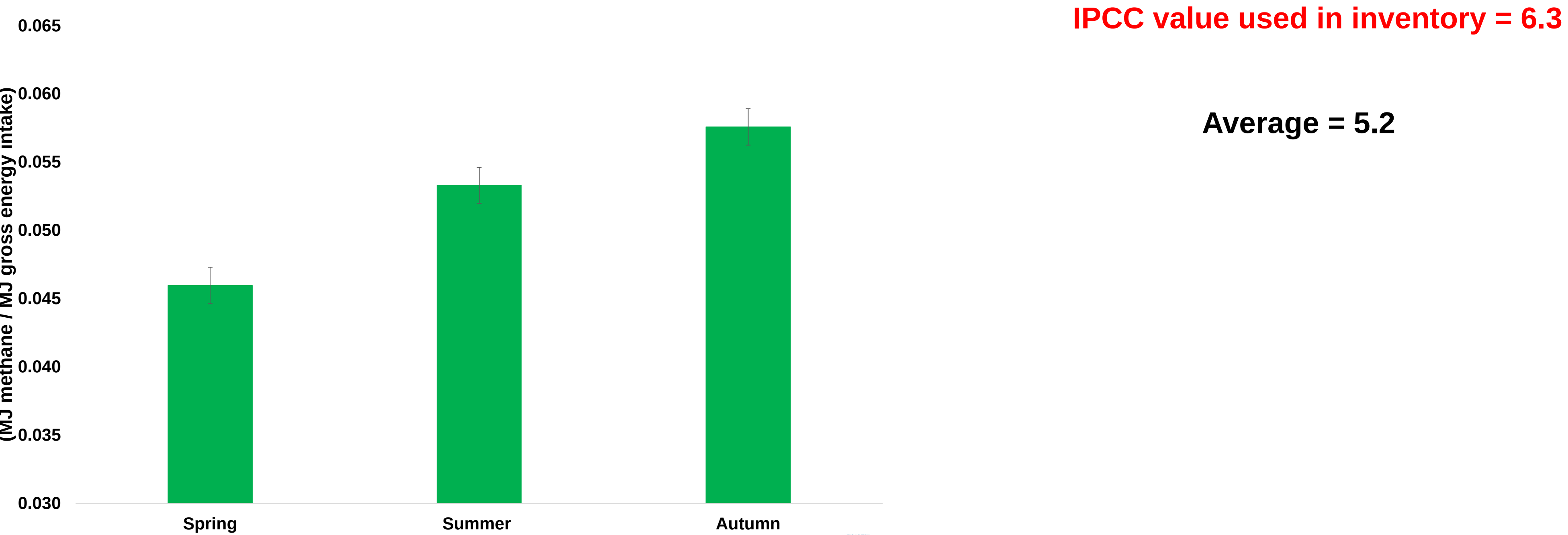


Gross energy intake $\times$ **6.3%**

Methane measurement



Enteric methane production of grazing dairy cows

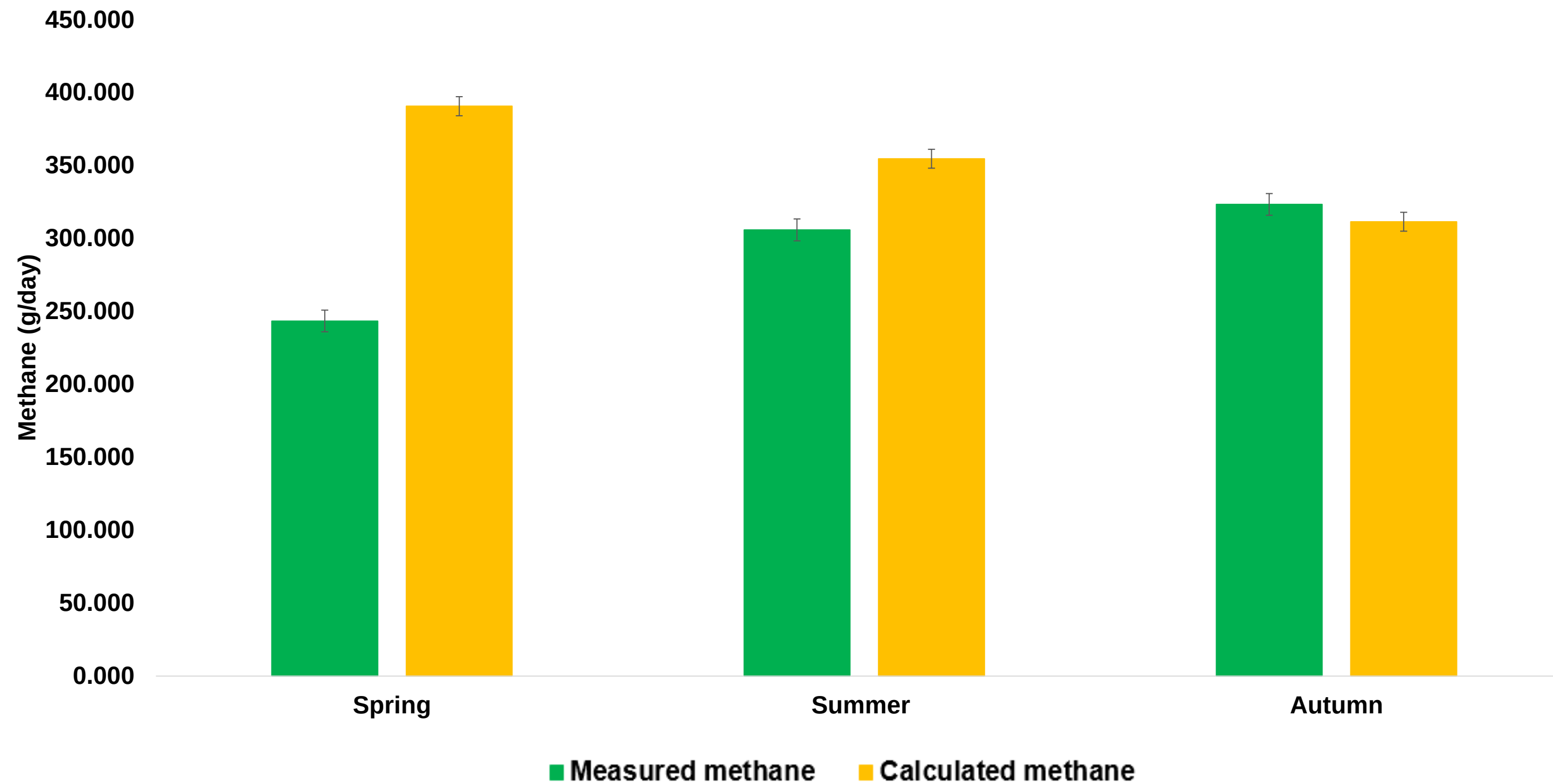


J. Dairy Sci. 107:383–397
<https://doi.org/10.3168/jds.2022-22646>
© 2024, The Authors. Published by Elsevier Inc. and Fass Inc. on behalf of the American Dairy Science Association®.
This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Evaluating enteric methane emissions within a herd of genetically divergent grazing dairy cows

B. Lahart,^{1*} F. Buckley,^{1,2} J. Herron,¹ R. Fitzgerald,¹ E. Fitzpatrick,¹ N. Galvin,¹ and L. Shalloo¹
¹Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland P61 P302
²School of Biological Earth and Environmental Science, University College Cork, Distillery Fields, North Mall, Cork, Ireland T12 K8AF

Seasonal variation in methane production



Methane conversion factors from Irish grazing dairy studies

Study	Method	Methane conversion factor
Wims et al. 2010	SF6	6.4
O'Neill et al., 2011	SF6	5.7
Ferris et al., 2020	SF6	4.9
Hynes et al., 2016	Chamber	5.6
Lahart et al., 2024	GreenFeed	5.2
Starsmore et al., 2024	GreenFeed	6.1
Jiao et al., 2014	SF6	5.6
Foley et al., 2008	SF6	6.3
Lovett et al 2005	SF6	5.6
Hidalgo et al 2014	SF6	6.8
Mean		5.8
IPCC 2019 used in inventory		6.3

Breeding

Grazing
management

Feed
additives

25
20
15
10
5
0

MT CO₂ equivalents

- 2018 GHG emissions from agriculture
- 2030 target for agriculture GHG emissions

Pasture

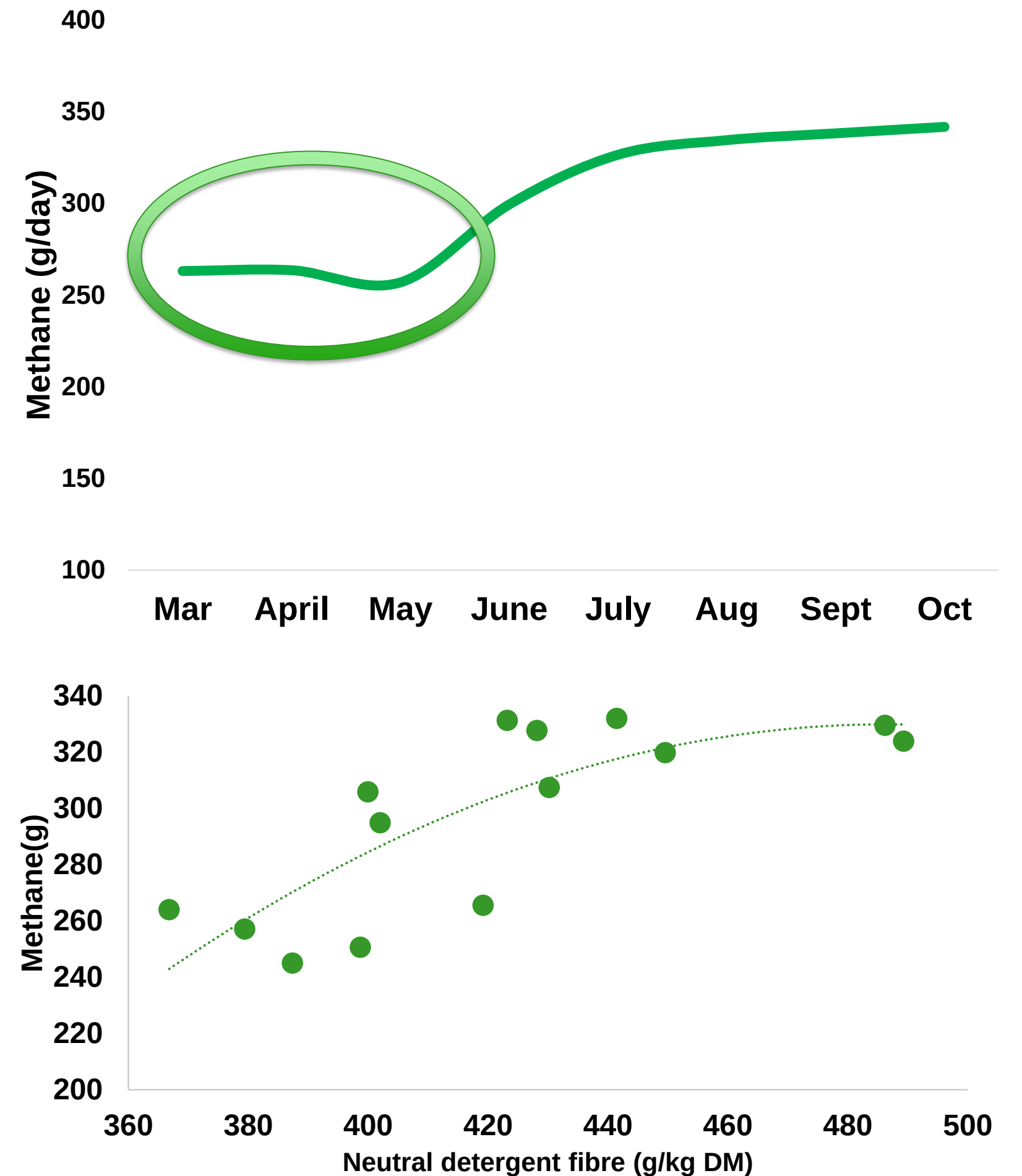
MT CO₂ equivalents



- 2018 GHG emissions from agriculture
- 2030 target for agriculture GHG emissions

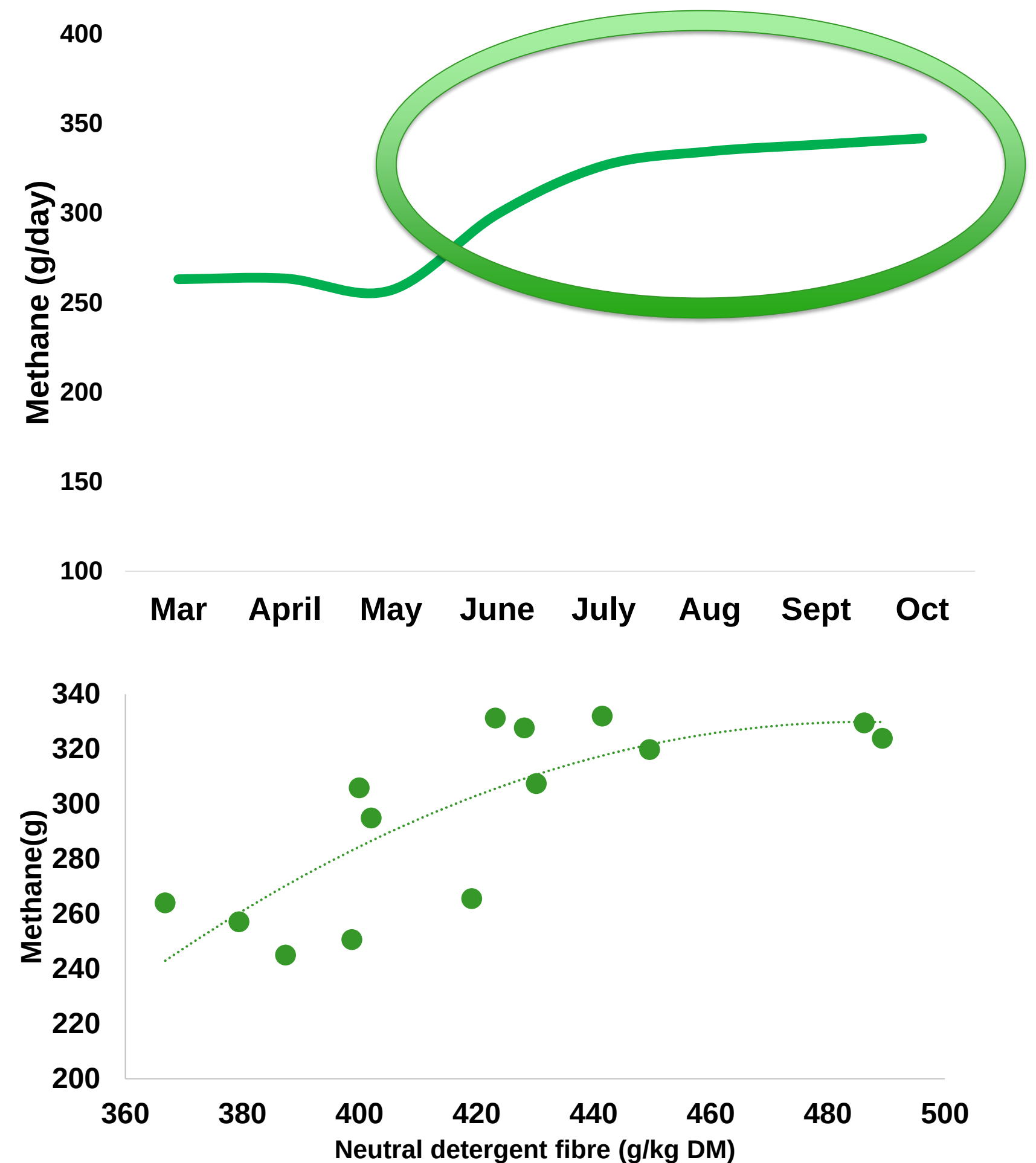
Grazing management

- Utilizing high quality spring grass can reduce methane



Grazing management

- Utilizing high quality spring grass can reduce methane
- Methane can be reduced by ensuring animals are grazing high quality pasture
- On-farm pasture quality data



Breeding

Grazing
management

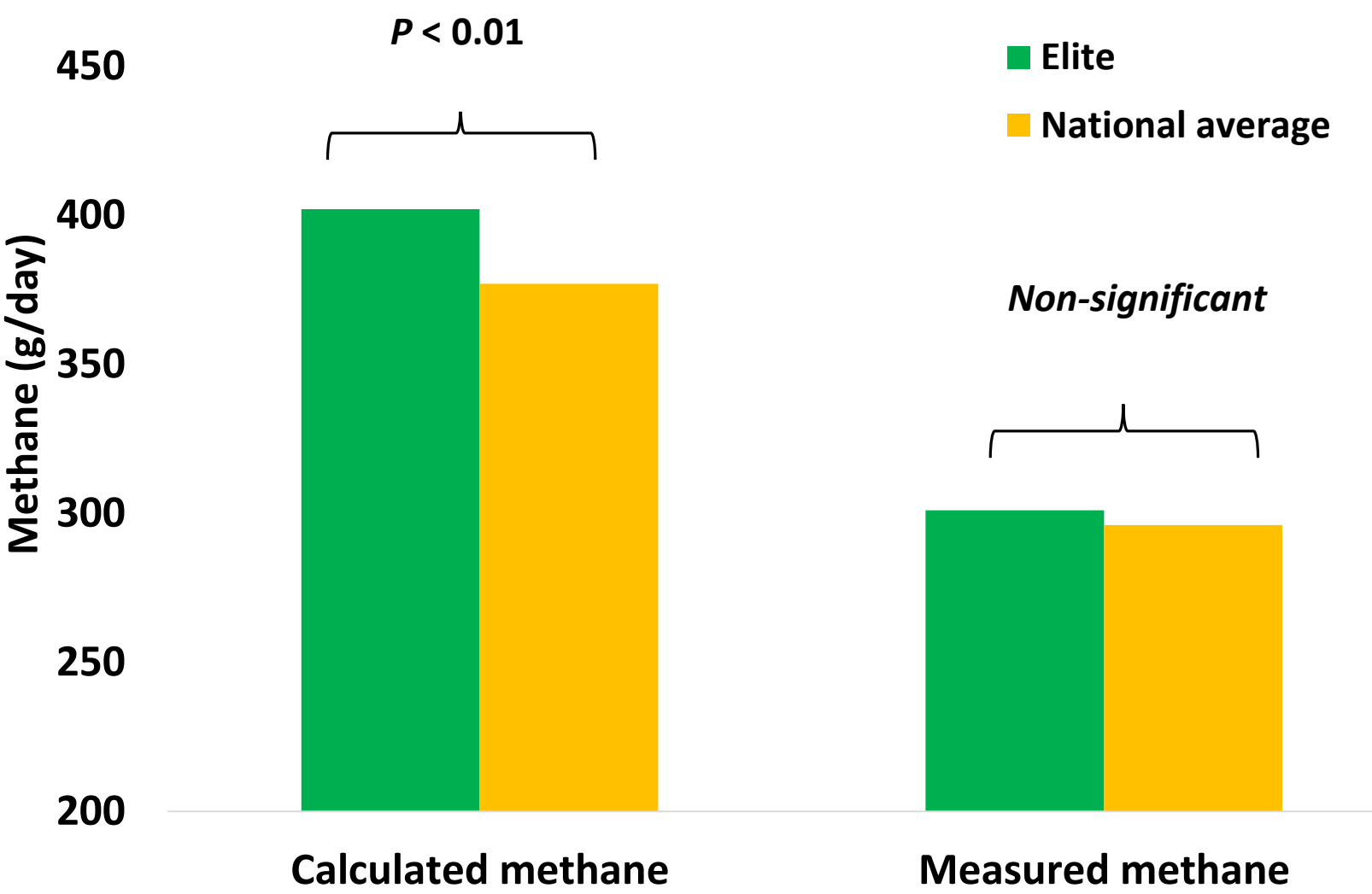
25
20
15
10
5
0

MT CO₂ equivalents

- 2018 GHG emissions from agriculture
- 2030 target for agriculture GHG emissions

Breeding-EBI

	Elite (€233)	NA (€133)	Sig.
Milk yield (kg)	22.2	22.1	NS
Milk solids (kg)	1.94	1.79	<0.01
Methane (g)	302	297	NS
Methane / milk solids (g/kg)	163	176	<0.05



Directly selecting for lower methane?



Low emitter

Milk solids = 2.4 kg

Methane = 248 g



High emitter

Milk solids = 2.4 kg

Methane = 352 g

- How much of this variation is due to genetics?
- Can we measure it on-farm?

Breeding

Grazing
management

Feed
additives

25
20
15
10
5
0

MT CO₂ equivalents

- 2018 GHG emissions from agriculture
- 2030 target for agriculture GHG emissions

What do we want from a feed additive?

- **Must Have**

- Consistent methane reduction potential
- Mechanism of delivery to the animal
- Capable of counting in the national inventory
- No food safety/residue implications
- No negative performance effects and palatability

- **Desirable**

- Low cost
- Increased performance benefits
- Natural origin
- Potential for combination with other solutions

Feed additives

- **Significant programme of work in Teagasc**
 - Enteric methane impact
 - Delivery
 - Residue
 - Performance
- **Many materials tested to date have showed little impact**
- **Other materials have shown significant promise**
- **Focus of research is compatibility with grazing systems**



Feed additives

PENN
STATE NEWS

HOME RESEARCH ACADEMICS IMPACT CAMPUS LIFE ATHLETICS ADMINISTRATION ARTS AND ENTERTAINMENT

Seaweed feed additive cuts livestock methane but poses questions

- Up to 80% reduction and no effect on milk yield when fed up to 0.5% of DMI
- Questions raised:
 - Is it effective long term? Adaptation?
 - Stability of active ingredients?
 - Palatability?

DSM: Dutch dairy cattle trial shows efficacy of methane reducing feed additive

By Jane Byrne

04-Feb-2021 - Last updated on 05-Feb-2021 at 09:26 GMT



© GettyImages/Clara Bastian

RELATED TAGS: methane emissions

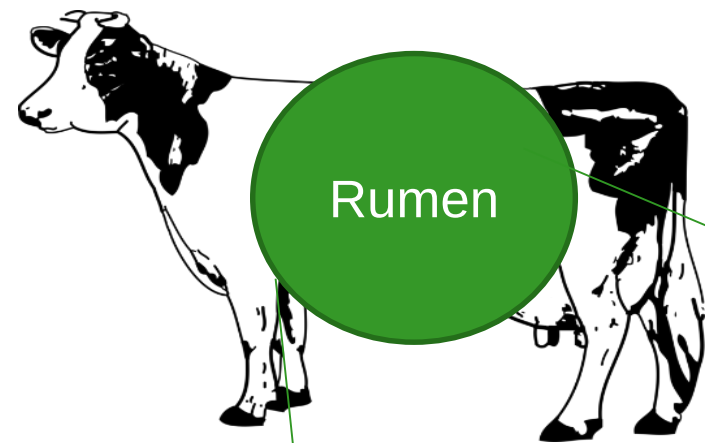
Additive	Efficacy			Potential animal welfare risks	Potential food safety risks	Potential co-benefits	Production system applicability ⁴	Development needs
	CH ₄ reduction potential ¹	No. of academic papers ²	Confidence in efficacy ³					
3-Nitrooxyproponal	Very High	> 20	5	None known	None known	Improved feed efficiency.	TMR systems immediately. Grazing systems in future.	Validation in large-scale TMR systems required. Formulation for grazing systems.
Asparagopsis	Very High	< 10	1	Damage to rumen wall	Bromide & iodine residues in animal tissue/products	Improved feed efficiency.	TMR systems immediately. Grazing systems in future.	Validation in large-scale TMR systems required. Formulation for grazing systems.
Nitrate	High	< 20	4	Toxicity in non-adapted animals	None known	Can reduce need for urea supplementation in animal feed.	TMR systems immediately. Grazing systems in future.	Validation in large-scale TMR systems required. Formulation for grazing systems.
Essential Oils	Low	< 20	2	None known	None known	Improved milk productivity (limited evidence & indication of reduced body growth).	TMR & grazing systems (where supplements are administered)	Peer reviewed studies of mitigation potential and productivity within TMR & supplement systems.
Saponin	Low	< 15	1	None known	None known	Improved protein supply by protozoa control.	TMR & grazing systems (where forage crops containing saponin are utilized)	Further research into CH ₄ reductions, productivity impacts & saponin chemistry required.
Tannins	Low	< 15	2	None known	None known	Shift from urine to faecal excretion of nitrogen reducing risk of N ₂ O emissions.	TMR & grazing systems (where forage crops high in tannins are utilized)	Tannins may have a stronger role in forage-based mitigation than as feed additives.
Monensin	Low	> 20	5	None known	None known	Improved weight gain. Reduced risk of bloat & acidosis.	TMR & specialized grazing systems	Few needs – already a widely used product.
Microalgae	Low	< 5	1	None known	None known	PUFA levels in meat improved. Enhanced antioxidants in food products.	TMR & grazing systems (where supplements are administered)	Microalgae supply dependent on use in renewable energy sector.
Biochar	Low	< 5	1	None known	None known	Toxins & heavy metals absorption prevention in animals. Enhanced soil quality when excreta is applied to soils.	TMR & grazing systems (where supplements are administered)	Engineering of an acidified biochar required to achieve adequate efficacy.
Bacterial Direct Fed Microbes	Low	< 15	2	None known	None known	Improved productivity (though inconsistent). Improved calf health. Reduced incidence of E.coli in manure.	TMR & grazing systems (where supplements are administered)	Development of high efficacy bacterial strains.
Fungal Direct Fed Microbes	Low	< 15	1	None known	None known	Improved productivity (+ 3% in milk observed). Improved feed efficiency.	TMR & grazing systems (where supplements are administered)	Development of high efficacy fungal strains.

Feed Additives in Grazing Dairy Cows – Bovaer (3-NOP)

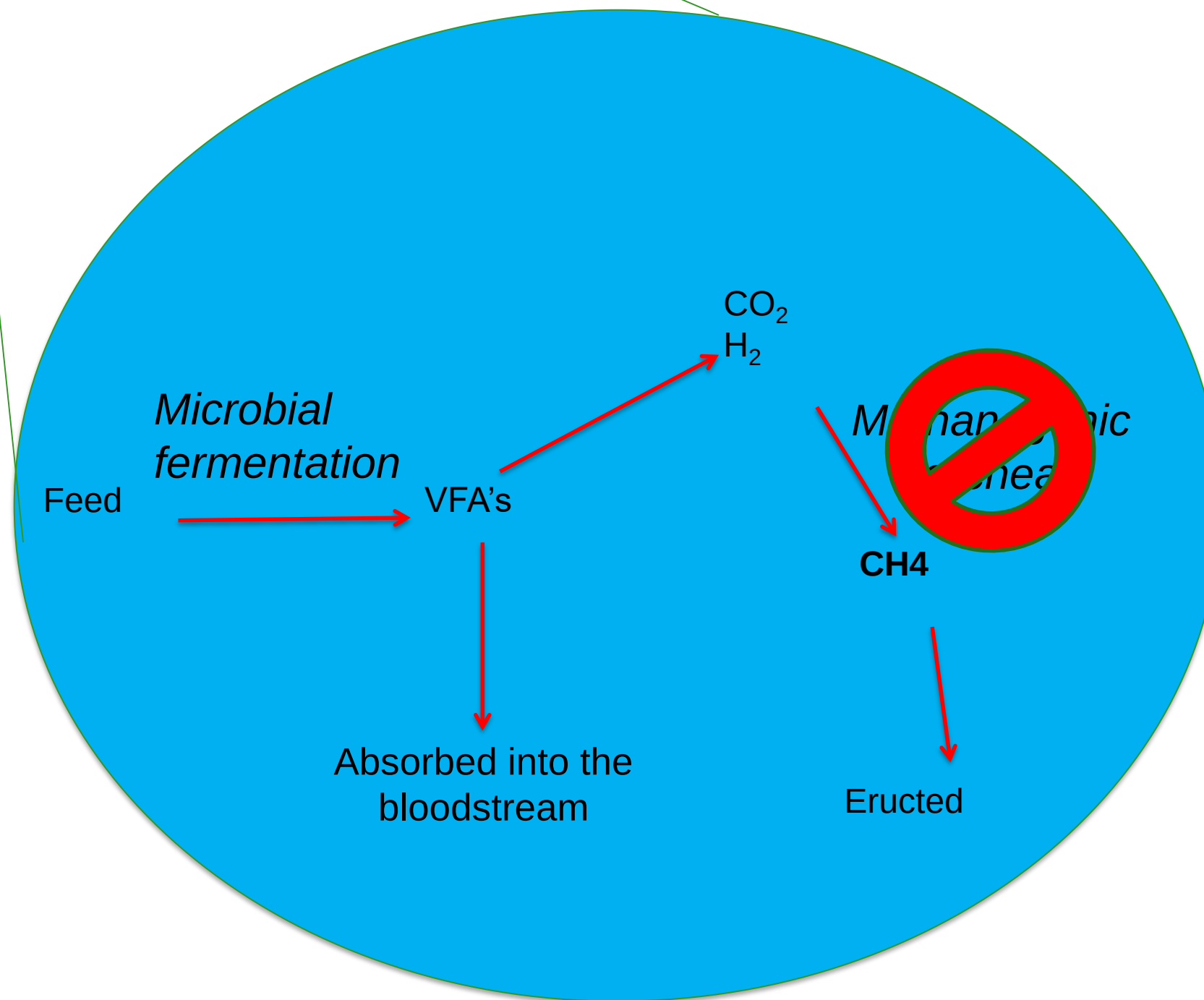
- 10-week trial in summer 2022
- 13.6 g/day Bovaer
 - 6.8 g at morning and evening milking



Bovaer (3-NOP)

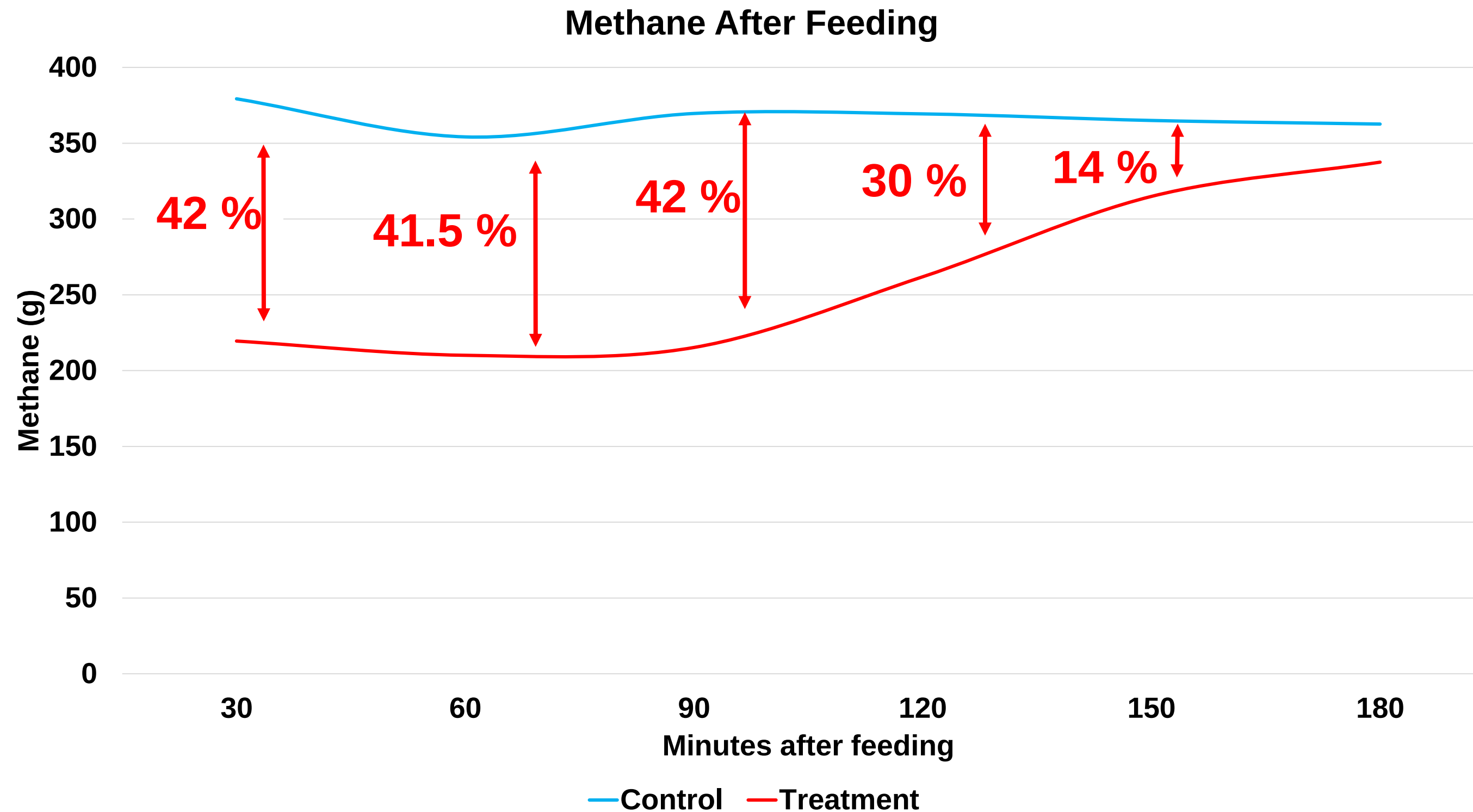


- 3-Nitrooxypropanol (3-NOP)
- Approved in EU in 2022
- > 50 papers report reductions in CH₄ of ~30%



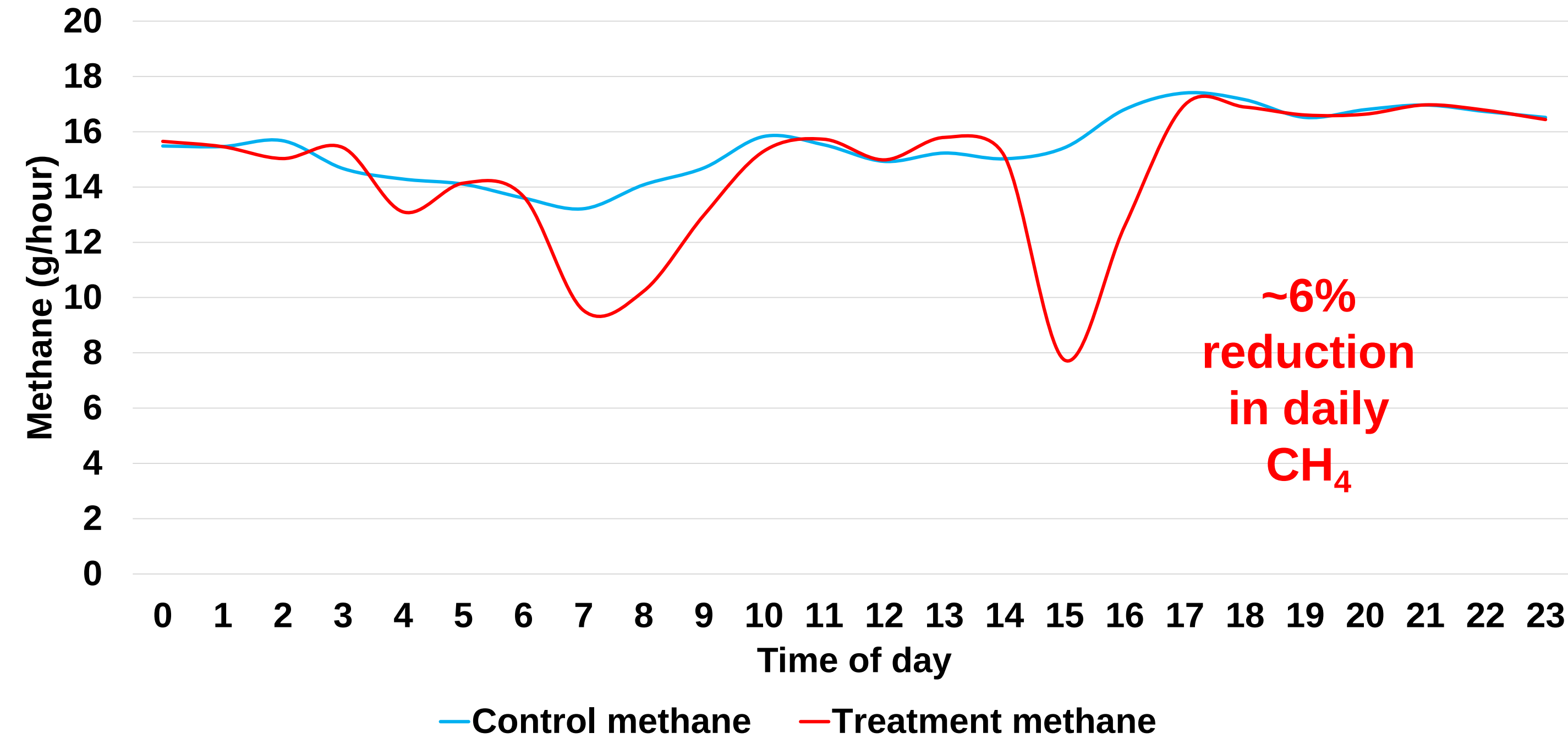
Feed Additives in Grazing Dairy Cows – Bovaer (3-NOP)

~30% reduction in methane for 2.5 hours after feeding



Feed Additives in Grazing Dairy Cows – Bovaer (3-NOP)

Daily Methane



- Practicality
- Slow release mechanisms
- Cost
- Residues
- Life cycle assessment



J. Dairy Sci. TBC

<https://doi.org/10.3168/jds.2024-24772>

© TBC, The Authors. Published by Elsevier Inc. on behalf of the American Dairy Science Association®. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

The impact of twice daily 3-nitroxypropanol supplementation on enteric methane emissions in grazing dairy cows

H. Costigan,^{1*} L. Shalloo,¹ M. Egan,¹ M. Kennedy,^{1,2} C. Dwan,^{1,3} S. Walsh,^{1,2} D. Hennessy,³ N. Walker,⁴ R. Zihlmann,⁴ and B. Lahart¹

¹Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland

²School of Agriculture and Food Science, University College Dublin, Belfield, Dublin, Ireland

³School of Biological, Earth and Environmental Science, University College Cork, Cork, Ireland

⁴DSM Nutritional Products, Animal Nutrition & Health, PO Box 2676, 4002 Basel, Switzerland



Bovaer in Late Lactation Buffer Feeding Systems

- 4-week study in November 2023
- Mixed throughout silage using a diet feeder

By day

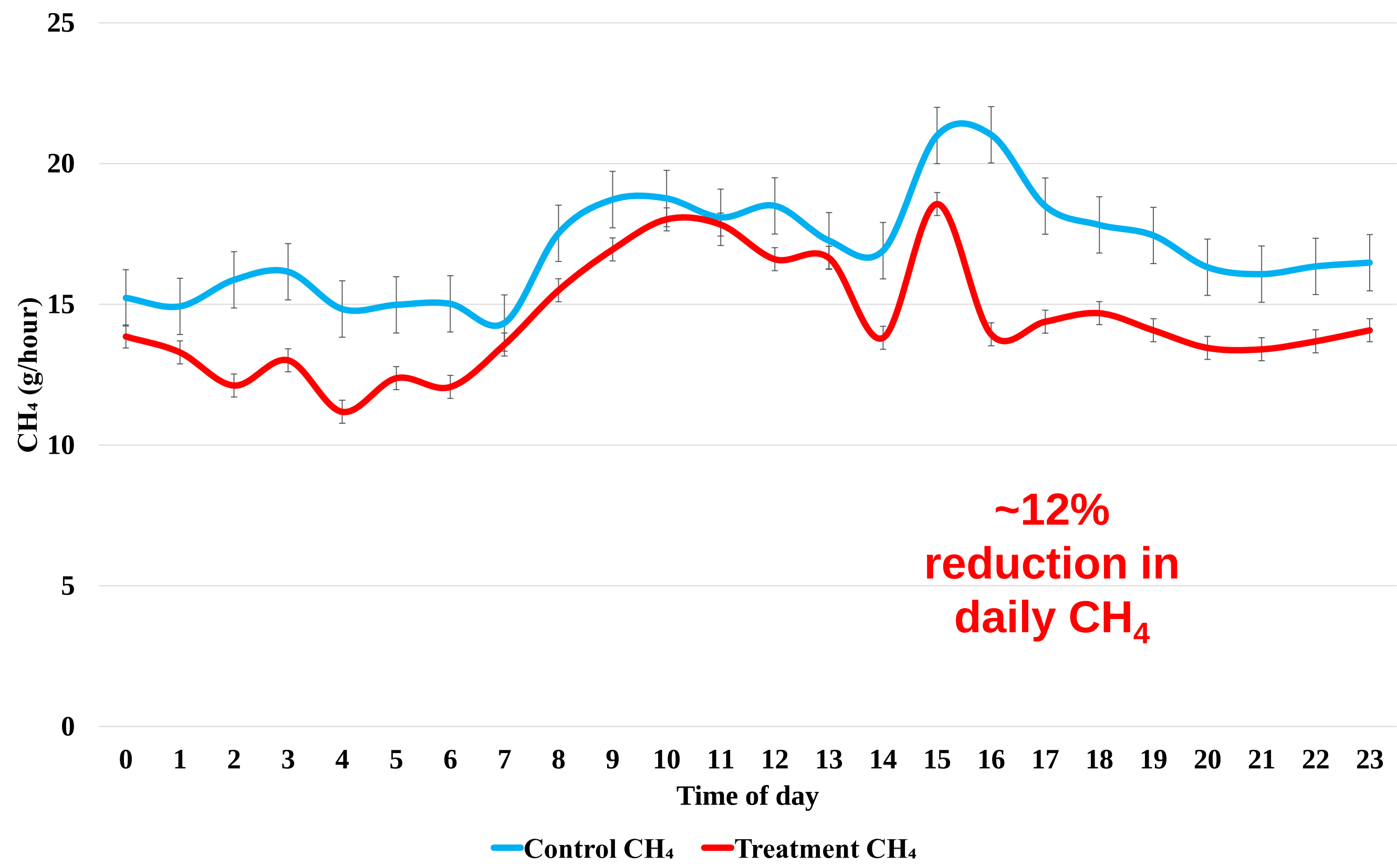


By night



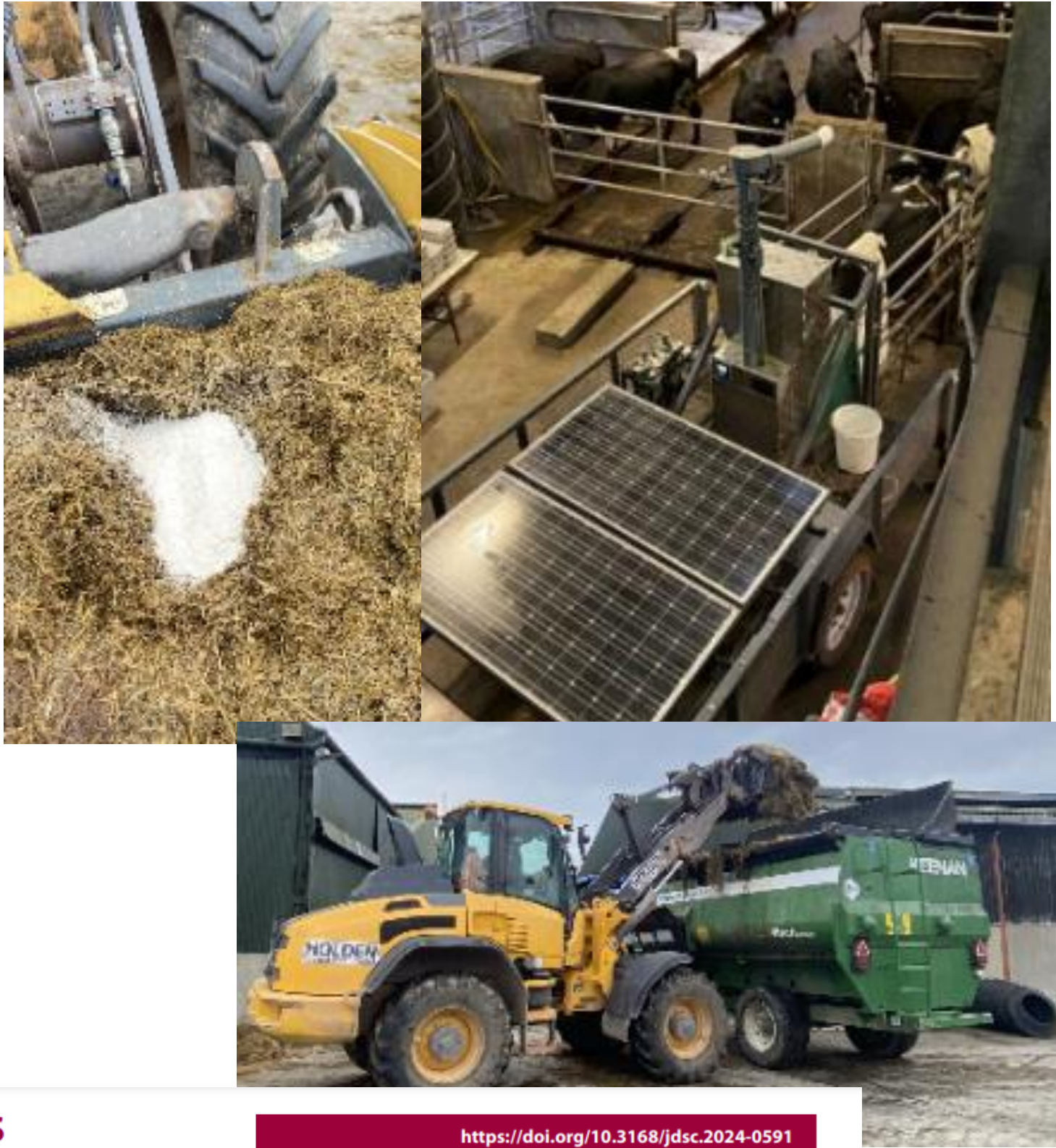
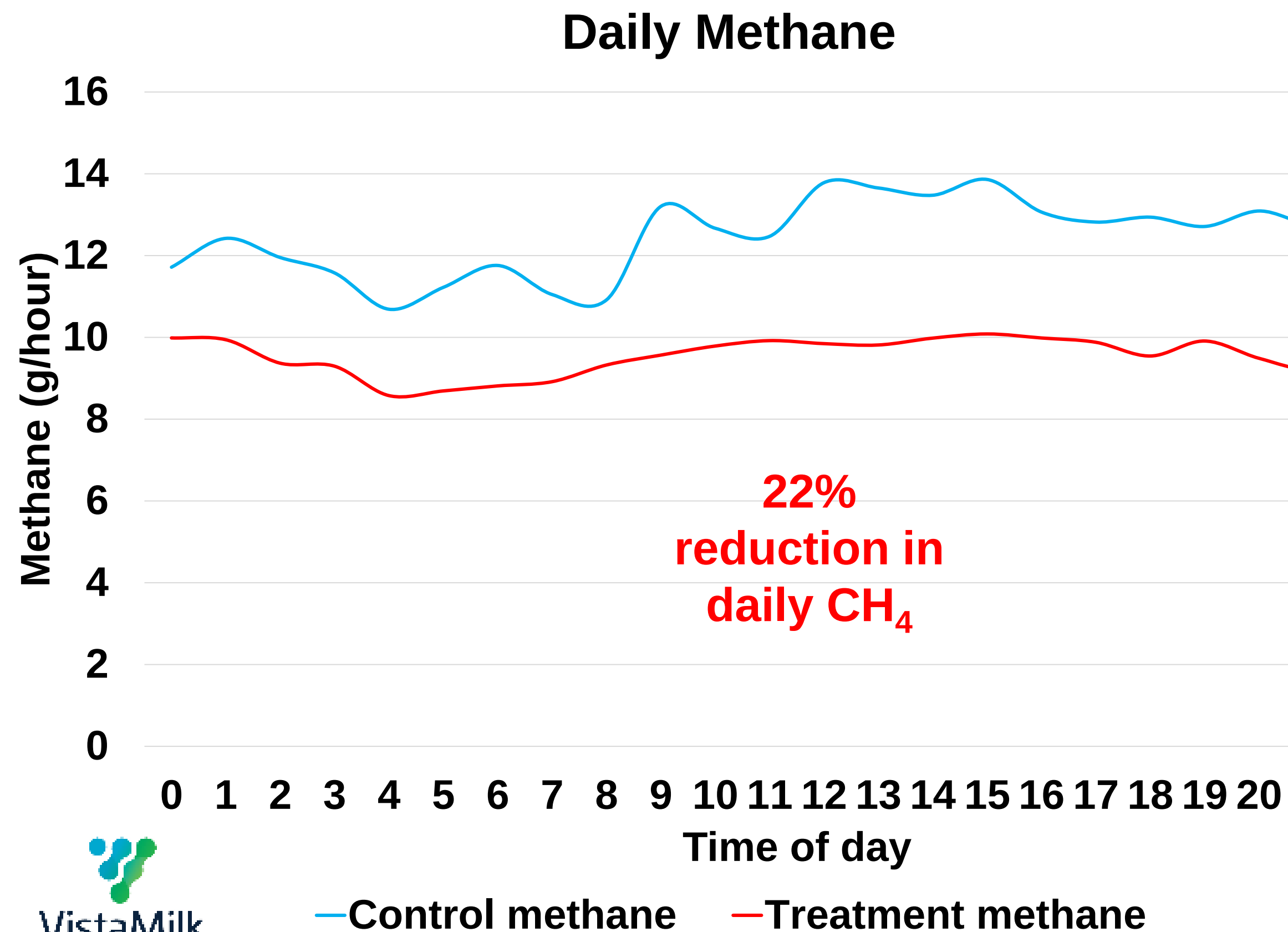
Buffer feeding Bovaer (3-NOP) in late lactation

- No significant effect on performance



Feed Additives During the Dry Period - Bovaer (3-NOP)

- Mixed throughout feed using a diet feeder
- No significant effect on performance



 **JDS Communications®**
TBC; TBC

<https://doi.org/10.3168/jdsc.2024-0591>
Short Communication
Animal Nutrition and Farm Systems

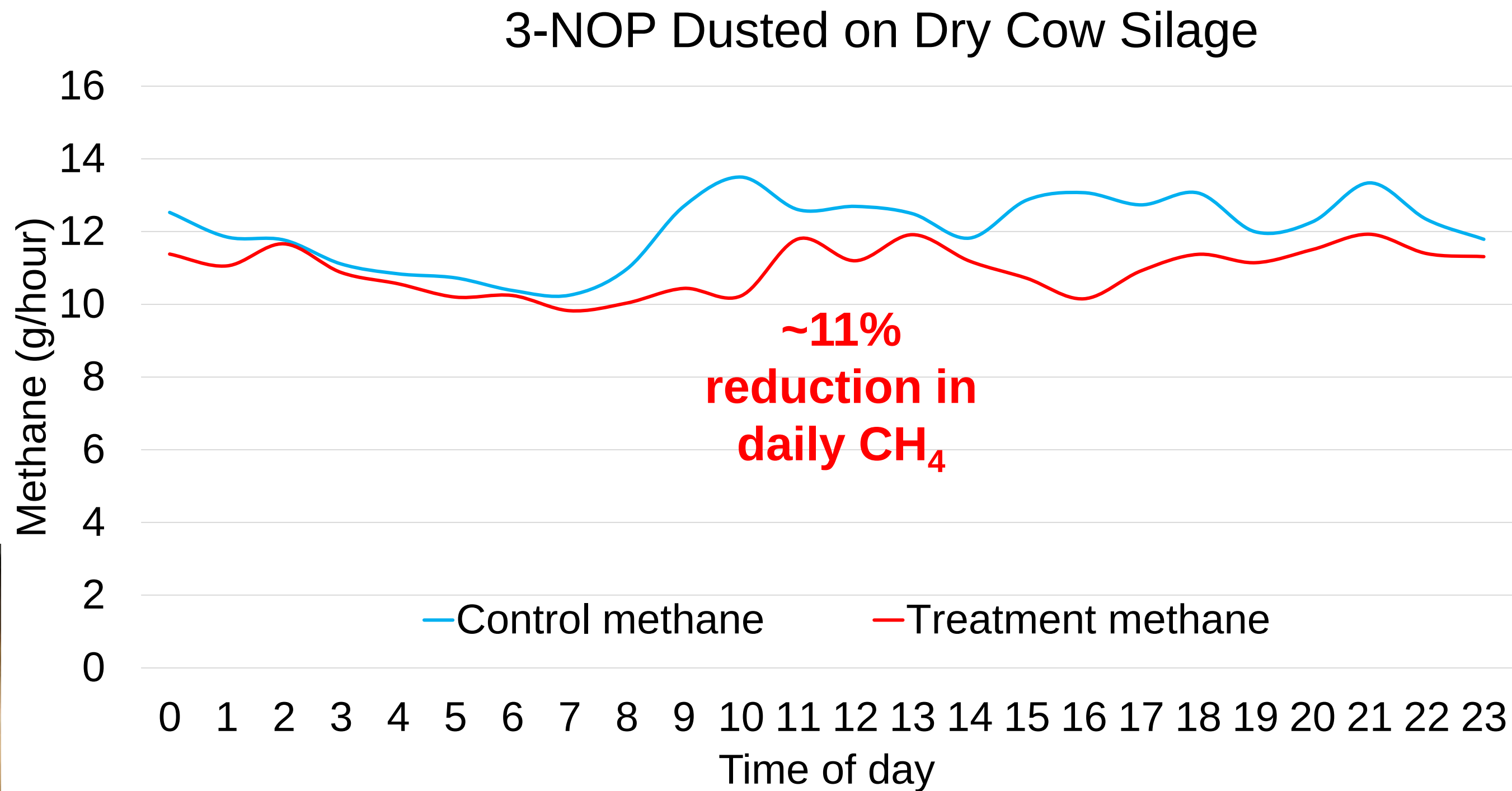
Evaluating the impact of 3-nitroxypropanol supplementation on enteric methane emissions in pregnant non-lactating dairy cows offered grass silage

B. Lahart,^{1*} L. Shalloo,¹ C. Dwan,^{1,2} N. Walker,³ and H. Costigan¹



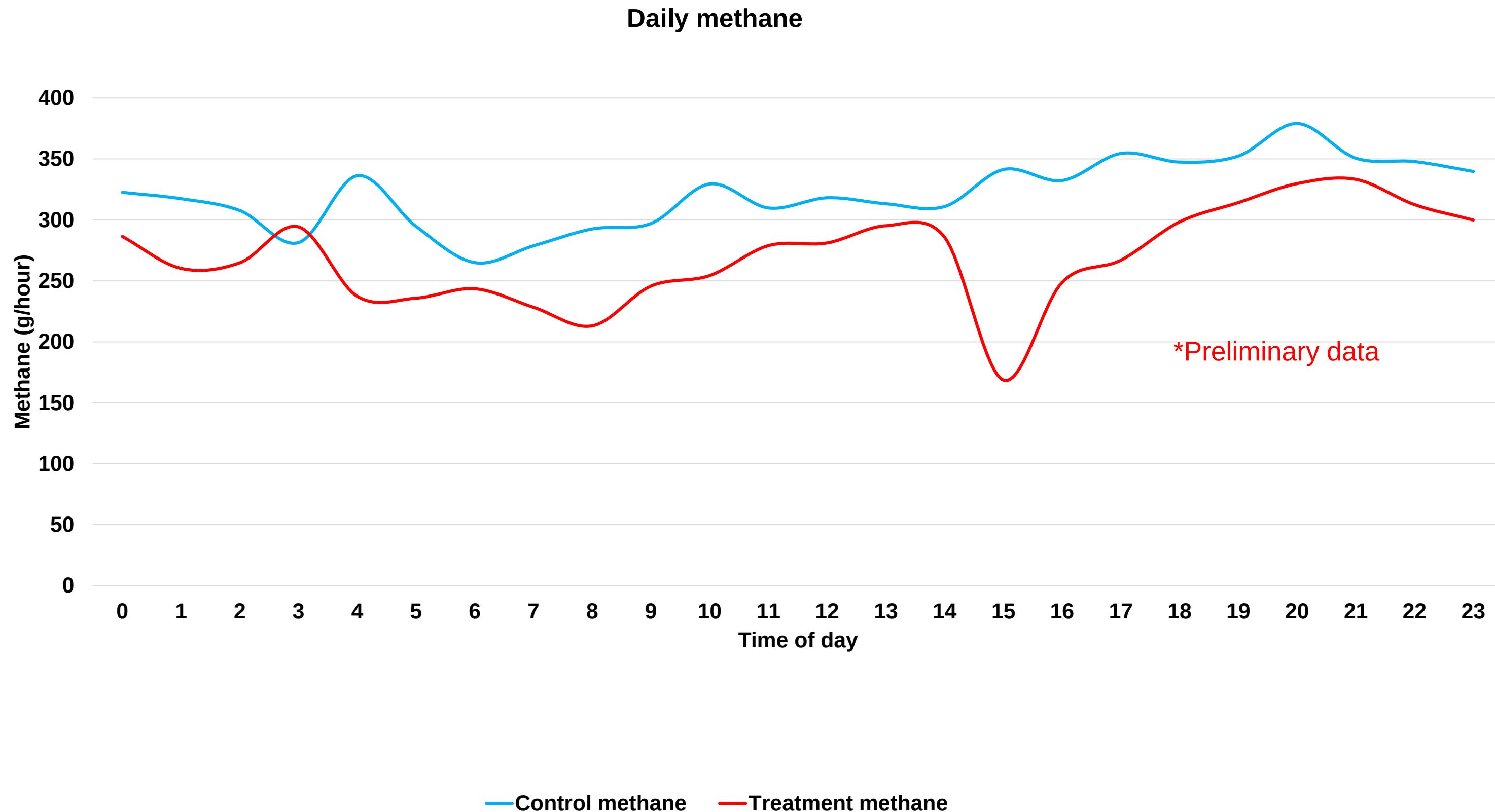
Feed Additives During the Dry Period - Bovaer (3-NOP)

- Mixed with dry cow minerals
- Dusted onto silage twice daily



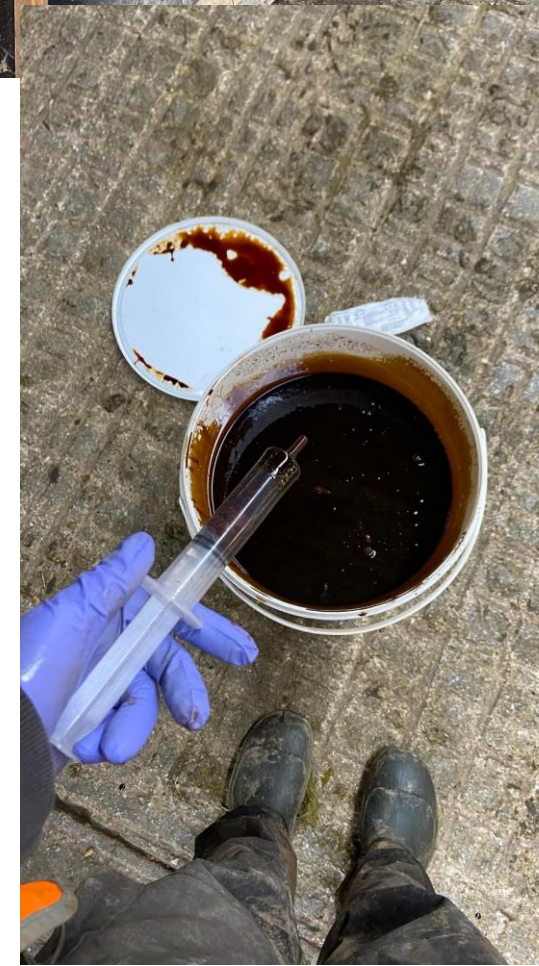
Feed Additives in Grazing Dairy Cows – Calcium Peroxide

- ~13% reduction in methane
- Reduced feed intake and milk solids



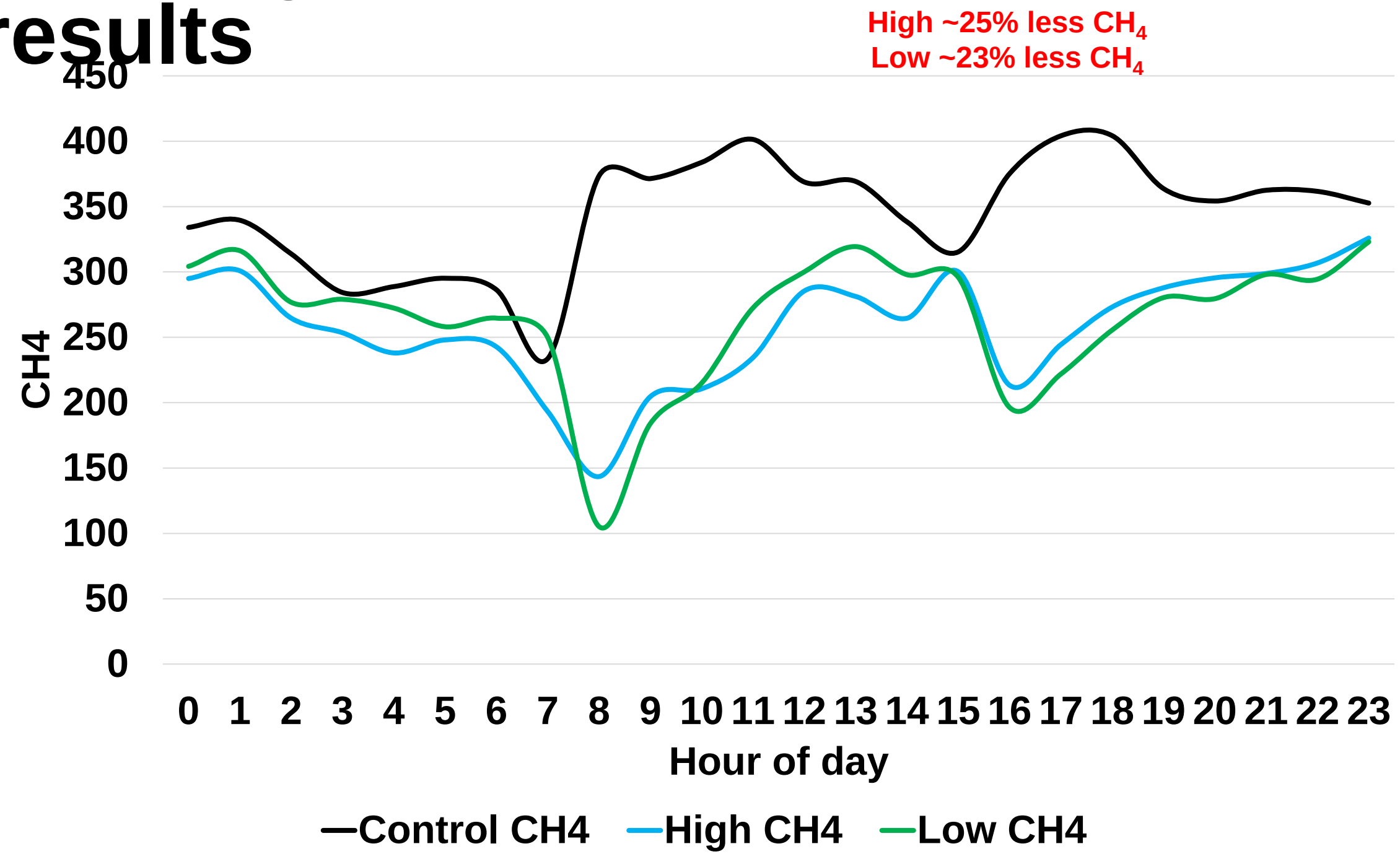
Costigan *et al.* in prep

Feed additives – Asparagopsis



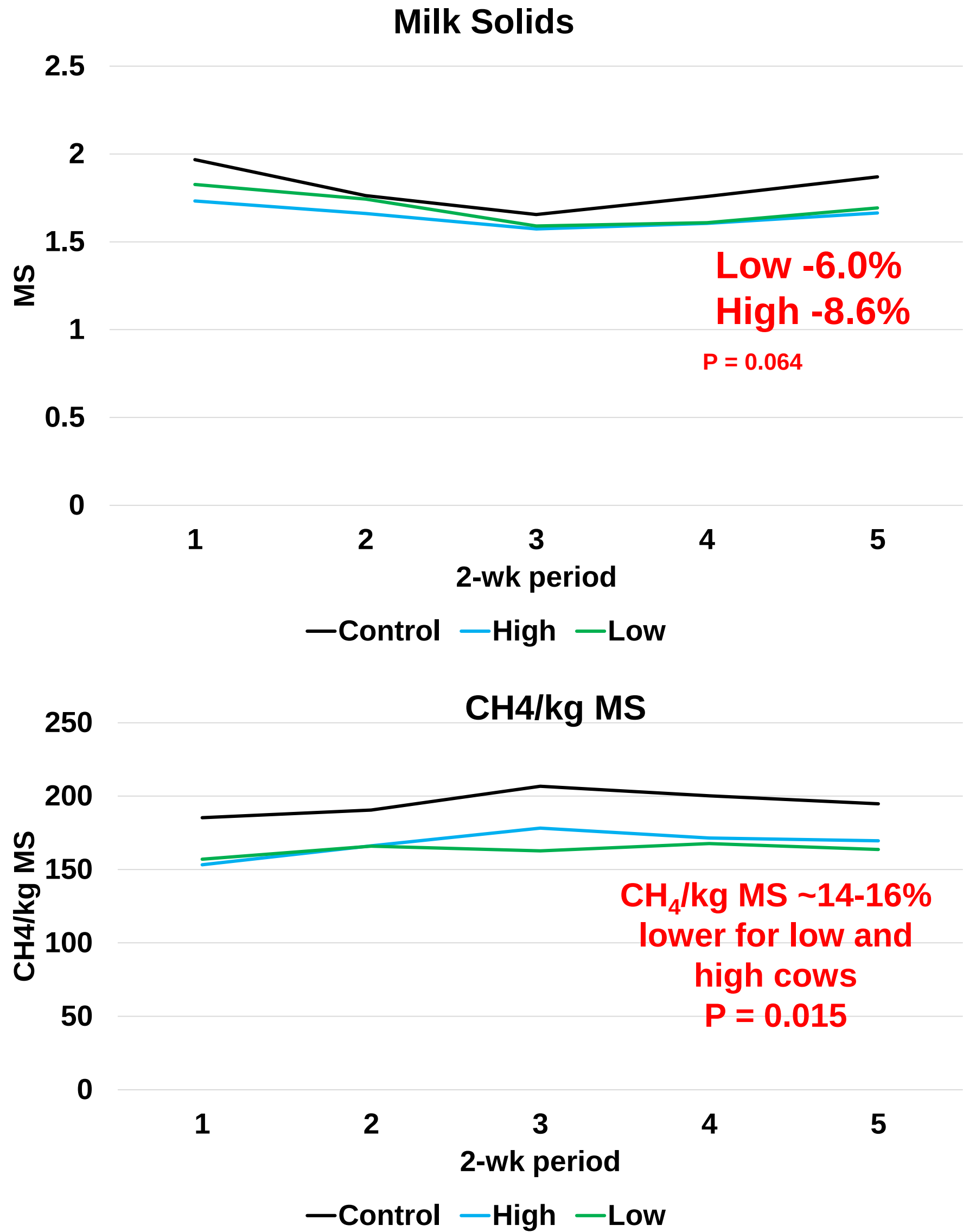


Asparagopsis – preliminary results



*Preliminary results

Costigan et al. in prep



Feed additive trials – milk sampling

- Milk quality
- Residues
- Processability
- Sensory analysis



Feed additive trials – health and performance

- Dry matter intake
- Body weight and body condition score
- Grazing behaviour
- Rumen samples
- Blood samples



Asparagopsis – pelleting study

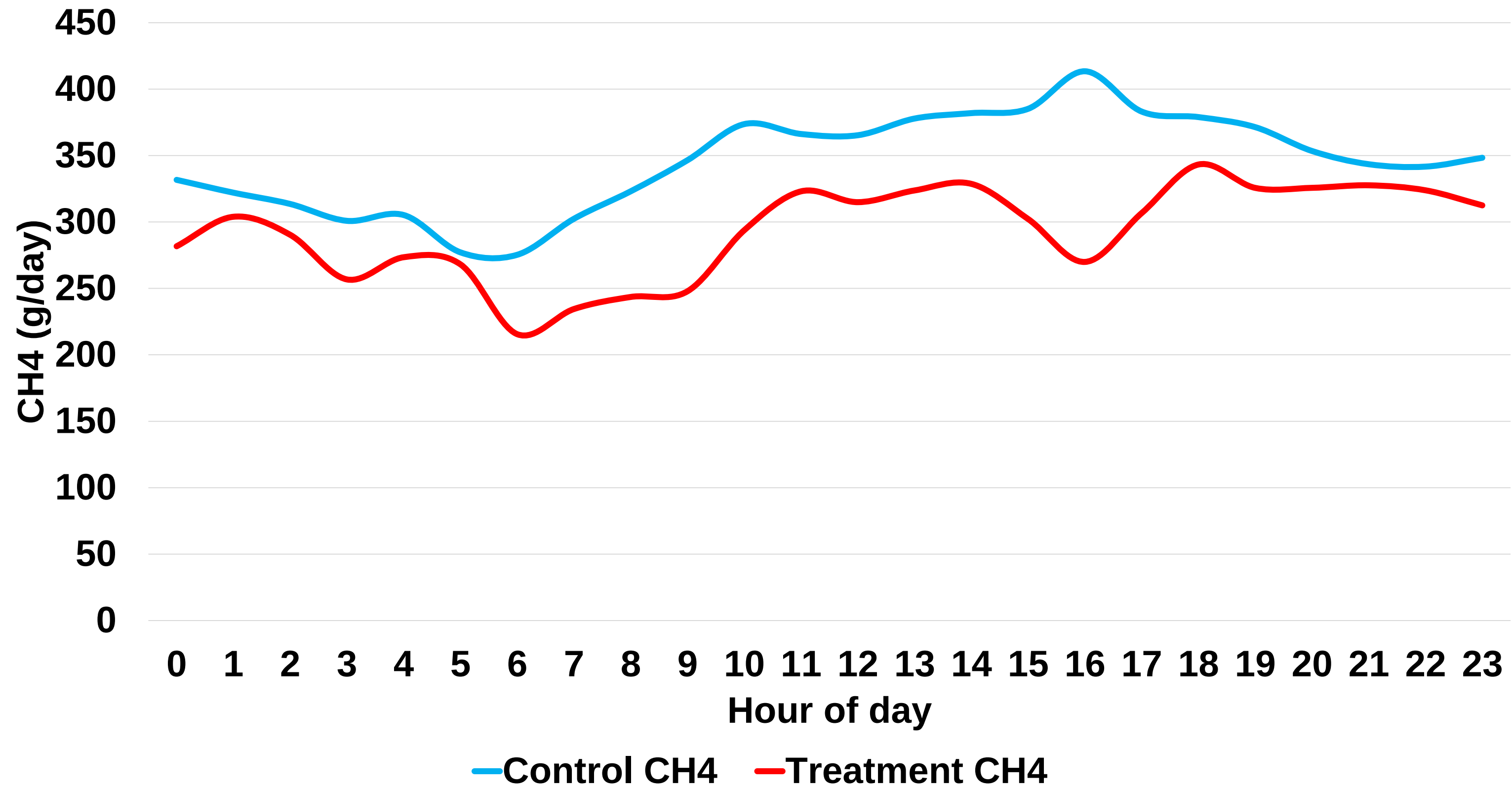


No Asp.

Asp.

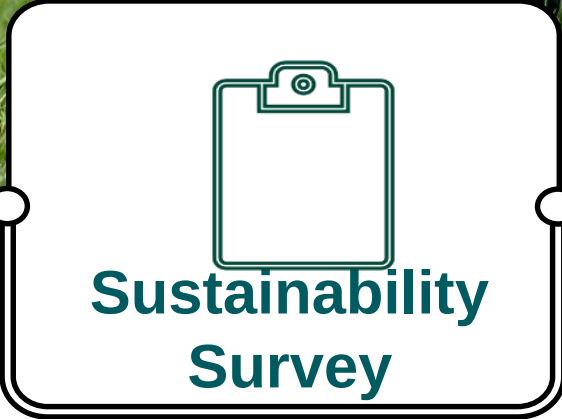
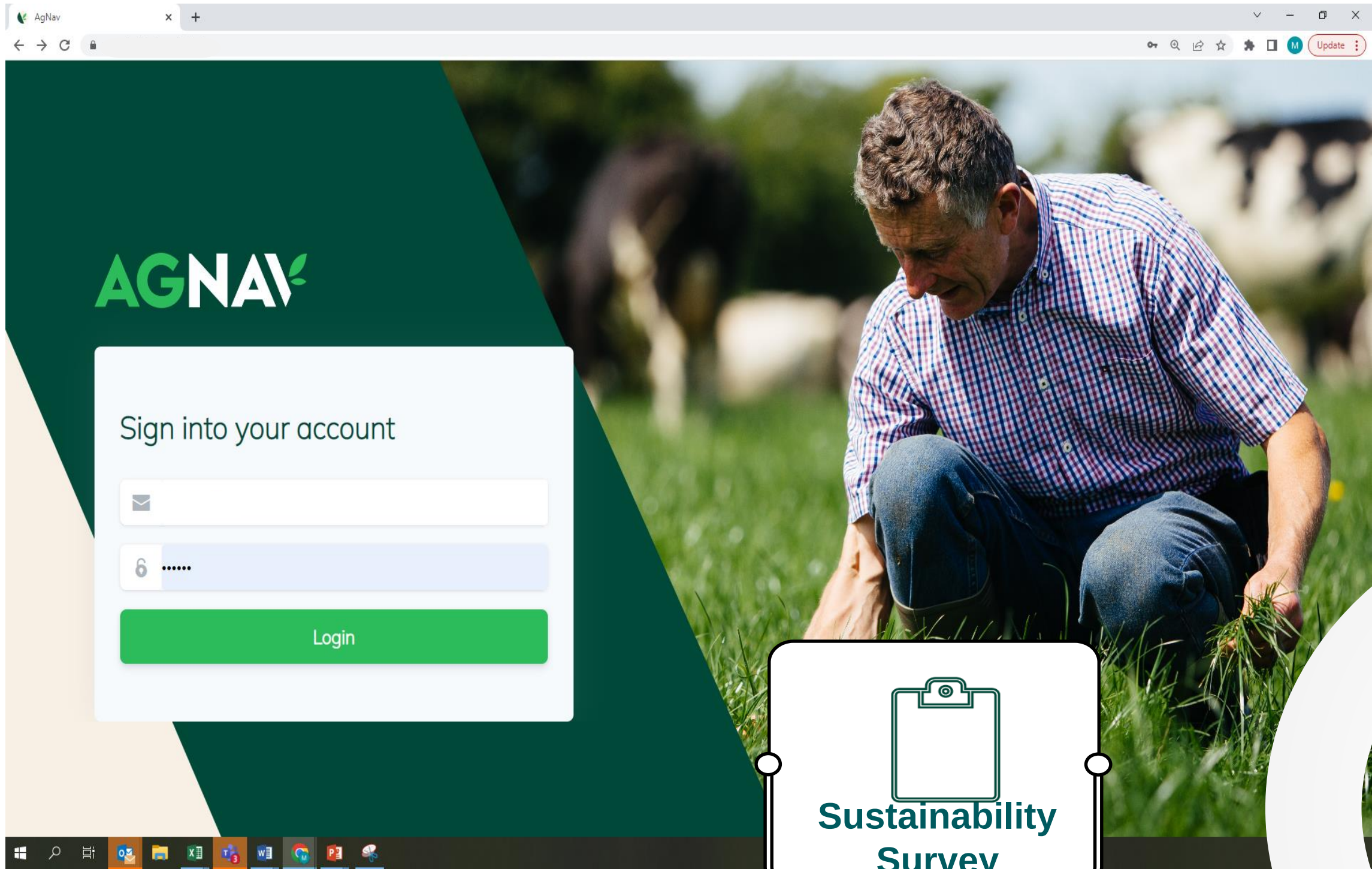
Asparagopsis – pelleting study

- No refusals
- ~15 % less CH₄



- Further research required to protect Asparagopsis during pelleting
- Continue investigating residues in milk

Quantifying Emissions



Assess



Analyse



Act



A platform guided by science to assist farmers in improving on-farm sustainability

Future Feed Additive Research

- Continue evaluating promising feed additives
 - Practicality
 - Slow release mechanisms
 - Cost
 - Residues
 - Life cycle assessment
 - Delivery
 - Business model

