Understanding Methane Supplements

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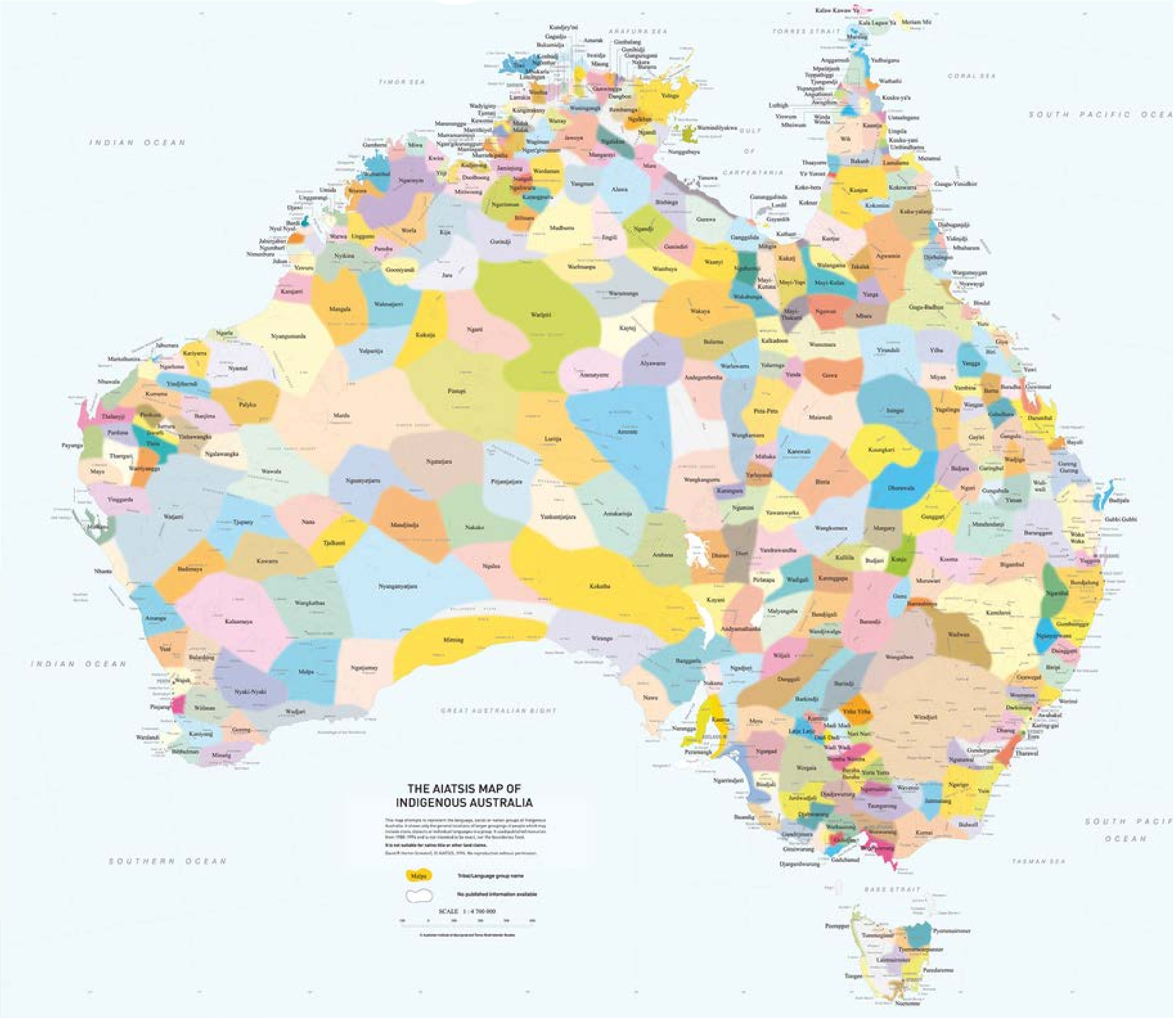
Acknowledgment of country



Source: AIATSIS Indigenous map of Australia

Overview

- **Why** is methane produced and why is it a problem?
- **How** is methane impacting the sustainability of farms?
- **What** is driving the need for methane supplements?
- **What** are methane supplements and **who** makes them?
- **How** effective are they?
- **What** are the impacts of their production and use?
- **Where** is research heading next?
- **How** will methane supplements fit into the farm systems of the future?

Supply chain responses to Paris Agreement

Fonterra

- Climate-neutral growth to 2030 for pre-farmgate emissions from a 2015 base year

Unilever **

- Reducing the GHG impact of their products by 50% by 2030, compared to baseline of 2010

Mondelez

- Reduce absolute GHG from manufacturing 15%
- 100% renewable energy

Nestle **

- Zero environmental impact in our operations

JBS

- Net-zero GHG by 2040 and zero deforestation across its global supply chain by 2035

Heineken

- Carbon neutral barley-malt supply chain

Rabobank & NAB

- Net zero financed emissions by 2050
- Hold 50% of Australia agri-debt market

Mars

- Reduce GHG across our value chain 27% by 2025 and 67% by 2050 (from 2015 levels)

Kellogg Company **

- 65% reduction by 2050
- 100% renewable energy

Pfizer

- 60 to 80% by 2050

Wilmar international

- 89.72% less GHG from 2013 to 2020
- 100% renewable energy

Olam

- Reduce GHGs by 50% by 2030 both in our own operations and in our supply chain
- By 2050, we aspire to be carbon positive in operations, requiring a 5% emissions reduction per year from 2031 – 2050

** committed to increasing plant-based protein

Source: Company sustainability reports https://oxfamapps.org/fp2p/the-worlds-top-100-economies-31-countries-69-corporations/

International drivers

USA: President Joe Biden

- “Failing to curb emissions means America will tax your exports”
- “to ensure his climate policies do not place US workers and companies at an unfair disadvantage” – Financial Times 26 April 2021

The EU's Carbon Border Adjustment Mechanism (CBAM)

- “The European Parliament... approval to... start taxing imports from countries without a carbon price... by 2023” – Financial Times 11 March 2020
- Initially not applied to agriculture but reviewed in 2026
- Other GHG compliance barriers already exist

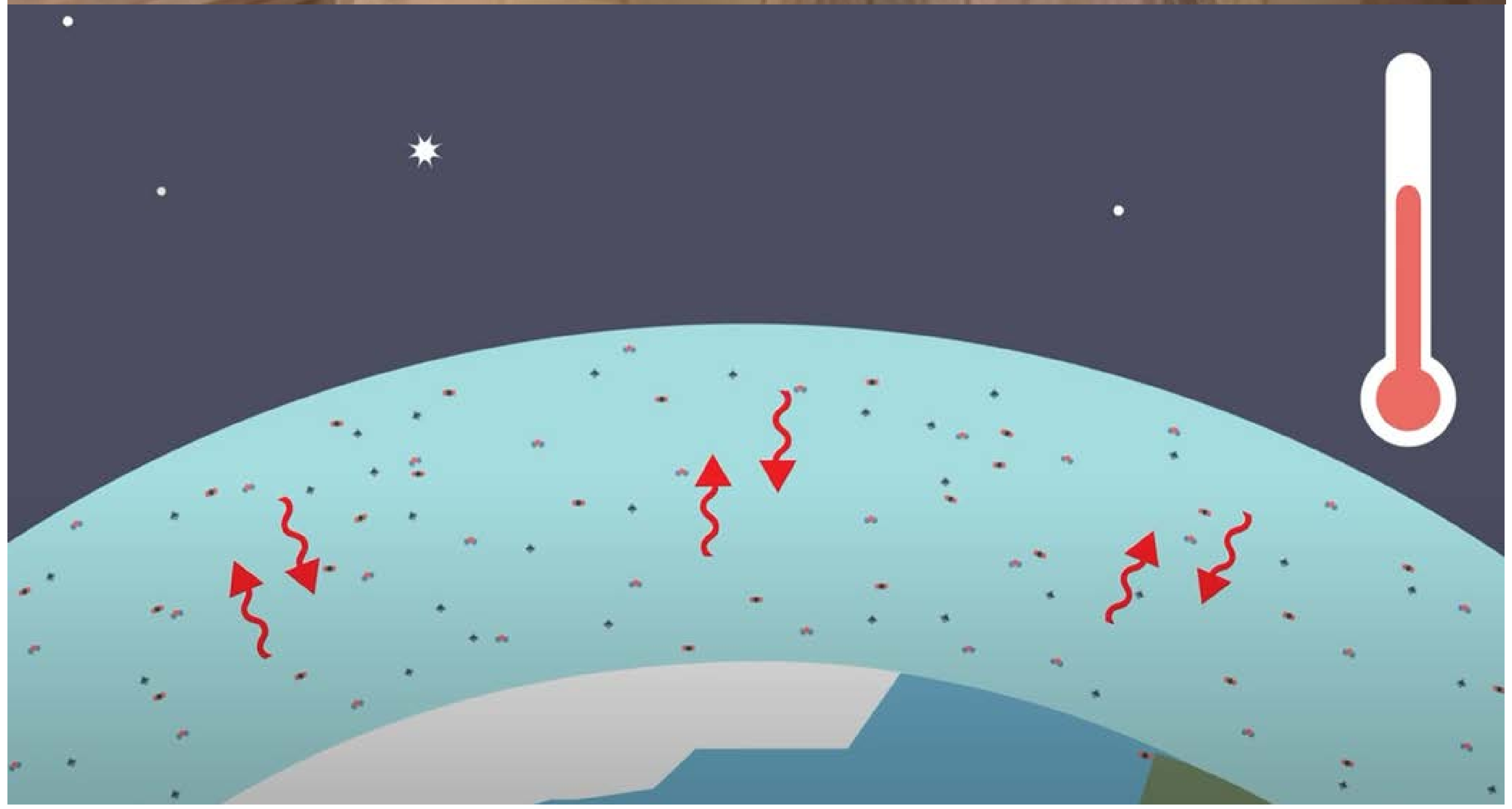
Around 70% of Australian Agricultural product is exported

Greenhouse gases

- The greenhouse effect was first observed by Eunice Foote in 1856
- Greenhouse gases absorb heat and are able to trap the suns heat to maintain the right environmental conditions for life

- e.g. CO2, water vapour, CH4, O3, CFCs

- But increases in GHGs increases the amount of heat that is absorbed into the atmosphere

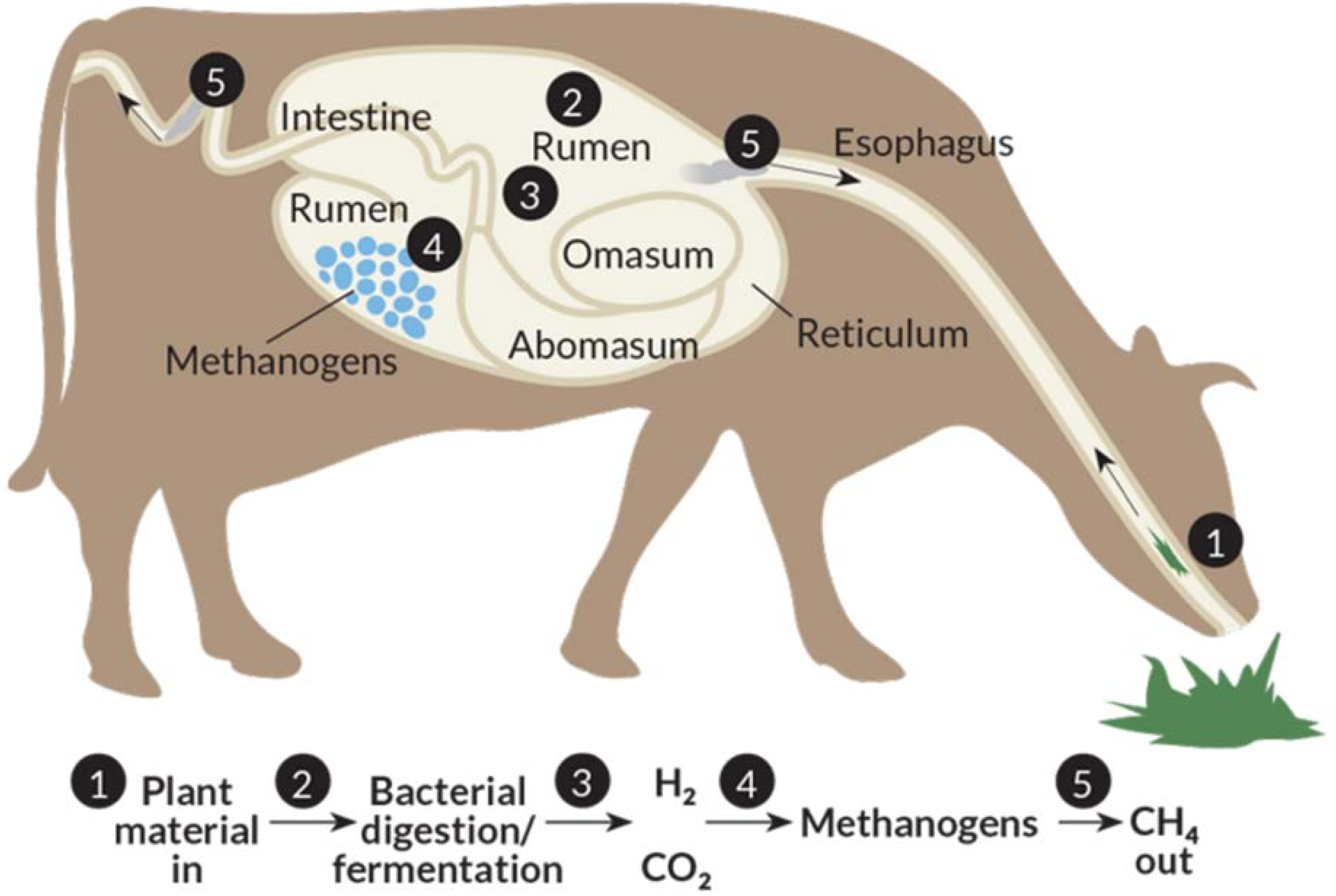


Source: Carlyn Iverson/NOAA Climate.gov and NASA

Methane (CH4) production

- Microbes digest feed in the rumen through anaerobic fermentation
- Fermentation produces Volatile Fatty Acids (VFAs) and CO2 and H2 gas
- Methanogenic archaea (methanogens) convert the by-products of fermentation into methane
- Methane is then eructated (burped) out
- This process evolved ~50M years ago

- Trying to change this in 30 years is difficult
- Adaptation to mitigants is a challenge



Source: Hackmann & Spain (2010), Zhao (2020)

Methane (CH4) potency

- Methane only has a lifespan of 8-12 years (CO2 is 100s-1,000s of years)

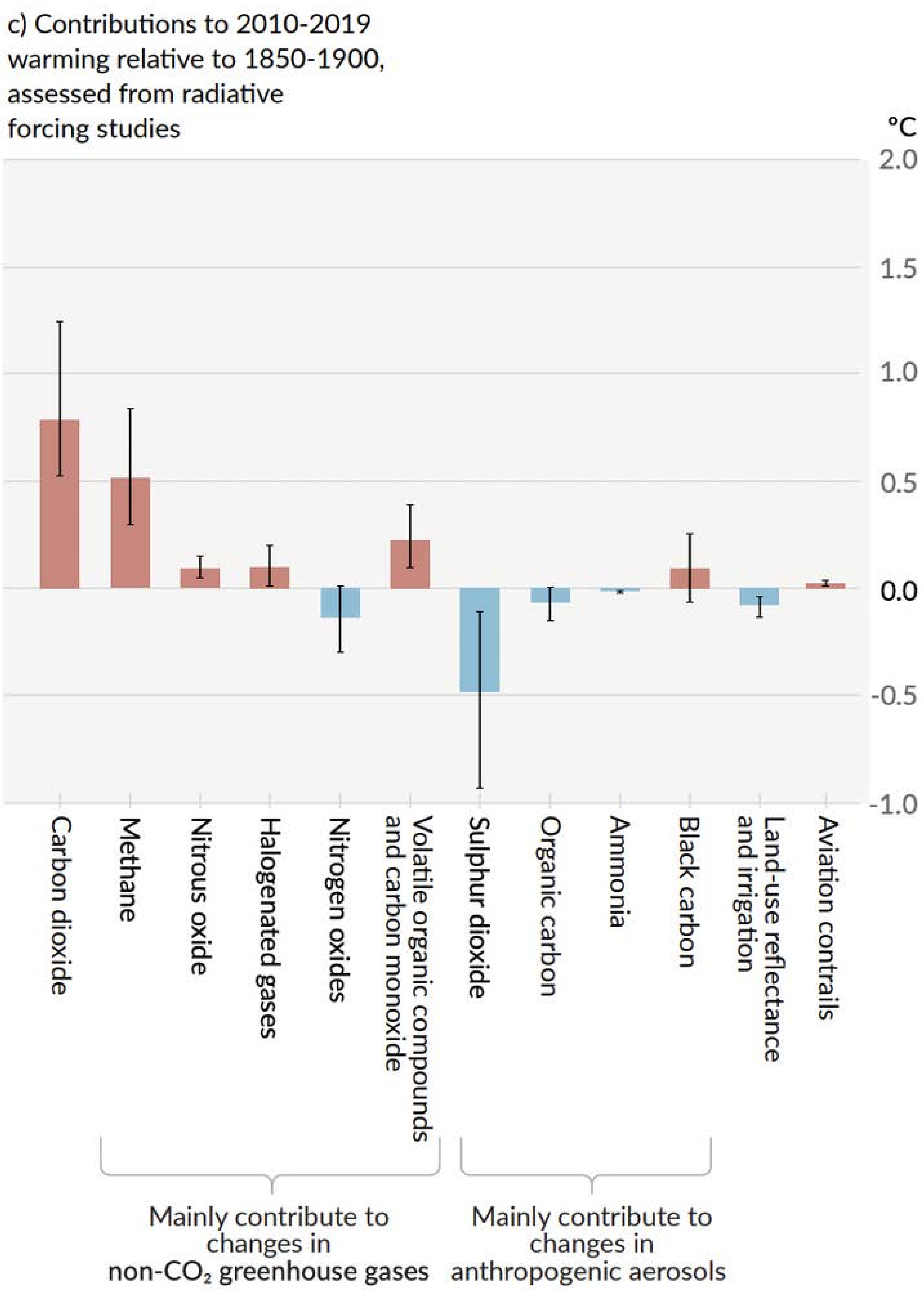
- Methane is oxidised by OH radicals

- The global warming potential of Methane

- **28** times greater than CO2 over **100** years
- **82** times greater than CO2 over **20** years

- CH4 is very good at absorbing radiation!!!
- Historically the volume and potency have made methane a problem
- BUT now reducing methane is seen as a solution because the impact is

- Instant
- Significant
- Achievable



Source: IPCC AR6 Summary for Policymakers

Methane reducing technology

Animal breeding

- Productivity
- Volume of methanogenic archaea
- Rumen passage rate

Richardson et al. 2021; Pickering et al. (2015); Pinares-Patiño et al. (2013); Cabezas-Garcia et al. (2017); J. Lassen (Viking Genetics); Beauchemin, Ungerfeld, Eckard and Wang (2020); Barwick et al. (2019)
Moate et al. (2011)

Diet

- Forage digestibility
- Energy density of diets
- Secondary compounds

-Oil (1% =~3.5% reduction)

-Tannins 10-15% reduction

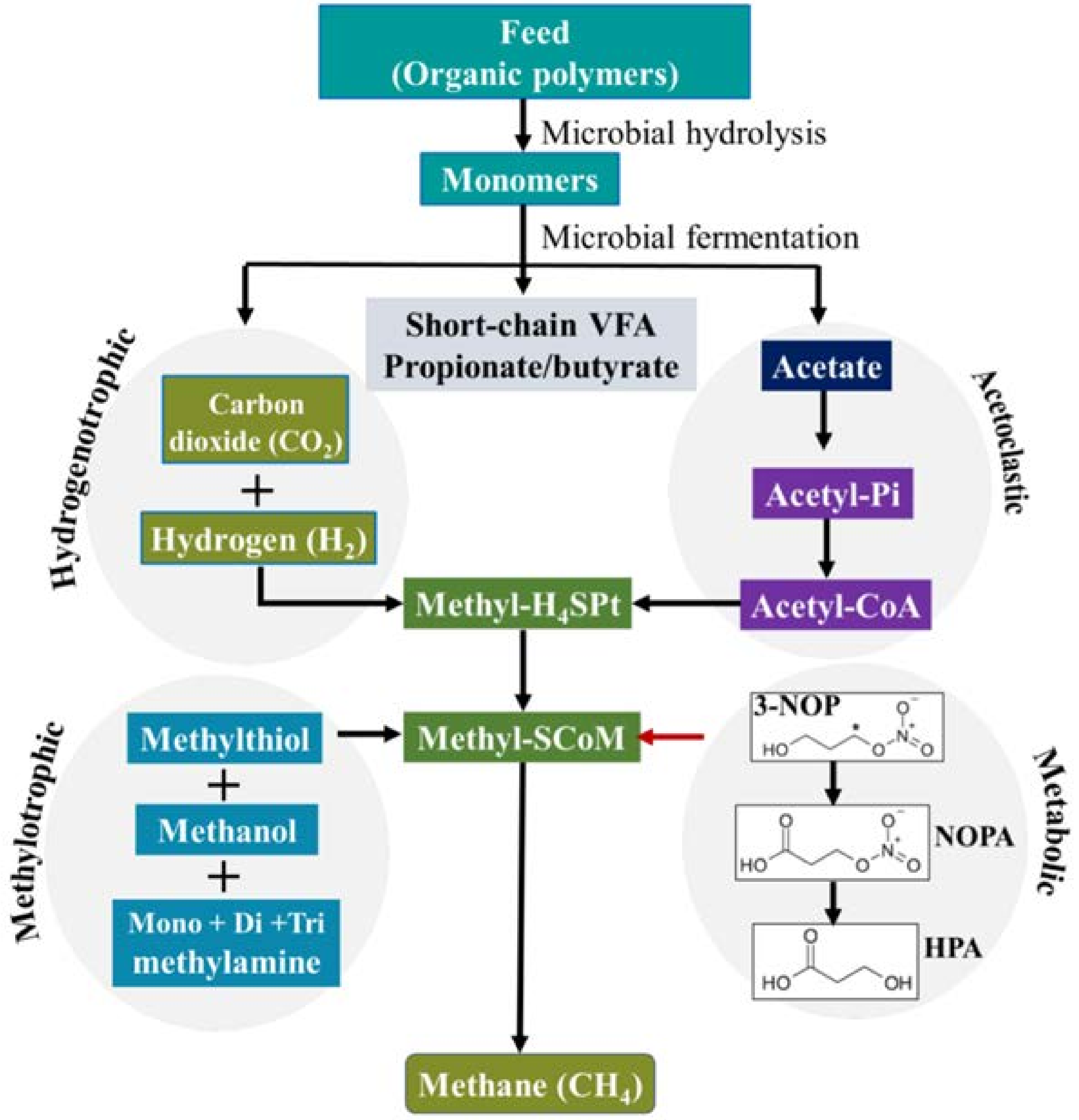
- Essential Oils 10-30% reduction

Supplements

- Bovear
- Asparagopsis

Bovaer®

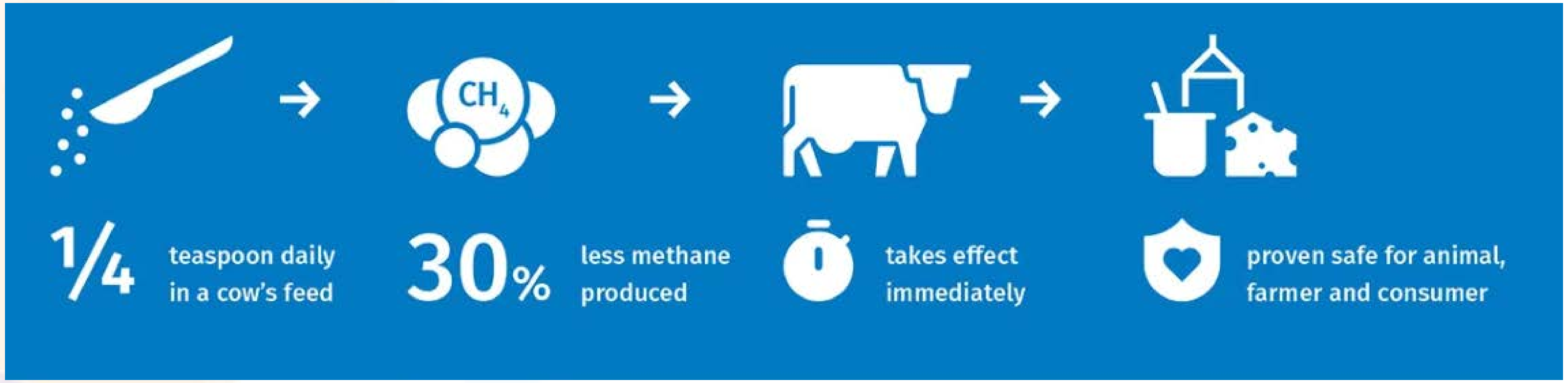
- aka 3-nitrooxyporopanol aka 3-NOP
- Made by DSM
- Methane inhibitor
- Synthetic analogue for Methyl coenzyme M
- Metabolised to form nitrite, nitrate and 1,3-propanediol, and then 3-hydroxypropinoic acid22



Source: Yu, 2021

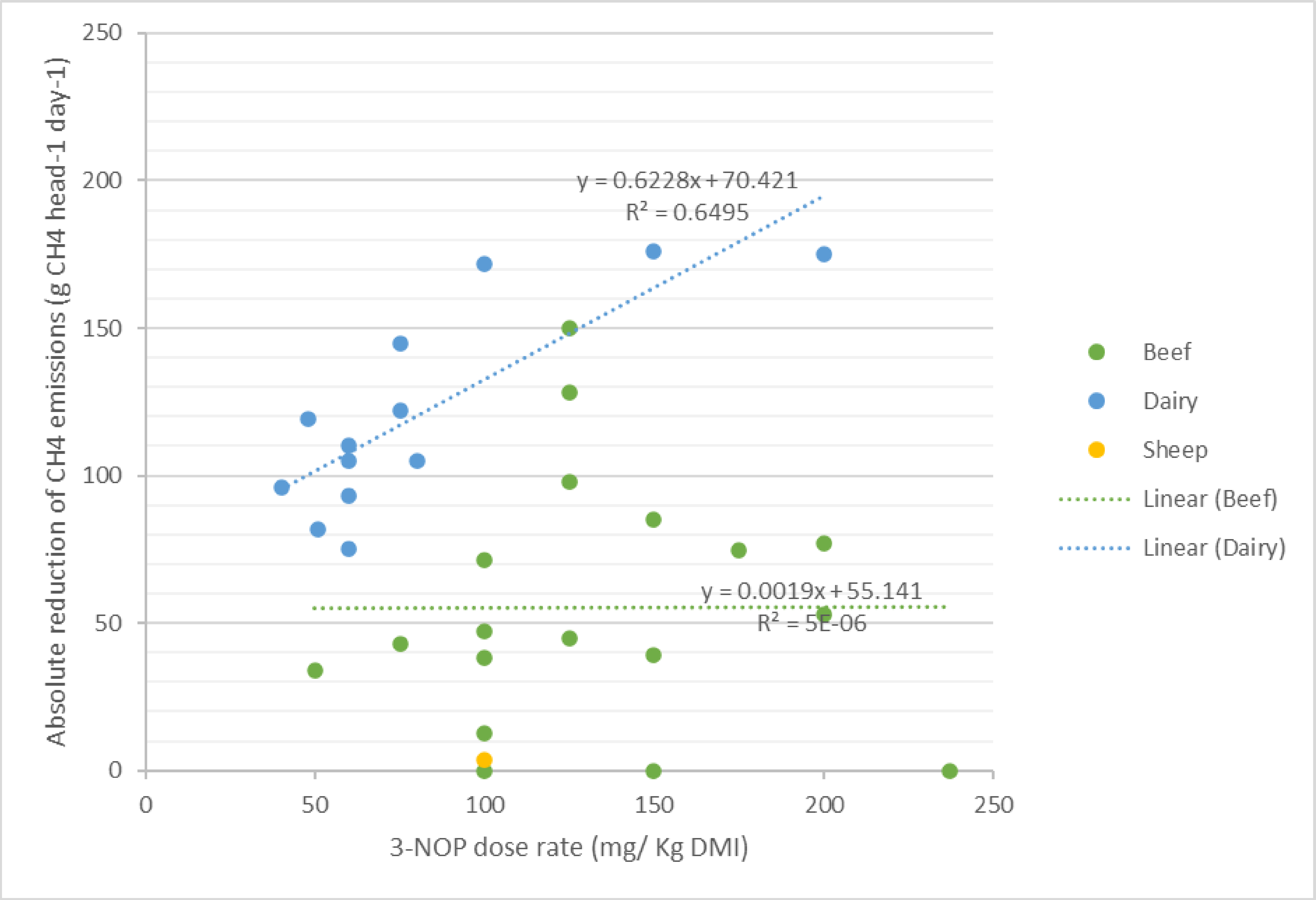
Bovaer®

- **Number of studies:** 31 in vivo, 20 in vitro and 9 in silico
- **Cost:** 30c-50c per cow per day (~1g)
- **Method of delivery:** mixed in with feed (consistently), or pellets before or after feeding
- **Efficacy:** 30% (50-80mg/ kg DMI)
- **Optimal dosage:** 125-150mg 3-NOP/ kg DMI
- **Availability:** Now in feedlots, 2-3 years for grazing (availability will increase when the new factory is built)
- **Sensory changes**: no changes to meat or milk



Source: DSM nutrition

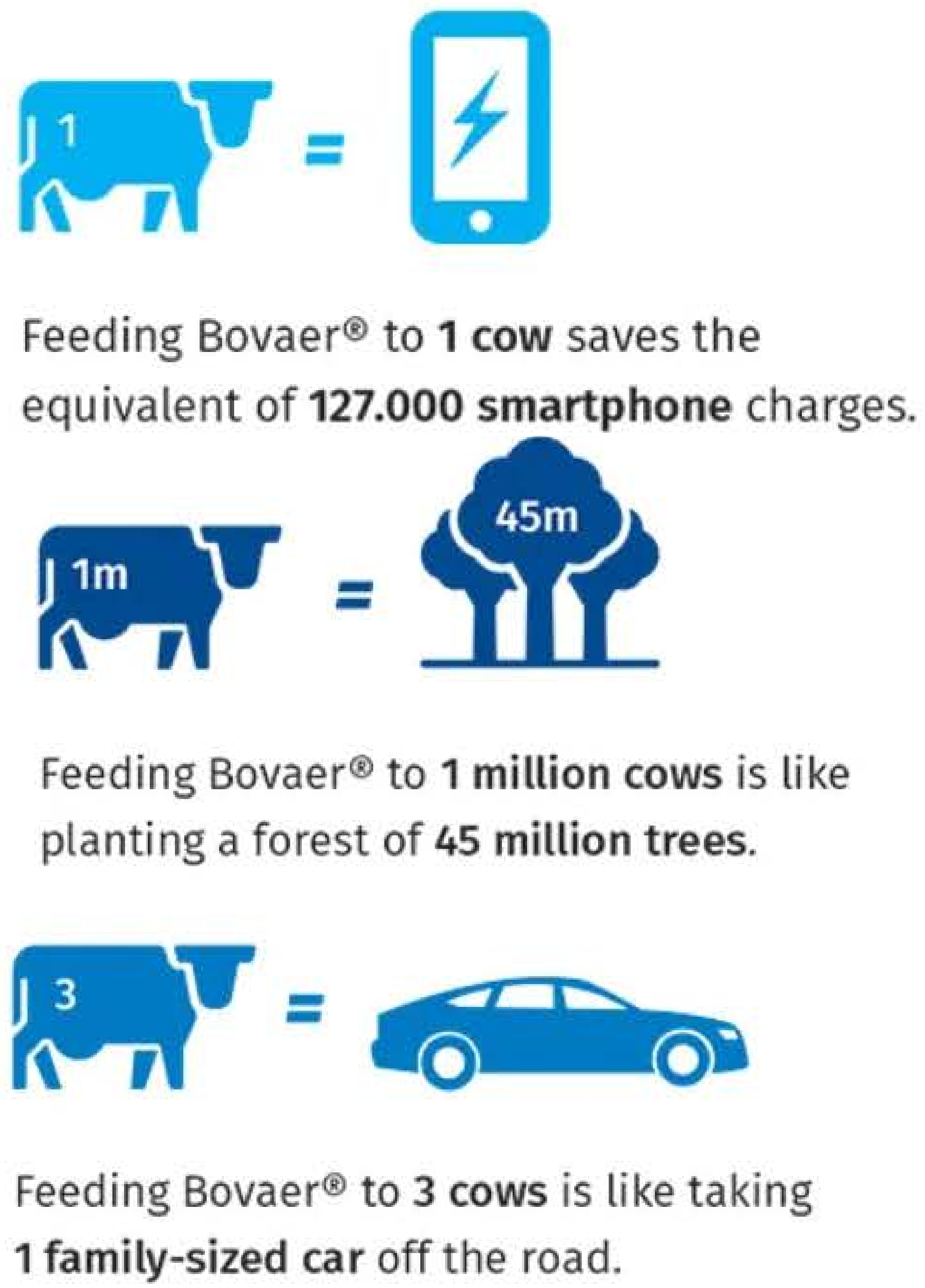
Bovaer® and efficacy



Scatter chart comparing the absolute reductions in CH_4 emissions (g head-1 day-1) documented in articles published between 2014-2022 separated by animal type.

Impact of production

- Production & Transportation produces 35-52kg CO_2e/kg 3-NOP
- 1g prevents 75g-105g of CH_4
- No negative impacts to animals or environments



Source: DSM nutrition & Feng (2020)

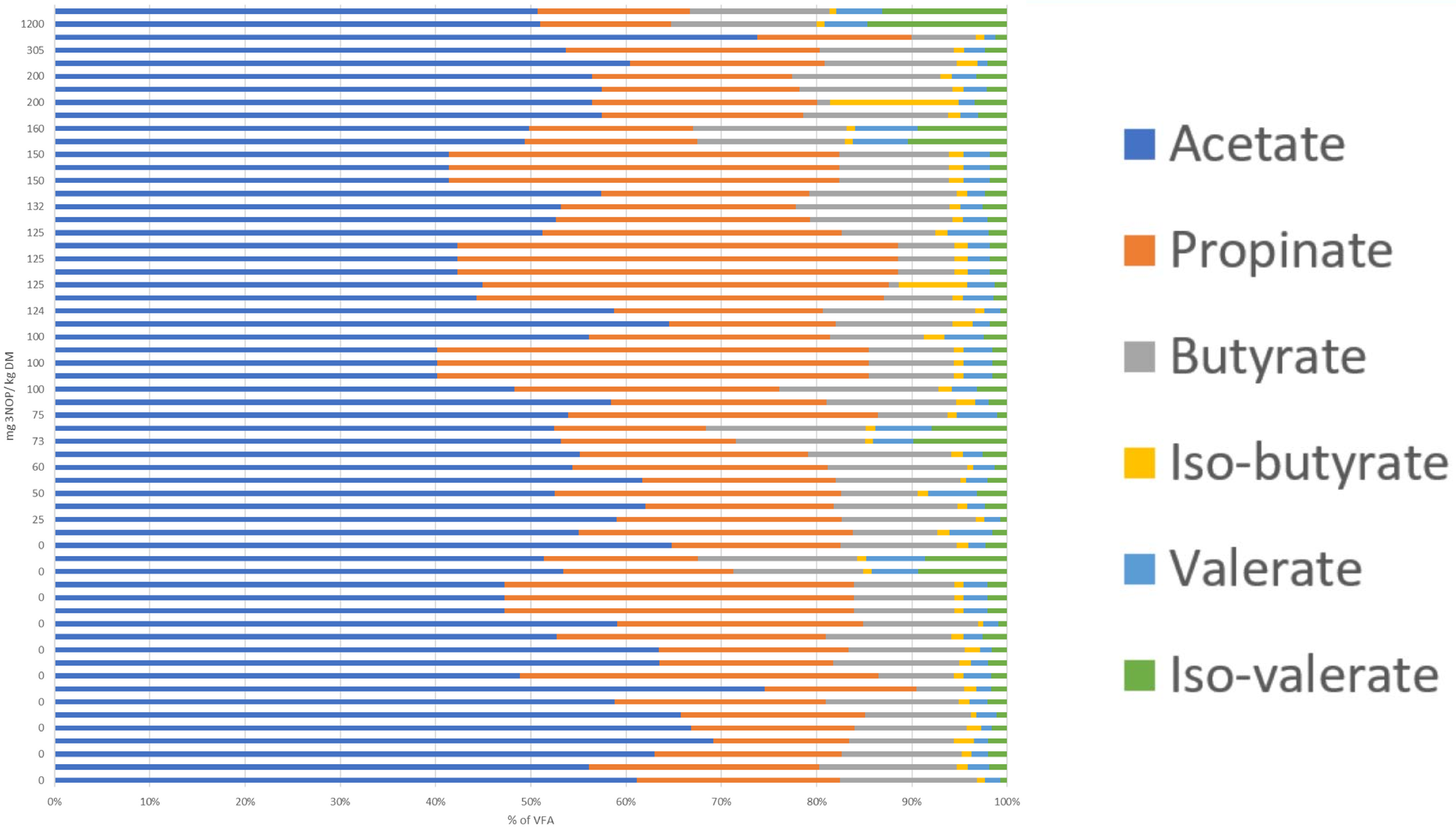
Health & safety

- Primarily excreted within 8hr of dosage via expired air (80%) and urine (4.8-13.1%), with the remaining metabolites found in tissue
- Metabolites present no threat to agricultural or non-agricultural ecosystems
- 3-NOP, other metabolites of 3-NOP have no mutagenic or genotoxic potential
- No negative impact on mortality, morbidity or fertility of ruminants has been observed

- 3-nitrooxypropionic acid (NOPA), a metabolite of 3-NOP, is found in both milk and meat.
- One study found 1 µg/kg and 5 µg/kg of NOPA in milk and meat tissue, respectively, after cattle were fed 3-NOP doses ≤100mg/kg DMI
- The small traces of NOPA residue found in animal products have been concluded to be safe for human consumption
- But reside in products limits the dosage of 3-NOP
- EFSA Panel recommended 60mg and a maximum of 100mg/ kg DMI in Dairy cattle

Source: EFSA Panel (2021)

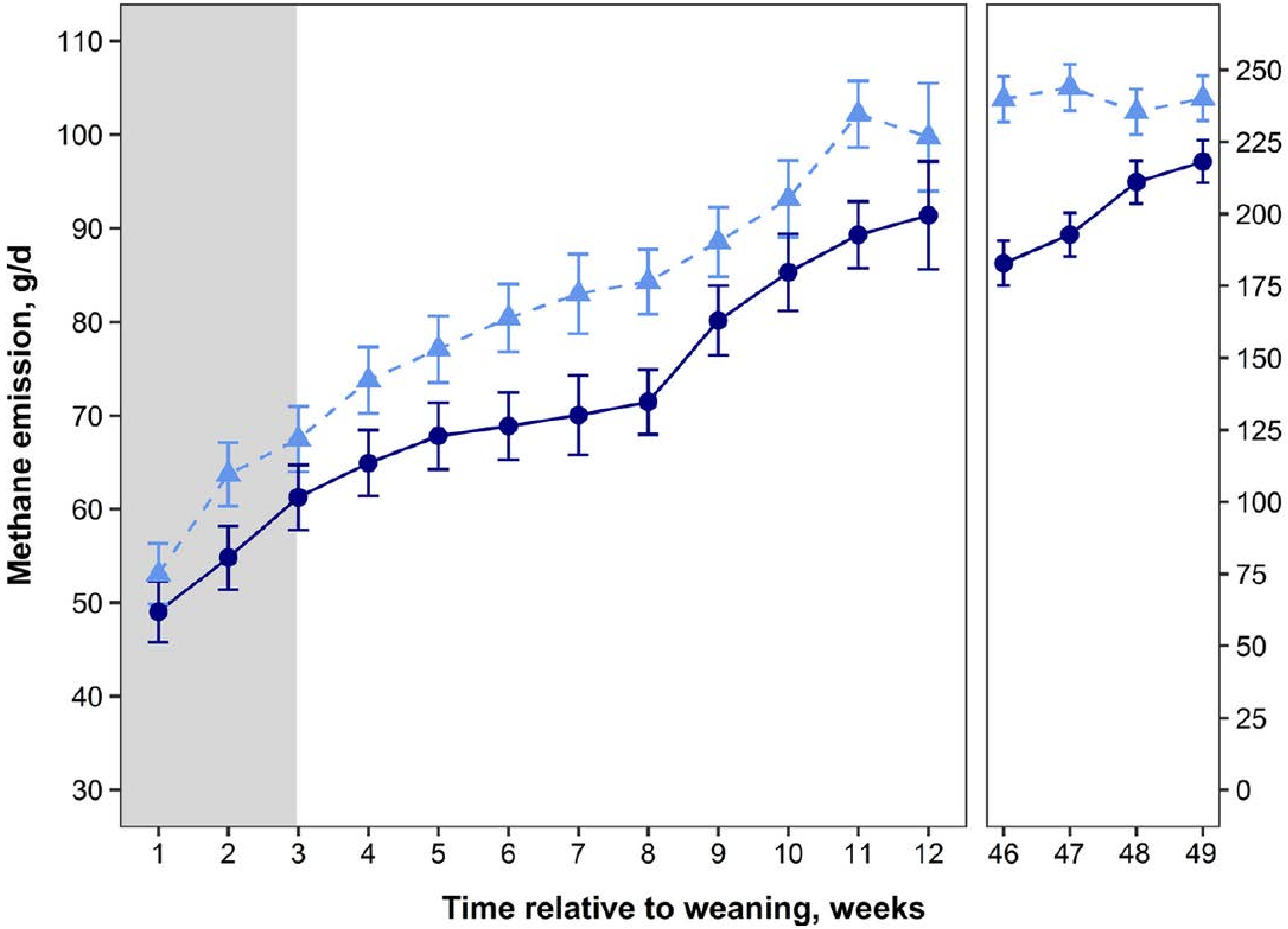
Productivity & performance



Further research

Early life interventions

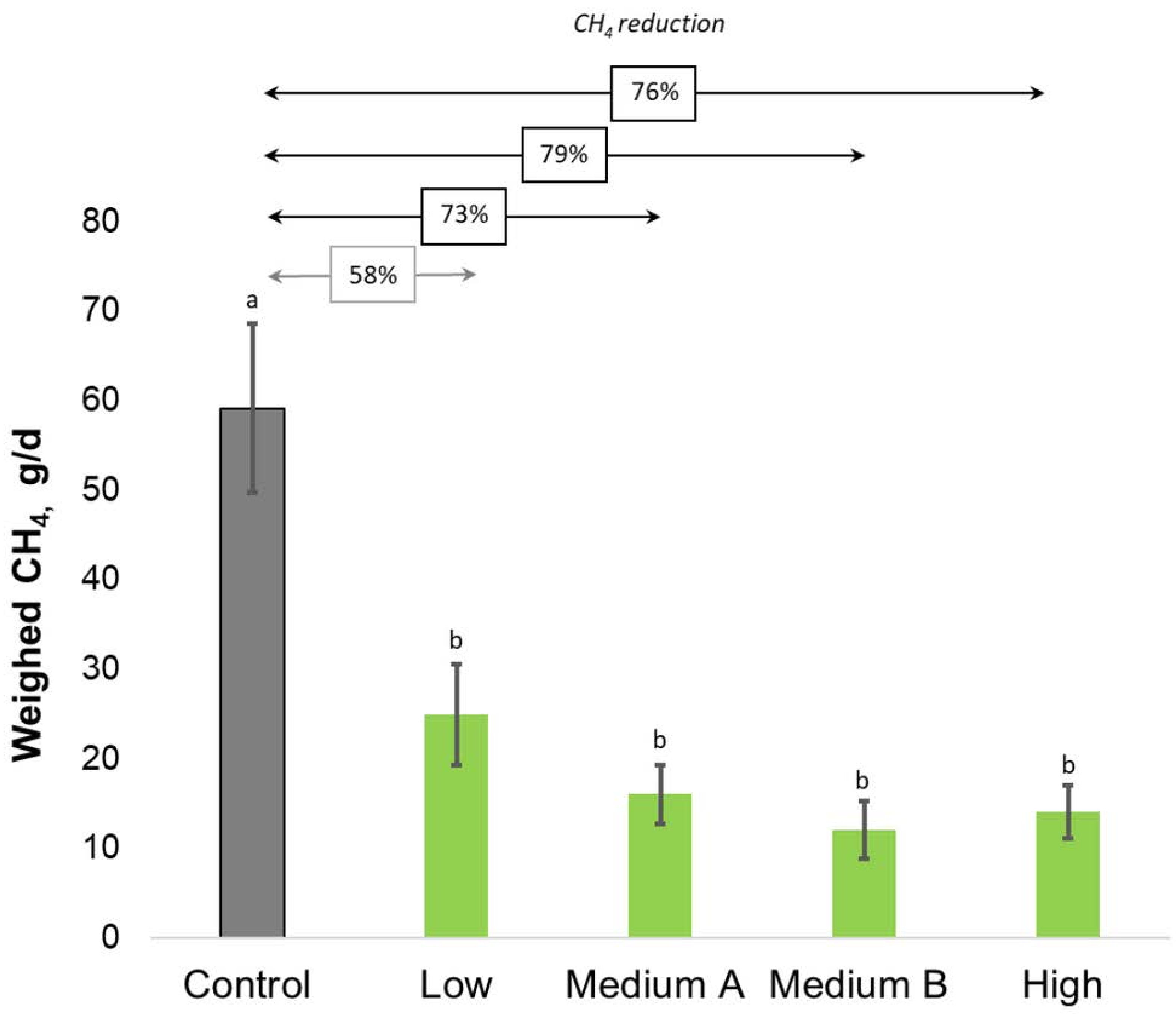
- **18** female Holstein and Montbéliarde calves
- **3 mg 3-NOP**/kg BW (mixed with water)
- Fed for the first **14 weeks** of life
- Supplementation ceased **3 weeks** post-weaning
- Reductions in CH_4 continued for *at least* **1 year**
- **Not replicated or approved**



Source: Meale, 2021

Further research

- **Australian diets and 3-NOP**
- 50-100mg of 3-NOP, 25ppm monensin and 7% fat reduced CH4 by **99% in the finishing phase**
- Over 112 days methane was reduced **78%** on average
- Higher then the **29**% in finishing and **27**% in backgrounding diets observed overseas
- **Not replicated or approved**



Source: de Almeida, 2022

Asparagopsis

- aka FutureFeed
- Methane inhibitor
- Owned by the CSIRO and licensed to companies

- Sea Forrest (TAS)
- CH4World (SA)

- Two species: Aspaargopsis taxiformis (tropical) & Asparagopsis armata (temperate)
- Native to Australia

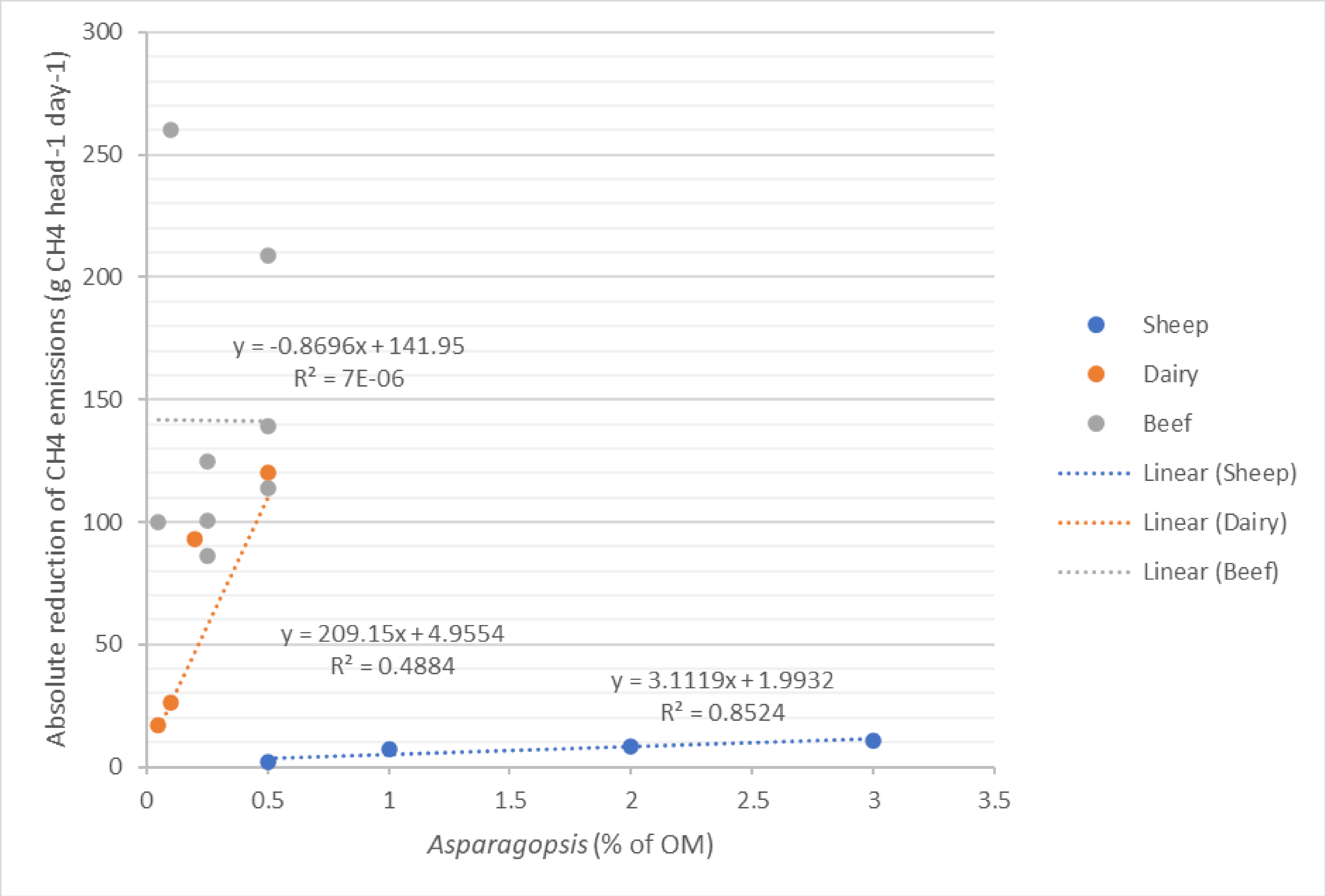
Asparagopsis armata (above) and A. taxiformis (below)

Asparagopsis

- **Number of studies:** 5 in vivo, ~30 in vitro and 2 in silico
- **Cost:** ~$1 per cow per day (33g per day)
- **Method of delivery:** mixed in with feed
- **Efficacy:** ~80%
- **Optimal dosage:** 0.2% of Organic matter (based on dried)
- **Availability:** Now in feedlots, 2-3 years for grazing
- **Sensory changes:** no changes in taste of meat or milk observed but had darker steaks and higher microbial counts

Asparagopsis carpospores form Sea Forrest

Asparagopsis and efficacy



Scatter chart comparing the average absolute reductions in CH_4 emissions (g head-1 day-1) documented in articles published between 2018-2021 and separated by animal type

Impact of production

Farming (open ocean or terrestrial)

- Open ocean farming

- 4,623-11,588 ha
- Increases plastic pollution
- Harvests are seasonal
- May exacerbate biodiversity loss caused by climate change

- Terrestrial farming

- 126-210ha
- Requires more resources and infrastructure
- risk loss of biodiversity
- May exacerbate biodiversity loss caused by climate change

Processing, storage, transport & consumption

- Processing

- Halogenated compounds leave *Asparagopsis* once harvested
- GHG emission from freeze dried or emulsified in oil
- Improper processing can reduce the concentration of CHBr3

- Storage & transport

- High temperatures, sunlight and time reduce CHBr3
- GHG emissions are produced from transportation

- Ozone depletion potential

- Bromoform reacts with ozone in the both the troposphere and stratosphere
- 34,000 tonnes of DW would increase ozone depletion by 0.006-0.016%

Source: Zanolla, 2022

Health & safety

- CHBr3 does not accumulate in the meat, fat, or tissue
- No negative impact on mortality, morbidity or fertility of ruminants has been observed
- Iodine and CHBr3 concentration increased in milk when supplemented at 0.25-0.5% of OM respectively
- 10 out of the 12 sheep examined post-mortem had an extensive area of nodular proliferation and white/tan discolouration, with blunting of ruminal papillae
- 5 out of 10 cattle examined post mortem had haemorrhages, ulcers and blisters

Source: Li, 2018

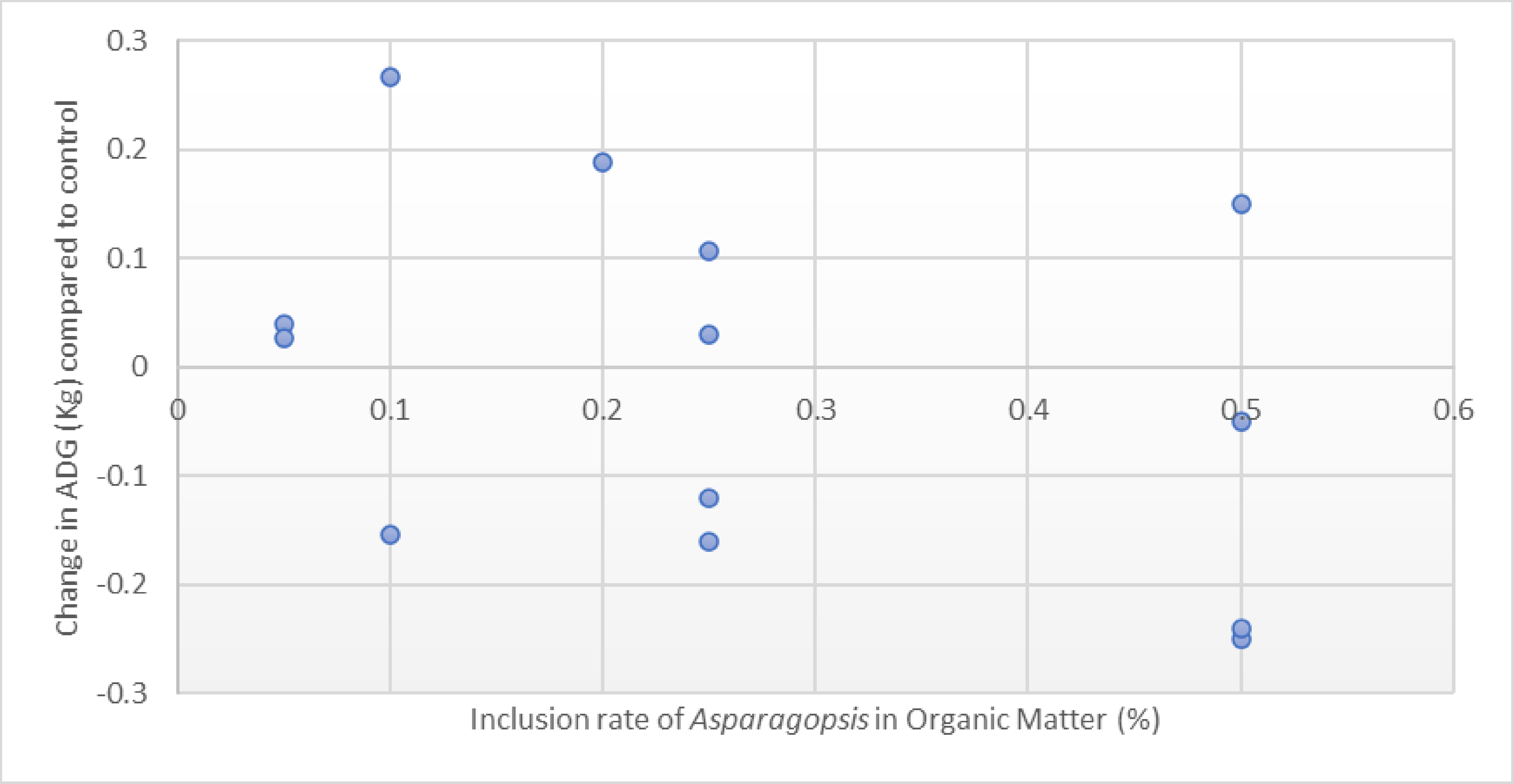
Productivity & performance

Feed energy otherwise lost as CH4 was partially conserved thus improving feed use efficiency with 26% (Mid) and 22% (High) increases in daily weight gain over the 90–day study period and 53% (mid) and 42% (high) in the last 60 days

- Future feed on Kinley, 2020

Sheep offered various inclusion levels of Asparagopsis had similar LWs at the end of the experiment. Neither the inclusion level of Asparagopsis nor the interaction with time could be associated with LW

- Li, 2018



Source: Stefoni (2021), Roque (2021), Kinley (2020), Roque (2019) & Li (2018)

Grazing technology

3-NOP

- Currently there are no published studies
- There is a MERiL study currently trailing different technologies including lick blocks & slow release pellets
- Further research is needed to determine if it can be delivered through water in grazing systems

Asparagopsis

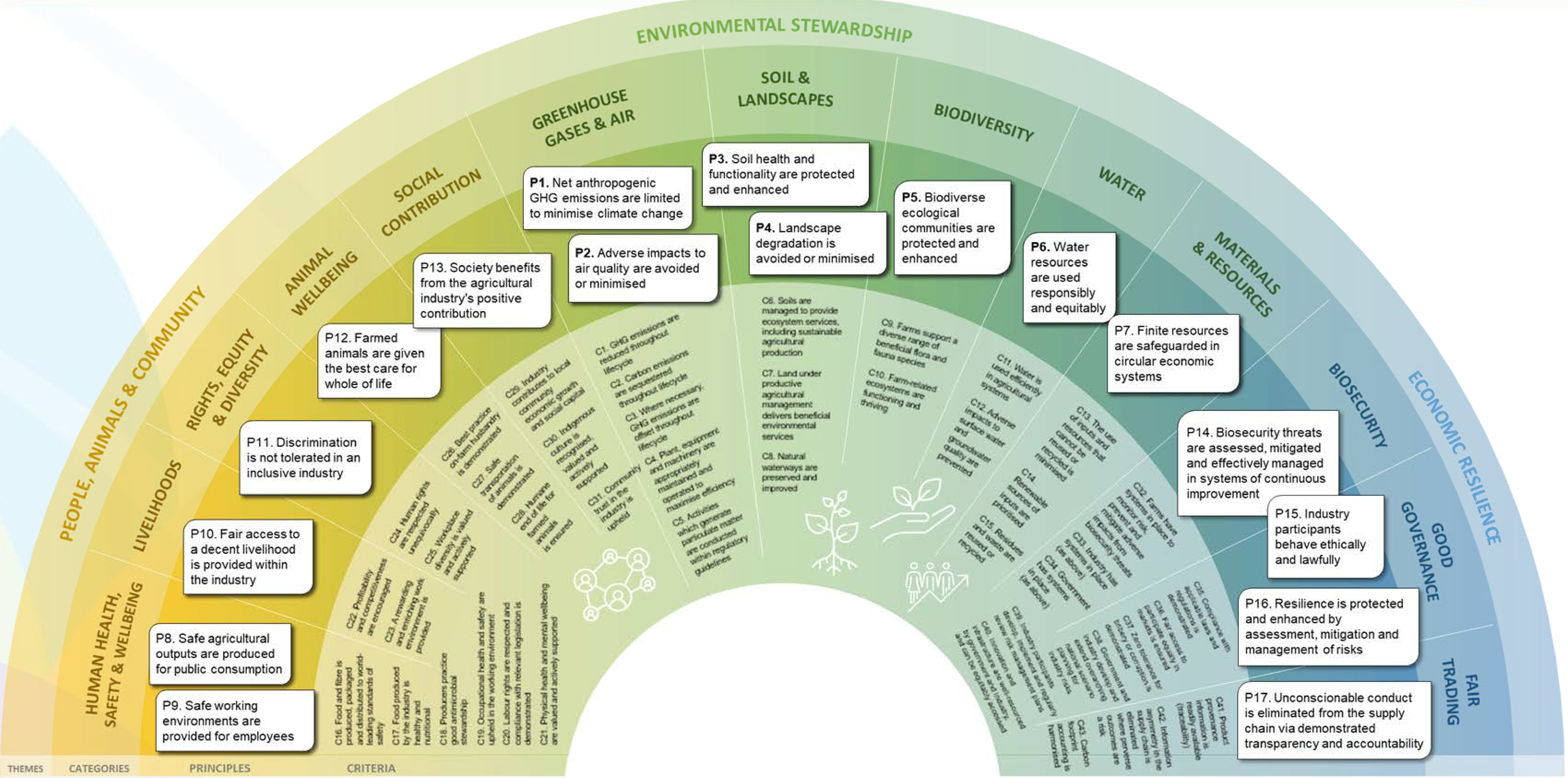
- Currently there are no published studies
- Lick blocks are also being tested
- Further research is needed to determine if it can be delivered through molasses in grazing systems

Further research

- **Asparagopsis and oil**
- **Adaptation**
- **Slow release technologies for grazing ruminants**
- **Sheep and goats**
- **Maximising efficacy through diet**

"What do you have for planet-warming gas?"

The future of farming



Source: The Australian Farm Institute

Resources

- **https://globalresearchalliance.org/**

- An evaluation of evidence for efficacy and applicability of methane inhibiting feed additives for livestock

- **https://www.mla.com.au/research-and-development/reports/**

- Use of 3-NOP for methane mitigation by programming rumen microbiome development in calves

- **https://piccc.org.au/**

- Greenhouse Accounting Frameworks (GAF) for Australian Primary Industries

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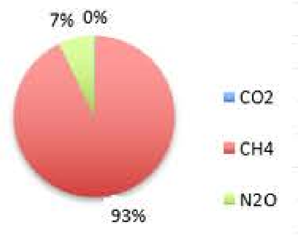
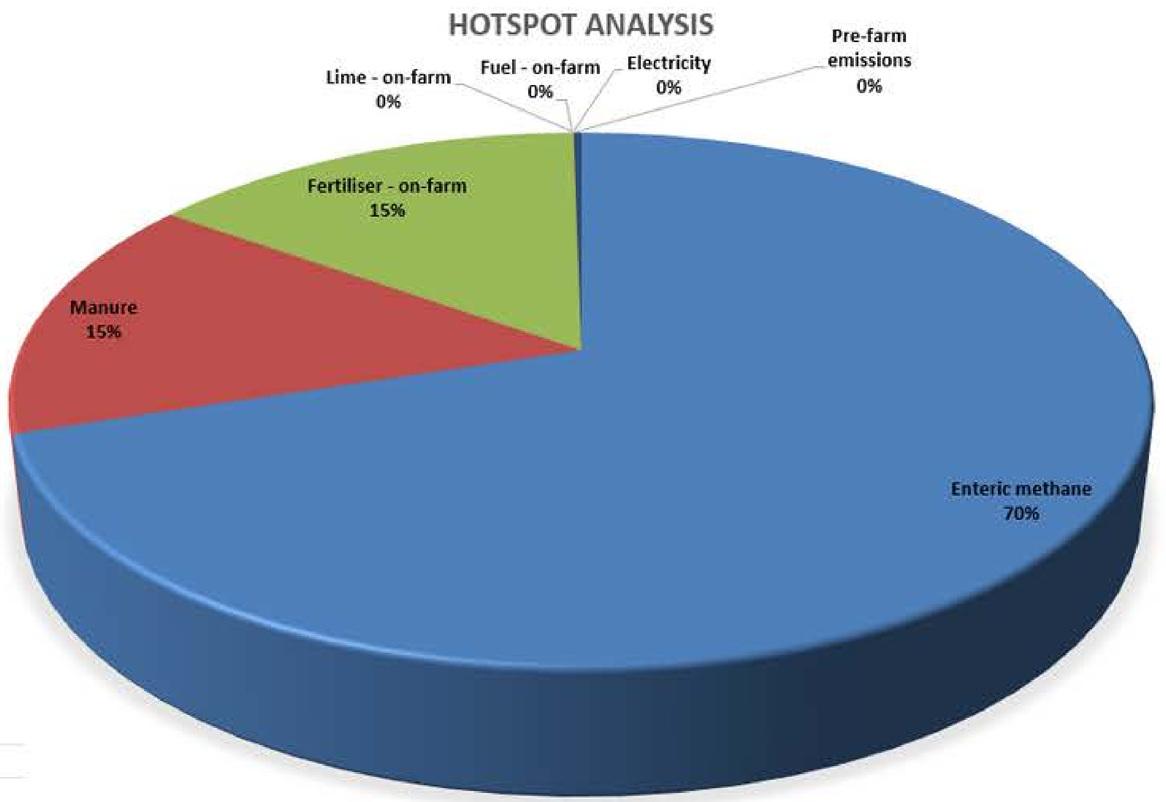
Resources

Dairy Greenhouse Accounting Framework

Outputs	t CO_2e/farm
Scope 1 Emissions (on-farm)	
CO_2 - Fuel	0.00
CO_2 - Lime	0.00
CO_2 - Urea	0.00
CO_2 - Transport	0.00
CH_4 - Fuel	0.00
CH_4 - Transport	0.00
CH_4 - Enteric fermentation	1,409
CH_4 - Manure Management	297.9
N_2O - Atmospheric Deposition	15.30
N_2O - Manure management	1.32
N_2O - Animal waste	12.26
N_2O - Direct fertiliser	0.42
N_2O - Urine and Dung	54.83
N_2O - Leaching and Runoff	48.38
N_2O - Fuel	0.00
N_2O - Transport	0.00
Scope 1 Total	**1,839**
Scope 2 Emissions (off-farm)	
Electricity	0.3825
Scope 2 Total	0.3825
Scope 3 Emissions (pre-farm)	
Fertiliser (urea + Superphosphate)	0.00
Purchased feed	0.00
Herbicides/pesticides	5.18
Electricity	0.04
Fuel	0.00
Lime	0
Scope 3 Total	5
Carbon Sequestration	
Carbon sequestration in soils (enter if you know)	0
Carbon sequestration in trees	-21.73
Net Farm Emissions	**1,547**
Emissions intensity	**10.35**

Summary	t CO2e/farm
CO_2	6
CH_4	1,707
N_2O	133





Citation: Ekonomou A., Eckard R. (2022). A Greenhouse Accounting Framework for Dairy properties based on the Australian National Greenhouse Gas Inventory methodology. Updated June 2022 http://piccc.org.au/Tools

Primary Industries Climate Challenges Centre

Questions

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