Why Should Commercial Cattlemen Care About Methane?

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eBEEF Brown Bagger
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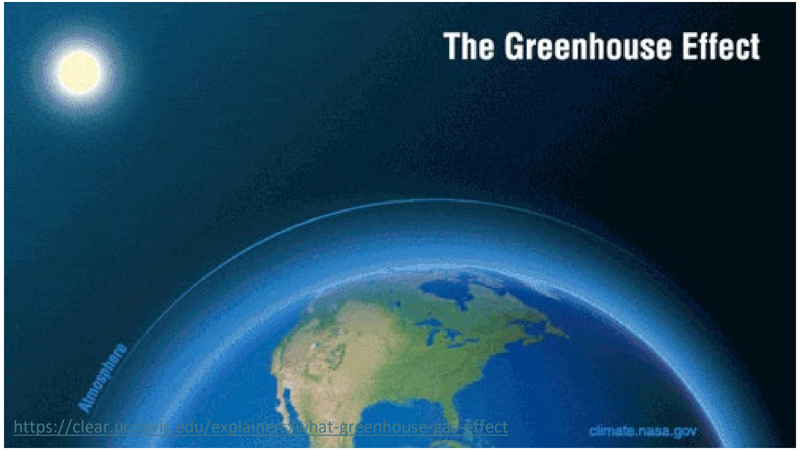
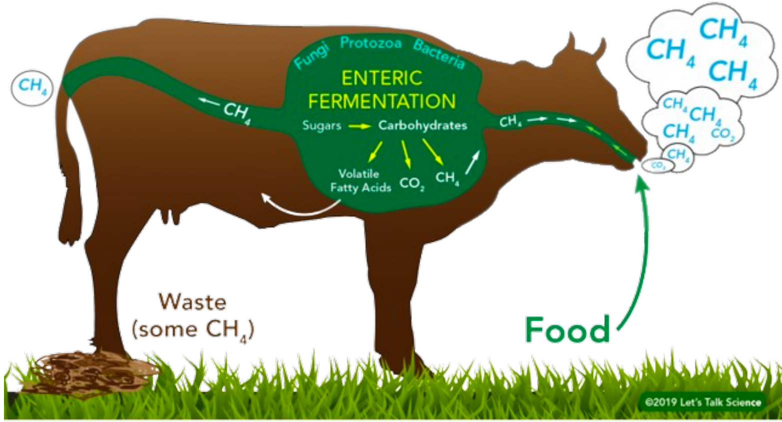
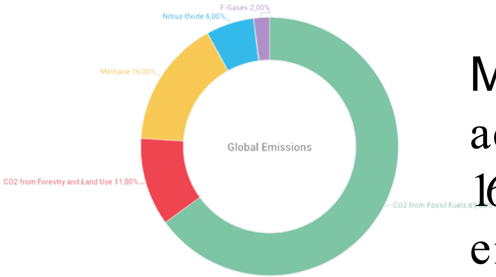
Why does the rest of the world care so much about methane?

Methane is a potent greenhouse gas



https://clear.ucdavis.edu/explainers/what-greenhouse-gas-effect

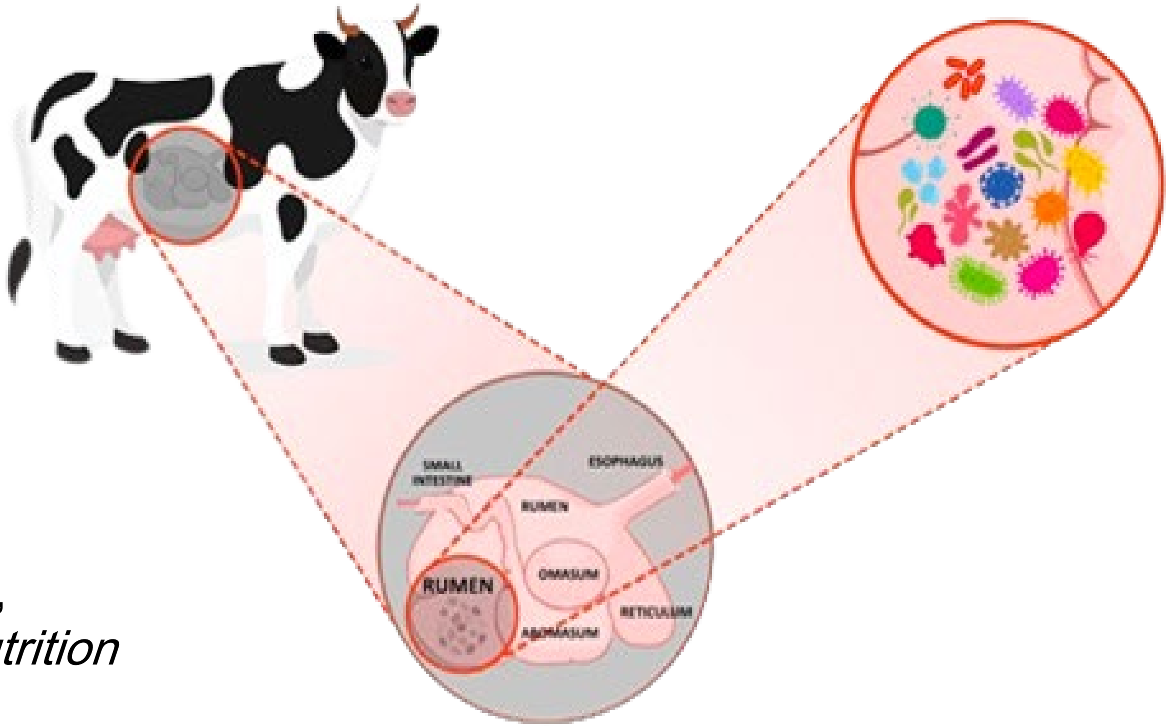




Methane accounts for 16% of GHGs emitted globally

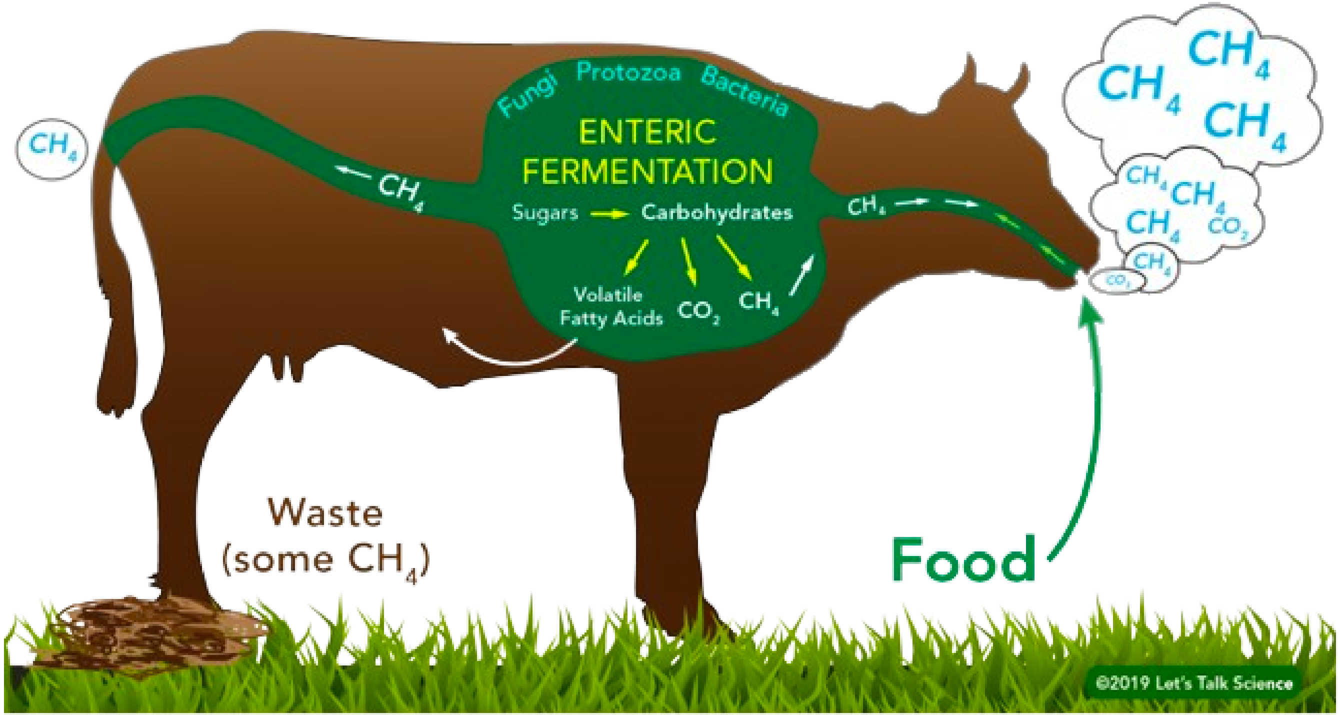
- Livestock account for ~11% global GHGs
- Cattle account for 4% of GHGs in US
- Beef cattle: 2.2% of GHGs in US

It’s not the cow producing methane… it’s her microbiome



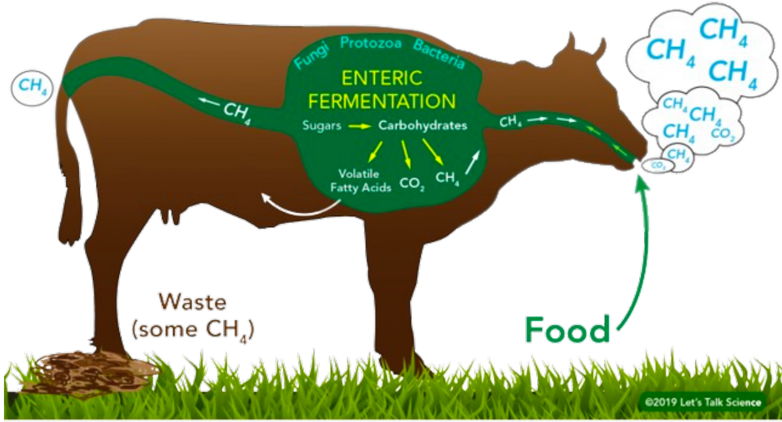
Xu et al., 2021,
Frontiers in Nutrition

Enteric Fermentation: Bovine superpower



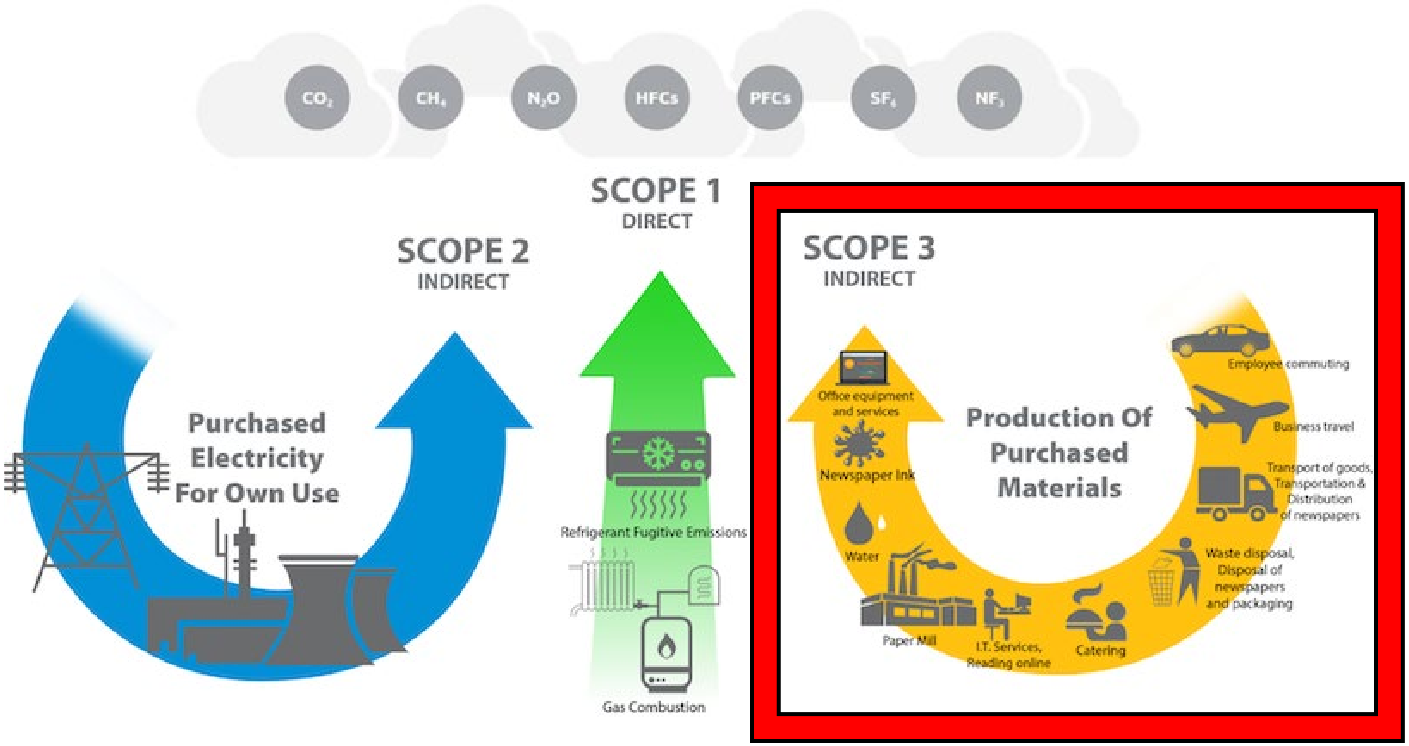
Fact: Beef Cattle Produce Methane

Beef cattle only emit 2.2% of GHGs in the United States!!!!



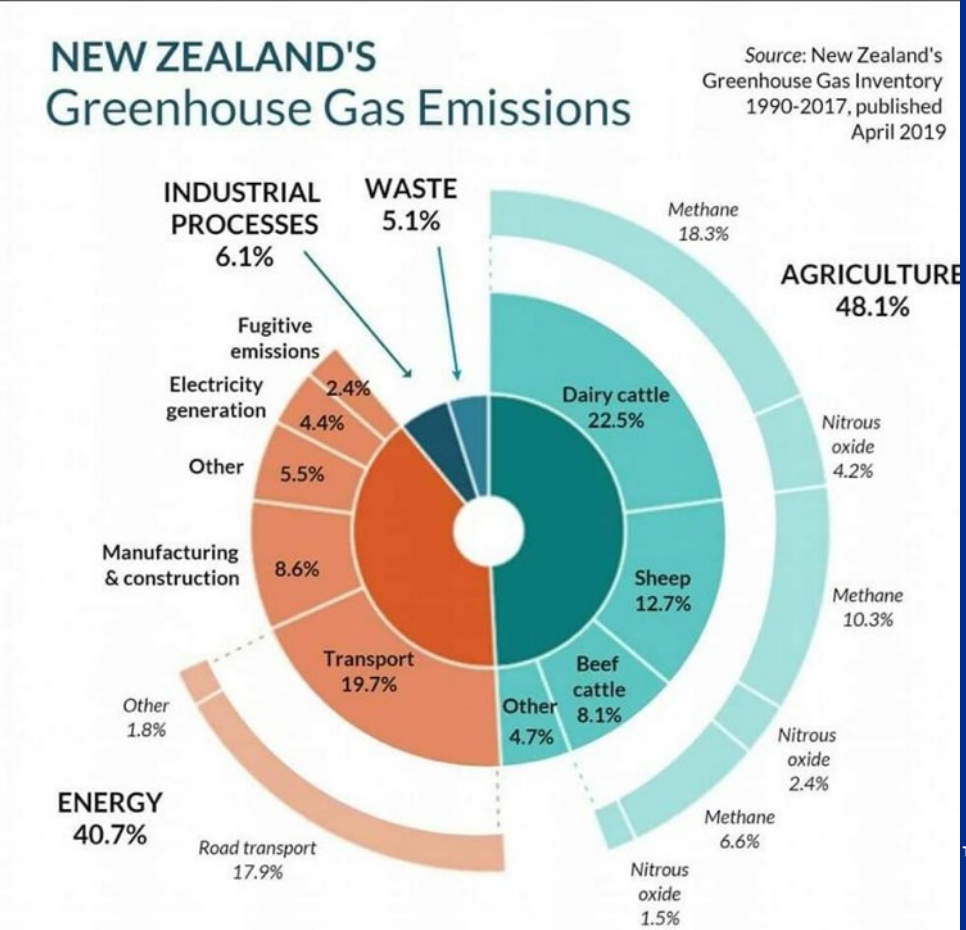
Why do food companies care about emissions?

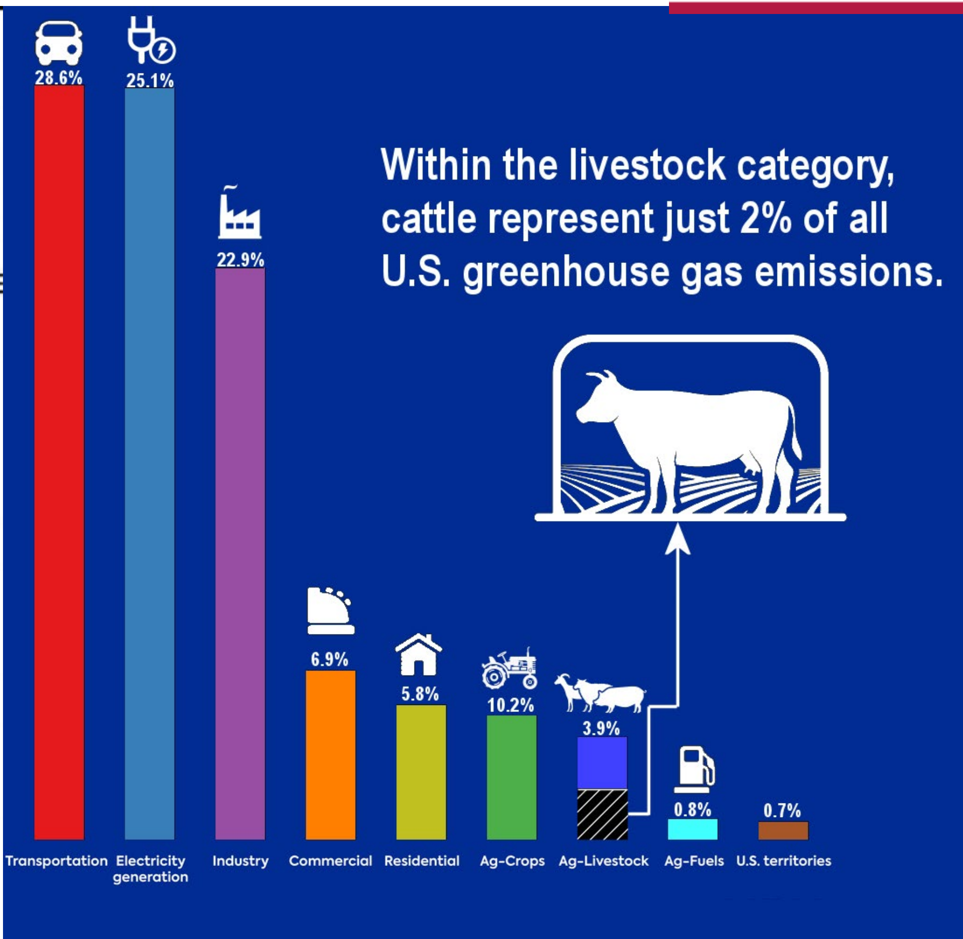
Why do food companies care about methane?



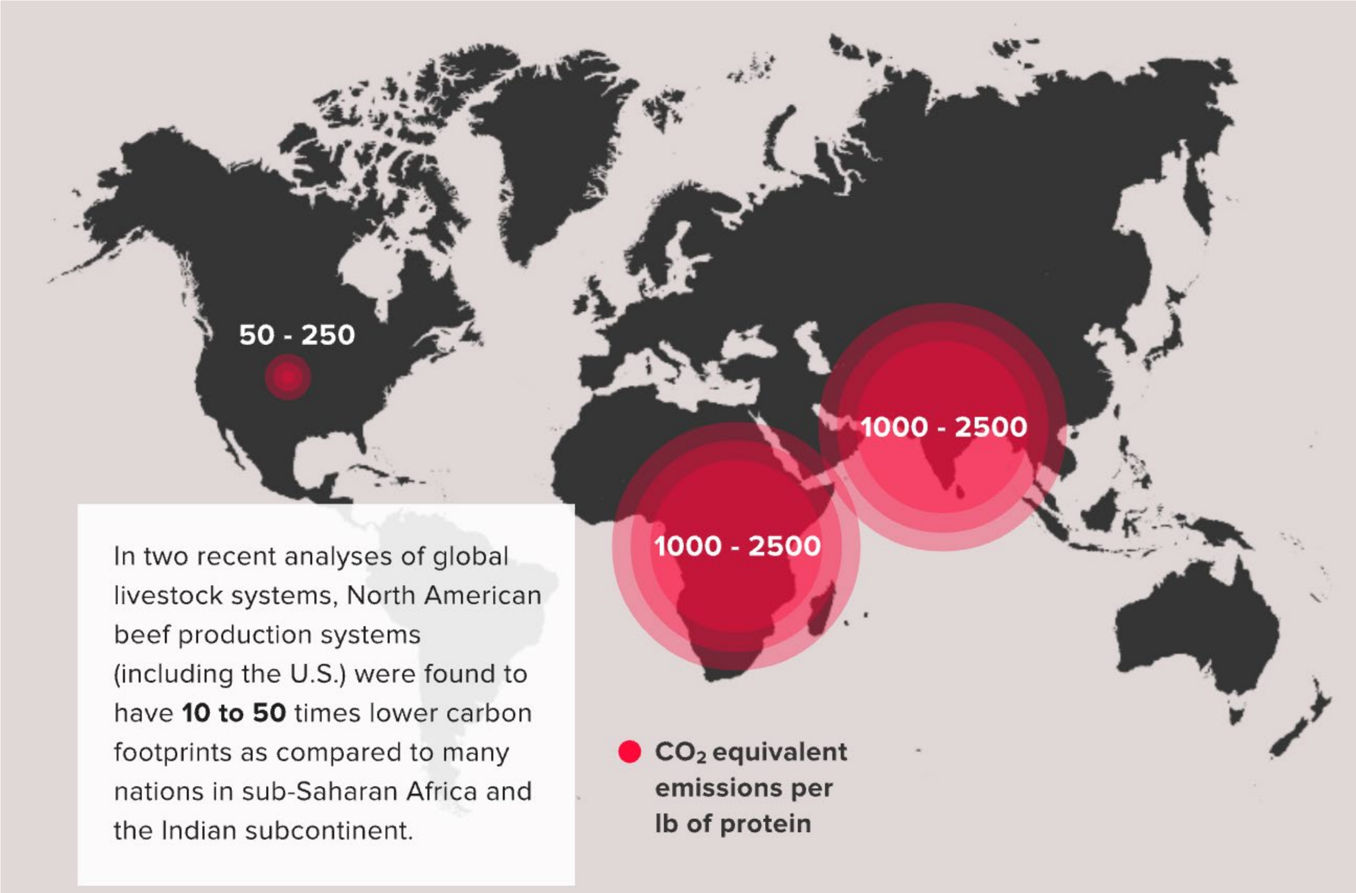
<u>87% of beef industry's enteric emissions</u> come from cow-calf & stocker sectors

Why do other countries care?





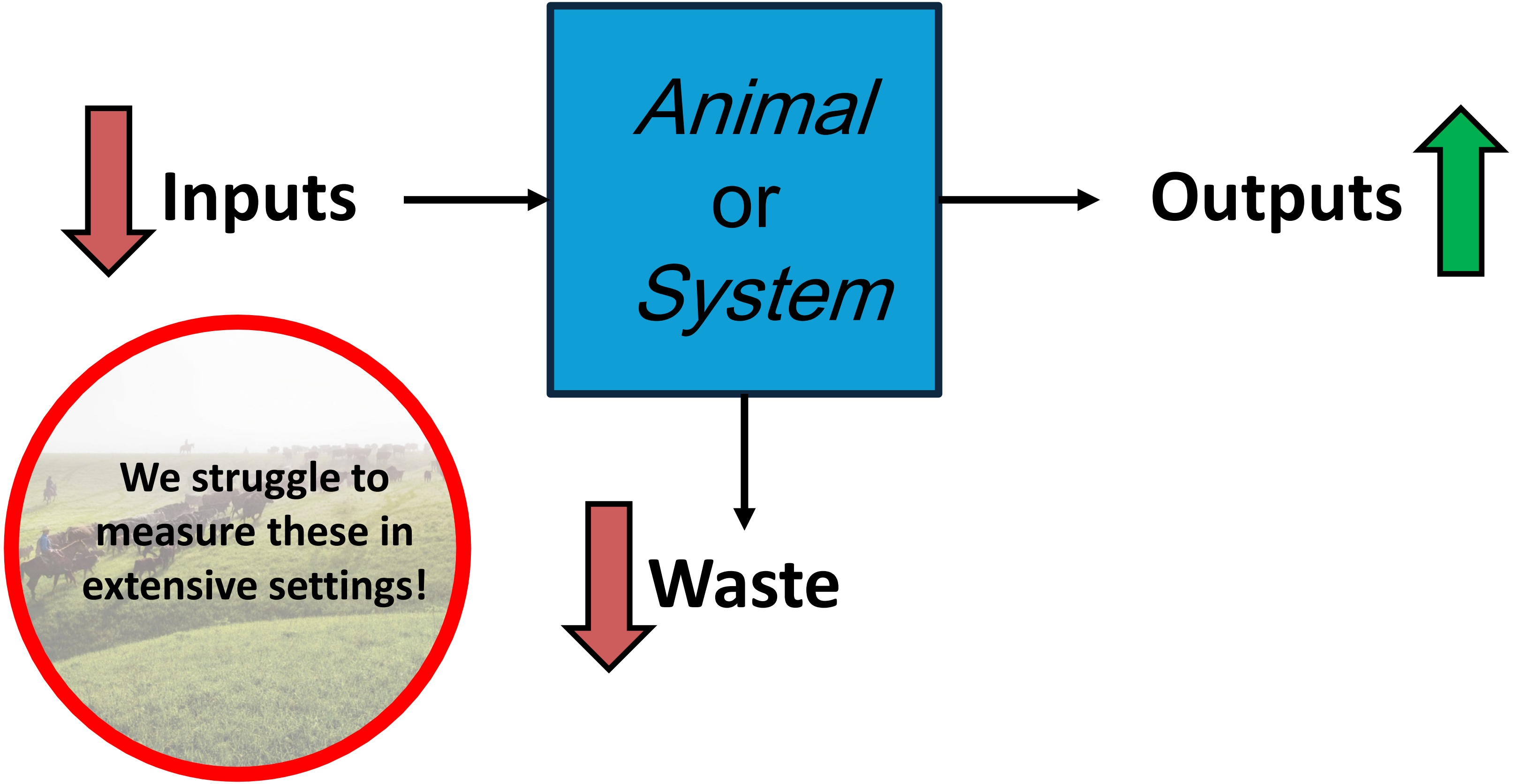
Disincentivizing beef in efficient systems is <u>counterproductive</u>

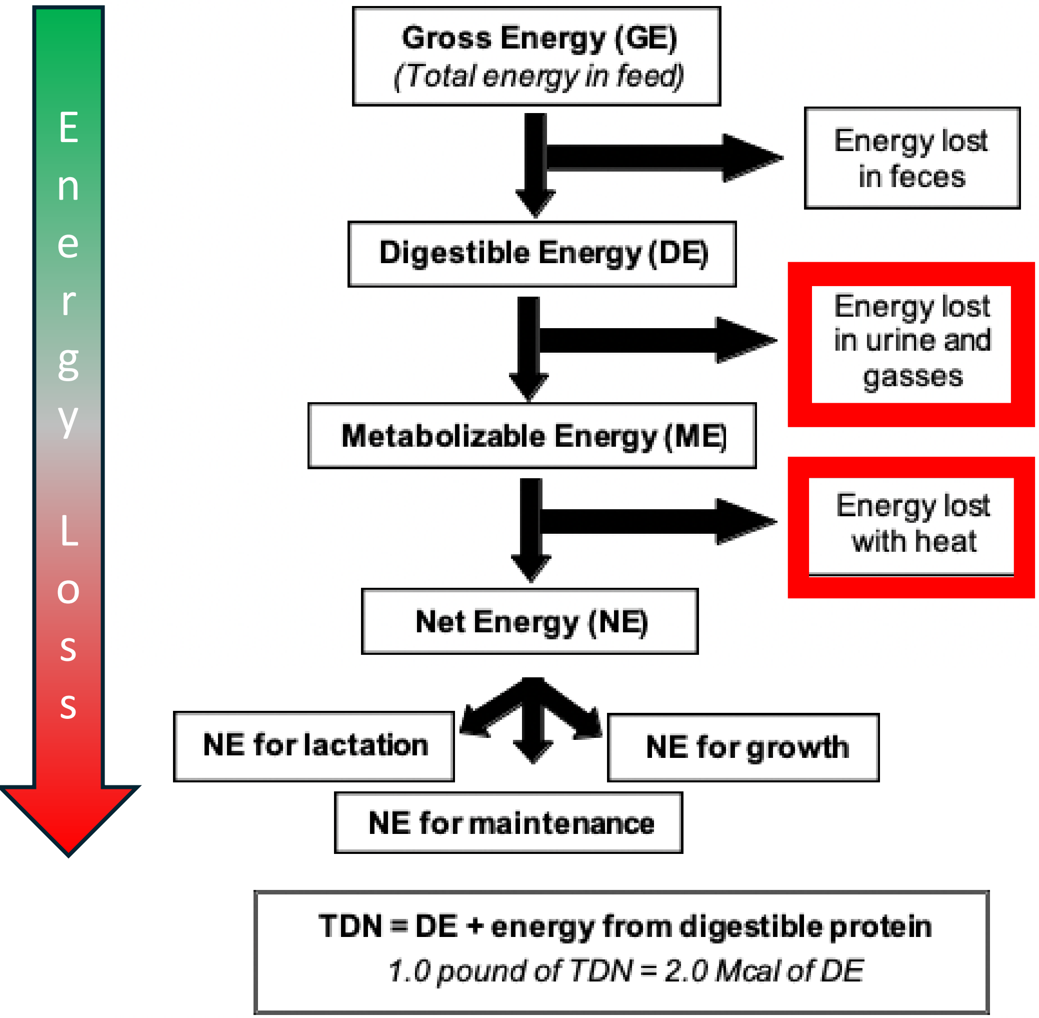


Energetics 101

i.e., Why producers should care about methane

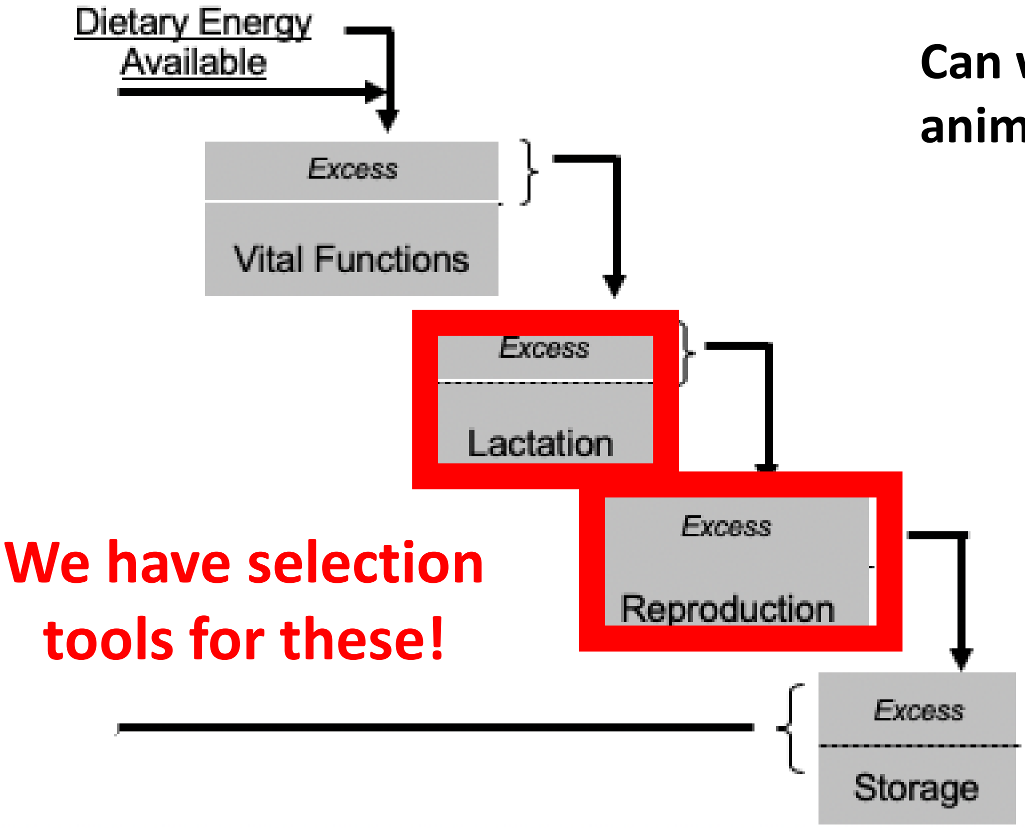
Efficiency, Sustainability, and Profitability Drivers





We would like to be able to measure these losses directly

Partitioning Net Energy



Can we fully account for where animals utilize their energy?

Mature body weight & metabolism

Bigger cows = greater energy requirements

Metabolic body weight = Live Weight$^{0.75}$

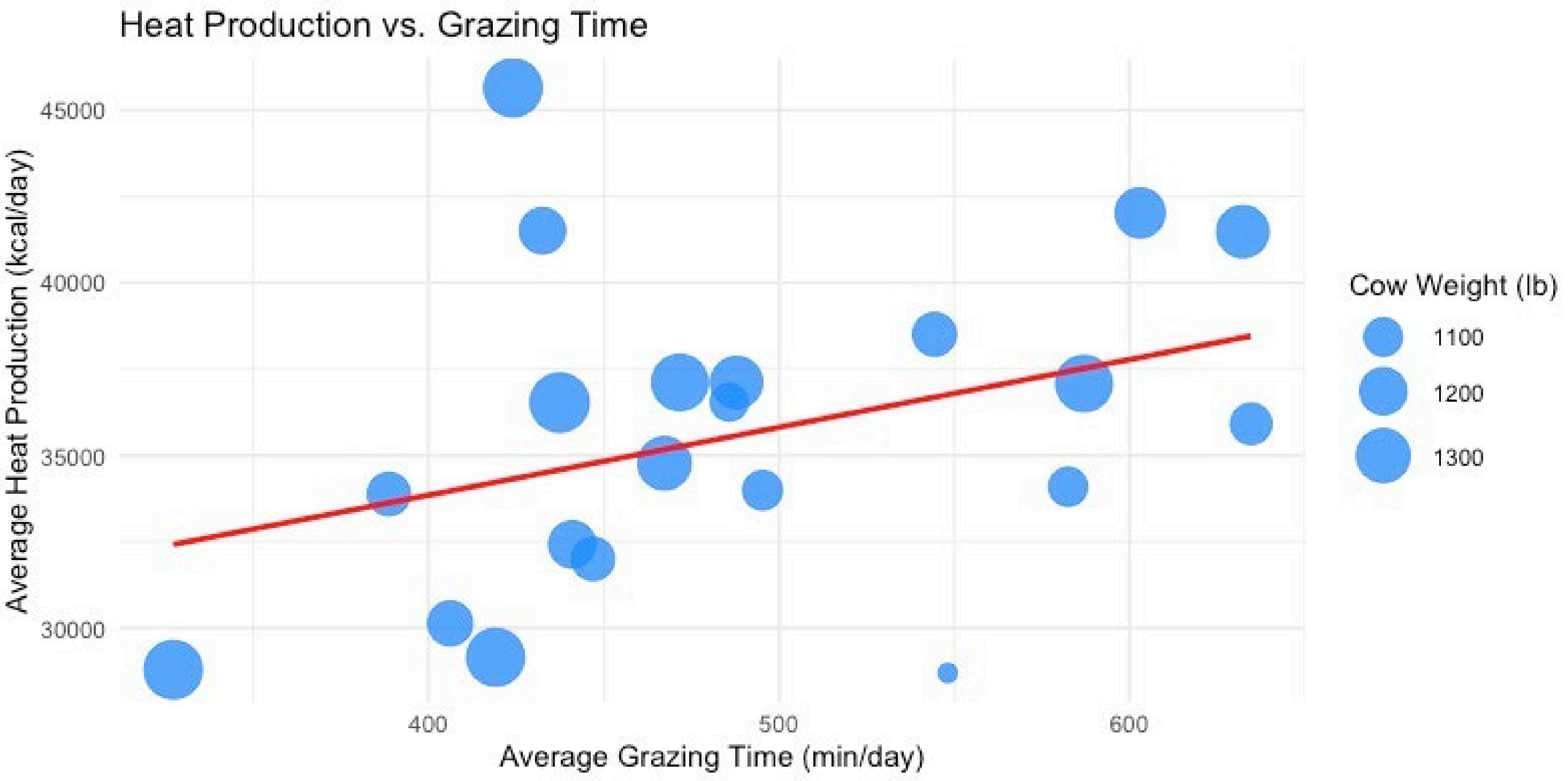
This is NOT a perfect estimate of actual metabolism but provides context for relative differences in energy across body sizes.

Fleshing Ability & Body Condition

OR

Difficult to know if condition is related to *intake* or *fleshing ability* on forage

Metabolism vs. Mature Weight vs. Intake



Genetics of methane emission and phenotyping methods

How do we select for methane traits?

- Where?
  - Sector of Industry: Cow/calf vs feedlot data
- Cow-calf sector is largest contributor
  - Estimated 63-80% of GHG emissions come from cow/calf sector
    - Must maintain cow and bull inventory year-round to obtain a single calf
    - Long life cycle compared to other livestock animals
      - More time in this sector
    - Eating forage diets=more methane produced
- This is where selection decisions are made
  - Making it relevant for the cow/calf producer
    - It's not just methane
  - WAY harder to get data

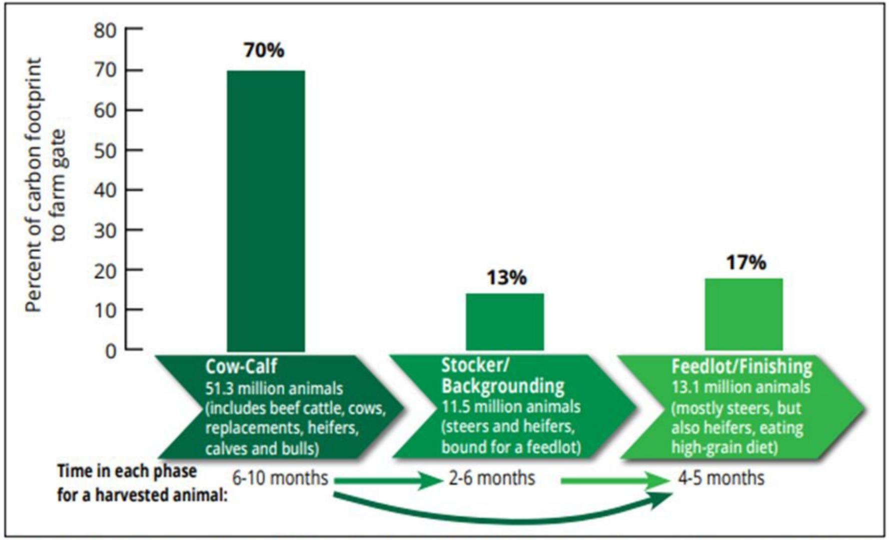
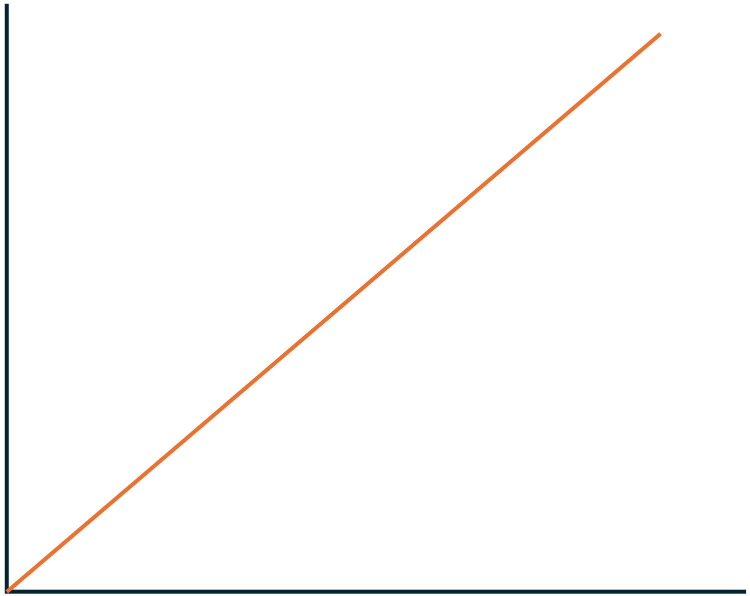


Figure 1. Average percentage[2-5] of the carbon footprint to the farm gate (i.e., greenhouse gas emissions generated per pound of beef prior to harvest of the cattle) due to the cow-calf, stocker/backgrounding, and feedlot/finishing phases of beef production and number of animals in each phase, as of January 1, 2015.[7]

How do we select for methane traits?

- How?
  - Proxies
    - Predicted phenotypes
    - Weight
  - Proxies will never identify outliers that defy expectations
    - Phenotyping methodologies???



Quantification method	**Abbreviation**	**Definition**
Respiration calorimetry		Whole-animal open-circuit systems to measure respiratory exchange and gas fluxes
Sulfur-hexafluoride tracer technique	SF_6 tracer technique	The tracer gas is released at a known concentration from a bolus within the rumen
The GreenFeed system, C-Lock, Inc.	GreenFeed, GF	An automated and voluntary head box system
Sniffers		A voluntary system measuring eructation amount and frequency

How do we select for methane traits?

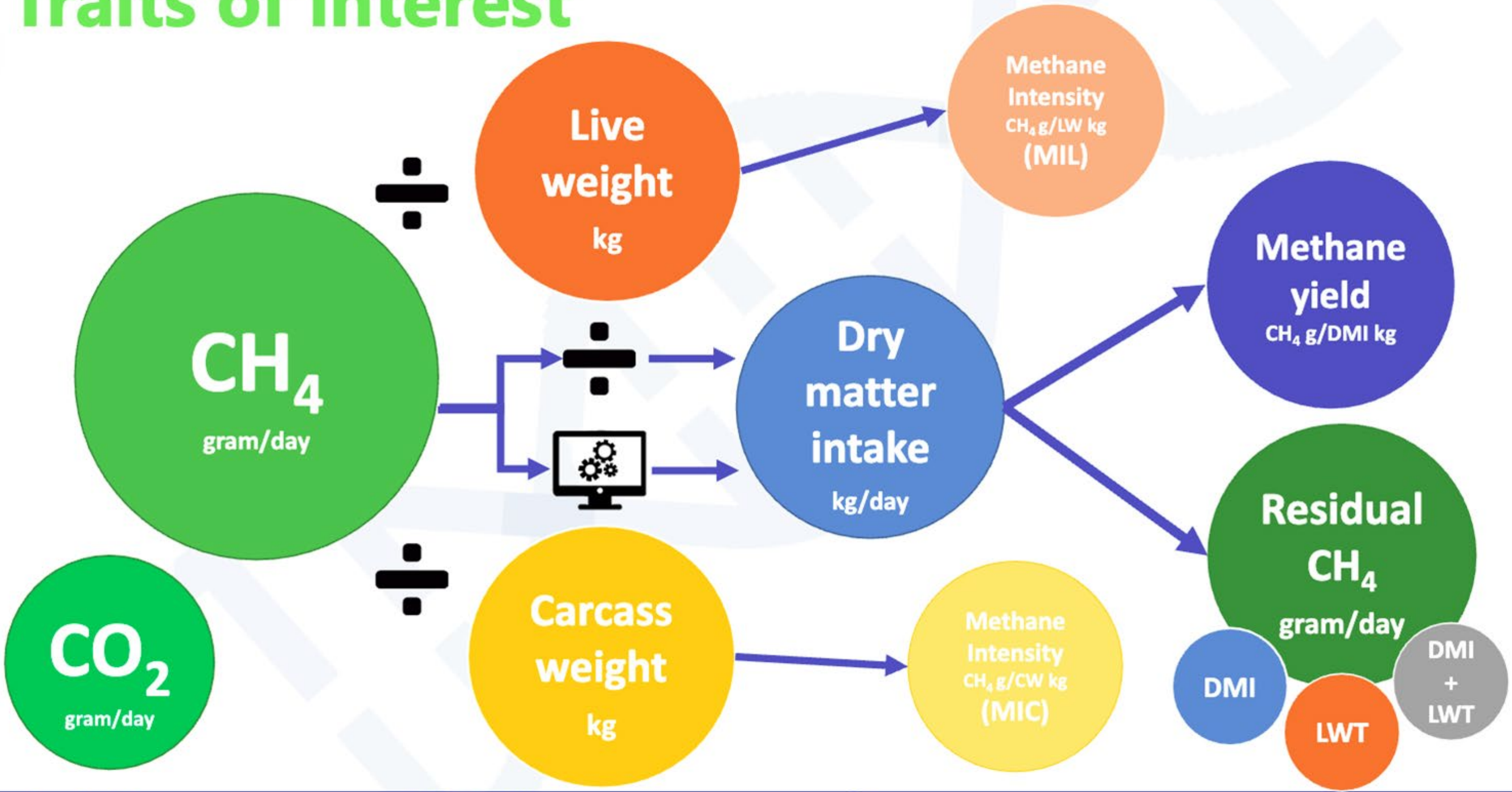
- When?
  - Stage of production?
    - Feedlot easier data collection
      - Likely very different from grazing output
      - Correlations?
    - Grazing more relevant to cow/calf
      - Data collection hard and expensive
      - Throughput challenges
    - Growing vs lactating vs gestating
      - Correlations?
        - Strong positive phenotypic correlations between DMI and CH_4 during lactation (0.61) and gestation (0.59) in 100 Angus/AngusX cows, no genetic correlations
        - CH_4, CO_2, and O_2 were not significantly different between gestation and lactation (Talley et al. 2025)
  - GxE?
    - Forage differences and diet differences
  - Trait of interest?

How do we select for methane traits?

- What is the most appropriate trait?

Phenotypic Methane Traits	Abbreviation	Definition
Methane Production Rate	MPR	CH_4 (g/d)
Methane Yield	MY	CH_4 (g/unit of feed intake)
Methane Intensity	MI	CH_4 (g/unit of animal product)
Residual Methane Production	RMP	Actual CH_4 (g) – expected CH_4 (g)
Predicted Methane Emissions	PME	CH_4 (g/d) predicted with mathematical models
Methane Concentration		CH_4 ppm

Traits of interest



C.V. Ryan et al. 2022 WCGALP

What does the literature tell us?

- Methane-related traits are heritable
  - Predicted Methane: 0.12-0.44
  - Methane: 0.19-0.33
  - Methane Yield: 0.2-0.22
  - Methane Intensity: 0.21-0.25
  - Residual Methane: 0.15-0.19
  - Methane Concentration: 0.18-0.32

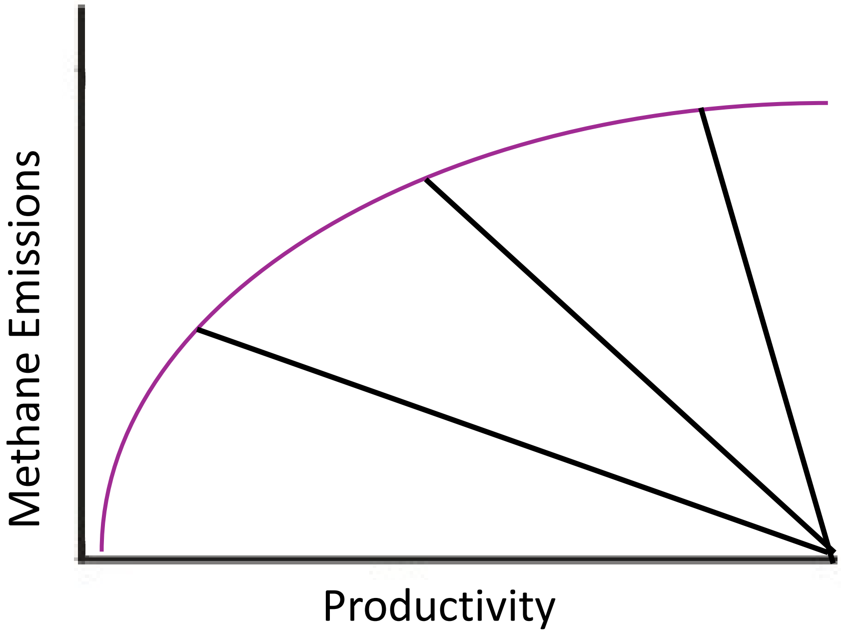
Before We Go Down This Path...

- We must understand how methane production (or chosen phenotype(s)) are related to other economically important traits

- We must have phenotypes on enough animals and methodologies to use them consistently and appropriately

What is the end goal?

- We know feed intake is related to methane production and so likely affects productivity of cows and offspring
  - There will almost certainly be tradeoffs in selection decisions
  - Desired gains vs productivity offset
- What are the market signals?



Potential for inclusion in genetic improvement programs

Focus of selection on methane changes with international context

- Emissions Intensity (kg CO_2/kg beef) altered through improvements in production traits that directly aligned with profit
  - Cow longevity
  - Fertility
  - Days on feed
  - Feed efficiency
- Absolute emissions are more difficult,
  - Likely targets in countries where CH_4 accounts for high % of country's emissions (e.g., NZ, Ireland, etc.)
- Valuation of carbon in marketplace remains an unknown

Relationships with other traits

EPD/index/trait	CED	BW	WW	YW	RADG	DMI	YH	SC	Doc	Claw	Angle	PAP	HS	HP	CEM	Milk	MW	MH	CalfWW
Avg_CH_4 EPD, Pear	-0.04	0.02	0.34**	0.40**	0.37**	0.33**	0.27**	0.15**	0.13*	0.02	0.09	-0.08	-0.06	0.08	0.05	-0.08	0.47**	0.36**	-0.13*
Avg_CH_4 EPD, Spear	0.01	-0.02	0.33**	0.39**	0.36**	0.35**	0.25**	0.16**	0.16**	0.01	0.09	-0.11*	-0.06	0.1	0.06	-0.09	0.44**	0.34**	-0.1
Avg_MHP EPD, Pear	-0.02	0.04	0.33**	0.39**	0.35**	0.37**	0.30**	0.06	0.13*	0.03	0.1	-0.04	-0.16**	0.06	0.11*	-0.12*	0.44**	0.37**	-0.11
Avg_MHP EPD, Spear	-0.01	0.03	0.28**	0.35**	0.34**	0.36**	0.25**	0.04	0.13*	-0.005	0.09	-0.05	-0.14*	0.05	0.09	-0.13*	0.39**	0.32**	-0.07

EPD/index/trait	$EN	CW	Marb	RE	Fat	$M	$W	$F	$G	$B	$C
Avg_CH_4 EPD, Pear	-0.45**	0.32**	0.05	0.03	0.08	-0.17**	0.11*	0.29**	0.04	0.24**	0.13*
Avg_CH_4 EPD, Spear	-0.42**	0.31**	0.05	0.03	0.11	-0.11	0.12	0.27**	0.04	0.21**	0.12*
Avg_MHP EPD, Pear	-0.41**	0.30**	0.12*	-0.02	0.06	-0.15**	0.09	0.26**	0.1	0.26**	0.16**
Avg_MHP EPD, Spear	-0.37**	0.27**	0.07	-0.01	0.06	-0.13*	0.05	0.24**	0.06	0.19**	0.09

*Significant at p-value < 0.05; **Significant at p-value < 0.01

What happens after sustained selection for reduced CH4 emissions? (in sheep)

frontiers | Frontiers in Genetics

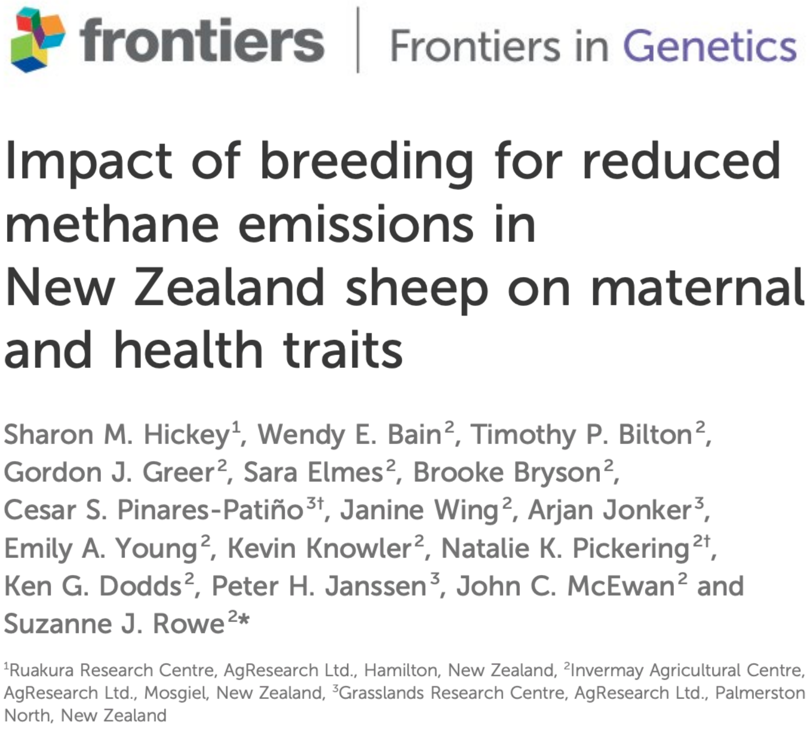
Can we have our steak and eat it: The impact of breeding for lowered environmental impact on yield and meat quality in sheep

S. J. Rowe[1]*, S. M. Hickey[2], W. E. Bain[1], G. J. Greer[1], P. L. Johnson[1], S. Elmes[1], C. S. Pinares-Patiño[3†], E. A. Young[1], K. G. Dodds[1], K. Knowler[1], N. K. Pickering[1†], A. Jonker[3] and J. C. McEwan[1]

[1]Invermay Agricultural Centre, AgResearch Ltd., Mosgiel, New Zealand, [2]Ruakura Research Centre, AgResearch Ltd., Hamilton, New Zealand, [3]Grasslands Research Centre, AgResearch Ltd., Palmerston North, New Zealand

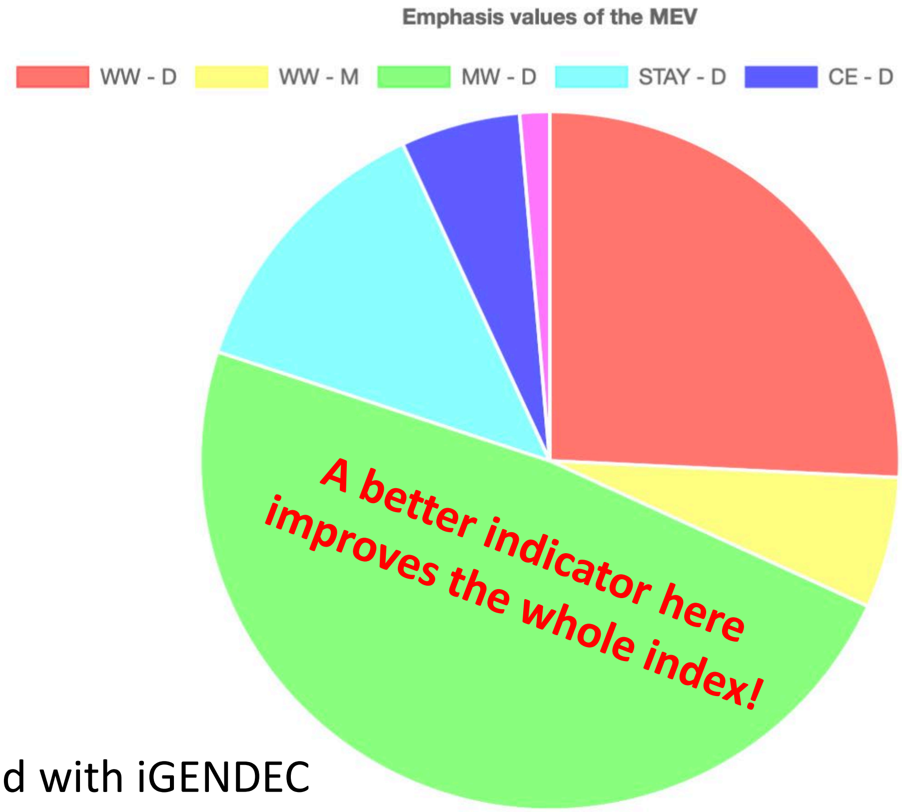
"Preliminary evidence, to date, shows that breeding for low methane may result in animals with higher lean yields that are economically favorable even before carbon costs and environmental benefits are taken into account."

What happens after sustained selection for reduced CH4 emissions? (in sheep)



"Results suggest that breeding for low CH_4/DMI is unlikely to negatively affect faecal egg counts, adult ewe fertility and litter survival traits, with no evidence for significant genetic correlations… wool, live weight and fat deposition traits may be affected over time and should be monitored"

Mature Weight (MW) is the indicator of cow feed intake in maternal & all-purpose indexes



- Cow feed costs are the largest variable cost for cow-calf operations
- Mature weight is our best indicator of feed intake
- MW is likely imperfectly related to actual forage-based feed intake
- Strong economic antagonism with carcass weight

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Gas Fluxes as a Proxy for Feed Intake

- Briggs et al. (2024): Low quality forage intake vs. GreenFeed Phenotypes in developing heifers

  “The phenotypic correlations of forage DMI with CO_2, CH_4, O_2, and heat production (HP) were 0.72, 0.66, 0.74, and 0.74, respectively.”

- Talley et al. (2025): Forage intake vs. GreenFeed phenotypes in lactating and gestating mature cows

  “positive phenotypic correlations for DMI ($r = 0.86$) and RFI ($r = 0.75$) between lactating and gestating cows”

  “strong positive phenotypic correlations between DMI and CO_2 or CH_4 during LACT ($r = 0.61$ CO_2 and $r = 0.61$ CH_4) and GEST ($r = 0.59$ CO_2 and $r = 0.56$ CH_4)”

One big remaining unknown:

Is feed efficiency on forage a different trait from feed efficiency on concentrate?

Ongoing Projects

- KSU – Ongoing phenotyping of grazing beef cows and comparisons of sniffers with GreenFeed
- UTK – Ongoing phenotyping, indirect indicators, microbiome
- UNL / USMARC / KSU – Phenotyping Germplasm Evaluation Herd
- BLUEGRASS Consortium – Phenotyping Angus Cows in USA, Australia, New Zealand, Ireland, and UK
- Colorado State – AgNext feedlot & pasture-based phenotyping
- Oklahoma State – Dr. Dave Lalman’s cow efficiency work

Thank you!