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Methane from Animal Agriculture

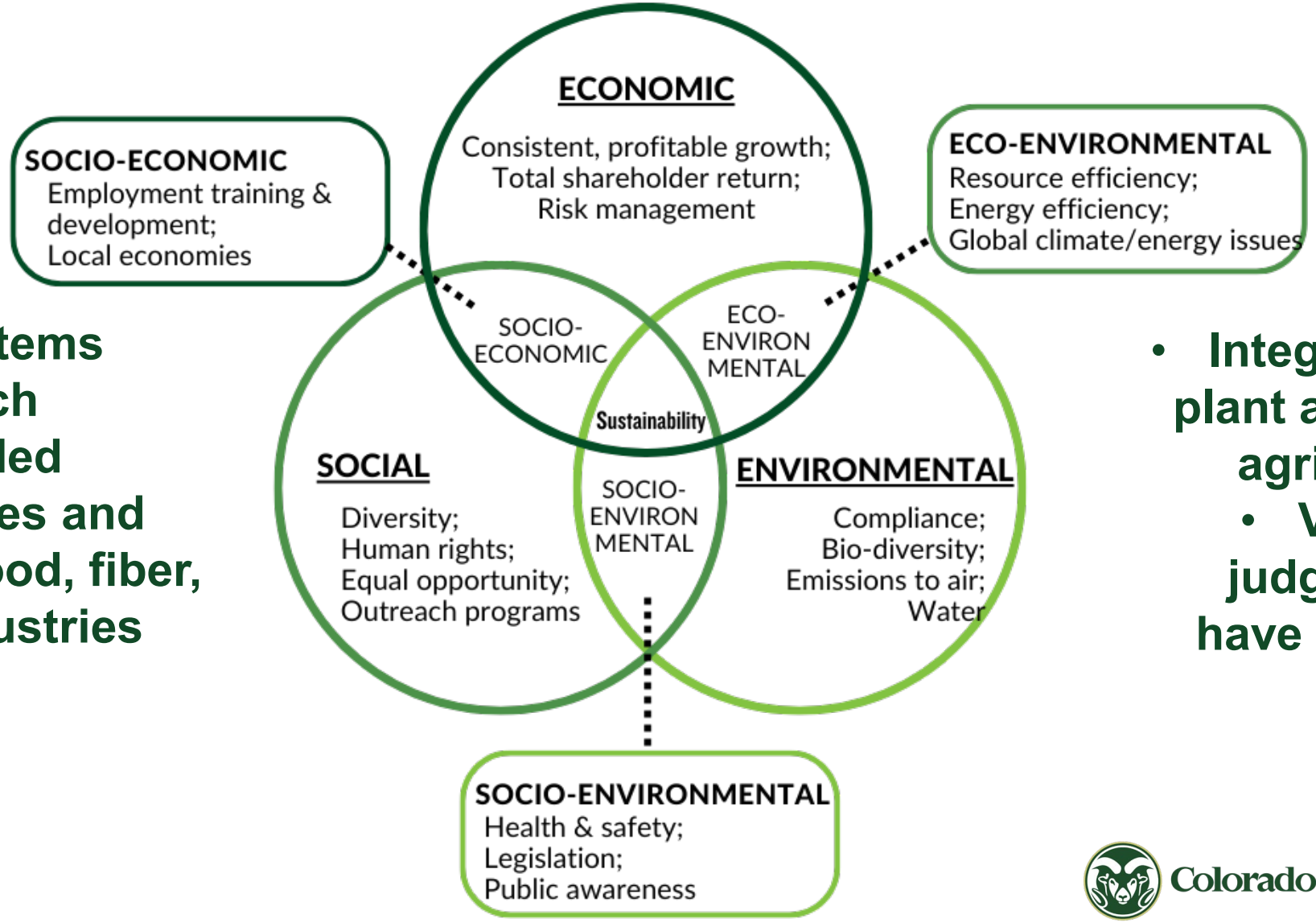
Methane Connections Conference

Kim Stackhouse-Lawson, PhD

October 5, 2023

Sustainability is Complex, Multi-Faceted and Often Emotionally Driven and Research Should Consider:

- Whole systems approach
- Unintended consequences and circularity of food, fiber, and fuel industries



- Integration of plant and animal agriculture
- Value judgements have influence

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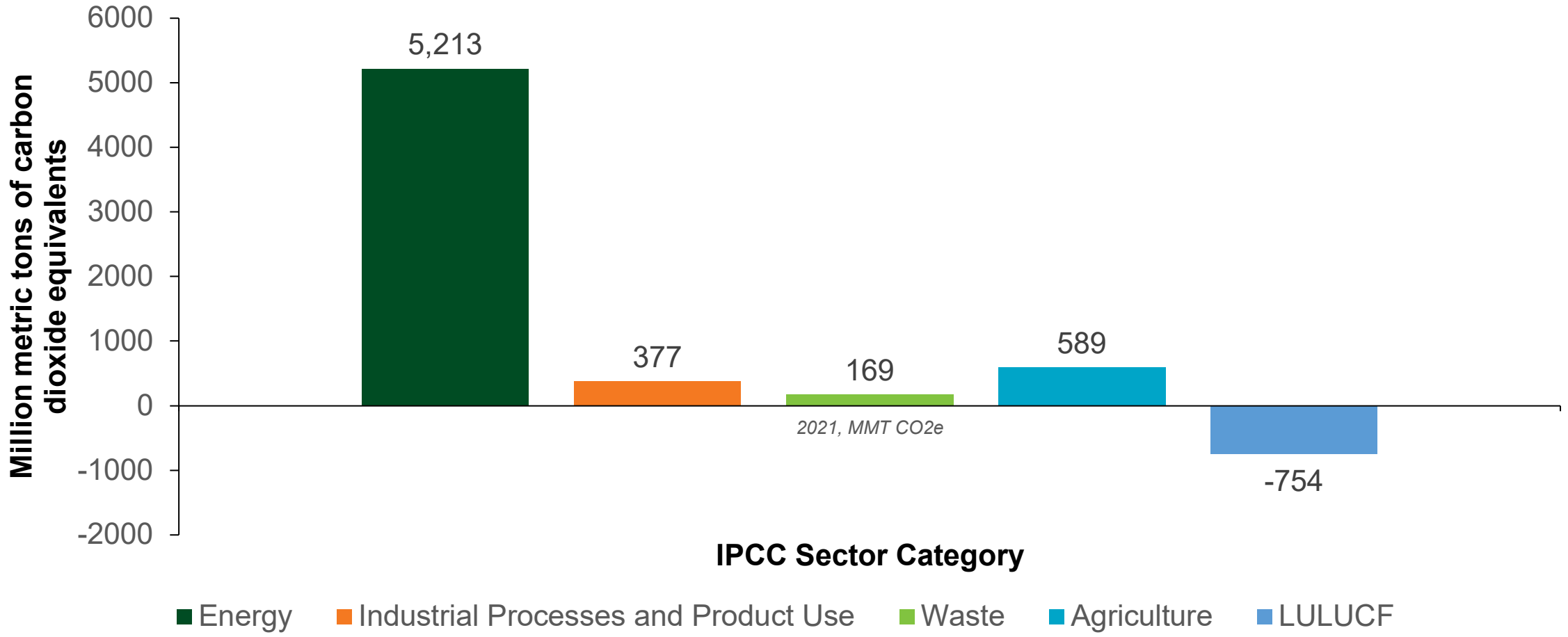
2021 US GHG emissions by IPCC sector/category – 82% of emissions are associated with energy, 9% from agriculture



Source: US EPA Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021
GWP100 values: CO_2 =1, CH_4 =28, N_2O = 265

2021 breakdown of agricultural emissions as % of US total GHG emissions

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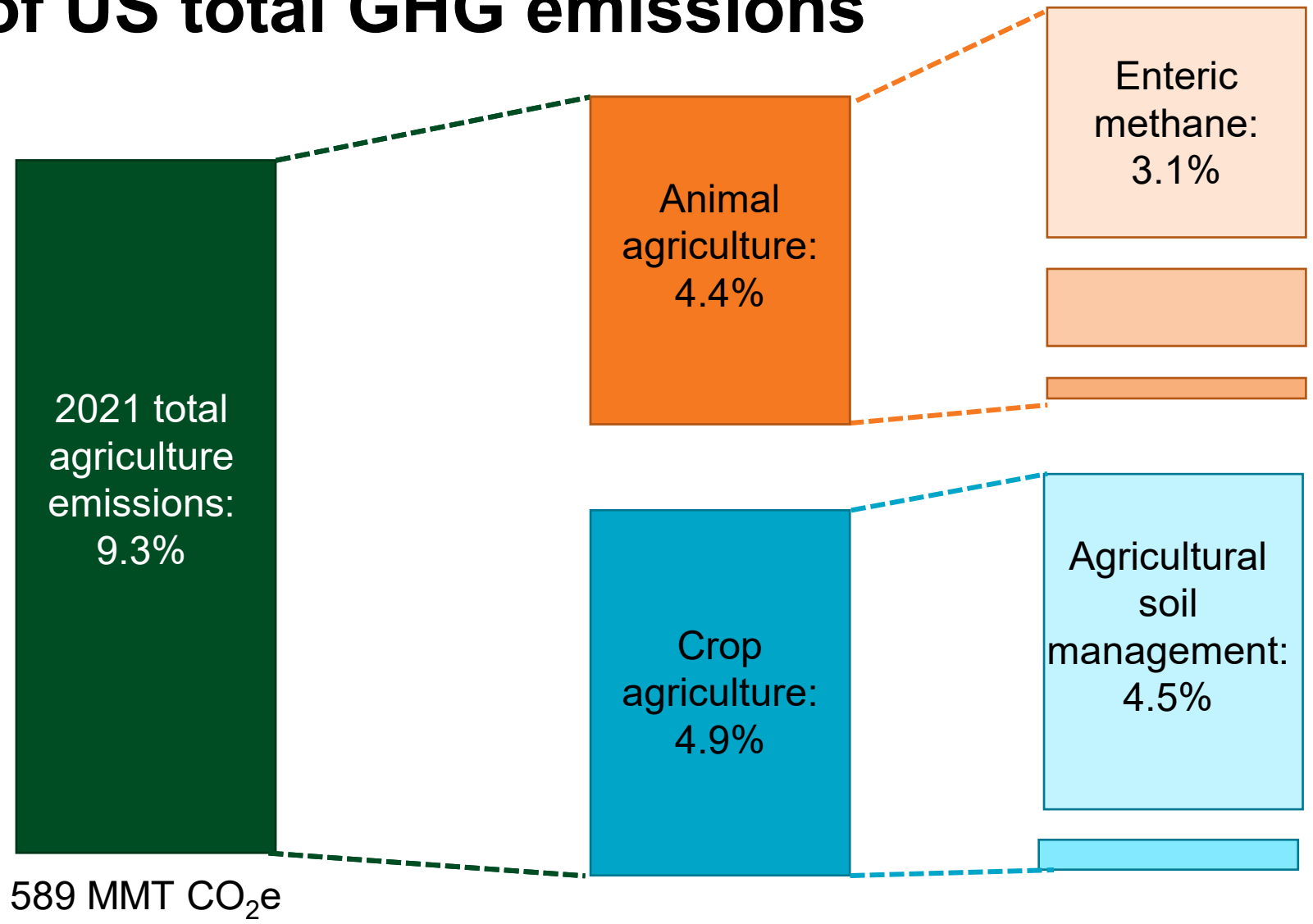

Source: US EPA Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021
GWP100 values: CO_2 =1, CH_4 =28, N_2O = 265

Methane emissions in the USA in 2021

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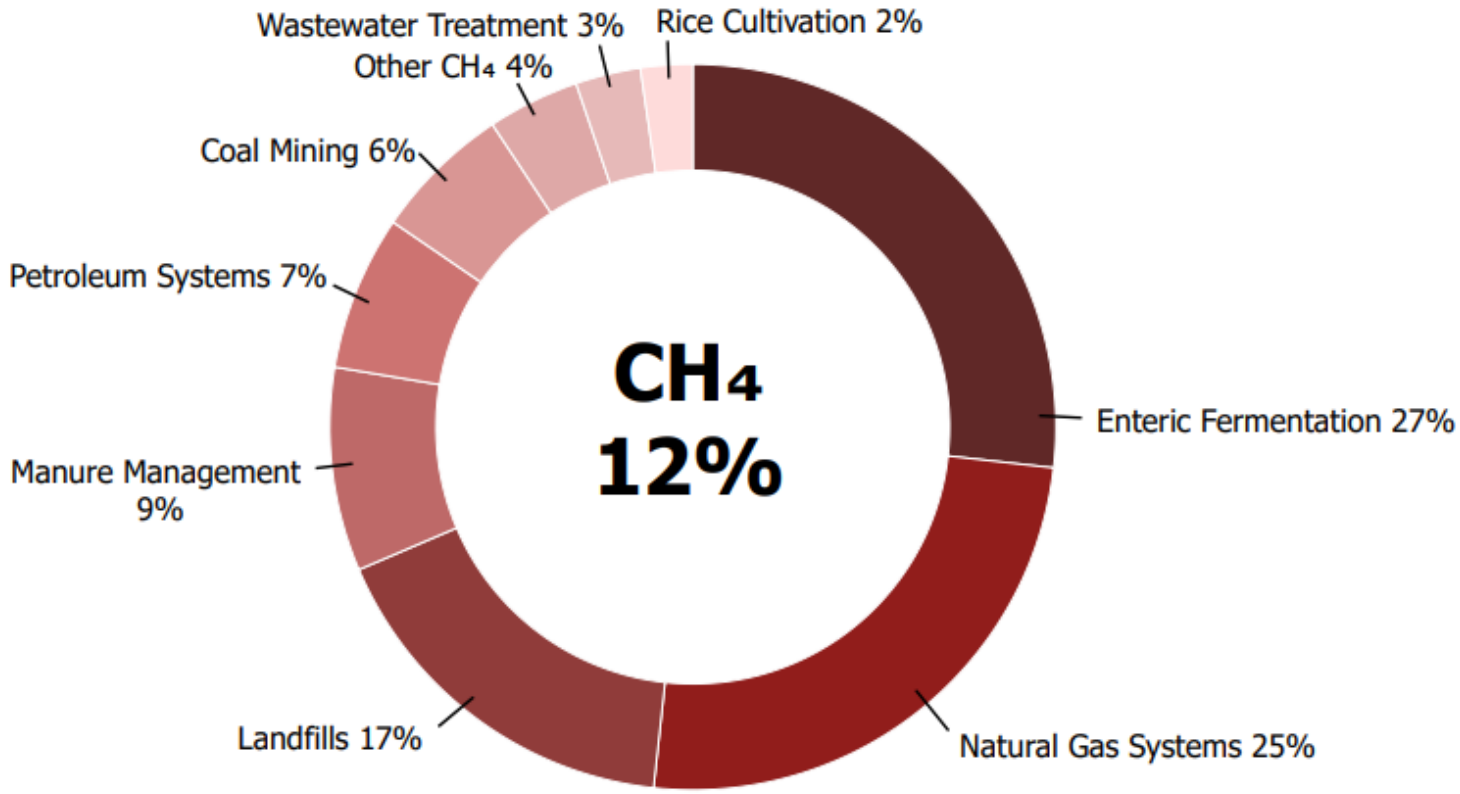

Figure 3: *2021 U.S. Sources of Methane (CH_4) Emissions, excluding CH_4 emissions from LULUCF sector from flooded lands, forest, and grassland fires.*

https://www.epa.gov/system/files/documents/2023-04/Data-Highlights-1990-2021.pdf

Environmental Footprints of Beef Cattle Production in the U.S.

150 representative production systems across seven regions

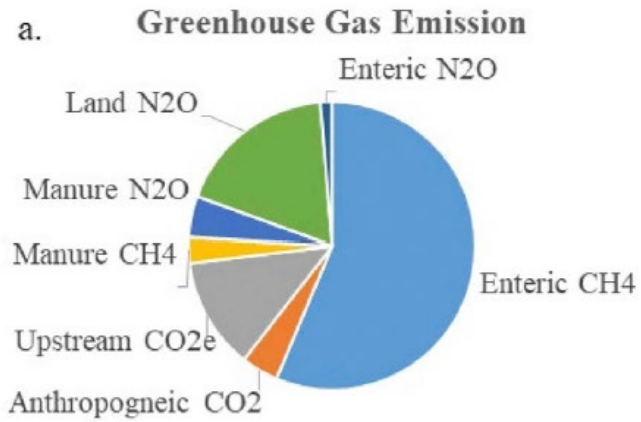

Fig 3 (abrev). Distribution of each environmental footprint among sources

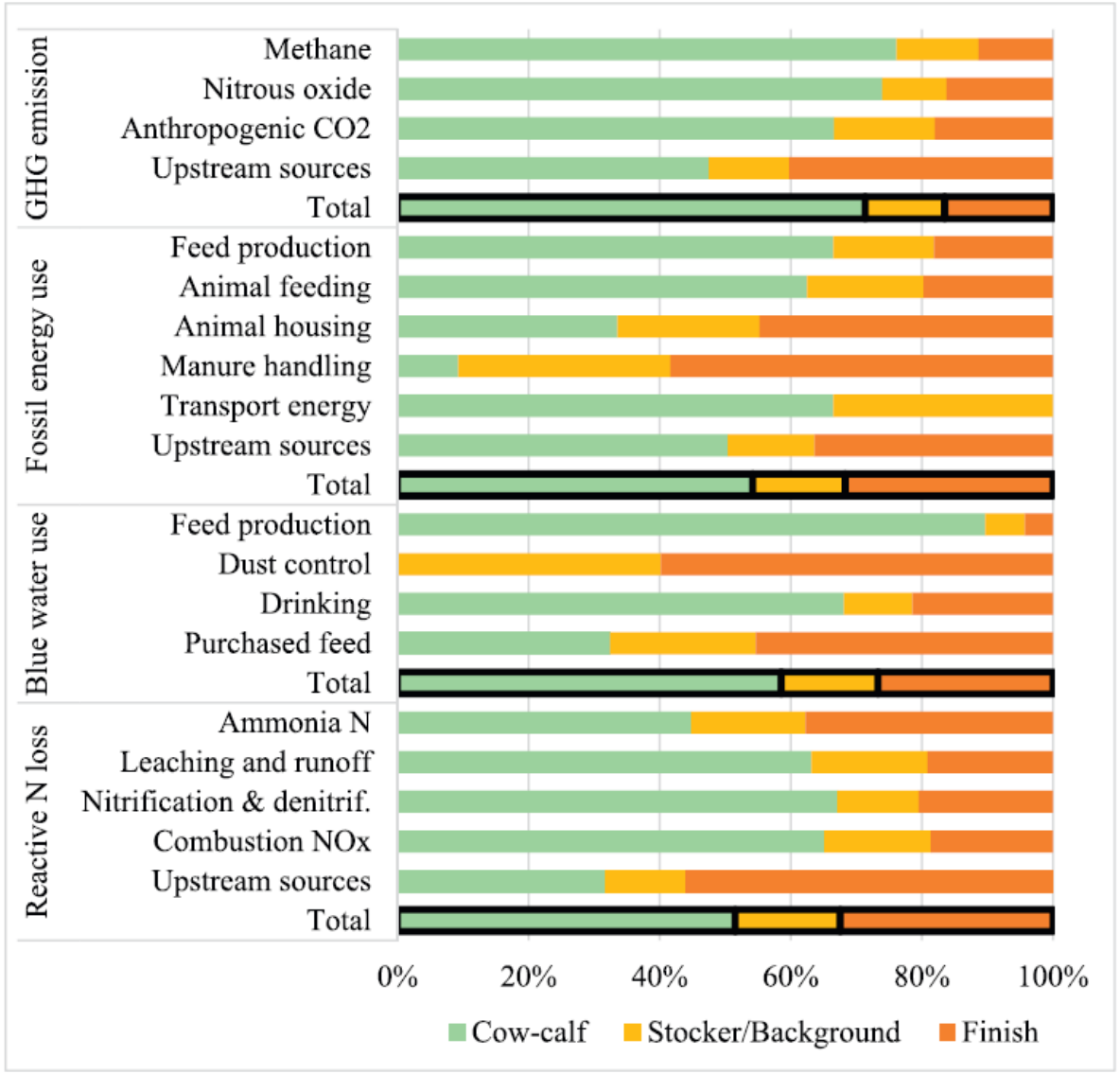

Fig. 2. Distribution of the sources of each environmental impact across the three major phases in the life cycle of beef cattle production.

Source: Rotz et.al, *2019. Agricultural Systems 1369:1-13.*

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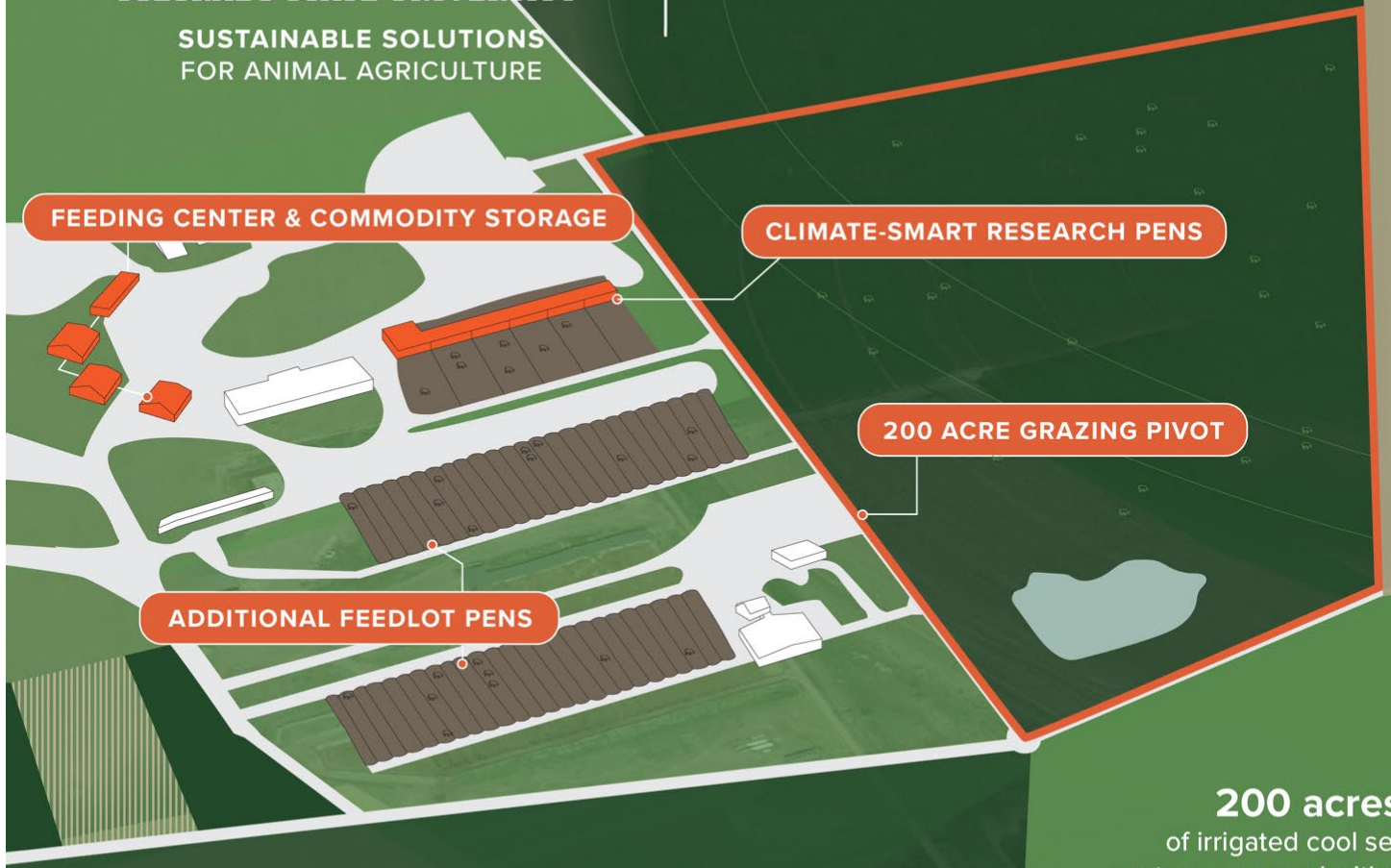
CLIMATE SMART INNOVATION



ADDITIONAL FEEDLOT PENS

Feedlot pens house **10 cattle per pen** for a total of **500 additional cattle.**

These feedlot pens allow for data replication to determine scalability of solutions.

CLIMATE SMART PENS

6 Climate-Smart Research Pens

6 GreenFeeds & **12 SmartScales**

totaling 1 GreenFeed & 2 SmartScales per pen

50 head pens,
space for
300 cattle

5 SmartFeeds
per pen for individual animal intake

The Climate-Smart Pen installation at ARDEC is the largest public institution research facility of its kindmeasuring sustainable livestock systems and cattle GHG emissions.

IRRIGATED GRAZING PIVOT

200 acres
of irrigated cool season pasture managed with rotational grazing practices

2 pasture GreenFeeds
emission measurement systems
CH_4 • O_2 • CO_2 • H_2

2 SmartFeed Pro trailers
for precision delivery of feed additives

GreenFeeds combined with SmartFeeds allow for evaluation of dietary and management strategies that impact cattle emissions, efficiency, and sustainability.

Having grazing and feedlot research in one facility allows researchers to conduct full system evaluation of beef cattle production sustainability and ecosystem health.

How we measure methane emissions

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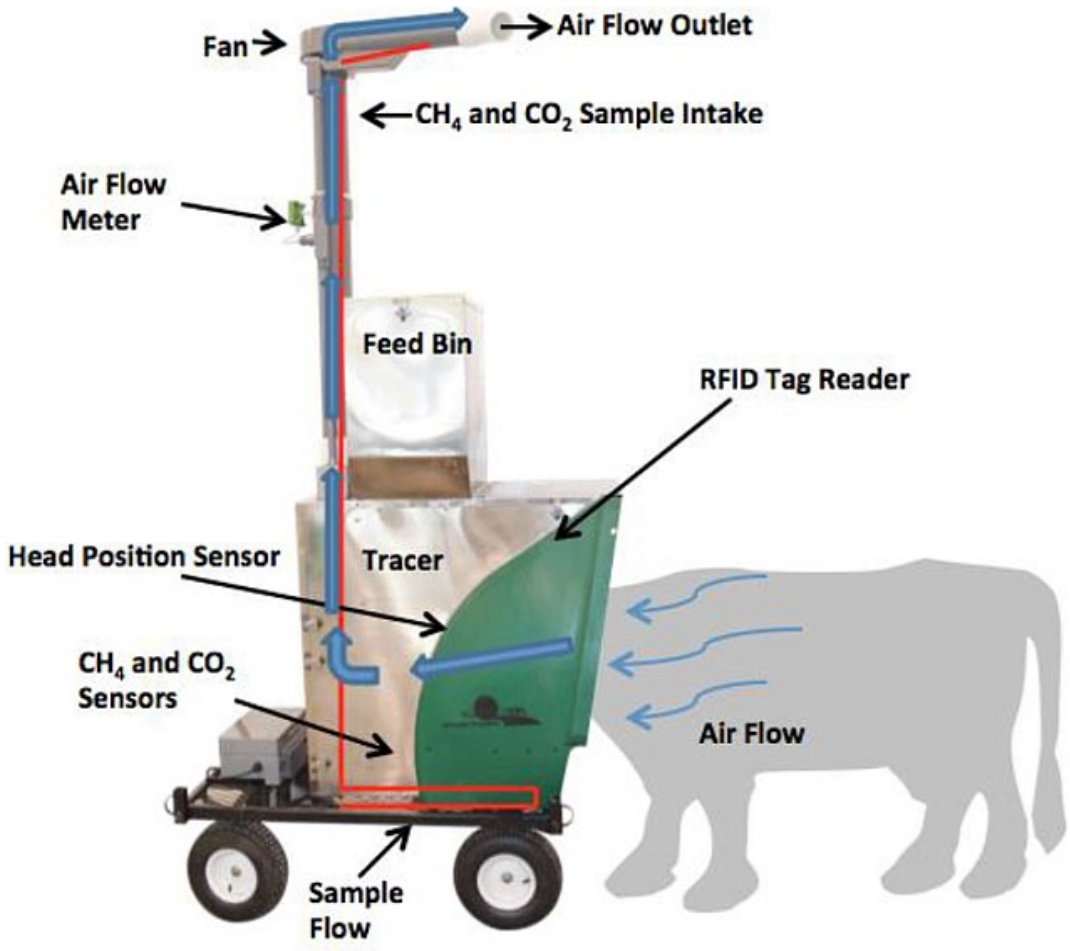
$$CH_{4volume} = F_c * C_R * \sum_{tp} [\Delta_t * (CH_{4avg} - CH_{4bkgrnd}) * Q_{air}]$$

Where:

- C_R = Capture rate of emissions into collection pipe, determined using the tracer (%)
- Δt = Time period over which emissions are measured (1 second)
- CH_{4avg} = Average concentrations during the measurement period (%)
- $CH_{4bkgrnd}$ = Background concentrations of CH_4 (%)
- Q_{air} = Airflow rate during the measurement period (flow per unit time)
- F_c = Dimensional factor

C Lock's GreenFeed



https://www.jove.com/t/52904/the-use-an-automated-system-greenfeed-to-monitor-enteric-methane

Methane concentration data from Greenfeed

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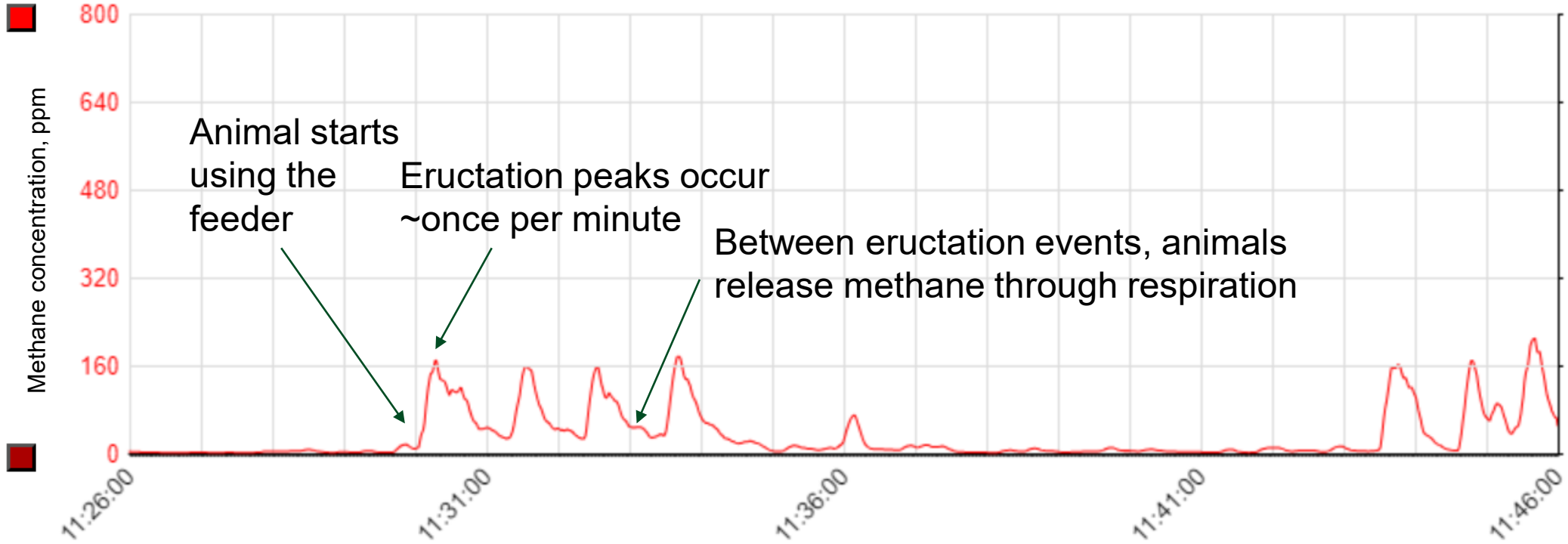

Auto-Scale Y-Axis Raw Values Converted Values

Save Link Series 1: CH4 Plot Data Series 2: ---

10-sec Moving Avg Download Data... 10-sec Moving Avg

Evaluation of methane emissions from CSU steers, heifers, and bulls

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November 2022 – January 2022

- First use of Climate Smart Research Pens
- 192 cattle evaluated for gas flux (methane, carbon dioxide, oxygen), body weight gain, and feed intake
  - 99 steers
  - 57 heifers
  - 36 bulls
- Cattle from Rouse & ARDEC herds

Maya Swenson

Diurnal pattern of methane emissions

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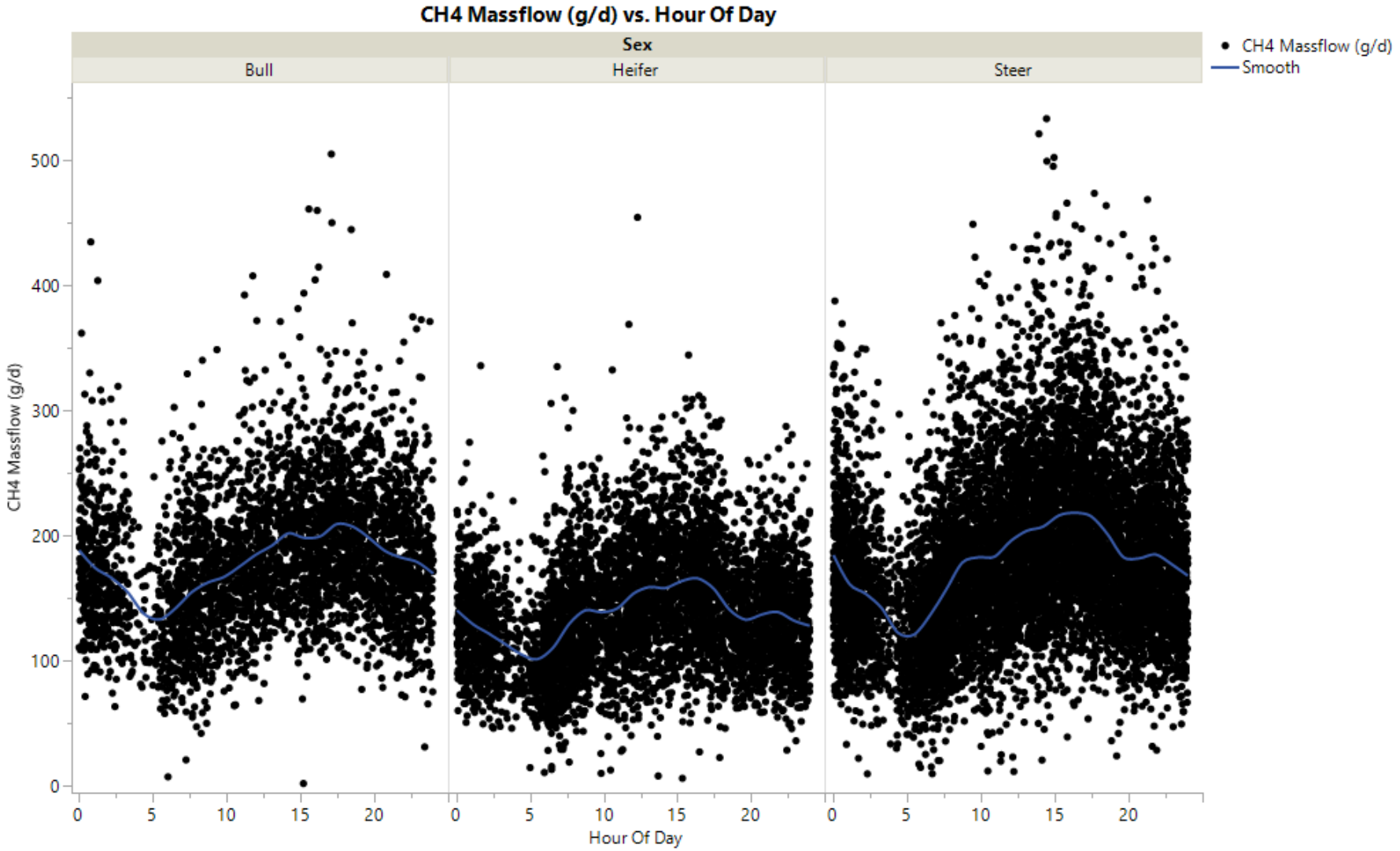

*Preliminary data; final published results may vary

Methane emissions are correlated with feed intake

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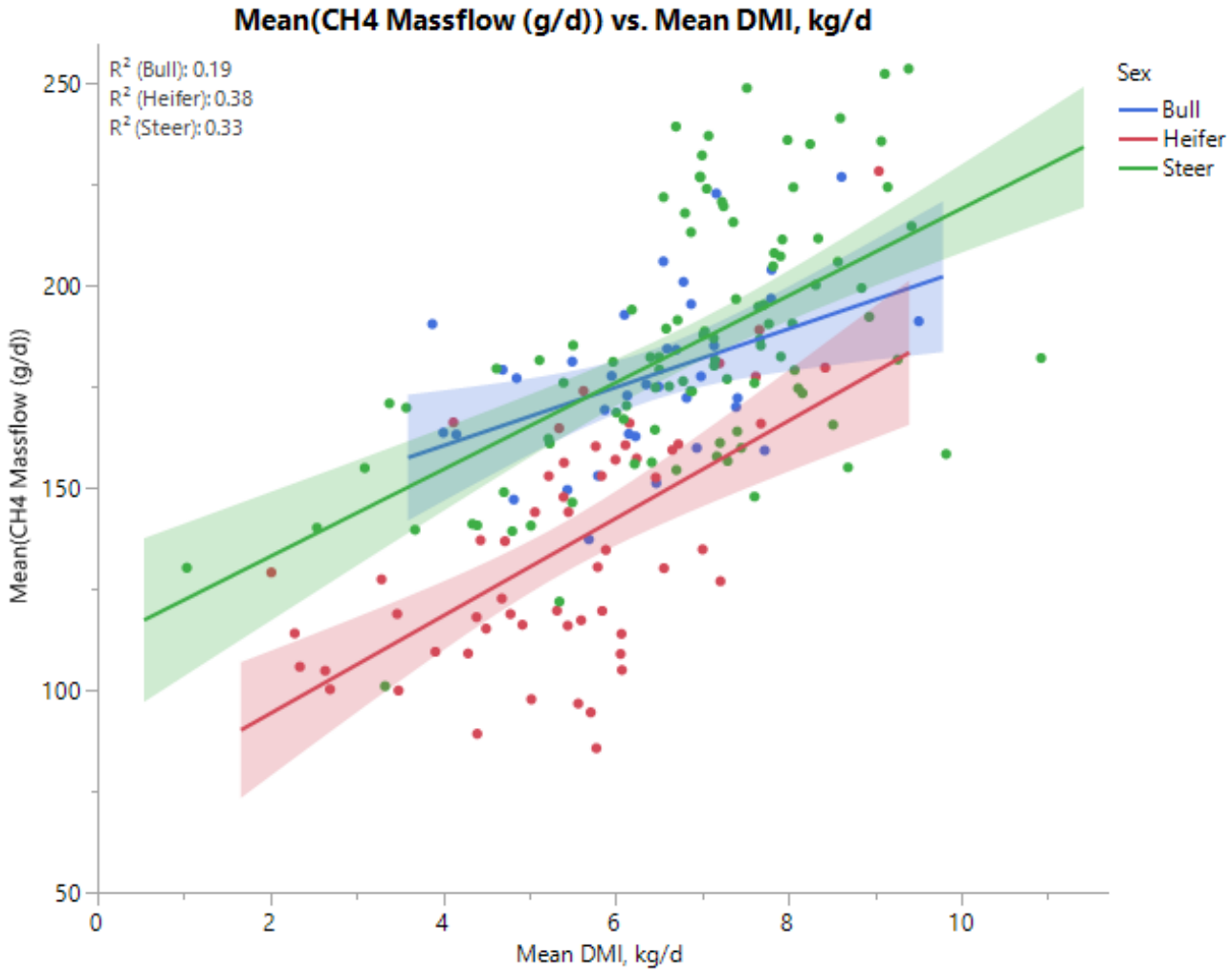

*Preliminary data; final published results may vary

Correlations between methane emissions and animal performance

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Variable	Methane emissions, g/d	ADG, kg/d	DMI, kg/d	Mid body weight, kg	Feed: Gain
Methane emissions, g/d	1				
ADG, kg/d	**0.76**	1			
DMI, kg/d	**0.65**	**0.72**	1		
Mid body weight, kg	**0.68**	**0.73**	**0.60**	1	
Feed: Gain	**-0.33**	**-0.56**	0.08	**-0.35**	1

Bold font = statistically significant $P < 0.05$

Faster growing, higher intake, and heavier cattle = higher methane emissions
More feed efficient cattle = slightly higher methane emissions

*Preliminary data; final published results may vary

Controlling for body size and feed intake, we can determine cattle that emit more or less methane than expected

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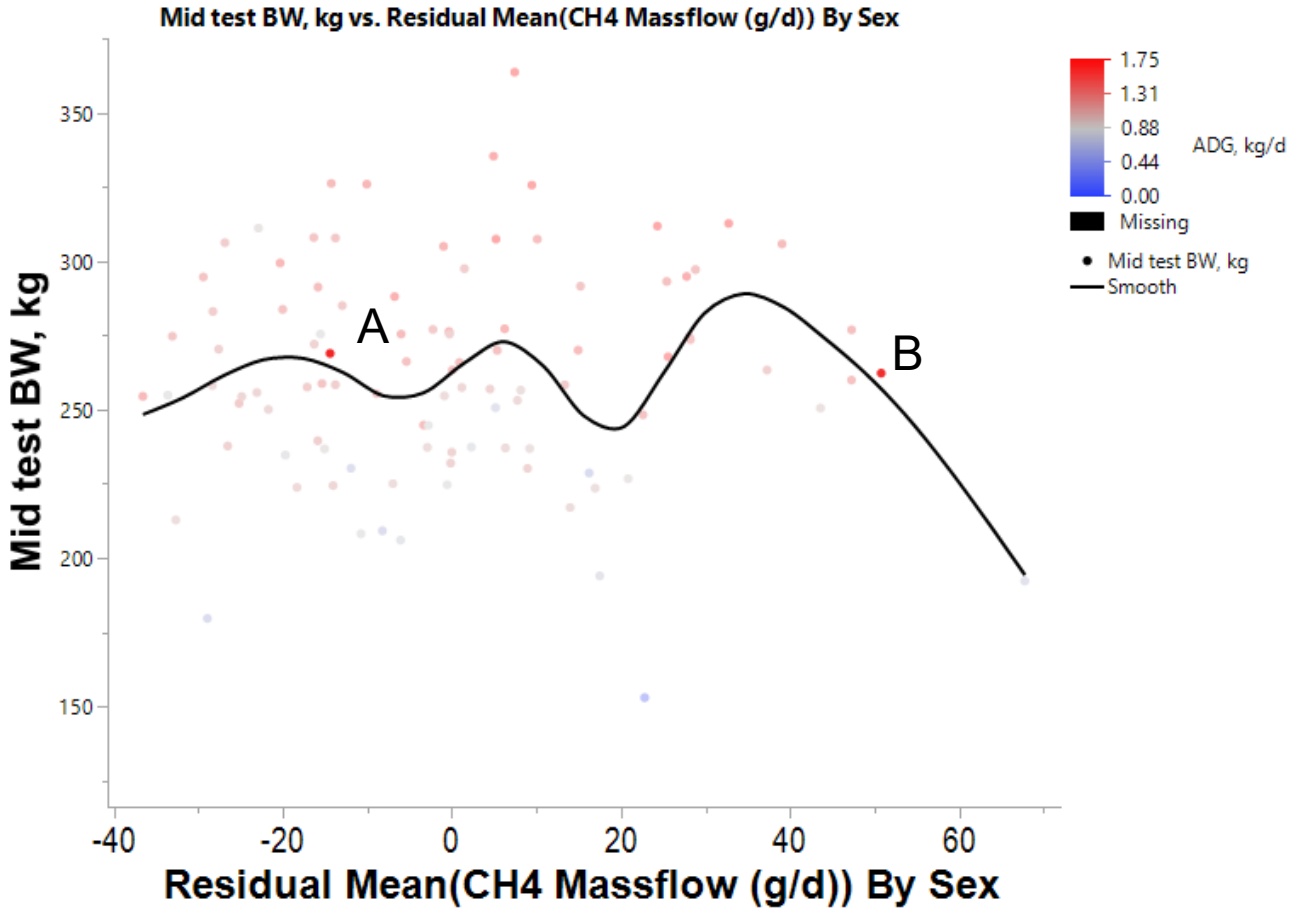

Steer A	Steer B
1.62 kg ADG	1.58 kg ADG
8.07 kg DMI	7.07 kg DMI
178 g CH4	237 g CH_4
269 kg BW	262 kg BW

Steer B had 33% higher methane emissions

*Preliminary data; final published results may vary

How do measured emissions compare with predictions (n=192)?

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Item, g CH_4/hd/d	Observed	Mills et al., 2003 NL2**	IPCC tier 2**	Moraes et al., 2014 Animal Level**
Mean	169.0	168.2	138.5	123.0
Median	171.4	173.2	142.0	126.2
Standard deviation	36.3	40.13	36.33	28.60
Min	85.59	30.34	22.58	26.44
Max	253.4	269.7	238.5	195.3

Mean not significantly different from observed emissions

18 & 27% lower than observed methane emissions

*Preliminary data; final published results may vary
**excludes GreenFeed bait feed

Born out of a need for industry-academic partnership to solve wicked problems.

AgNext's enteric methane focus areas

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1. Improve empirical models
   - Better understand baselines
2. Develop and test dietary mitigation techniques
3. Understand rumen microbiome controls
   - Future: develop mitigation techniques targeting microbial processes
4. Investigate prospect of developing selection tools for low methane emitting cattle

Overarching: focus on practicality, scalability, economic viability

AgNext Faculty and Staff

Dr. Kim Stackhouse-Lawson
Director

Jenn "JR" Rieskamp
Head of Strategy and Communications

Dr. Sara Place
Associate Professor of Feedlot Systems

Dr. Greg Thoma
Director of Agricultural Modeling and Lifecycle Assessment

Dr. Nathan Delay
Associate Professor of Livestock Economics

Dr. John Ritten
Associate Professor of Livestock Economics

Dr. Diego Manriquez
Assistant Professor and Dairy Systems Specialist

Dr. EJ Raynor
Grazing Research Scientist

Dr. Pedro Carvalho
Assistant Professor, Feedlot Specialist

Brooklynn Moore
Administrative Coordinator

Erica Giesenhagen
Communication Coordinator

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