Changing the Narrative Around Animal Agriculture Using Innovative Genetic Selection

Dr. Michael Lohuis, The Semex Alliance

Outline

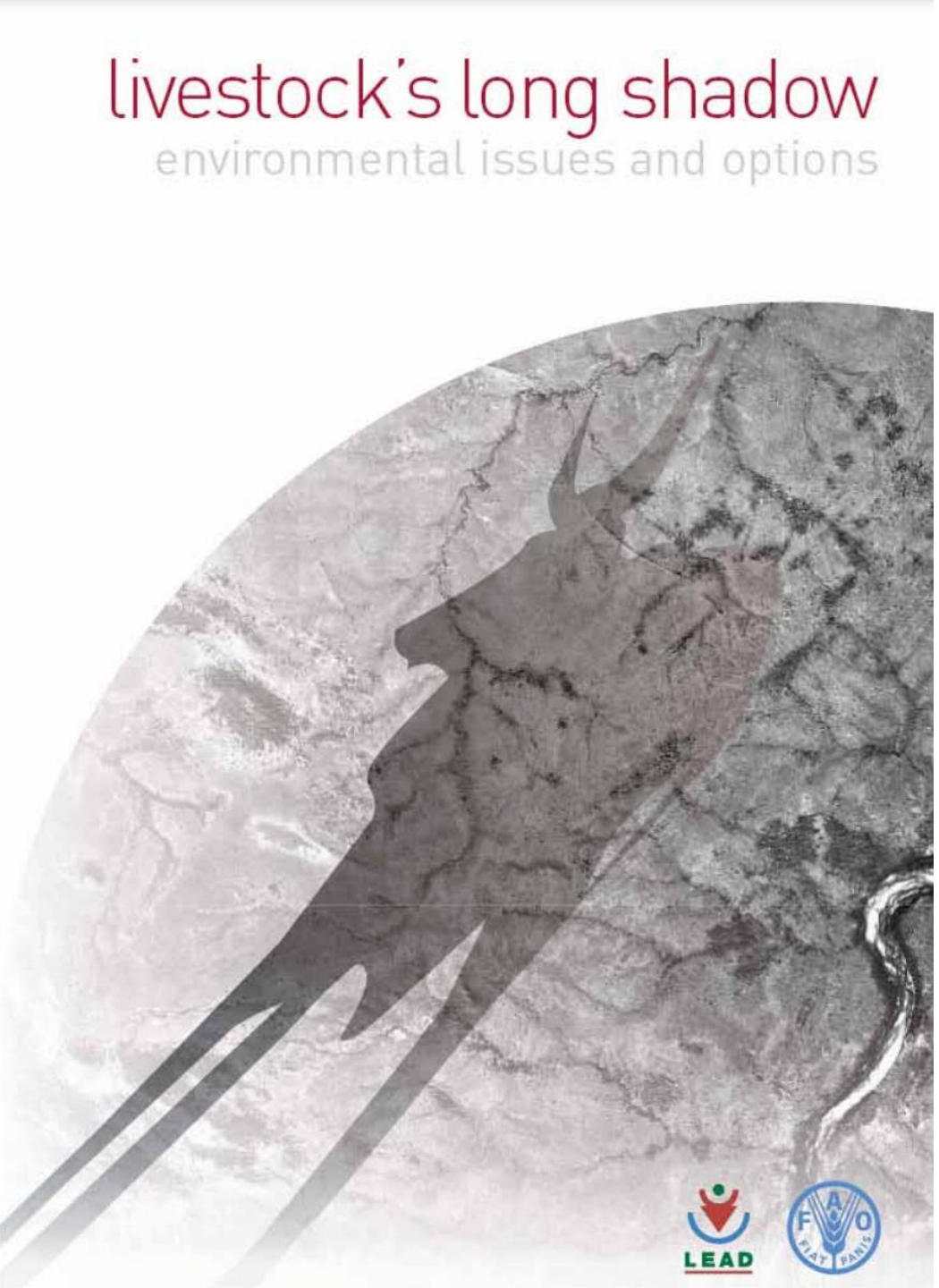
- The Narrative
- Environmental traits
- Health & Welfare Traits
- Beef on Dairy
- Reframing the Narrative Surrounding Beef

What's the narrative about livestock?

- High quality source of protein
- Enjoyable food and livelihoods
- Large contributor to economies
- Essential for developing countries

BUT there is another narrative…

- Environmental impacts
- Animal welfare
- Antibiotic use
- Factory farms
- Depletion of resources
- Deforestation



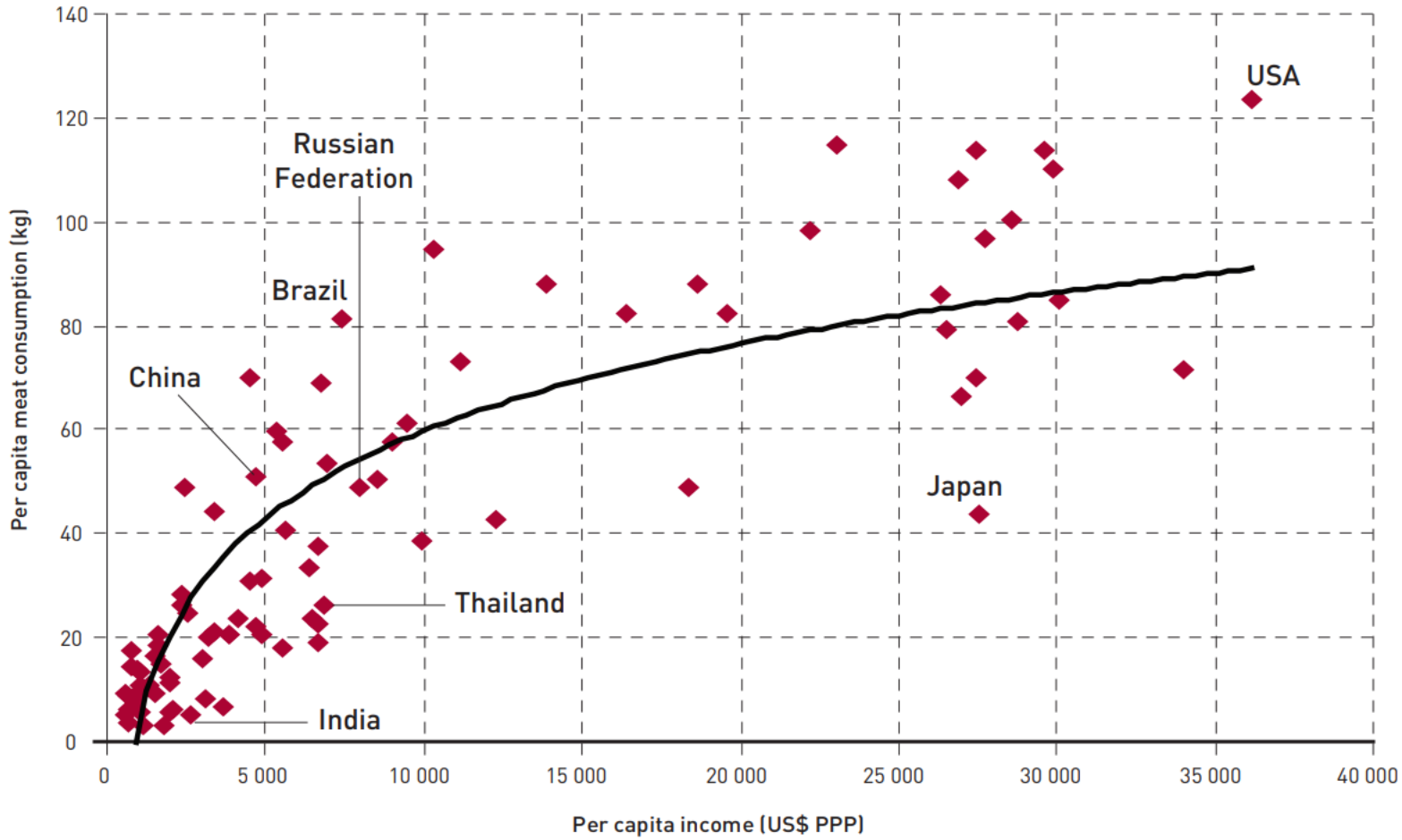
Environmental Concerns

"The livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions measured in CO2 equivalent. This is a higher share than transport."

"The environmental impact per unit of livestock production must be cut by half, just to avoid increasing the level of damage beyond its present level."

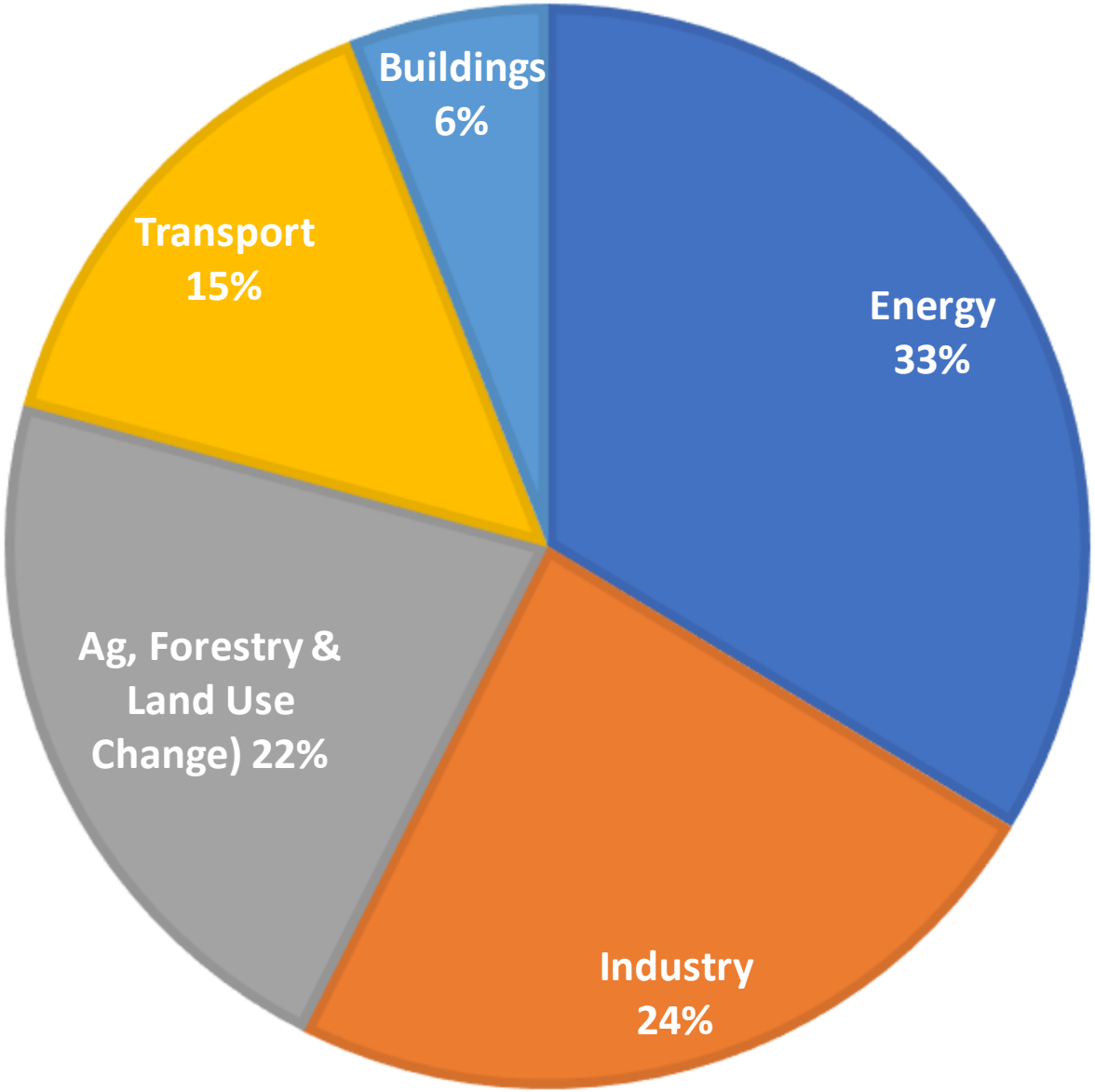
Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, and C. de Haan. 2006. Livestock's Long Shadow – Environmental Issues and Options. Food and Agriculture Organization of the United Nations, Rome, Italy.

Figure 1.4 **The relationship between meat consumption and per capita income in 2002**



Note: National per capita based on purchasing power parity (PPP).
Source: World Bank (2006) and FAO (2006b).

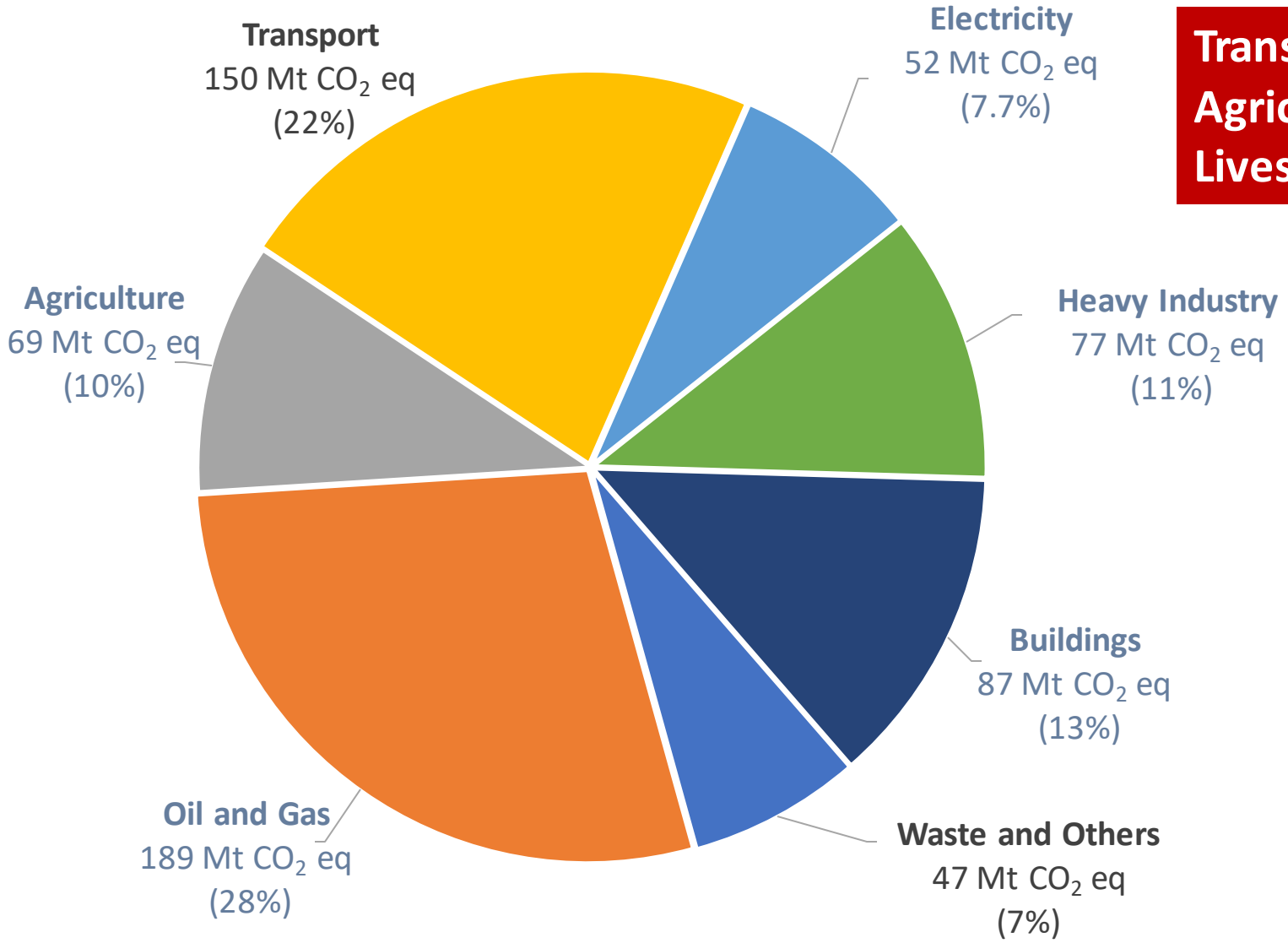
Global GHG Emissions by Economic Sector (2019)



Transport:	8.7 Gt CO_2 eq (15%)
AFOLU:	13 Gt CO_2 eq (22%)
Forestry & LUC	6.8 Gt CO_2 eq (12%)
Agriculture:	6.2 Gt CO_2eq (10%)
Livestock:	3.1 Gt CO_2 eq (5%)
Cropping:	3.1 Gt CO_2 eq (5%)

Adapted from IPCC ARC WG III (2022)

Canada's GHG Emissions by Economic Sector (2021)

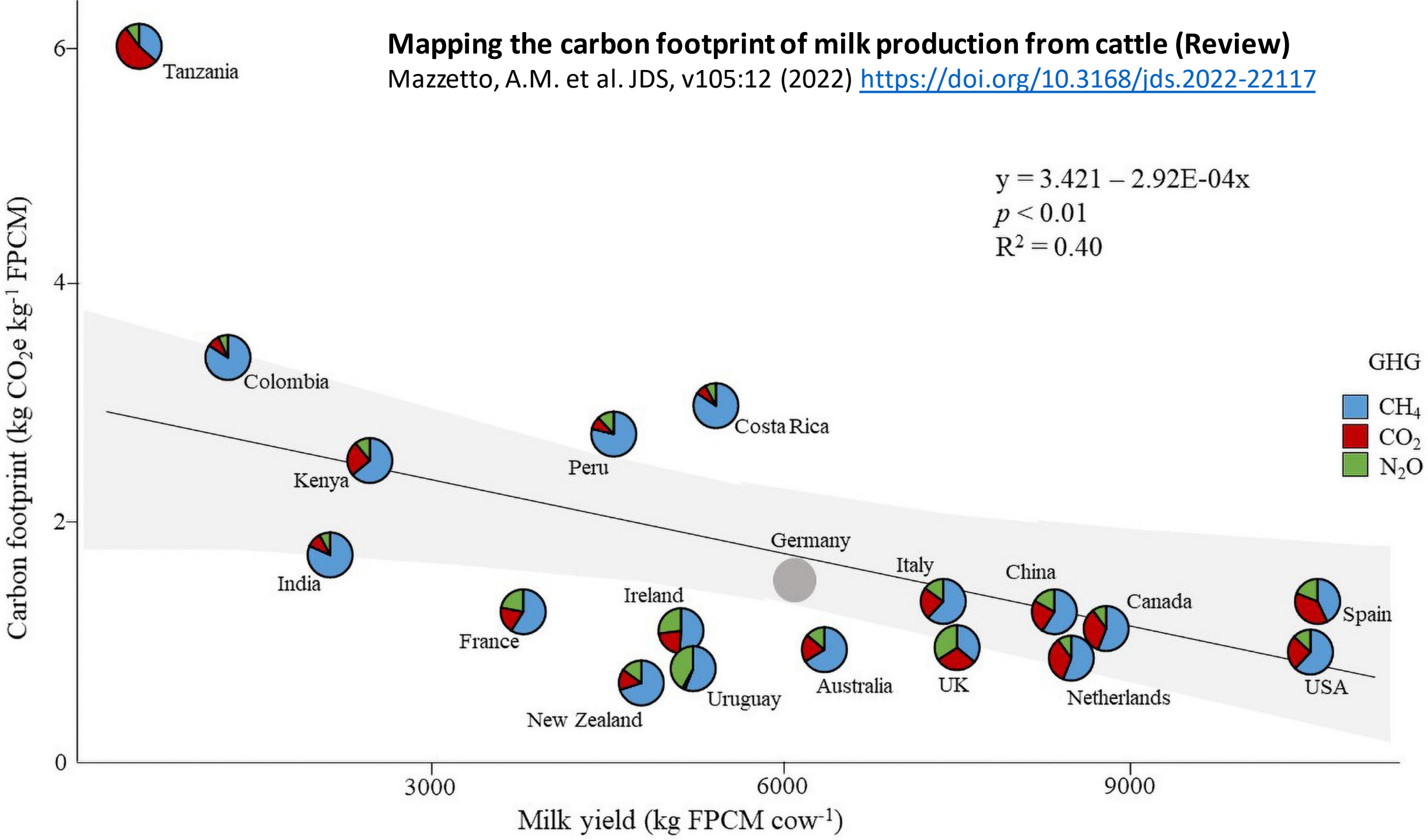


Transport:	**150 Mt CO_2 eq (22%)**
Agriculture:	**69 Mt CO_2 eq (10%)**
Livestock:	**34 Mt CO_2 eq (5%)**

Adapted from https://publications.gc.ca/collections/collection_2022/eccc/En81-4-2020-1-eng.pdf

Mapping the carbon footprint of milk production from cattle (Review)

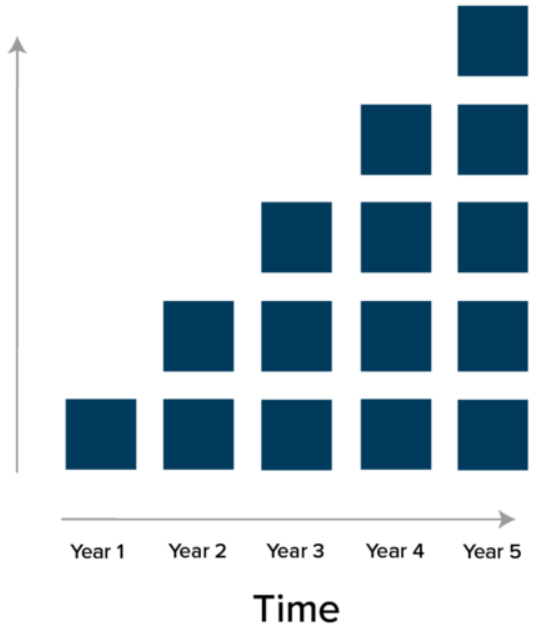
Mazzetto, A.M. et al. JDS, v105:12 (2022) https://doi.org/10.3168/jds.2022-22117



= Pulse of CO_2

Stock Gas

Carbon dioxide (CO_2)

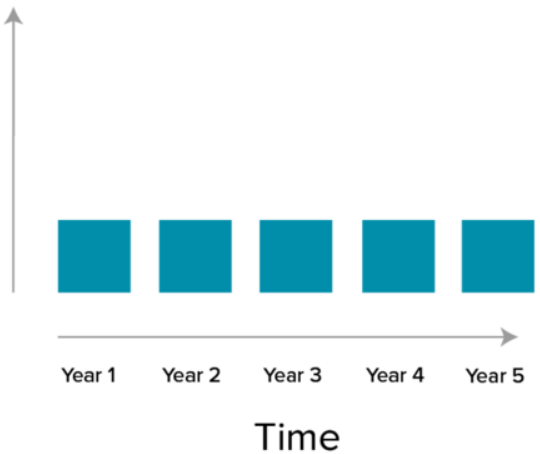


Stock gases will accumulate over time, because they stay in the environment.

= Pulse of CH_4

Flow Gas

Methane (CH_4)



Flow gases will stay stagnant, as they are destroyed at the same rate of emission.

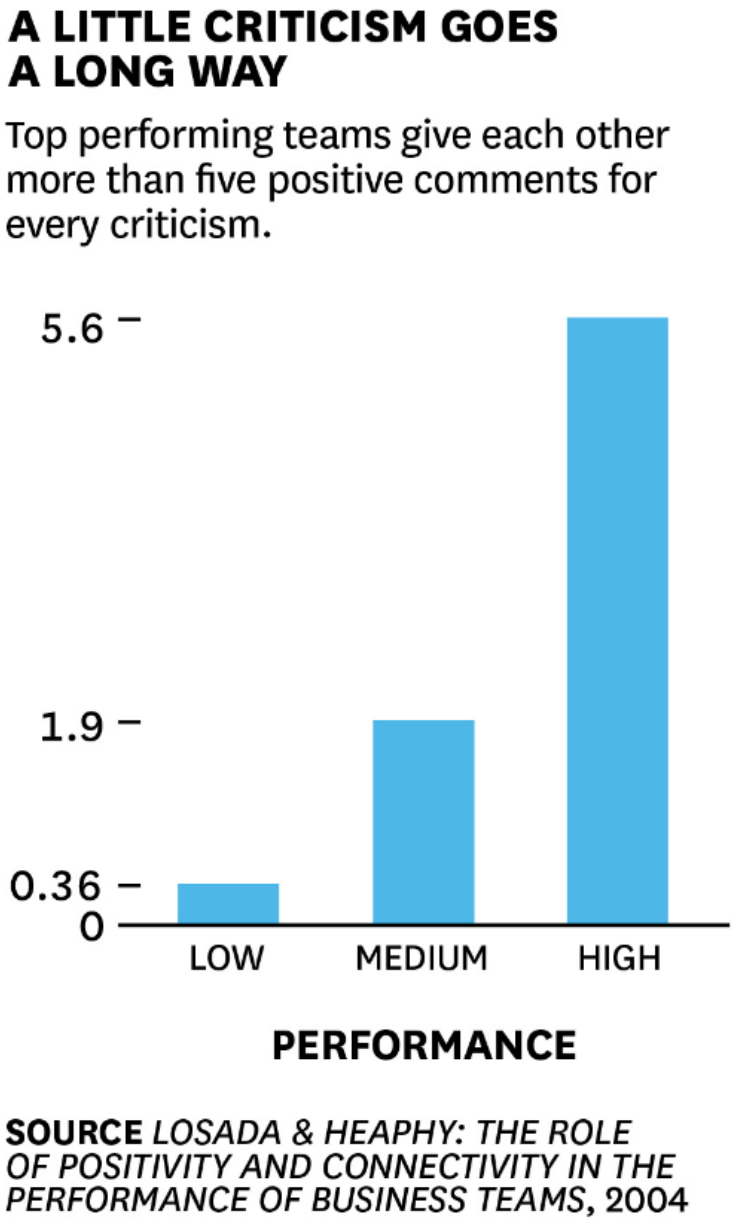
UCDAVIS CLEAR Center

Based on research by Myles R. Allen, Keith P. Shine, Jan S. Fuglestvedt, Richard J. Millar, Michelle Cain, David J. Frame & Adrian H. Macey.
Read more here: https://rdcu.be/b1t7S

Why not just provide the facts?

Countering the narrative

How many positive stories does it take to counter a bad story?



Net Zero by 2050

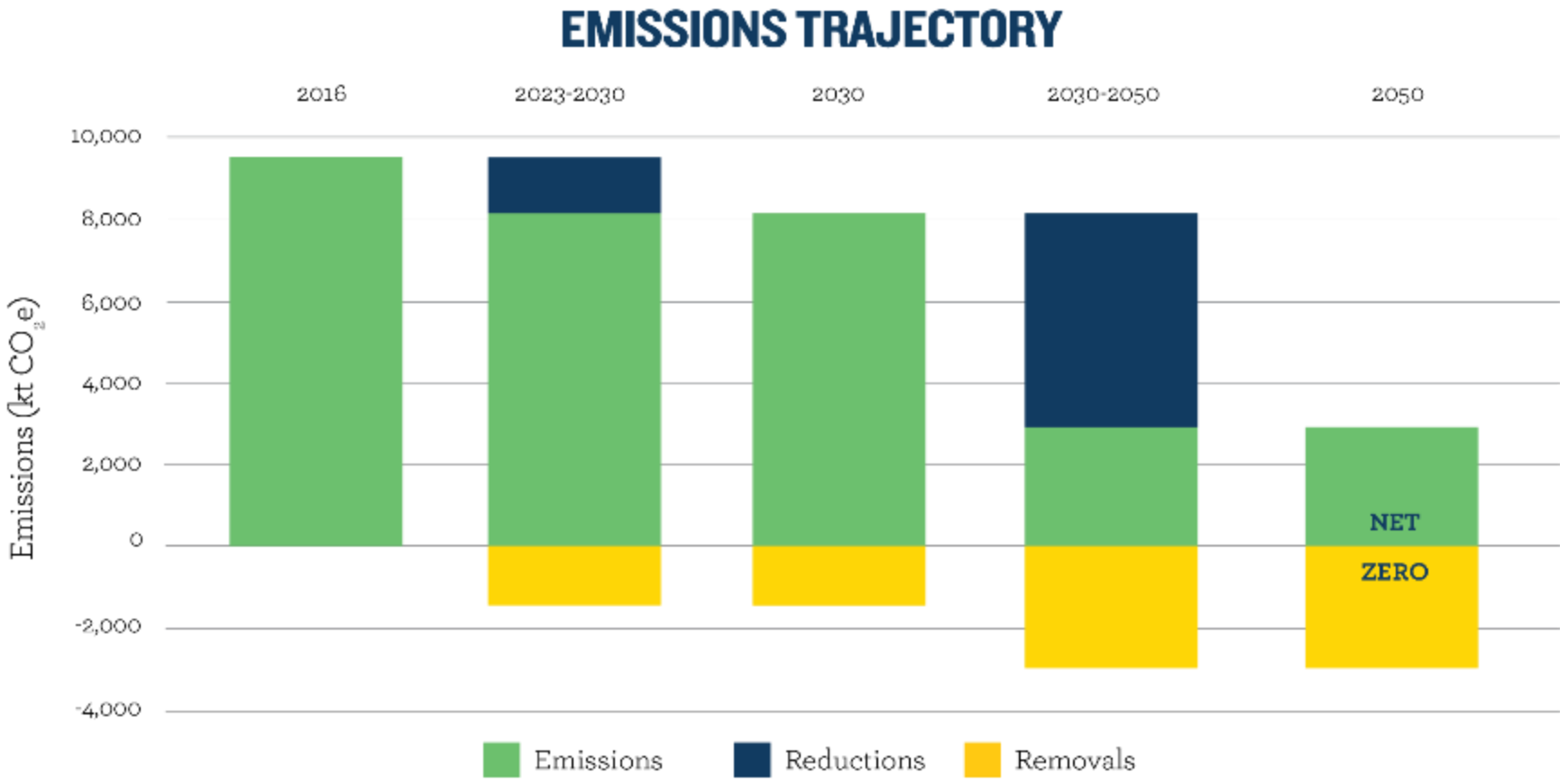
Respond to Consumer Expectations

Support a Thriving Sector

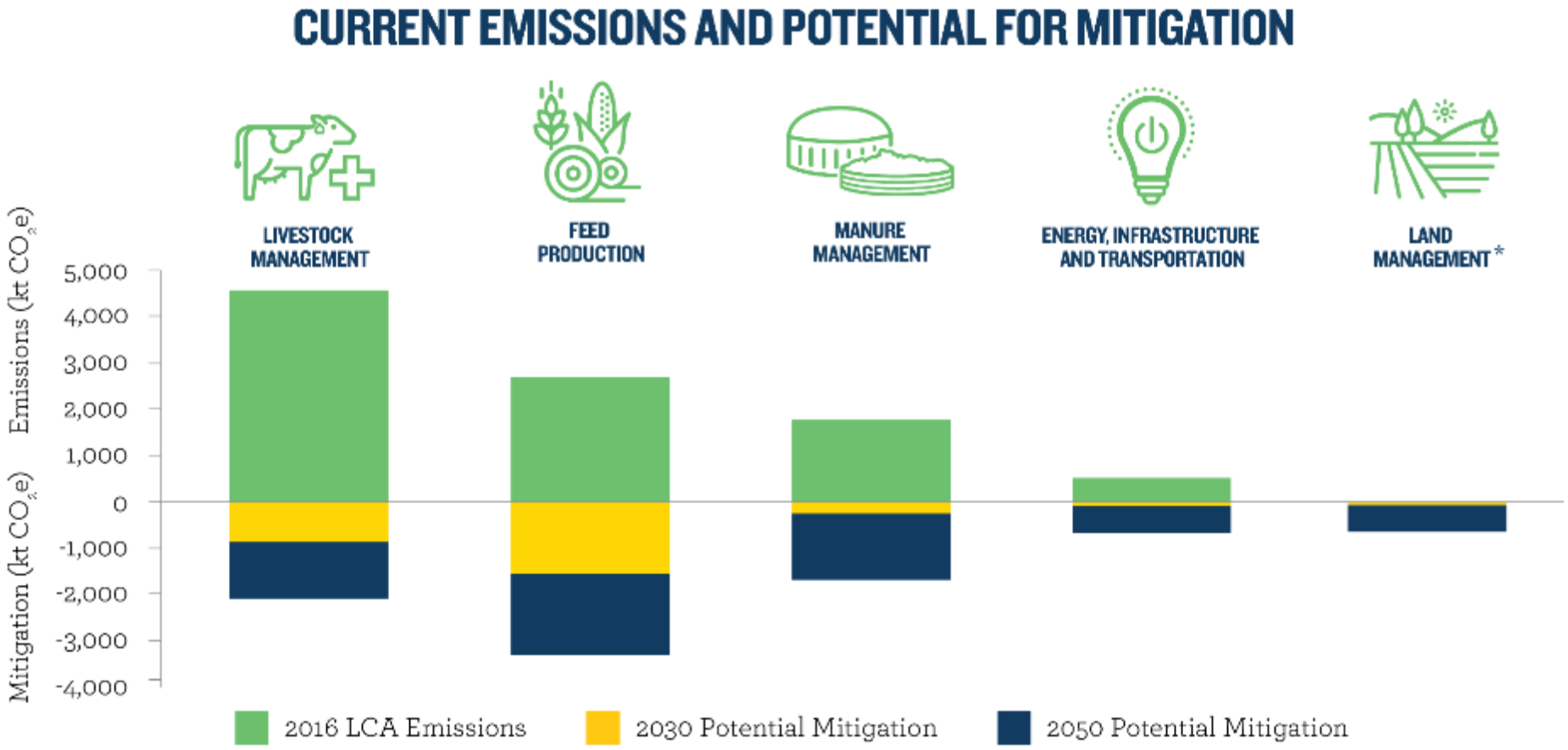
Mitigate Impacts of Climate Change

Align with outside targets

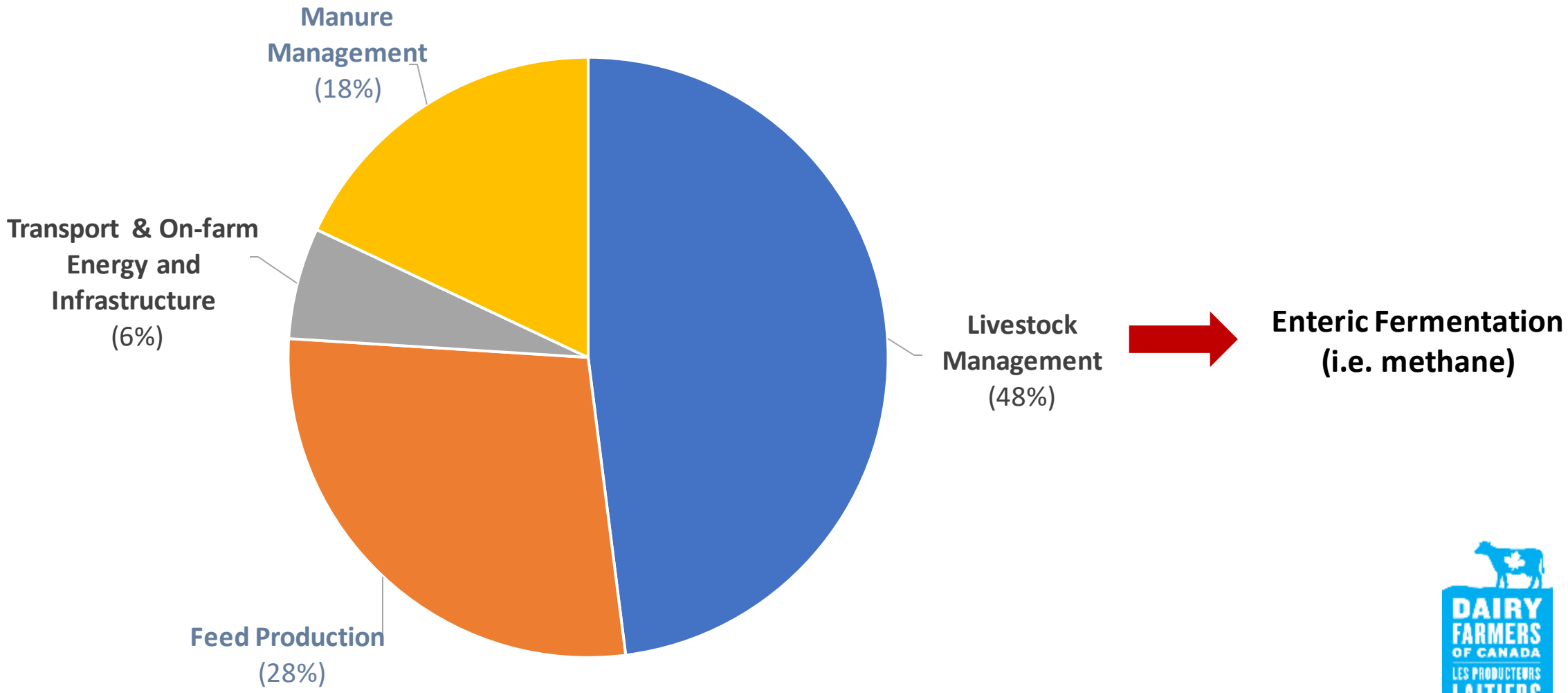
How Will We Get There?



Supporting On-Farm Action

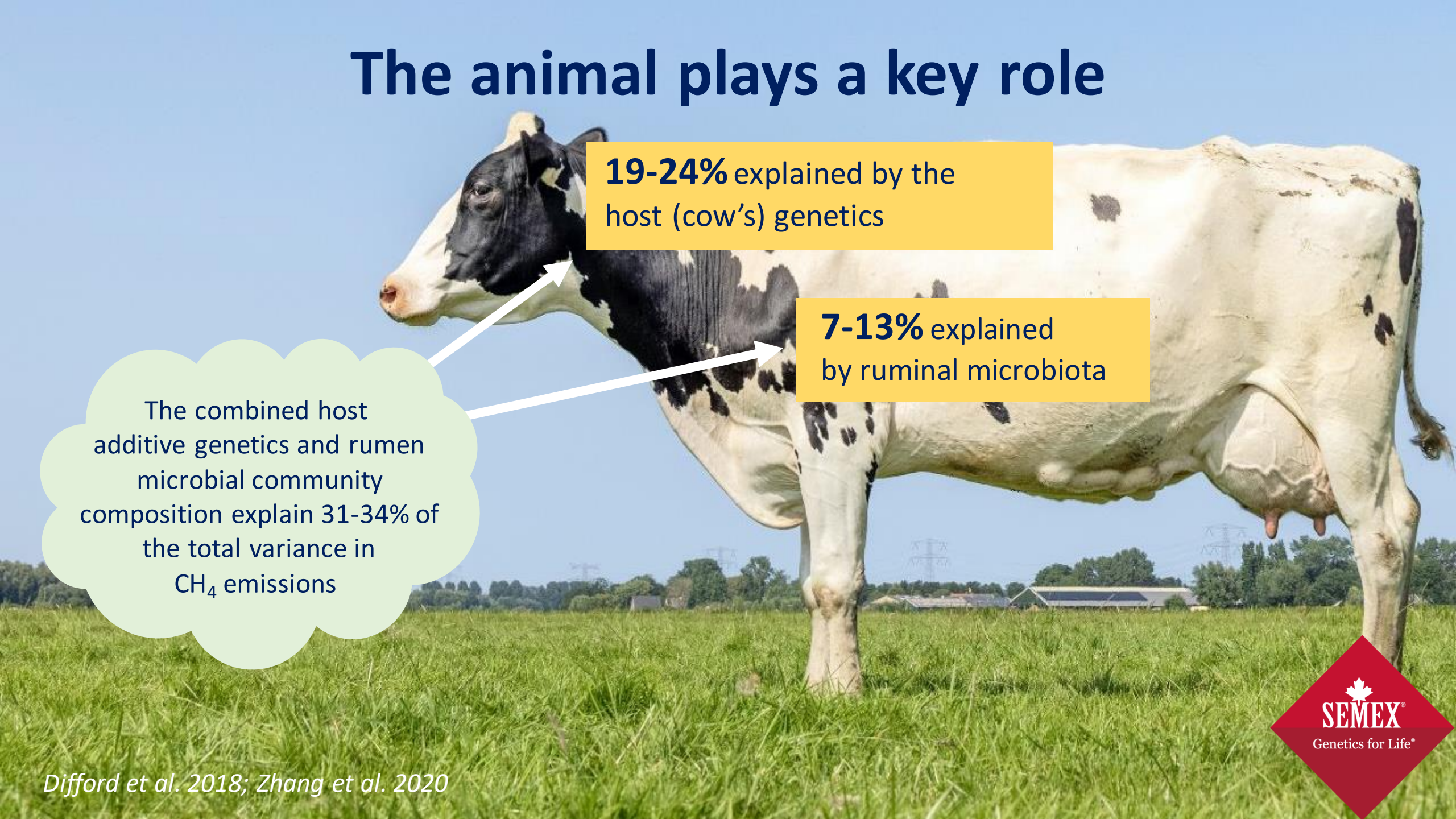


Greenhouse Gas Emissions from Producing 1 kg of Canadian milk (2016)



Adapted from https://www.dairyfarmers.ca/content/download/6327/56092/version/2/file/LCA__ExecutiveSummary.pdf.

The animal plays a key role



19-24% explained by the host (cow's) genetics

7-13% explained by ruminal microbiota

The combined host additive genetics and rumen microbial community composition explain 31-34% of the total variance in CH_4 emissions

Difford et al. 2018; Zhang et al. 2020

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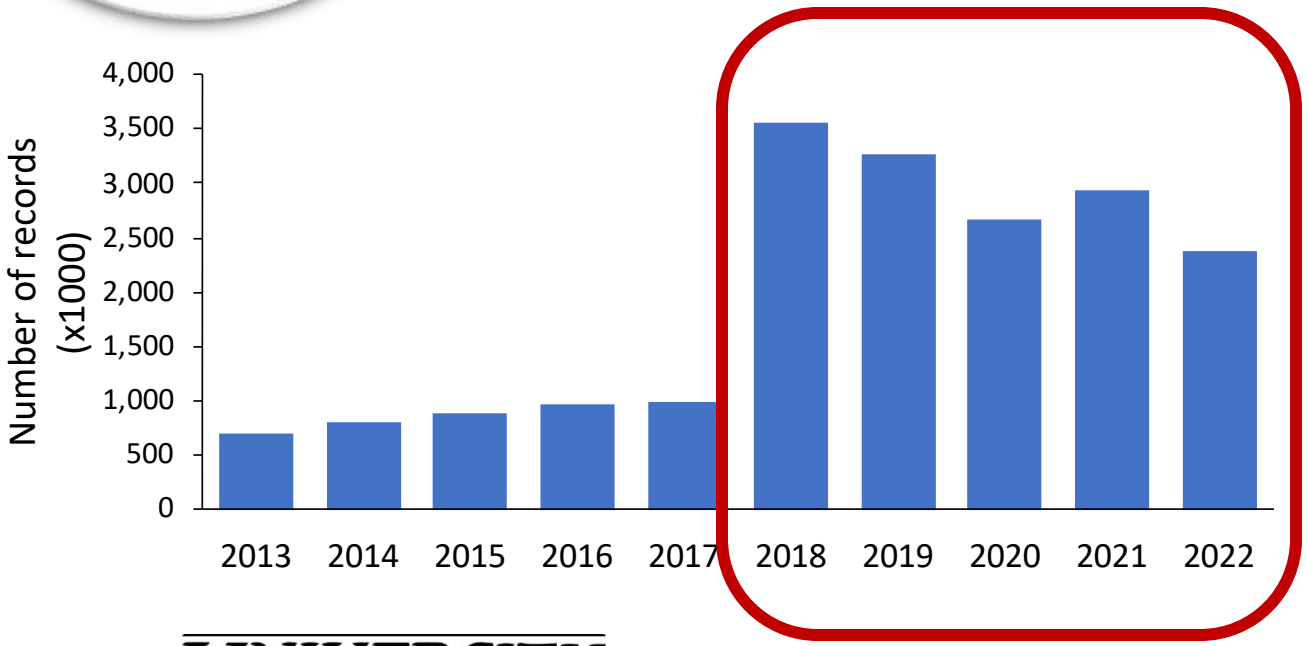
Milk sample collected on farm

Milk sample analyzed in lab

Mid-Infrared (MIR) data:
biological sense, great potential, and availability

More than 13M records from 1.6M cows

PREDICTING CH_4 USING MIR DATA



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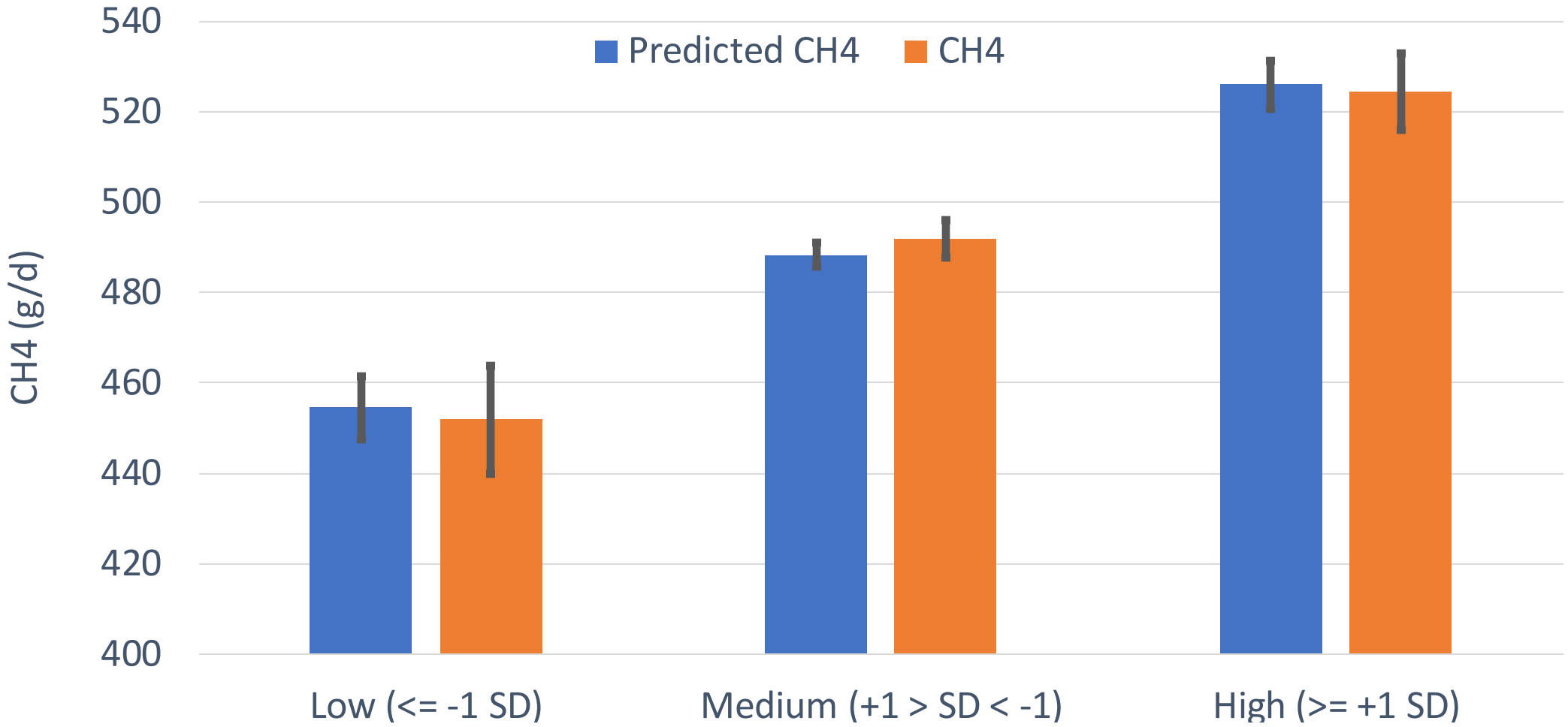
Lactanet

Average Predicted and Collected CH4 by GEBV class



92% genetic correlation between predicted and collected methane

METHANE EFFICIENCY

- Genetically independent of production
- Methane emission at the same level of milk, fat, and protein yield
- Adding more phenotypes across herds and environments

Lactanet

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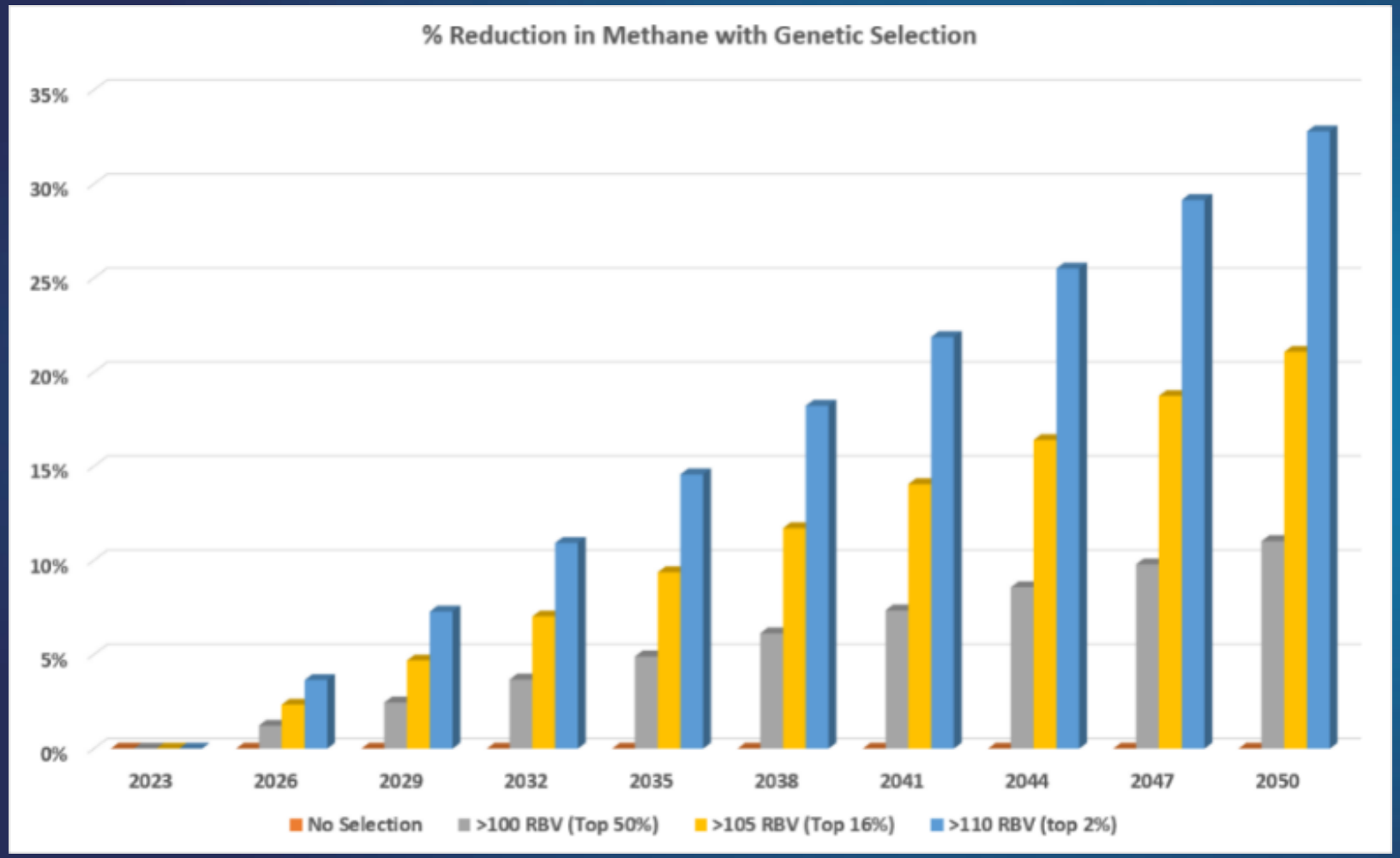
REDUCE METHANE 20-30% BY 2050



Can this open doors to new opportunities?

IMPACT OF GENETIC SELECTION

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Can this change the narrative?

Will farmers select on it?

BREEDING THE WAY TO LOW METHANE COWS

Genomic Index April 2023

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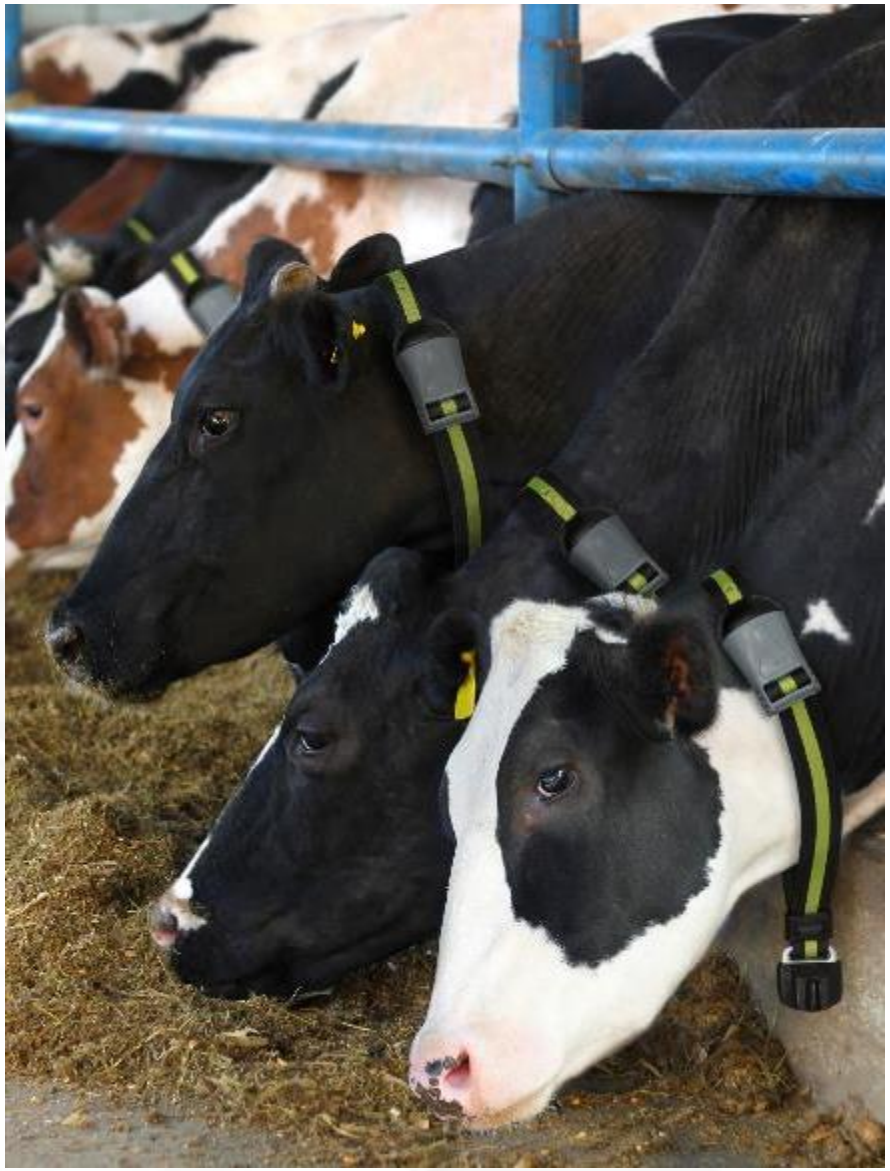
Animal Health & Welfare



Health & Welfare

- Difficulties in obtaining reliable heath and management data
- Variation in management contributes to low heritability
- Sensor data has potential to get closer to animal biology

Semex ai24™

HEALTH

Identify sick cows 1-3 days **sooner** than a physical evaluation.

Sensor data and health status

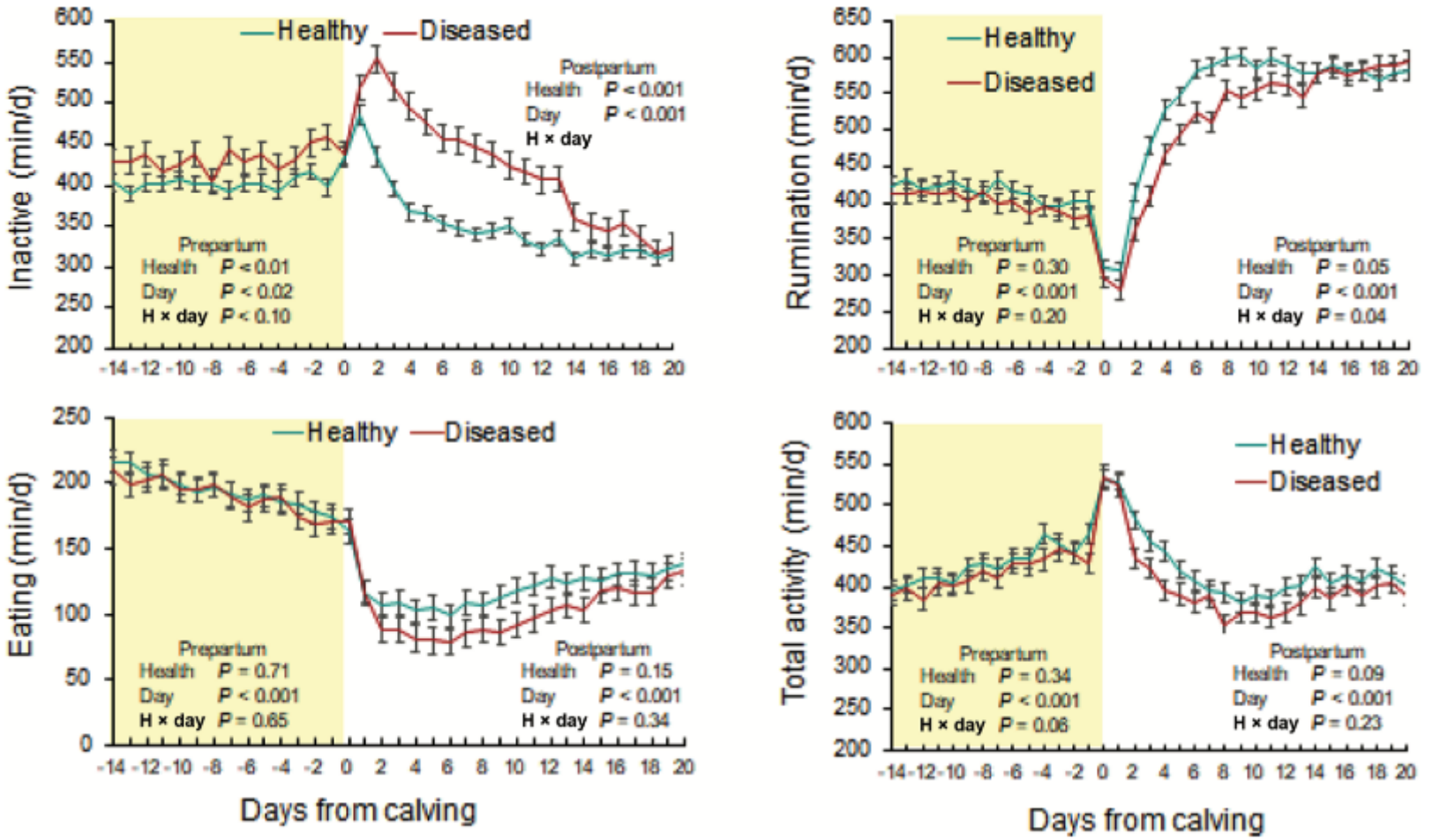


Figure. Least squares means (±SEM) of inactive time, eating time, rumination time, and total activity during 14 d before calving and 20 d postcalving for healthy (n = 92) and diseased (n = 68) dairy cows. Diseased cows included any case of defined metritis, digestive disorders, ketosis, hypocalcemia, calving problems, mastitis, or lameness during the first 60 DIM.

(Stevenson et al., 2020)


Can we use sensor data for genetic evaluations?
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Genetic Parameters – Rumination

- Rumination pattern has moderate heritability
  - 0.14±0.27 to 0.44±0.34 Byskov et al., 2017
  - 0.41±0.15 Lopes et al., 2022
  - 0.31±0.05 to 0.36 ±0.05 Moretti et al., 2018
- Define trait(s) that best correlate with the health events

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To develop and implement a genomic selection program for environmentally robust and fertile dairy cows based on the use of automated precision sensor technologies

Dr. Christine, Professor (Canada Research Chair in Livestock Genomics)

Dr. Diercles Cardoso (PDF)

Dr. Christina Rochus (PDF)

Camila Rosenberg (MSc)

MERCK Animal Health

AllFlex SCR by Allflex

Antelliq

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What did we learn?

- Activity related indexes can be used to define and evaluate estrous-related fertility traits
- Activity-derived traits (h^2 = 0.07 to 0.16)
- Calving to first high activity (first heat) identified (h^2 = 0.16-0.27)
- Genetic correlation with “classic” fertility traits suggest suitability of proxy traits

Conclusions for Sensor Data

- Useful tools for monitoring health and welfare
- Sensor data is abundant, affordable and longitudinal
- Direct connection to economic traits
- Careful editing and trait definitions are essential
- Collecting sensor data from a reference population is very feasible for use in genomic selection.
- We can breed for health and welfare traits never possible before

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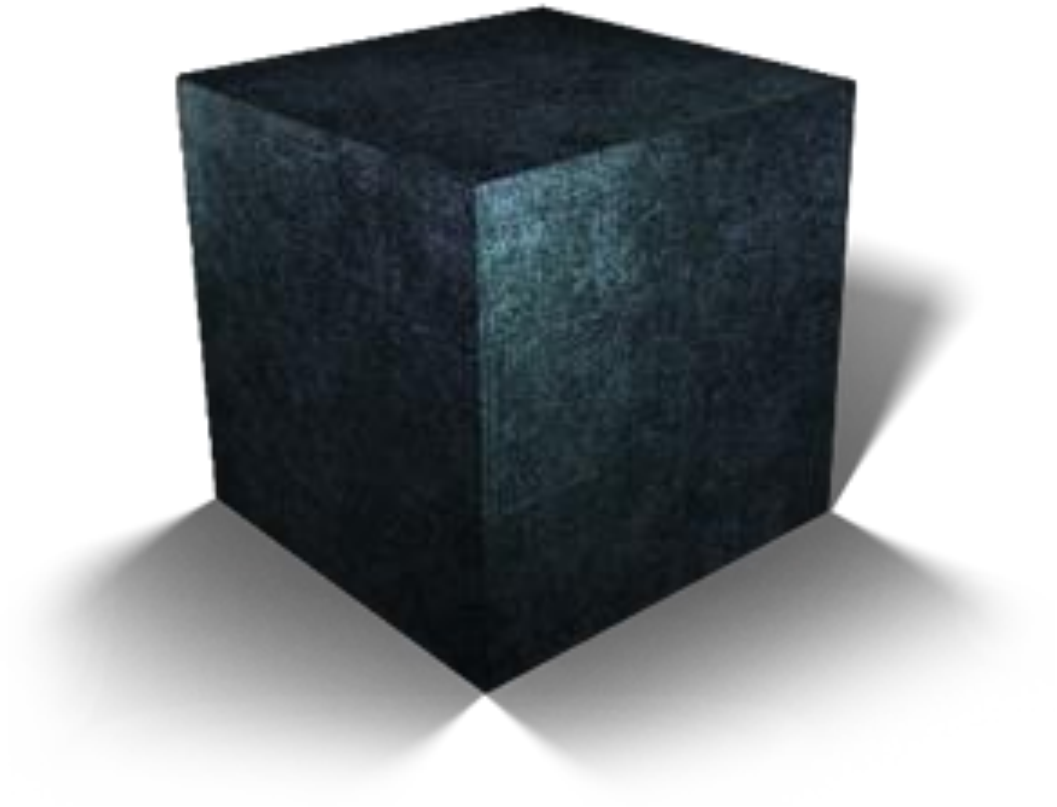
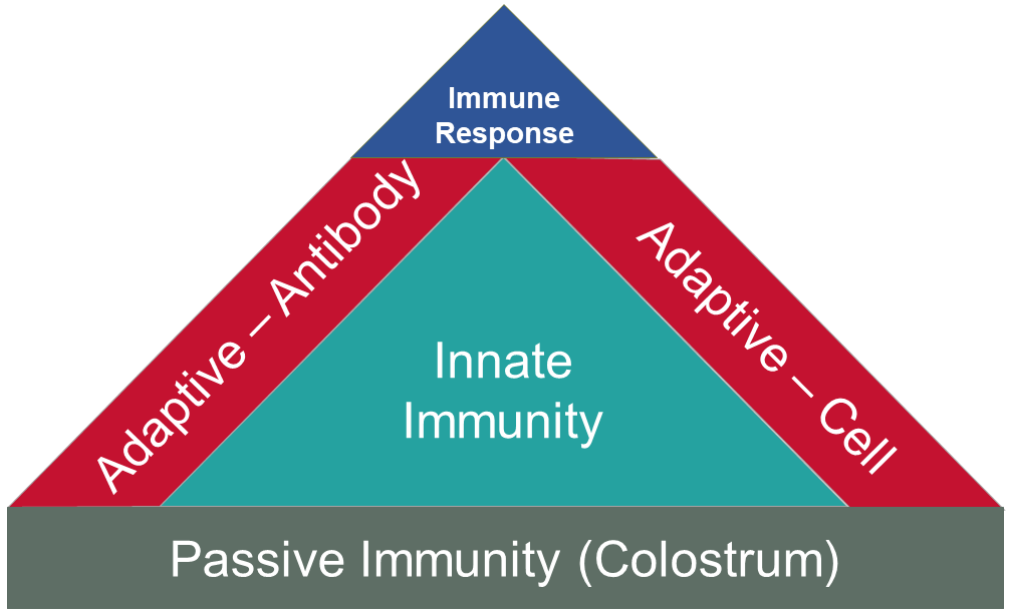
Can we breed for disease resilience?



- What really happens inside the black box?
- What measures are available?

Immunity consists of several elements



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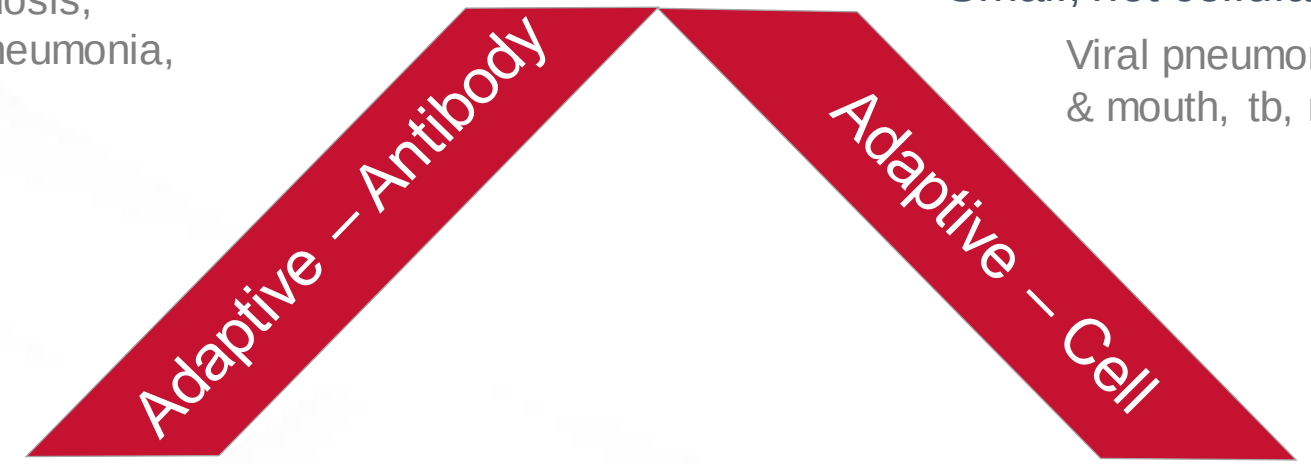
Adaptive Immunity

AMIR (Antibody-mediated IR)

- Fights bacterial infections outside the cells
- Attacked primarily by antibodies
- Large, living creatures

Mastitis, listeriosis, brucellosis, e. coli scours, bacterial pneumonia, metritis, digital dermatitis



CMIR (Cell-mediated IR)

- Fights viral and mycobacterial infections inside the cells
- Attacked primarily by macrophages
- Small, not cellular

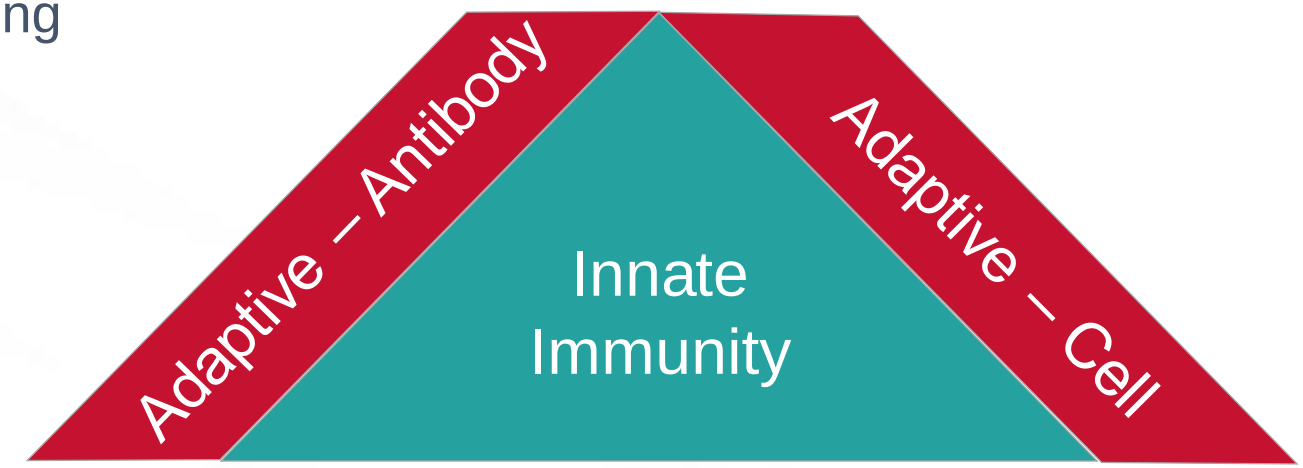
Viral pneumonia, BVD, IBR, leucosis, foot & mouth, tb, retained placenta, Johne's

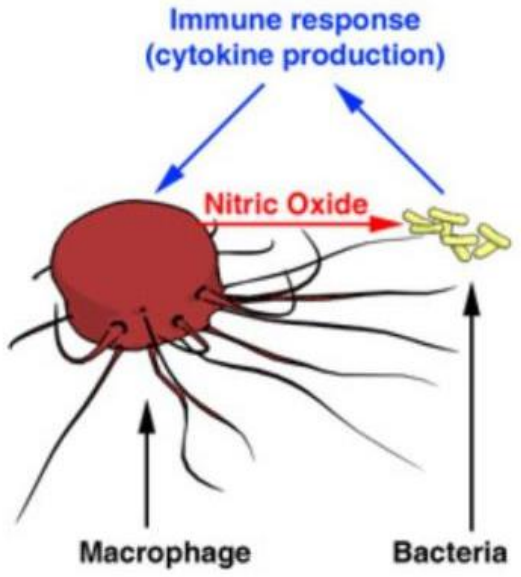
Innate Immunity

First line of defense against harmful invading microbes

- No memory of past exposure to pathogen
- Non-specific responses
- Not long-lasting

- Initiation of immune response
- Primes an adaptive immune response





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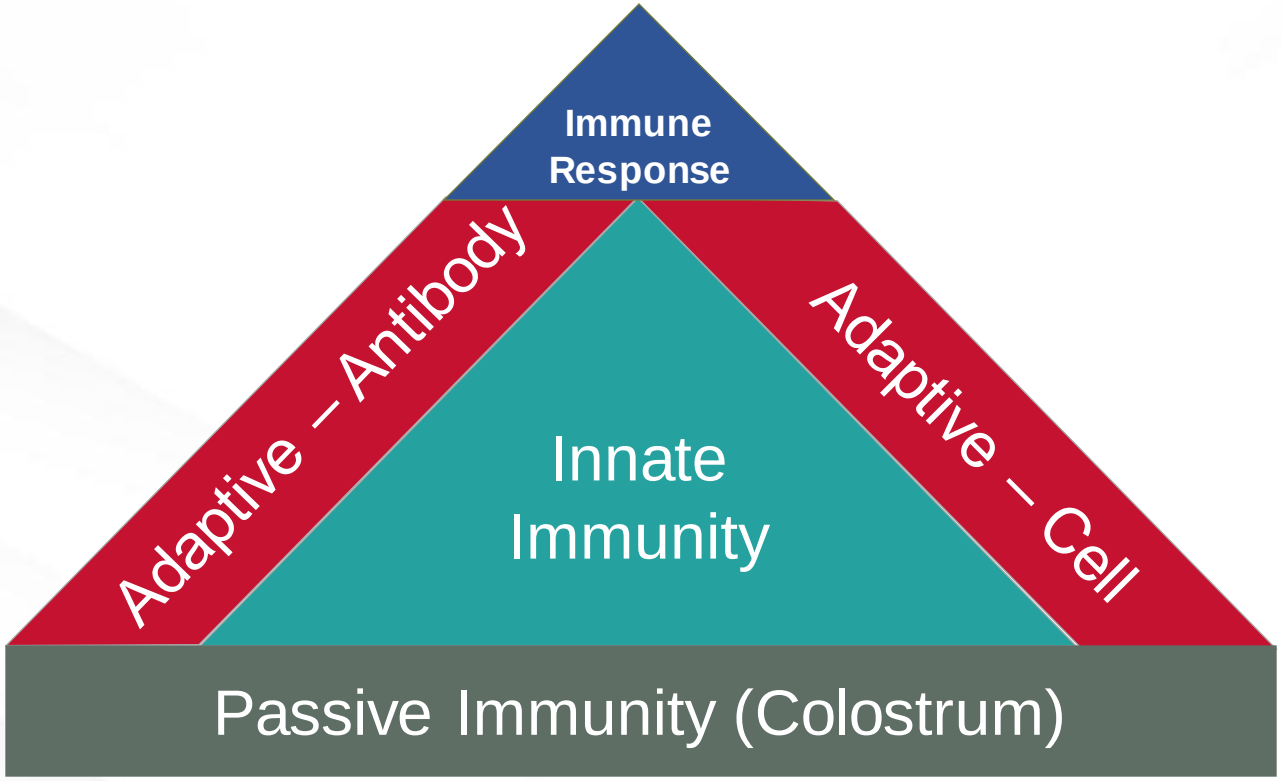
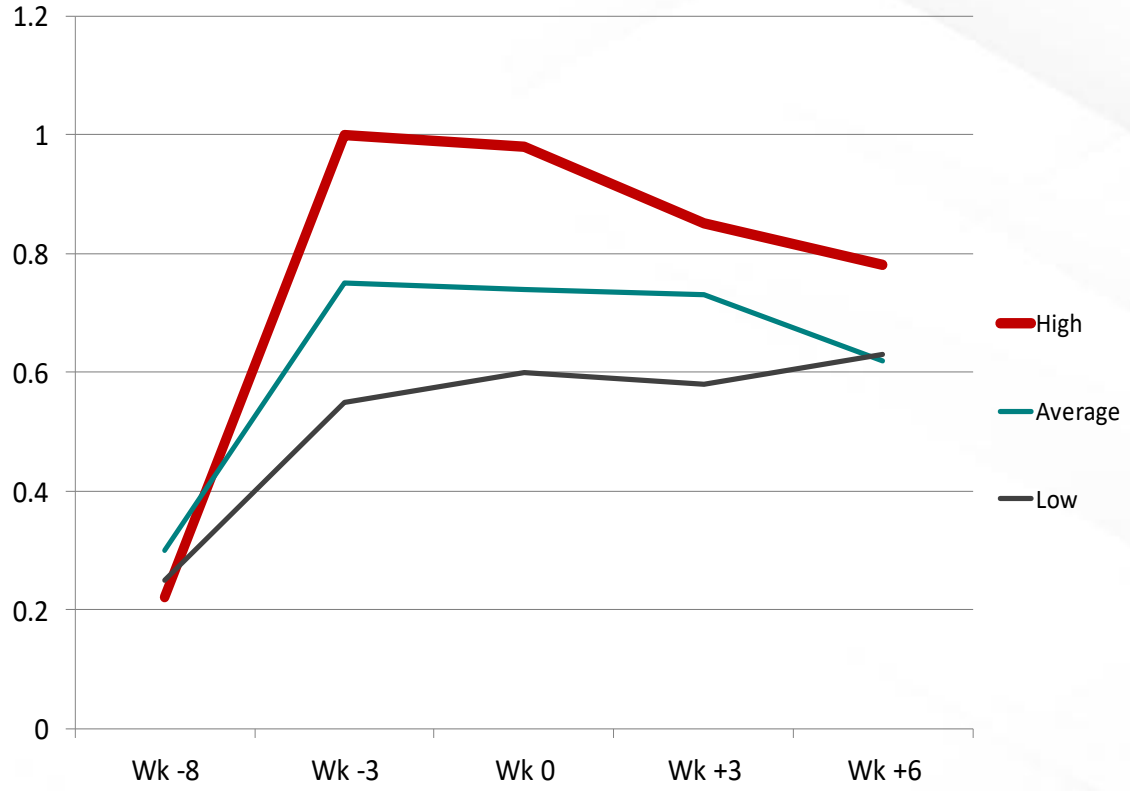
Immune Response is more heritable than disease incidence



Immunity+®

High Immunity = Improved Vaccine Response

High immune cows respond better to commercial vaccines.



Wagter & Mallard et al. 2000 JDS 83:488

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Passive Immunity

- Initial and temporary
- Passed through colostrum
- Contains protective features from the dam
- Fades as own immune system matures

Economic Impact (in USD$)

Daughters of Immunity+ Sires vs. Whole Herd

	MAST	LAME	RETP	KETO	DA	METR	OTHER*	Total
Disease Reduction (>=105)	-25.6%	-31.4%	-24.9%	-42.4%	-15.2%	-6.4%		
Population Frequency (NAHMS)	24.8%	16.8%	4.5%	4.2%	2.2%	6.9%		
Cost of Disease 1st Lact (Liang et al., 2017)	$325.76	$185.10	$150.41	$77.00	$432.48	$171.69		
Cost of Disease 2nd+ Lacts (Liang et al., 2017)	$426.50	$333.17	$313.49	$180.91	$639.51	$262.65		
Savings 1st Lact	$20.68	$9.76	$1.69	$1.37	$1.45	$0.76		
Savings/Lact: 2nd+ Lacts	$27.08	$17.58	$3.51	$3.22	$2.14	$1.16		
Savings Lifetime (2.8 Lacts)	**$69.42**	**$41.40**	**$8.01**	**$7.17**	**$5.30**	**$2.85**	**$13.30**	**$147.45**

* Includes calf diseases, vaccine response effectiveness and higher quality colostrum

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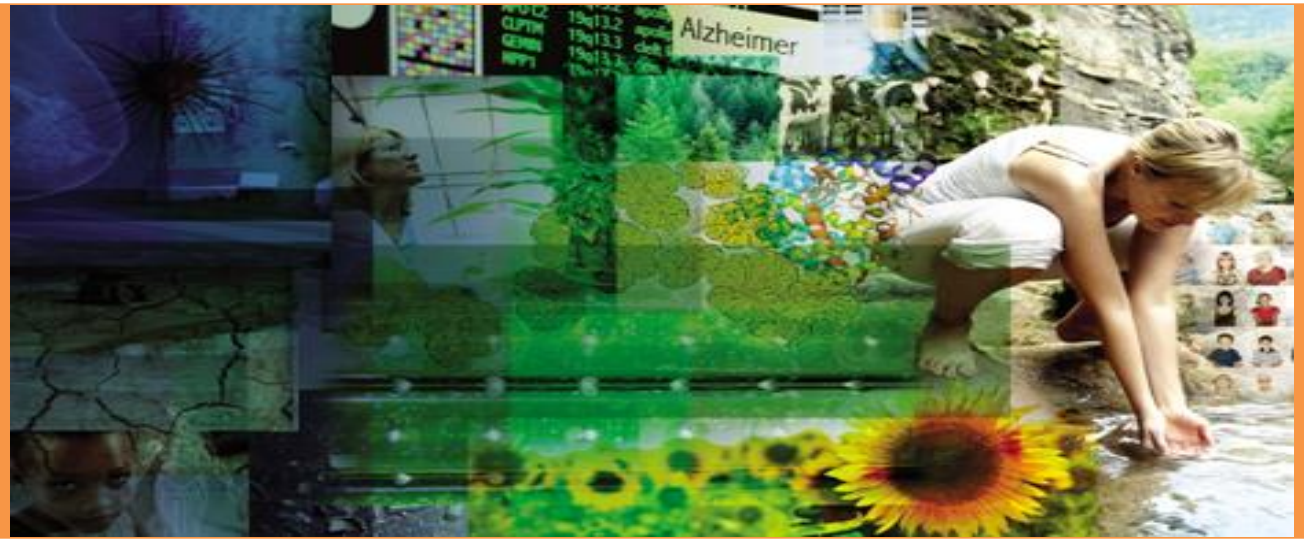
Economic Impact (in USD$)

High Immunity Genomic Females vs. Whole Herd

	MAST	LAME	RETP	KETO	DA	METR	OTHER*	Total
Reduction in females 105+	-42.6%	-41.2%	-25.3%	-33.4%	-38.2%	-8.9%		
Population Frequency (NAHMS)	24.8%	16.8%	4.5%	4.2%	2.2%	6.9%		
Cost of Disease 1st Lact (Liang et al., 2017)	$325.76	$185.10	$150.41	$77.00	$432.48	$171.69		
Cost of Disease 2nd+ Lacts (Liang et al., 2017)	$426.50	$333.17	$313.49	$180.91	$639.51	$262.65		
Savings 1st Lact	$34.42	$12.81	$1.71	$1.08	$3.63	$1.05		
Savings/Lact: 2nd+ Lacts	$45.06	$23.06	$3.57	$2.54	$5.37	$1.61		
Savings Lifetime (2.8 Lacts)	**$115.52**	**$54.32**	**$8.14**	**$5.65**	**$13.31**	**$3.96**	**$16.09**	**$216.99**

* Includes calf diseases, vaccine response effectiveness and higher quality colostrum



Translating High Immune Response (HIR™) Genomics to Improve Beef Cattle Health and Welfare

Academic Partner: Mallard Lab., University of Guelph
Key Receptor: Semex Alliance
Co-Receptors: Canadian Angus Association, Angus Genetics Inc.

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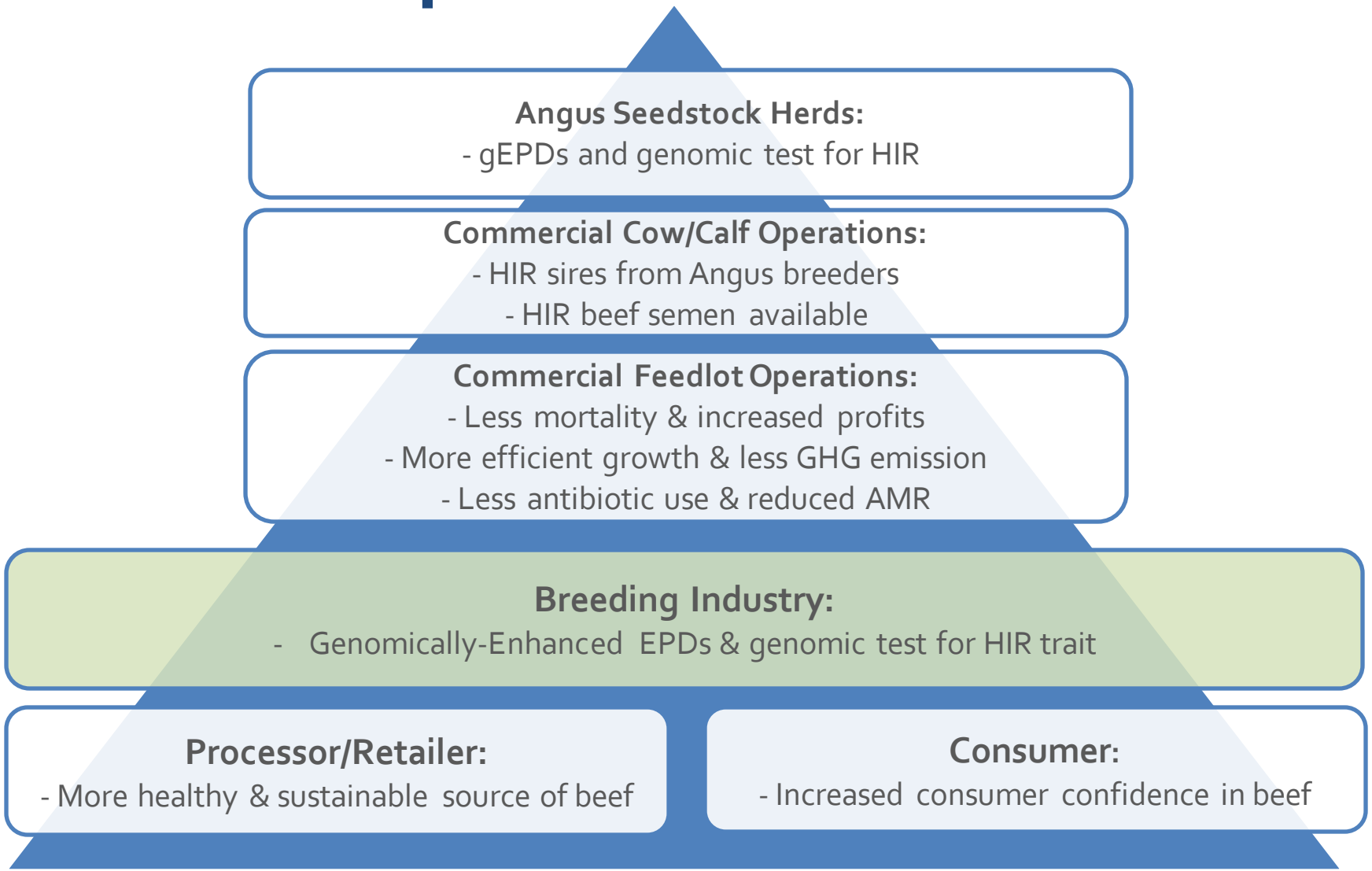
AGI

Canadian Angus

HIGH IMMUNE RESPONSE HAUTE IMMUNITÉ

Ontario Genomics
The Future is in Our Genes

Expected Outcomes

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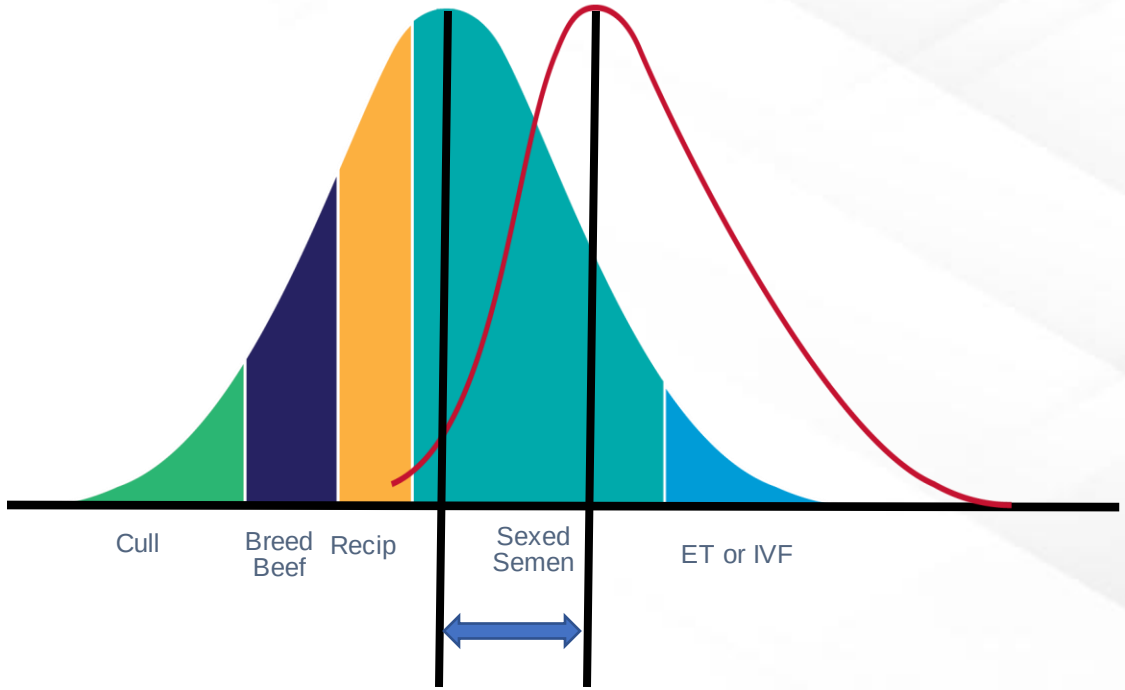
Can producing beef from dairy herd change the narrative?

Changing times

- Sexed semen is displacing conventional semen
- Production of excess heifers
- Genomic testing to identify most profitable females
- **Use of beef semen is now standard practice for >90% of dairy herds**



Dairy vs native beef genetics

DAYS ON FEED
Extended length of time to finish straight dairy calves

DRY MATTER INTAKE
Higher volume of feed required

AVERAGE DAILY GAIN
Lower average daily gain

DRESSING %
Low volume of product produced per head

MARBLING
Higher % of cattle grade in the top grading tier

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Turning a byproduct into a core product

Change the mindset of dairy producers

- Produce beef calves with the same selection pressure as what is placed on replacement dairy females

Learning from mistakes:

- It’s more than conception rate
- It’s more than calving ease
- It’s more than being black

Dairy-Beef producers are also learning

- Good relationship with dairies and/or calf buyers
- Communicating expectations
- Understanding how to manage dairy-beef genetics

Muscle Structure and Function

- Holstein vs Beef
  - Lower dress percentage
  - Smaller ribeye steaks

Beef | Beef on Dairy | Dairy

- Variability in muscle shapes in crossbreds

Foraker, 2022

Summary

- Sire selection for dairy-beef is critical to address deficiencies of dairy genetics:
  - Slower growth rates
  - Lower feed conversion
  - Rib eye shape
  - Meat colour
  - Liver abscesses (22-25%*)
- Dairy-beef can lower the environmental footprint of our beef supply

*Herrick et al., 2022. https://doi.org/10.15232/aas.2021-02228

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Reframing the narrative around Beef

What are the innovations that are improving sustainability of beef production?

Have we communicated them?

Can we give equal time to what consumers care about?

Why is sustainability important?

Sustainable: it's a fundamental idea about meeting the needs of the present, without compromising future generations to meet their own.

Our Vision

That the Canadian beef industry is recognized globally as socially responsible, environmentally sound and economically viable.

Mission

To advance, measure and communicate continuous improvement in the sustainability of the Canadian beef value chain.

PRODUCERS

If anyone understands responsible beef production practices, it's the farmers and ranchers on the ground. The CRSB's beef sustainability certification recognizes best practices, and invites producers on a journey of continuous improvement.

Steps for certification

PROCESSORS

Processing is a crucial part of bringing beef to tables across Canada, and processors play an important role in getting the beef from Certified Sustainable farms and ranches to the stores and restaurants for consumers.

Steps for Certification

SOURCING

Marketing beef as certified sustainable appeals to people who are seeking to make responsible food choices. It also helps recognize the producers and processors who are working hard to bring sustainably-raised beef to Canadian consumers.

Sourcing CRSB Certified beef

CONSUMERS

When you purchase beef from certified sustainable farms and ranches, you are demonstrating that sustainability is important to you. You are supporting the people who are producing your food, and encouraging stores and restaurants where you shop and eat to source products certified to sustainability standards.

Purchasing CRSB Certified beef

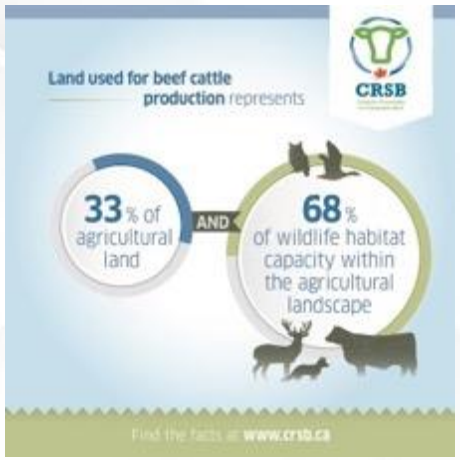
CRSB Mission

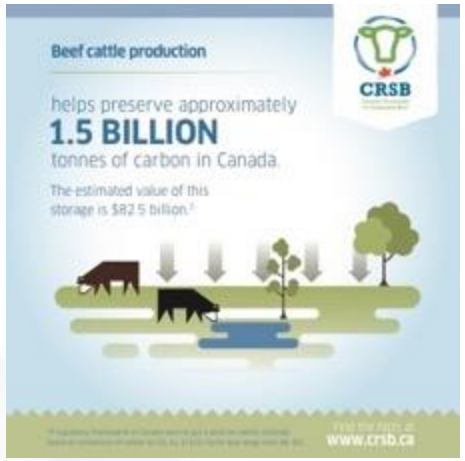
- Through collaborations we are advance four core areas:
  - Benchmarking & Goals
  - Projects and Initiatives
  - Certification Framework
  - Communications and Engagement

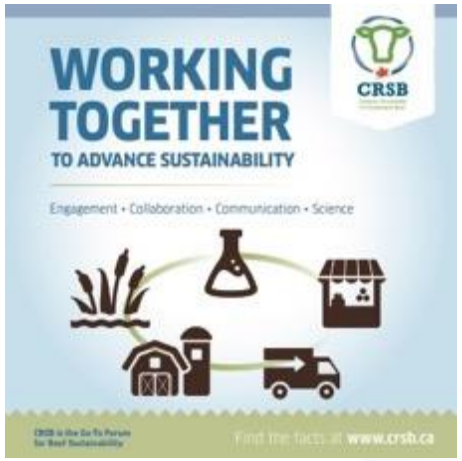
Assessment

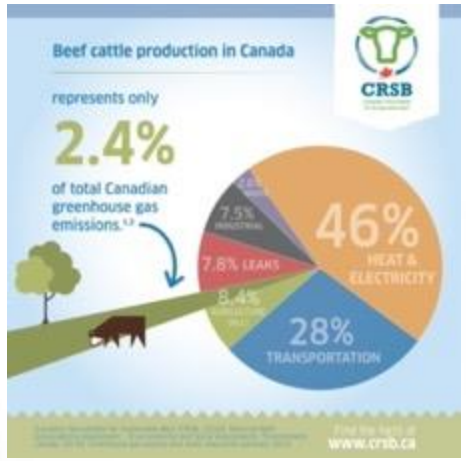
Sustainability Strategy

Long-term goals (2030)









New Data coming later in 2023

CANADIAN

BEEF GOALS 2030

MAINTAIN THE

35 MILLION

ACRES OF NATIVE GRASSLAND

in the care of beef producers

SUPPORT INNOVATION, RESEARCH, AND COMMERCIALIZATION OF

TECHNOLOGY

THROUGHOUT THE SUPPLY CHAIN

INVEST IN

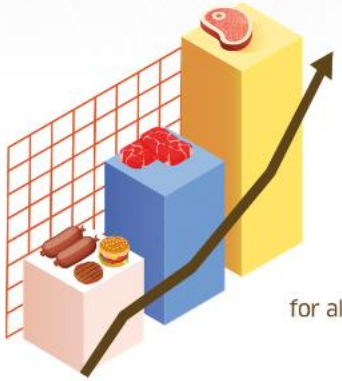
INNOVATIVE SOLUTIONS

FOR A BETTER TOMORROW

LEADING EXCELLENCE IN

BEST PRACTICES

REGARDING ANTI-MICROBIAL USE



INCREASE THE

VALUE

OF AAA AND PRIME CARCASSES

by building demand for all cuts on the carcass

BEEF CATTLE

GUARDIANS OF THE WETLANDS

- ✓ protect wetlands
- ✓ filter nutrients
- ✓ build resilience to droughts and flooding

REDUCE FOOD LOSS AND WASTE BY

50%

from secondary processing to consumer

SEQUESTER AN ADDITIONAL

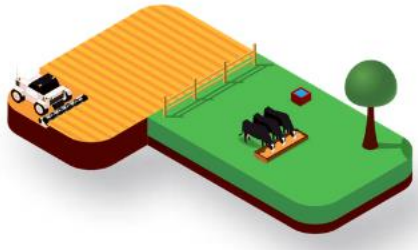
3.4 MILLION TONNES

OF CARBON EVERY YEAR

REDUCE PRIMARY PRODUCTION GHG EMISSION INTENSITY BY

33%

BY 2030



MAINTAIN & ENHANCE

68%

OF WILDLIFE HABITAT CAPACITY

within agricultural lands being supported by beef production

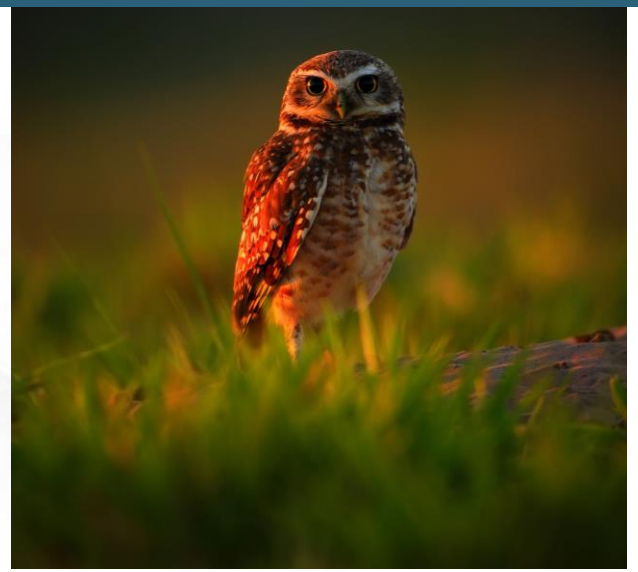
ENSURE THE

FIVE

FREEDOMS OF ANIMAL WELLBEING

- HEALTH
- MENTAL STATE
- NUTRITION
- BEHAVIOUR
- ENVIRONMENT

Projects & Initiatives



Species at Risk on Agricultural Lands

189,000 acres

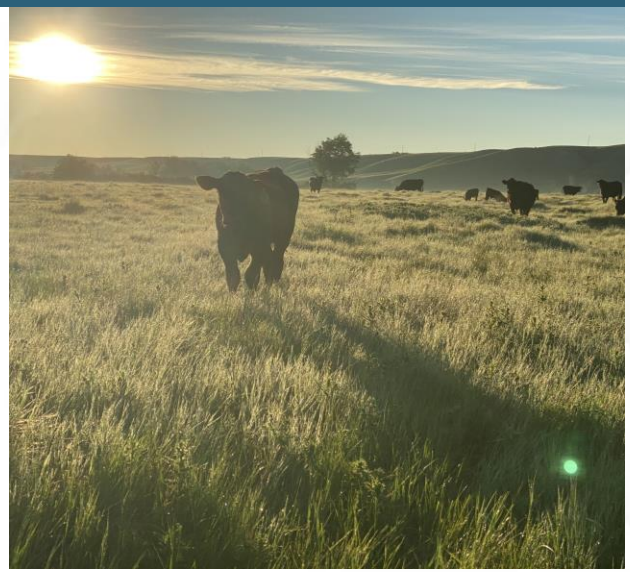
of grassland where habitat for species at risk is being conserved by a rancher as part of their ranching operation.

[Nature Conservancy Video]

Online Project Inventory

>60 projects

that **Pilot**, **Demonstrate** and **Promote** continuous improvement, aligned with strategic sustainability goals



Conservation Action Plan For Biodiversity & Species At Risk

Co-Leader with Environment Canada

The Agriculture Sector Core Planning co-leads development of a conservation action plan for biodiversity and species at risk with the agriculture sector.

- Grazing cattle and preserving the Canadian grasslands is one of the most effective nature-based solutions to climate change. Cattle are a key tool and their ability to cycle carbon plays a critical piece in the ecosystem.

Guardians of the Grasslands

Watch this short 12-minute documentary for the full story.

https://www.youtube.com/watch?v=oh6zcXckLRw

Summary

- A challenging narrative has formed around animal agriculture.
- We as animal breeders possess skills and tools to meet the expectations of both our industry and society.
- We need to tell the story of how animal breeding and management tools can:
  - Mitigate climate change
  - Improve animal health & welfare
  - Provide more sustainable beef
  - Improve the environment
- Society is more open to how science and technology can provide solutions.

Thank You

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