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.”

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

Note: National per capita based on purchasing power parity (PPP).

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$_2$ eq (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%)
- **Oil and Gas**: 189 Mt CO\(_2\) eq (28%)
- **Electricity**: 52 Mt CO\(_2\) eq (7.7%)
- **Heavy Industry**: 77 Mt CO\(_2\) eq (11%)
- **Buildings**: 87 Mt CO\(_2\) eq (13%)
- **Waste and Others**: 47 Mt CO\(_2\) eq (7%)

Adapted from [https://publications.gc.ca/collections/collection_2022/eccc/En81-4-2020-1-eng.pdf](https://publications.gc.ca/collections/collection_2022/eccc/En81-4-2020-1-eng.pdf)
Mapping the carbon footprint of milk production from cattle (Review)


\[
y = 3.421 - 2.92 \times 10^{-4} x \\
p < 0.01 \\
R^2 = 0.40
\]
Stock gases will accumulate over time, because they stay in the environment.

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

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/b1775
Countering the narrative
How many positive stories does it take to counter a bad story?

Why not just provide the facts?

A LITTLE CRITICISM GOES A LONG WAY
Top performing teams give each other more than five positive comments for every criticism.

PERFORMANCE

SOURCE LOSADA & HEAPHY: THE ROLE OF POSITIVITY AND CONNECTIVITY IN THE PERFORMANCE OF BUSINESS TEAMS, 2004
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

CURRENT EMISSIONS AND POTENTIAL FOR MITIGATION
Greenhouse Gas Emissions from Producing 1 kg of Canadian milk (2016)

- Livestock Management (48%)
- Manure Management (18%)
- Feed Production (28%)
- Transport & On-farm Energy and Infrastructure (6%)
- Enteric Fermentation (i.e. methane) (6%)

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 CH₄ emissions

Difford et al. 2018; Zhang et al. 2020
Mid-Infrared (MIR) data: biological sense, great potential, and availability

More than 13M records from 1.6M cows

PREDICTING CH₄ USING MIR DATA
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
REDUCE METHANE 20-30% BY 2050

Can this open doors to new opportunities?

IMPACT OF GENETIC SELECTION
Can this change the narrative? Will farmers select on it?

BREEDING THE WAY TO LOW METHANE COWS

Genomic Index April 2023
Animal Health & Welfare
Health & Welfare

- Difficulties in obtaining reliable health and management data
- Variation in management contributes to low heritability
- Sensor data has potential to get closer to animal biology
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?
Genetic Parameters – Rumination

• Rumination pattern has moderate heritability
  • \(0.14 \pm 0.27\) to \(0.44 \pm 0.34\) Byskov et al., 2017
  • \(0.41 \pm 0.15\) Lopes et al., 2022
  • \(0.31 \pm 0.05\) to \(0.36 \pm 0.05\) Moretti et al., 2018
• Define trait(s) that best correlate with the health events
To develop and implement a genomic selection program for environmentally robust and fertile dairy cows based on the use of automated precision sensor technologies.
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
Can we breed for disease resilience?

- What really happens inside the black box?
- What measures are available?
Immunity consists of several elements
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
Immune Response is more heritable than disease incidence
High Immune cows respond better to commercial vaccines.
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

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

* Includes calf diseases, vaccine response effectiveness and higher quality colostrum
## Economic Impact (in USD$)

### High Immunity Genomic Females vs. Whole Herd

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

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

**SEMEX | BOVITEQ**
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.
Expected Outcomes

Angus Seedstock Herds:
- gEPDs and genomic test for HIR

Commercial Cow/Calf Operations:
- HIR sires from Angus breeders
- HIR beef semen available

Commercial Feedlot Operations:
- Less mortality & increased profits
- More efficient growth & less GHG emission
- Less antibiotic use & reduced AMR

Breeding Industry:
- Genomically-Enhanced EPDs & genomic test for HIR trait

Processor/Retailer:
- More healthy & sustainable source of beef

Consumer:
- Increased consumer confidence in beef
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
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

• 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
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
Sustainability Strategy

Long-term goals (2030)

*New Data coming later in 2023*
CANADIAN BEEF GOALS 2030

- Invest in innovative solutions for a better tomorrow
- Leading excellence in best practices regarding anti-microbial use
- 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
- Reduce food loss and waste by 50% from secondary processing to consumer
- Sequester an additional 3.4 million tonnes of carbon every year

- Increase the value of AAA and prime carcasses by building demand for all cuts on the carcass
- Reduce primary production GHG emission intensity by 33% by 2030
- Beef cattle guardians of the wetlands
  - Protect wetlands
  - Filter nutrients
  - Build resilience to droughts and flooding
- 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, Environment, Nutrition, Behaviour
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.

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

Dr. Michael Lohuis
VP, Research & Innovation – Semex
mlohuis@semex.com