Novel approaches to breeding for climate-smart dairy cattle

Gabriella R. Dodd[1], Christine F. Baes[1], Flavio S. Schenkel[1], Coralie Machefert[1], Issabelle Ampofo[1], Baran Amini[1], Victoria Storing[1], Allison Fleming[2], Kristin Lee[2], Francesca Malchiodi[1,3], Caeli Richardson[4], and Filippo Miglior[1,2]

[1]Centre for Genetic Improvement of Livestock, University of Guelph
[2]Lactanet, Guelph, Canada
[3]Semex, Guelph, Canada
[4]AbacusBio International Ltd, Roslin Innovation Centre, Edinburgh, United Kingdom

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Evolving with Industry Needs

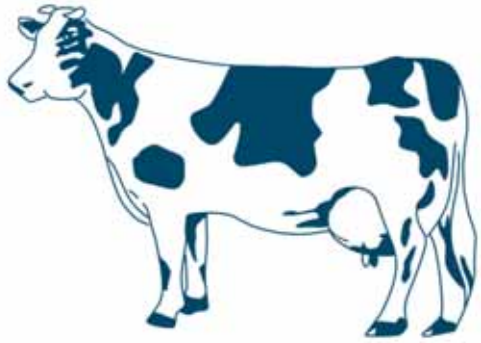
Early 1900s
Production

Mid
Proc
+ Conf

Production
Conformation
+ Functional

Climate-Smart Dairy Cattle

Increasing adaptability to environmental challenges



Mitigating environmental impact of dairy cattle

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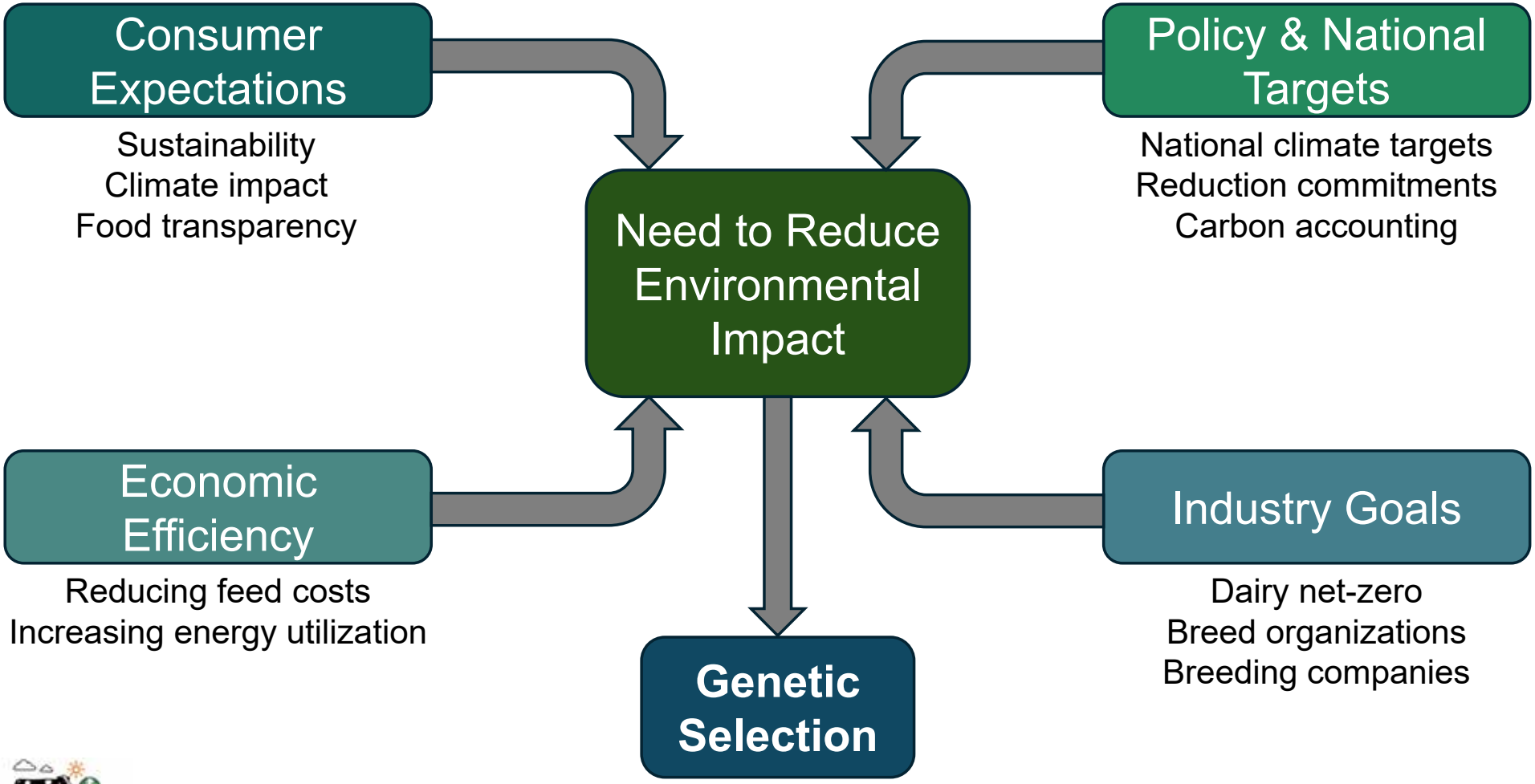
1 Evaluate Direct Effects of Heat Stress on Productivity

2 Evaluate Interactions Between Adaptation and Mitigation traits

3 **Future-Proof Index**

Integrating mitigation, adaptation, and productivity traits

Pressure to Mitigate Impact



Current Implementations – Methane & Feed

Organization (Country)	Methane	Feed Efficiency
Lactanet (CAN & CHE)	Methane Efficiency	Feed Efficiency
CDCB (USA)	-	Feed Saved (FSAV)
DataGene (AUS)	-	Feed Saved ABV
NAV (DNK,FIN,NOR,SWE)	Methane Index (concentration)	Saved Feed
CRV (NLD)	Methane Saved	Feed Efficiency
CONAFE (ESP)	Methane Index (concentration)	-
ANAFIBJ (Italy)	Methane Index (Bulls)	Feed Efficiency (Bulls)
Zoetis	-	Residual Feed Intake

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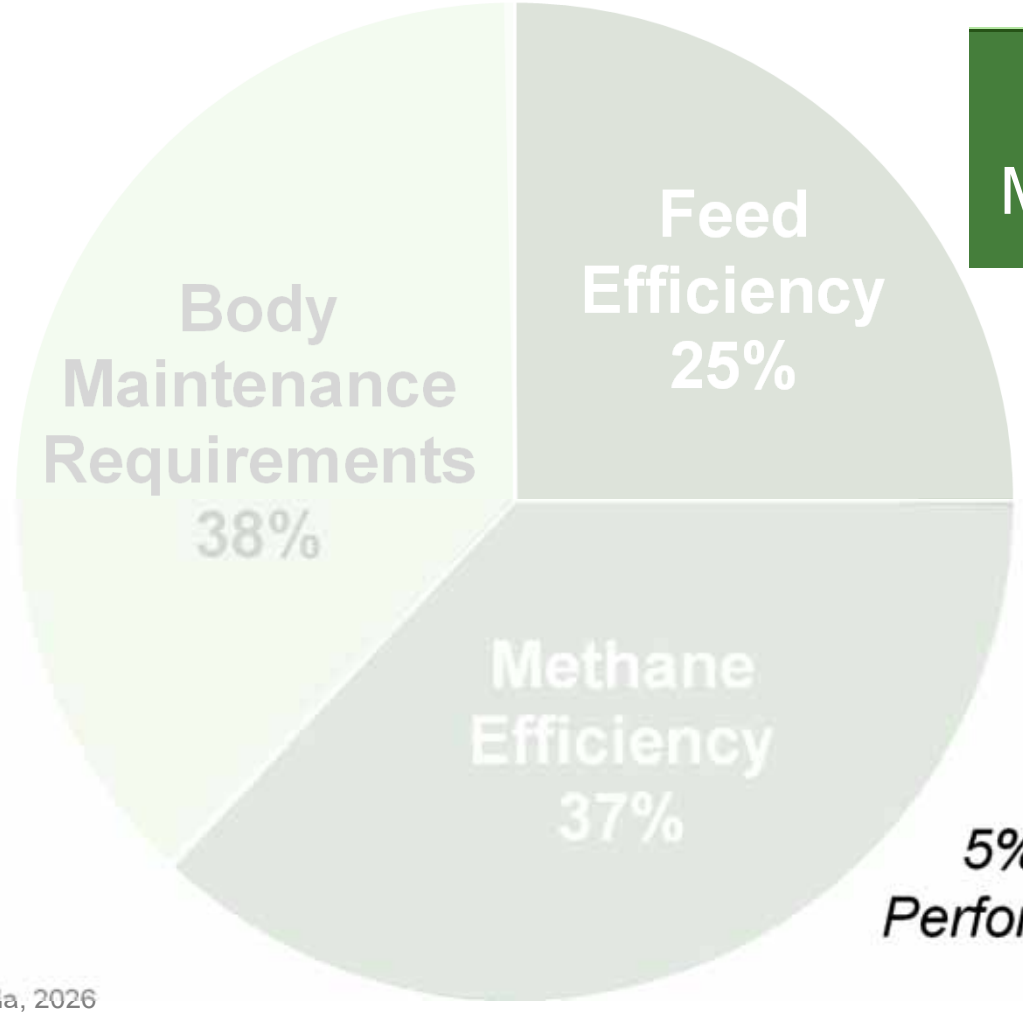
Environmental Impact Subindex



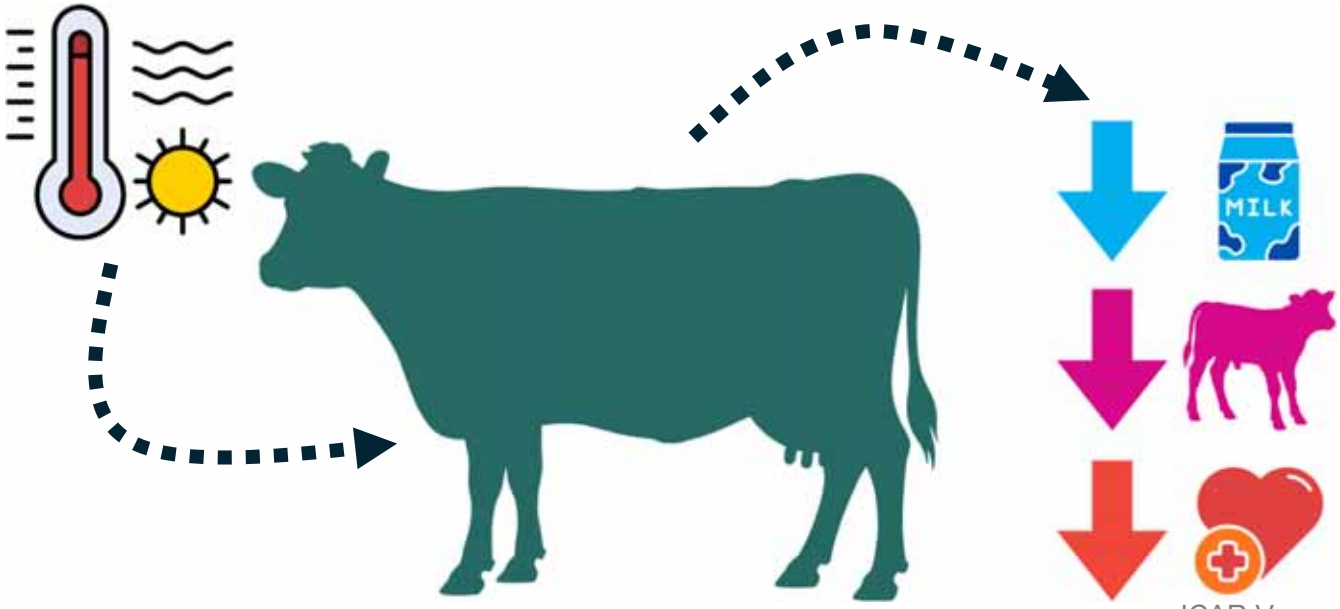
Genetic Residual Methane Production

5% weight in Lifetime Performance Index (LPI)

Selection for Adaptation

Heat Tolerance

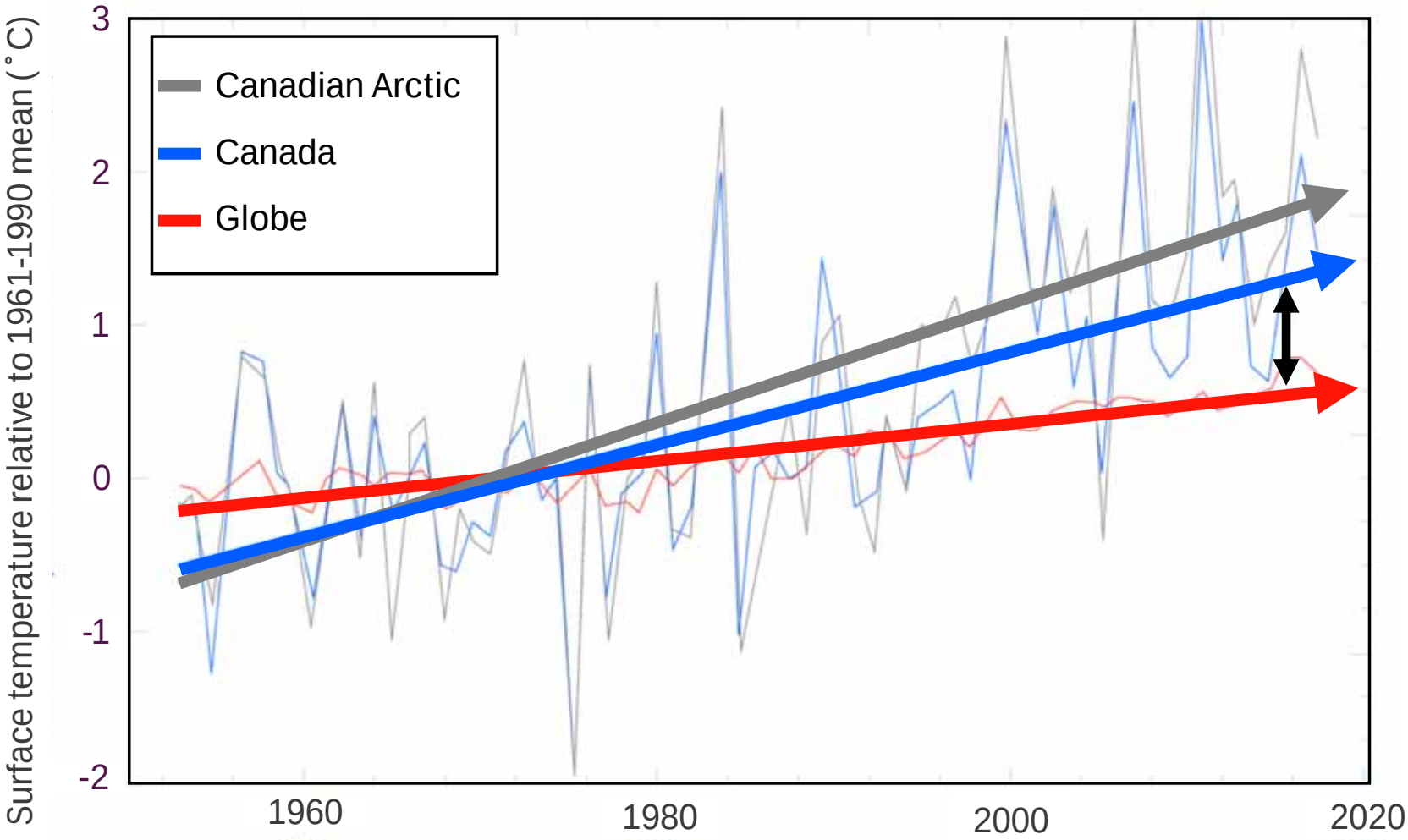
- High heat load has severe consequences on performance
  - Production, fertility, and health
- High production cows particularly susceptible



Current Implementations – Heat Tolerance

Organization (Country)	Methane	Feed Efficiency	Heat Tolerance
Lactanet (CAN & CHE)	Methane Efficiency	Feed Efficiency	-
CDCB (USA)	-	Feed Saved (FSAV)	-
DataGene (AUS)	-	Feed Saved ABV	Heat Tolerance ABV
NAV (DNK,FIN,NOR,SWE)	Methane Index (concentration)	Saved Feed	-
CRV (NLD)	Methane Saved	Feed Efficiency	-
CONAFE (ESP)	Methane Index (concentration)	-	-
ANAFIBJ (Italy)	Methane Index (Bulls)	Feed Efficiency (Bulls)	Italian Heat Tolerance (IHT)
Zoetis	-	Residual Feed Intake	Fertility Heat Resilience Milk Heat Resilience
Breedi & Eurofins	-	-	Heat Stress Tolerance

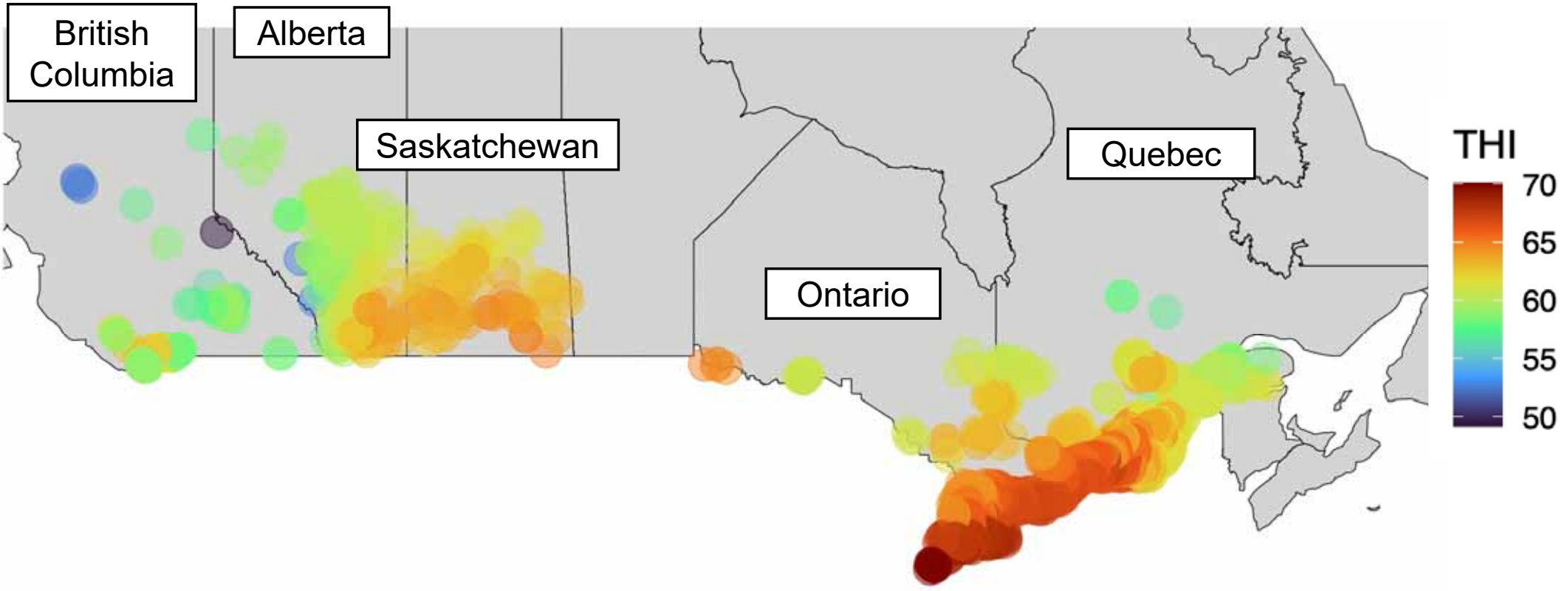
Temperatures Increasing Twice Global Average



Flato et al., 2019

Average THI Across Canada

(Summer Months: 2009–2021)



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Dodd et al., 2025

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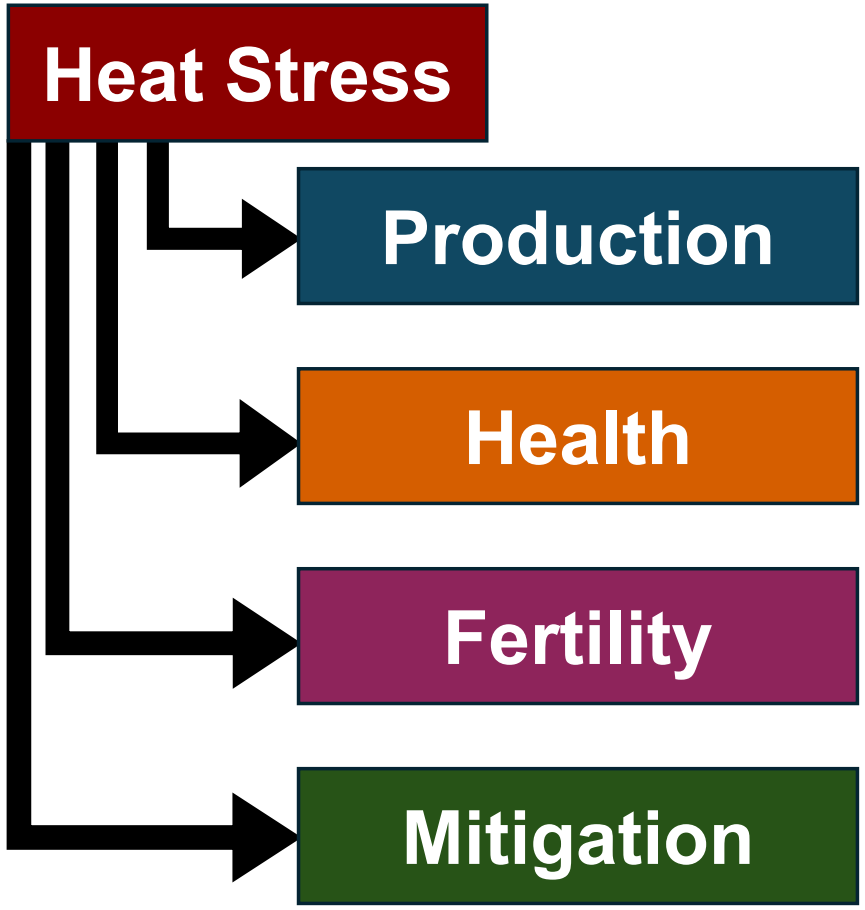
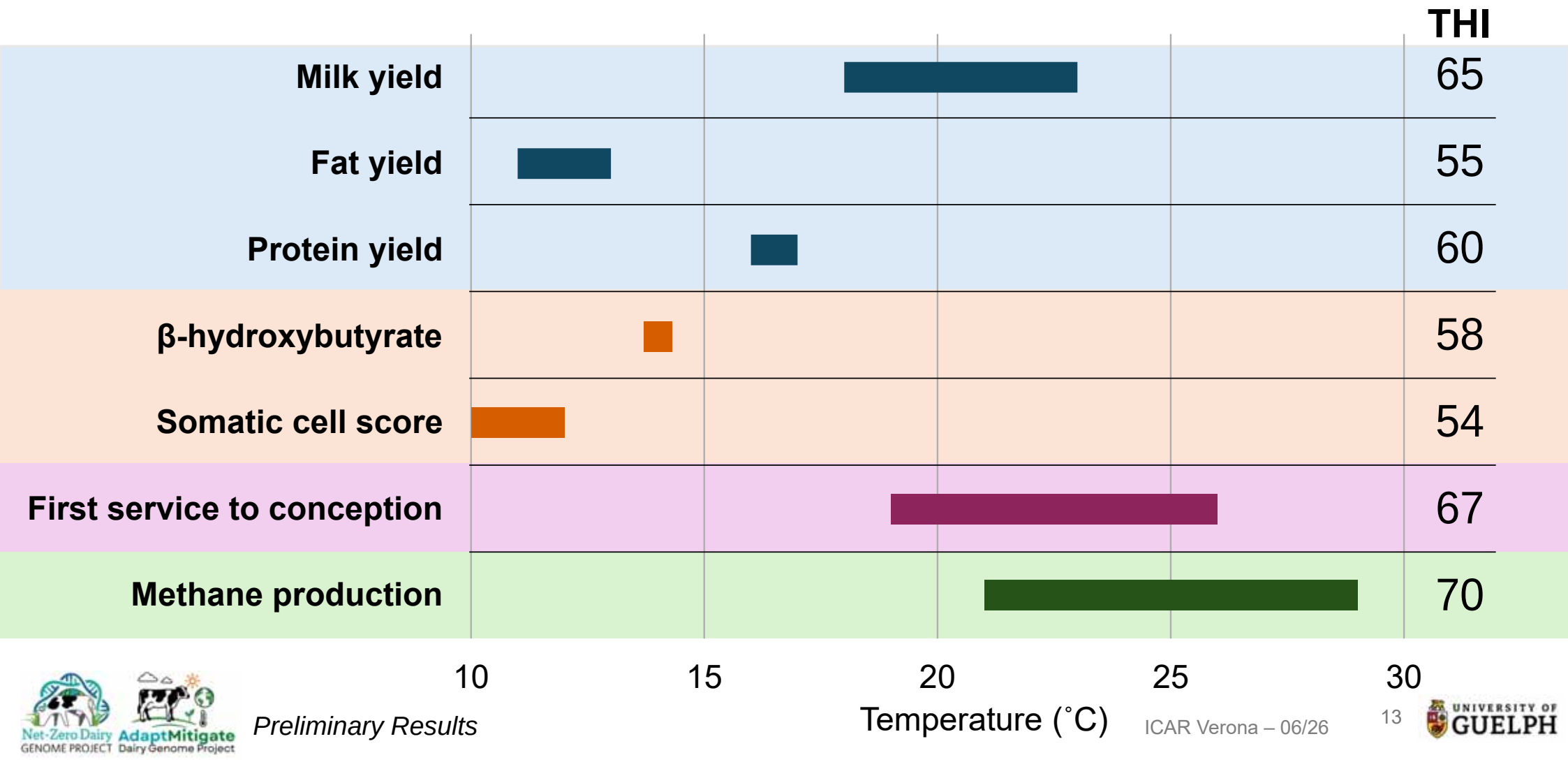
How does heat stress affect different traits?

1

Evaluate Direct Effects of Heat Stress on Productivity



Onset of Heat Stress Varies Across Traits



Preliminary Results

Productivity vs. Adaptation

Thermoneutral h^2	0.31
Heat Stress h^2	0.29

TN h^2	0.23
HS h^2	0.22

TN h^2	0.23
HS h^2	0.24

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Implementation Challenges for Heat Tolerance

Many trait groups are affected

- Onset of heat stress varies by trait
- Window of time when traits are affected varies

"One-size-fits-all" evaluations likely will not work

Productivity vs. adaptation trade-offs

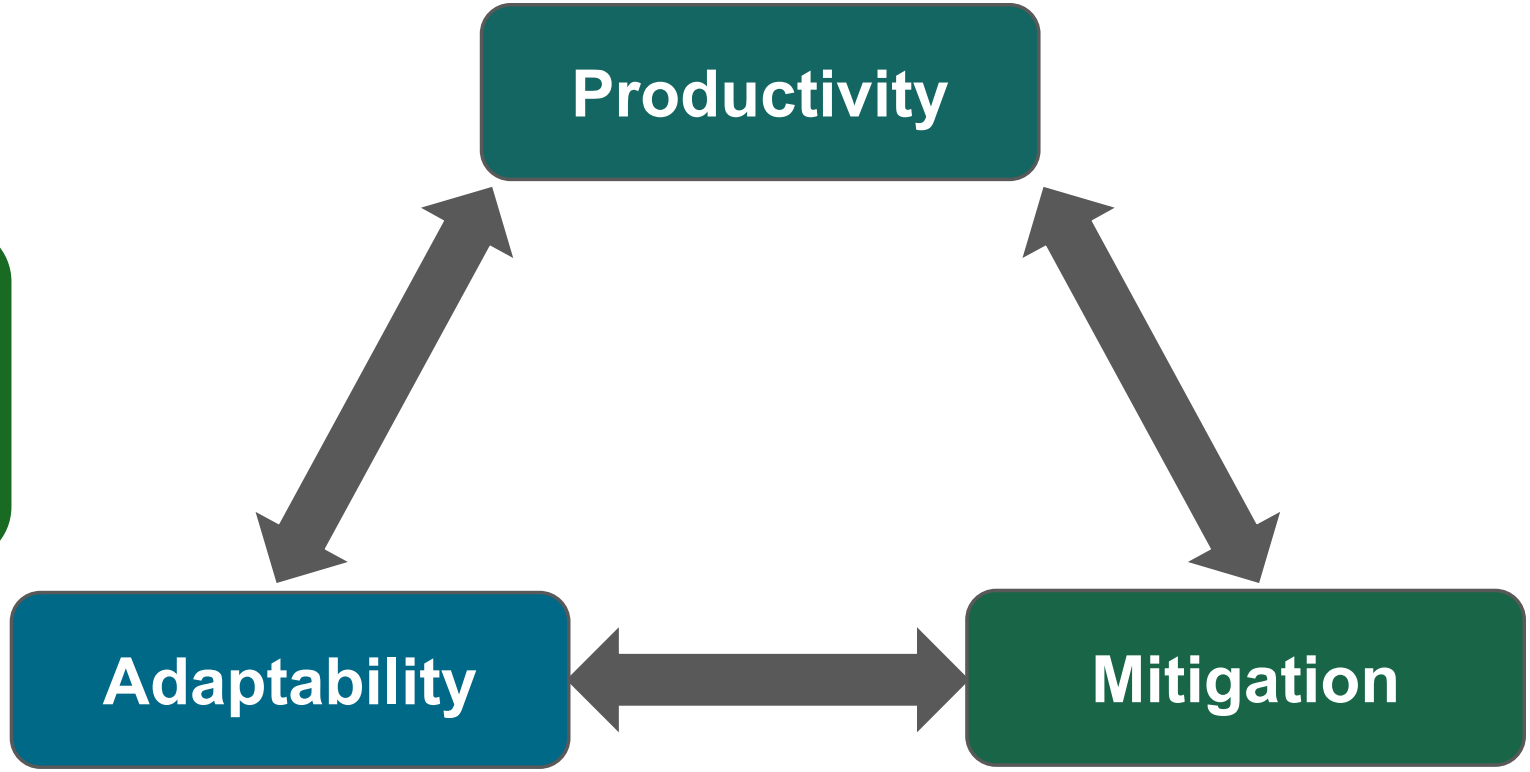
- High performance under normal conditions = reduced performance under heat stress

Balanced breeding objectives needed

Can we improve these traits simultaneously?

2

Evaluate Interactions Between Adaptation and Mitigation traits



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Methane and Heat Tolerance of Production

Group	Trait	Correlation to CH_4	Pattern Observed
Production	**Milk yield**	-0.10 to 0.26	No relationship
	Fat yield	-0.05 to -0.16	Lowly favorable
	Protein yield	-0.03 to 0.09	No relationship

↑ **heat tolerance of fat yield**
corresponds to
↓ **production of methane**

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Conclusions and Next Steps

Future-Proof Index
Integrating mitigation, adaptation, and productivity traits

Heat stress affects dairy traits differently

- Onset and sensitivity vary by trait

Antagonistic relationships for productivity and adaptation

- Balanced breeding goals

Methane reduction appears compatible with heat tolerance

- No strong unfavorable relationships observed

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Acknowledgements

Contact
gdodd@uoguelph.ca

Website
adaptmitigatedairy.com

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Agriculture, Pêcheries et Alimentation Québec
Alberta Agriculture and Forestry
Les Producteurs de lait du Québec
Milk
Alberta Innovates
RDAR Results Driven Agriculture Research
Alberta Milk
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