

# Interaction between adaptation and mitigation traits in Canadian Holsteins



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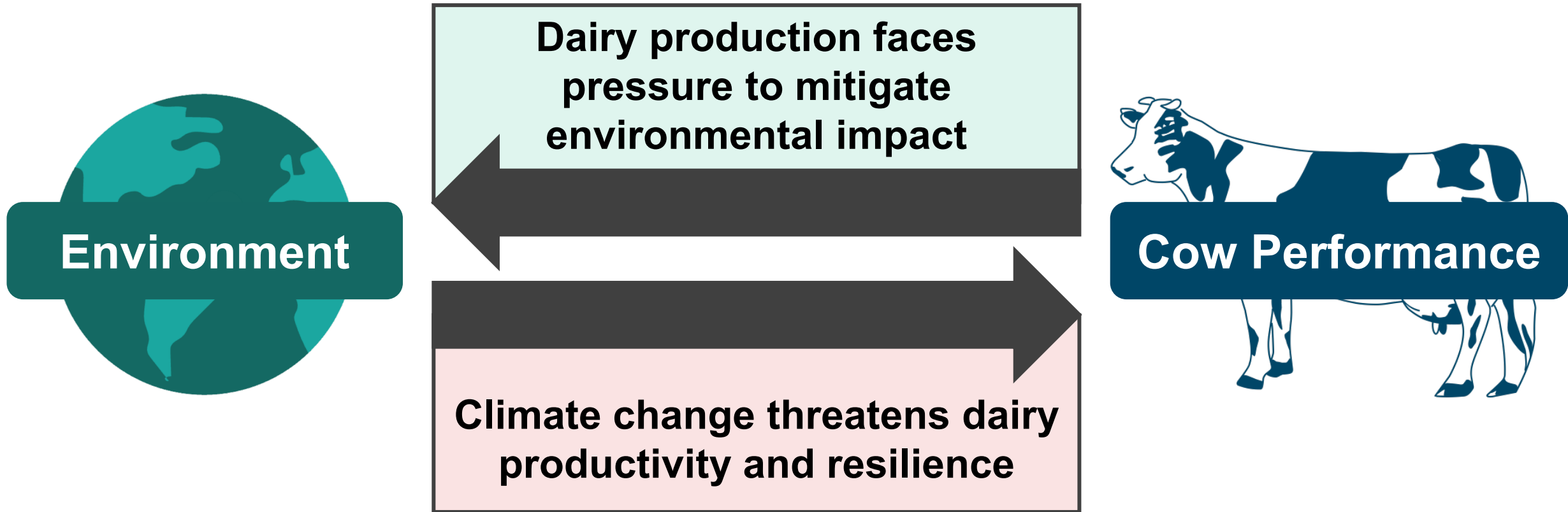
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<sup>4</sup>AbacusBioInternational Ltd, Roslin Innovation Centre, Edinburgh, United Kingdom



# Breeding for the Future



**Climate-smart dairy breeding requires addressing both simultaneously**

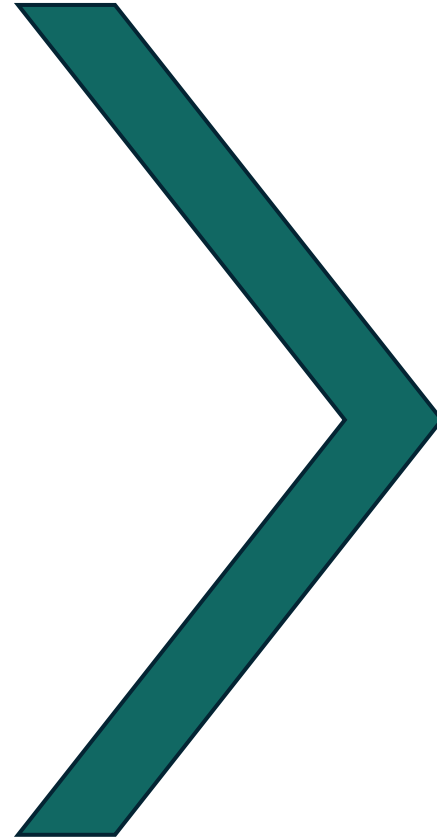
# AdaptMitigate Dairy Genome Project

1

Evaluate Direct Effects  
of Heat Stress on  
Productivity

2

Evaluate Interactions  
Between Adaptation and  
Mitigation traits



3

**Climate-Smart Selection**

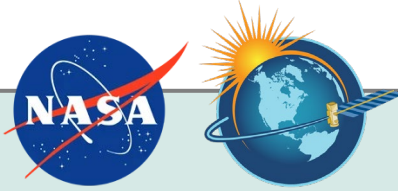
*Integrating mitigation, adaptation,  
and productivity traits*

# Phenotypic Data

Mitigation Traits	Methane Production	Body maintenance requirements	Dry matter intake
	MIR-predicted (g/d)	(Body weight) <sup>0.75</sup>	Direct or predicted measure (kg/d)

Adaptation Traits	Production	Health	Fertility
	Milk yield (kg/d) Fat yield (g/d) Protein yield (g/d)	β-hydroxybutyrate (BHB) Somatic cell score (SCS)	First service to conception (FSTC)

# Weather Data



## NASA POWER Database

Hourly ambient temperature (**AT**) and relative humidity (**RH**) extracted

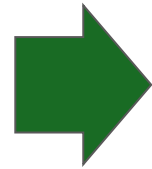
Hourly temperature and humidity index (**THI**) value calculated

$$THI = (1.8 \times AT) + 32 - (0.55 - (0.0055 \times RH)) \times ((1.8 \times AT) - 26)$$

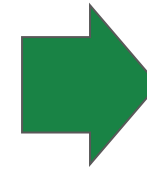
Daily THI generated by averaging across each 24-h day

# Identifying Heat Stress Effects

Phenotypic  
Records



Adjust for Known  
Effects



Extract  
Residuals



**Optimal  
Heat Stress  
Definition**

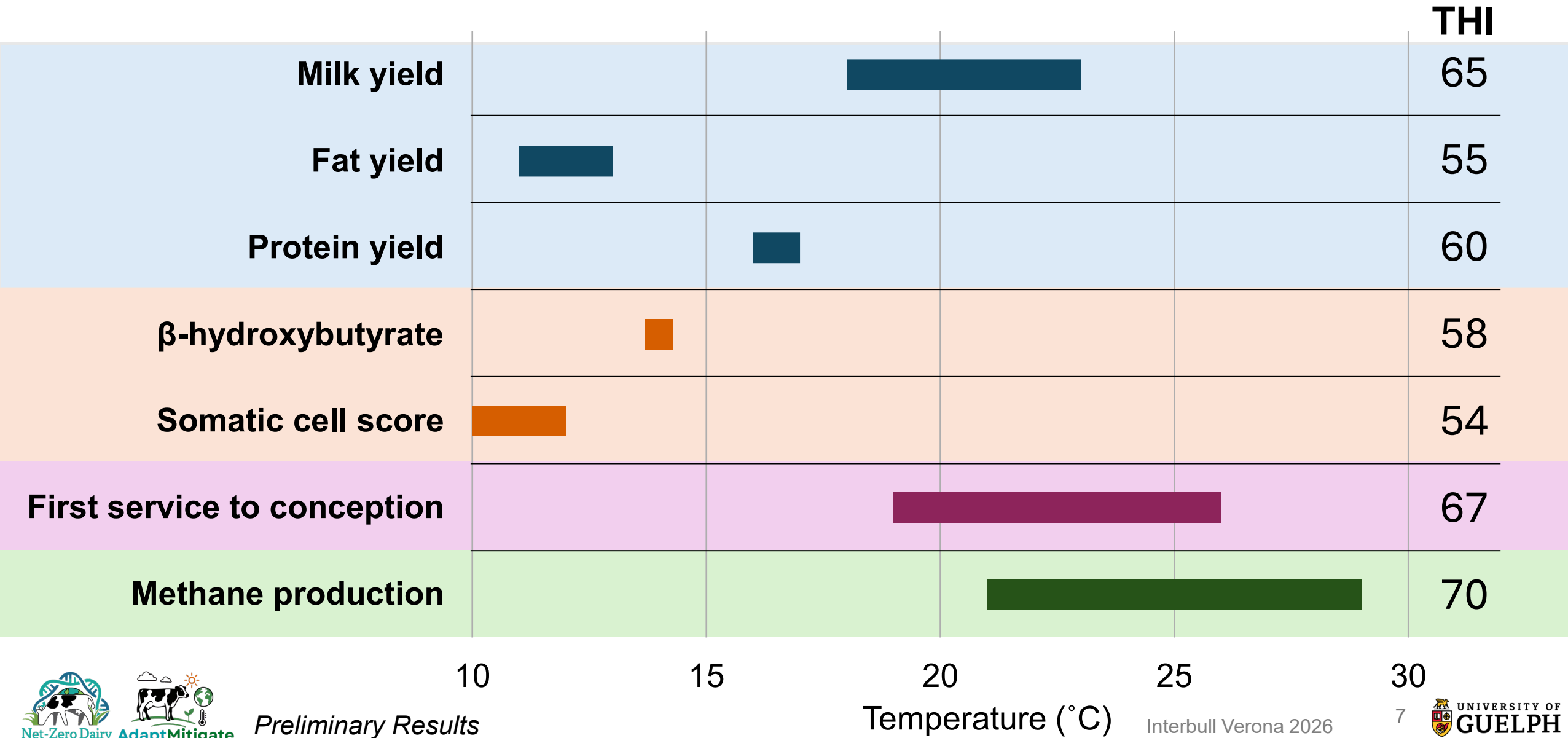


Test Temporal  
Windows



Estimate THI  
Thresholds

# Onset of Heat Stress Varies Across Traits



# Heat Tolerance Modeling

Heat tolerance evaluated using a **reaction norm model** with a heat stress function ( $Hsf$ )

$$Hsf = \begin{cases} 0 & \text{if } THI \leq th_i \\ THI - th_i & \text{if } THI > th_i \end{cases}$$

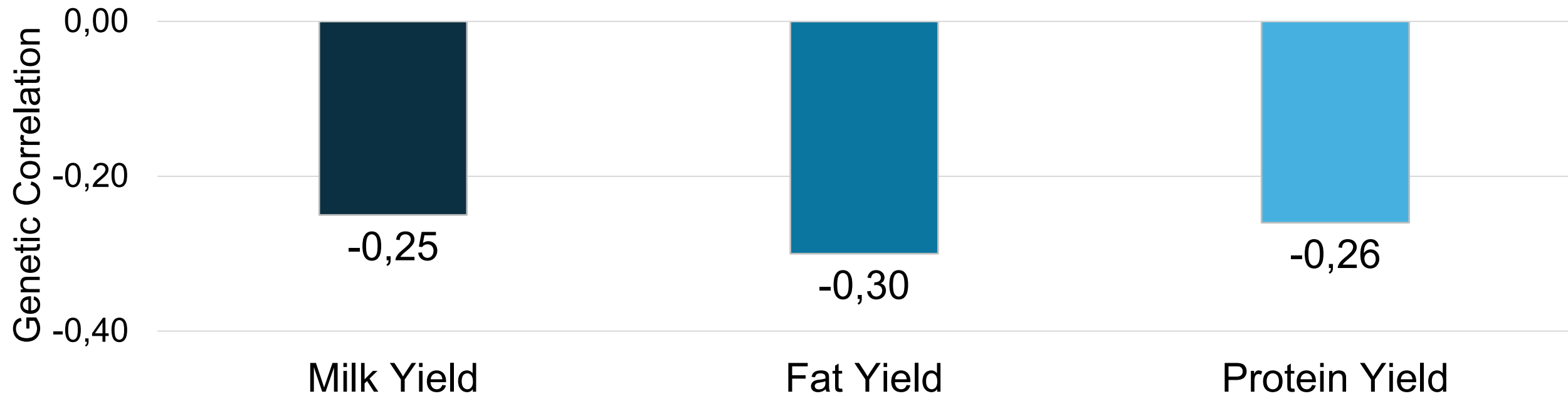
Trait	$th_i$
Milk yield	65
Fat yield	55
Protein yield	60
$\beta$ -hydroxybutyrate	58
Somatic cell score	54
First service to conception	67
Methane production	70

# Productivity vs. Adaptation

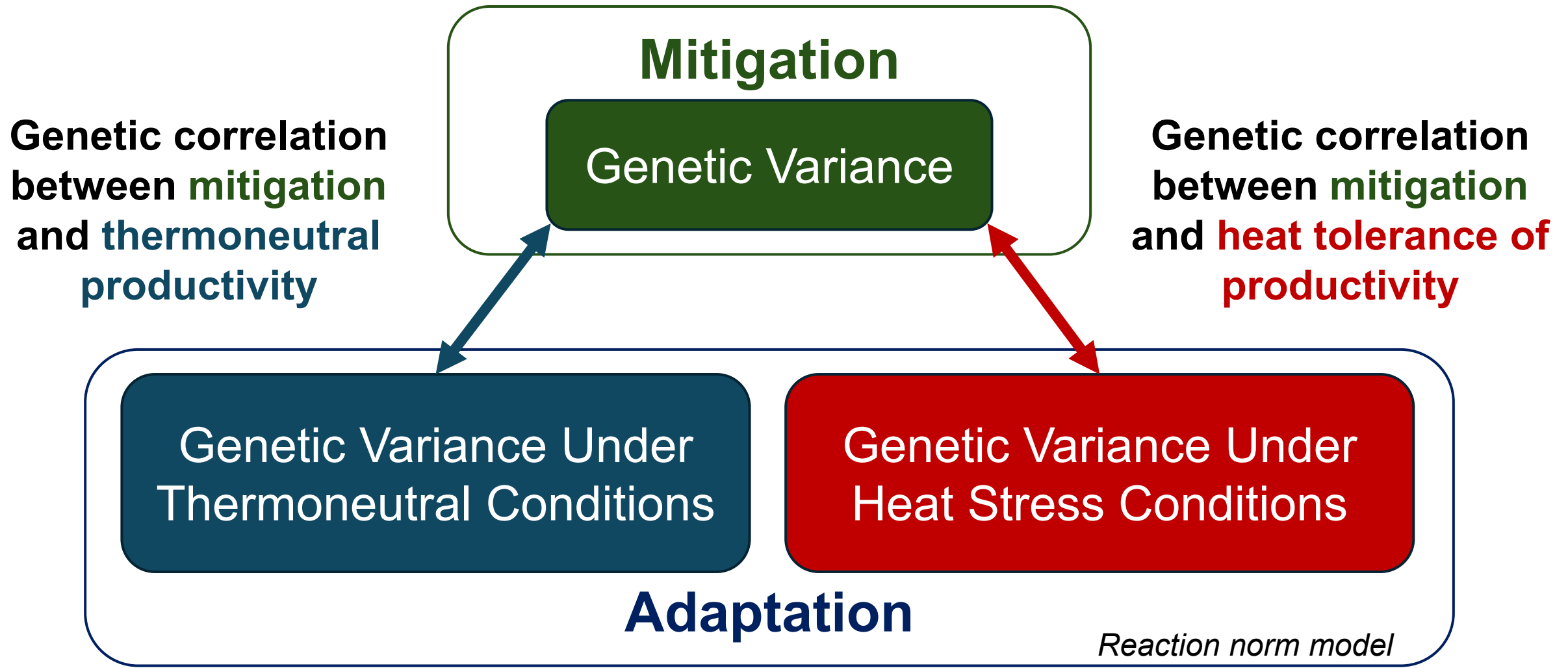
Thermoneutral $h^2$	0.31
Heat Stress $h^2$	0.29

TN $h^2$	0.23
HS $h^2$	0.22

TN $h^2$	0.23
HS $h^2$	0.24

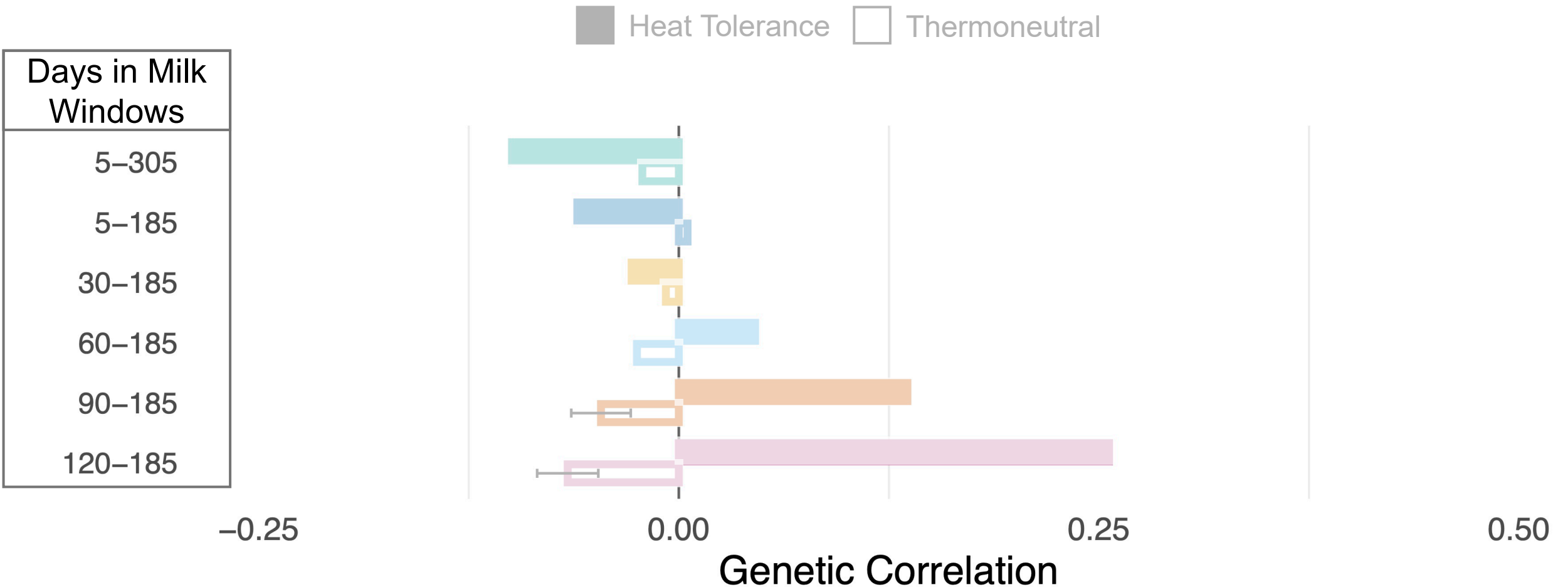


# Adaptation-Mitigation



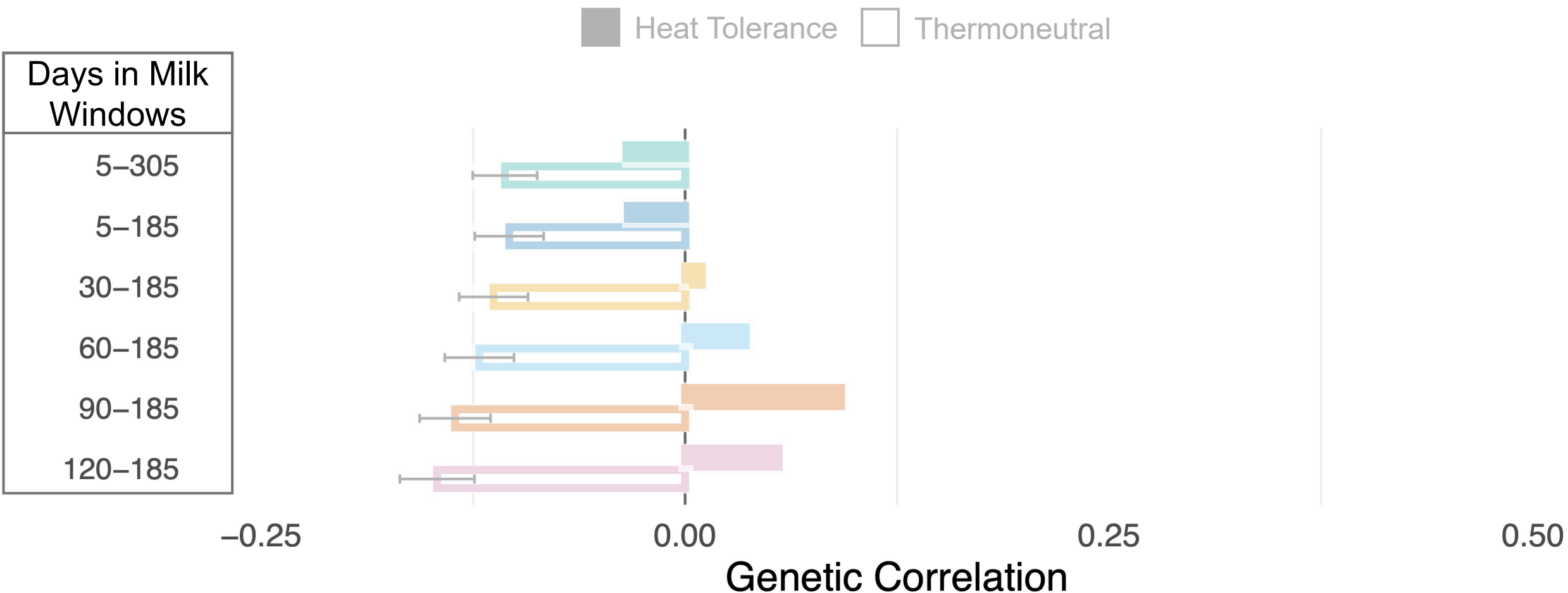
# Methane & Milk Yield

## Correlations Between MIR Predicted Methane and Milk Yield



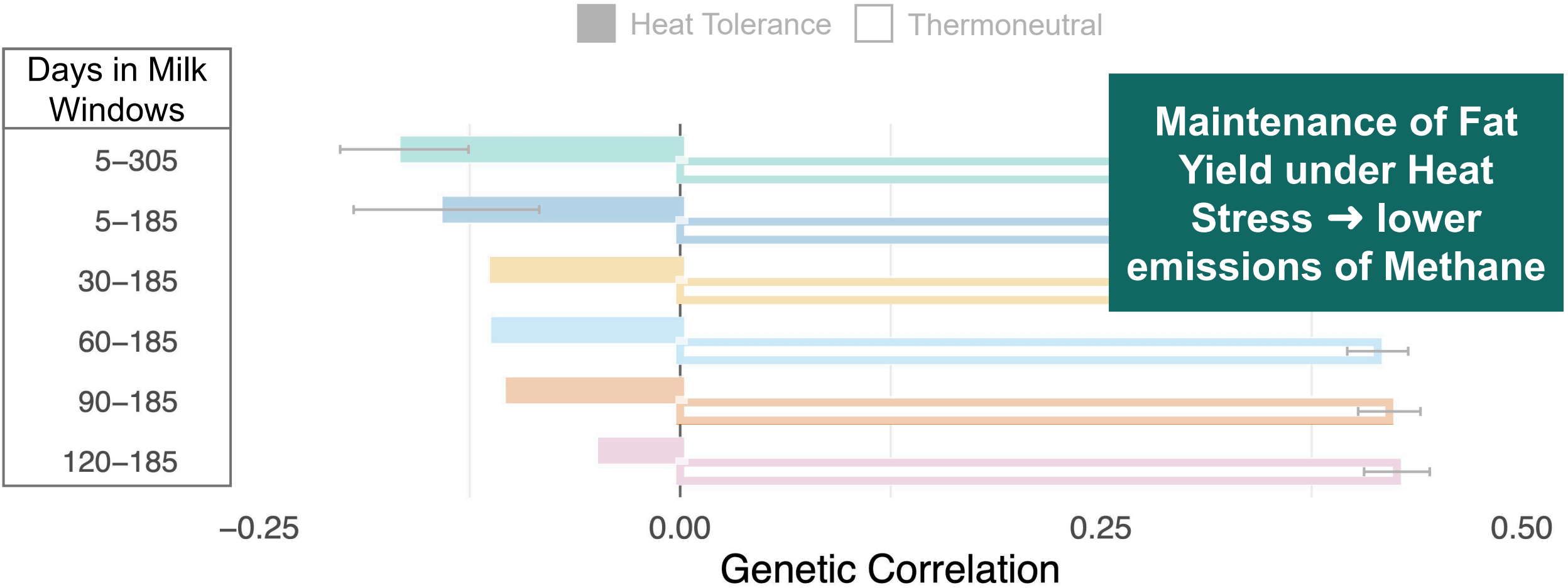
# Methane & Protein Yield

## Correlations Between MIR Predicted Methane and Protein Yield



# Methane & Fat Yield

## Correlations Between MIR Predicted Methane and Fat Yield



# Preliminary Conclusions

## 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

# Ongoing Project

## Industry and Research Collaboration



UNIVERSITY OF  
**GUELPH**



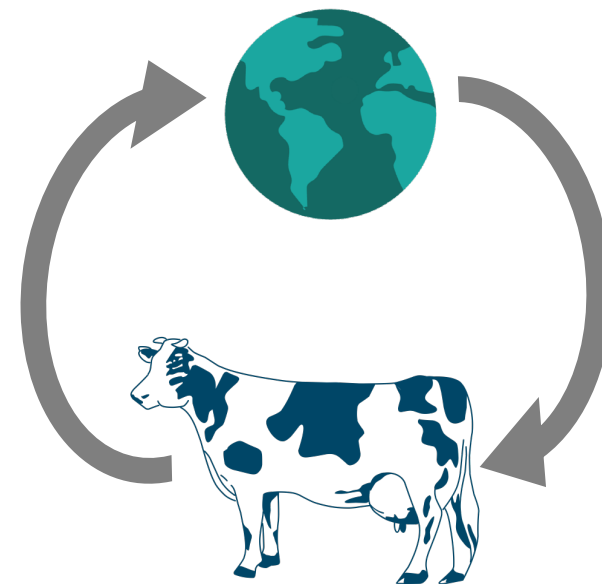
**SEMEX**

**Lactanet**  
CANADIAN NETWORK FOR DAIRY EXCELLENCE

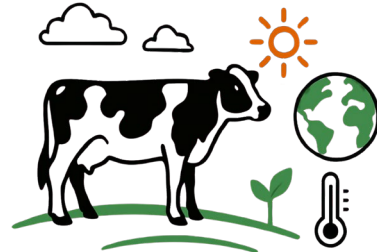


abacusbio.

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



# Acknowledgements



**Net-Zero Dairy** **AdaptMitigate**  
GENOME PROJECT Dairy Genome Project

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