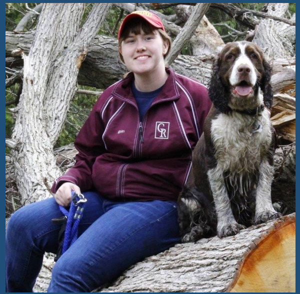
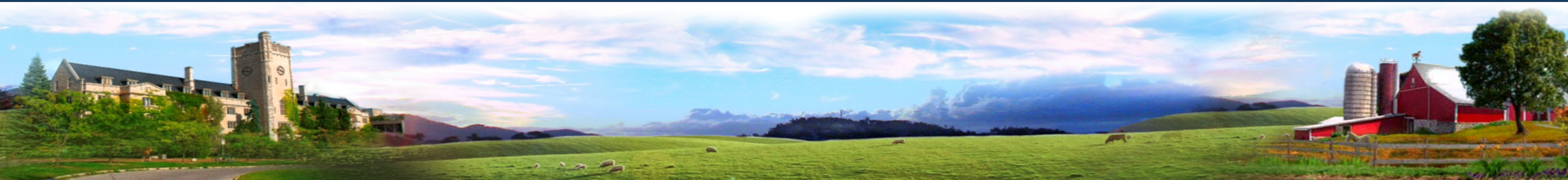
# Accuracy of Single-Step Genomic Breeding Values for Milk Production Traits of Canadian Alpine and Saanen Dairy Goats




Erin Massender[1], Luiz F. Brito[1,2], Laurence Maignel[3], Hinayah R. Oliveira[1,2], Mohsen Jafarikia[1,3], Christine F. Baes[1,4], Brian Sullivan[3], Flavio S. Schenkel[1]

[1]Centre for Genetic Improvement of Livestock, University of Guelph
[2]Department of Animal Sciences, Purdue University
[3]Canadian Centre for Swine Improvement Inc.
[4]Institute of Genetics, Vetsuisse Faculty, University of Bern





# Take Home Message

The implementation of single-step genomic evaluations for milk production traits of Canadian Alpine and Saanen goats will increase accuracy of selection for breeding candidates, and consequently, accelerate genetic gain.

This will increase the efficiency of Canadian goat milk production, leading to greater profitability and competitiveness of the dairy goat sector.

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# Goat Milk Production in Canada

- Canadian goat herds produce about **63.4 million litres** of milk per year, with over 80% produced in Ontario (CDIC, 2019)
- The cost to produce a litre of goat milk is **64.9%** higher than milk from cattle and producer margins are narrow
  - Not supply managed
  - Low milk production per doe (**2.5 L/day**) (Ontario Goat, 2016)
  - Seasonal fluctuations in production
  - High rates of producer turn-over
- Increasing production efficiency is critical to the profitability of the sector

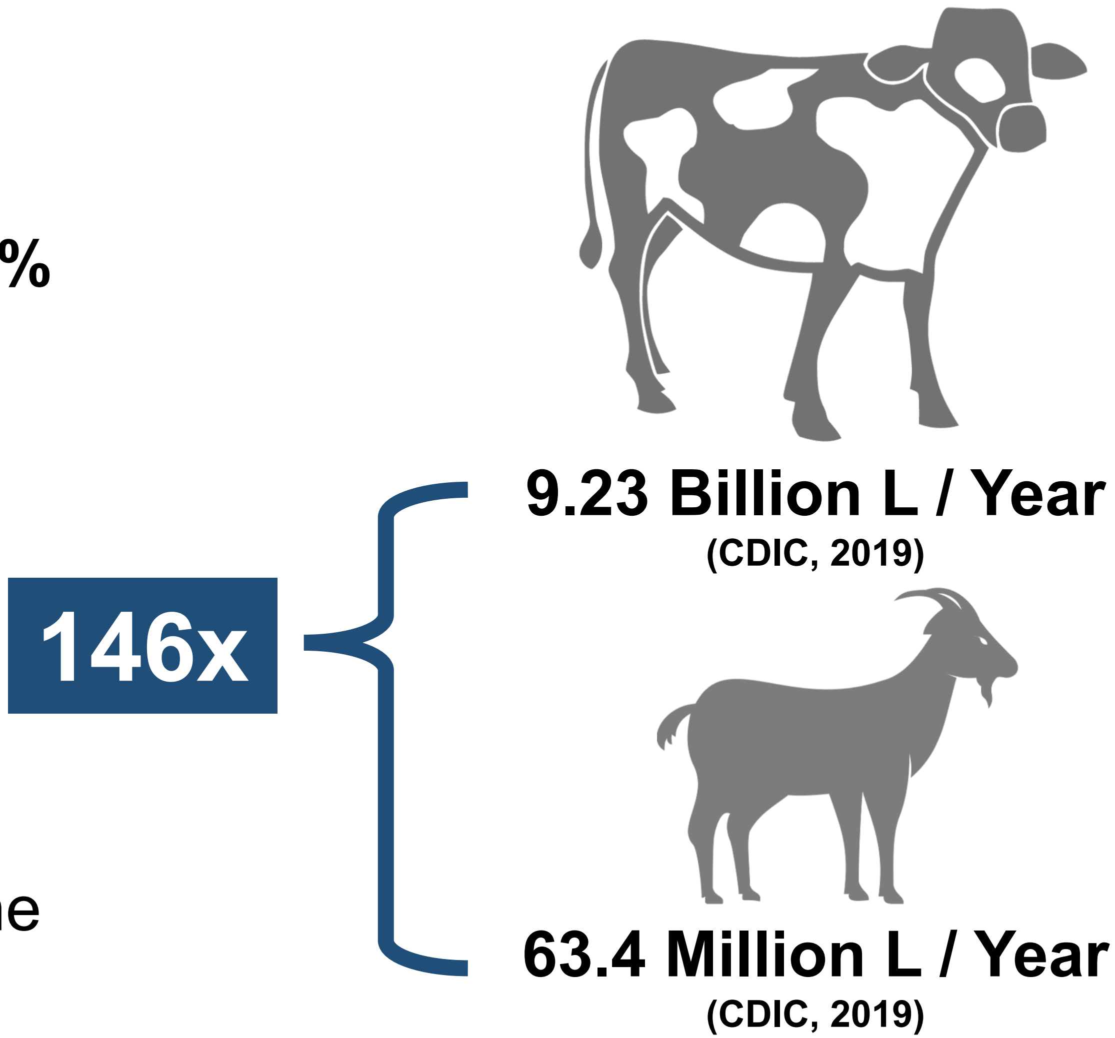


Image Source: Goat Icon by Wahyuntitle from the Noun Project

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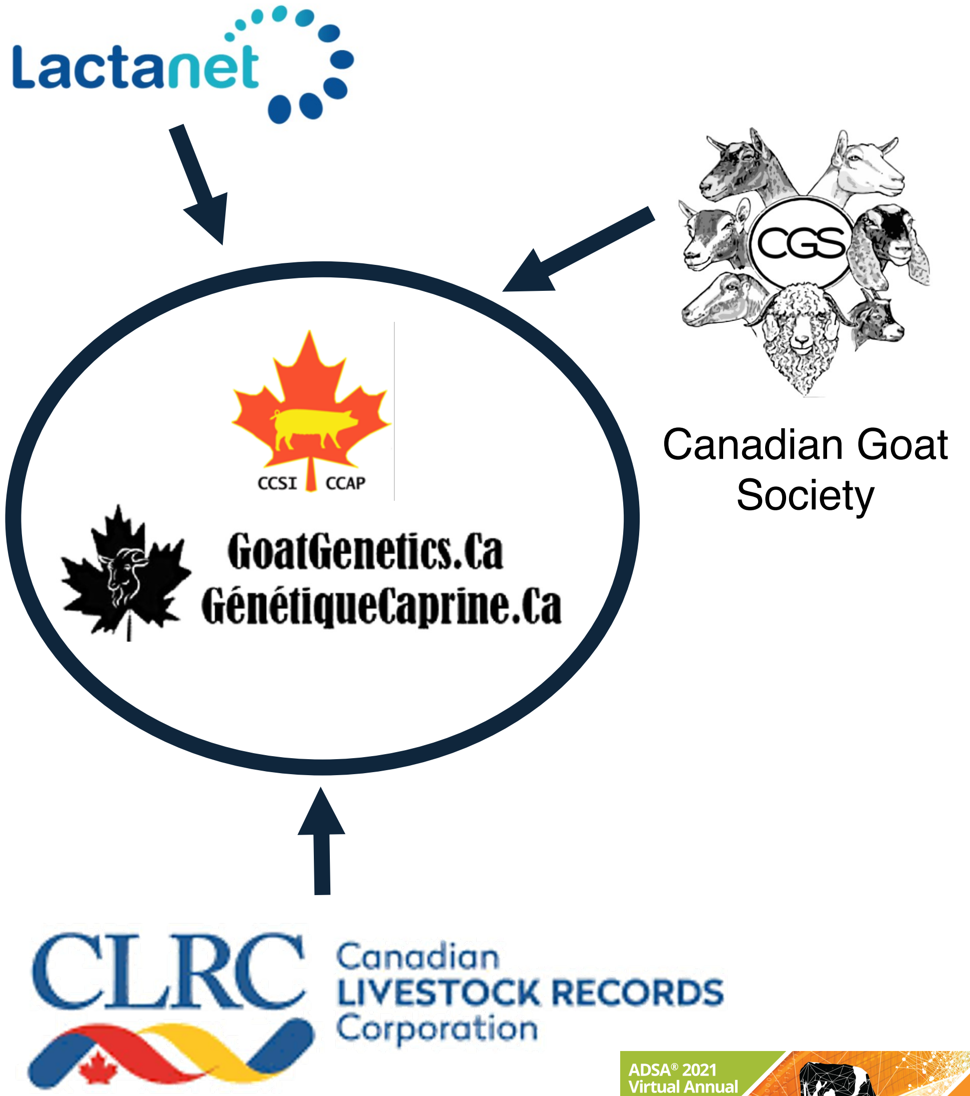
# Genetic Improvement Program

- Genetic evaluations are computed by the Canadian Centre for Swine Improvement (CCSI) and made available through GoatGenetics.ca
- Multiple-breed evaluations
- Single-trait test-day model for milk yield and fat and protein yields and contents
  - **Fixed effects** – breed, breed-parity-age-season, days in milk and age
  - **Random effects** – herd-test date, permanent environment within a lactation and animal additive genetic



# Factors Limiting Genetic Progress

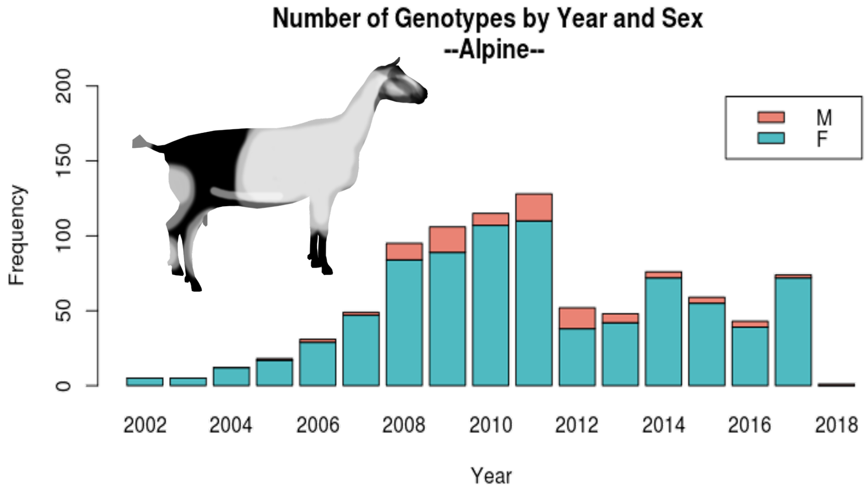
- Limited individual doe identification
- Reliance on "bulk-tank measurements" as performance indicators
- Low registration rates and participation in milk recording programs
- Low use of available selection tools (e.g., EBV, indexes) at the commercial level
- Genetic evaluations have not been updated to reflect recent advancements, such as genomic prediction

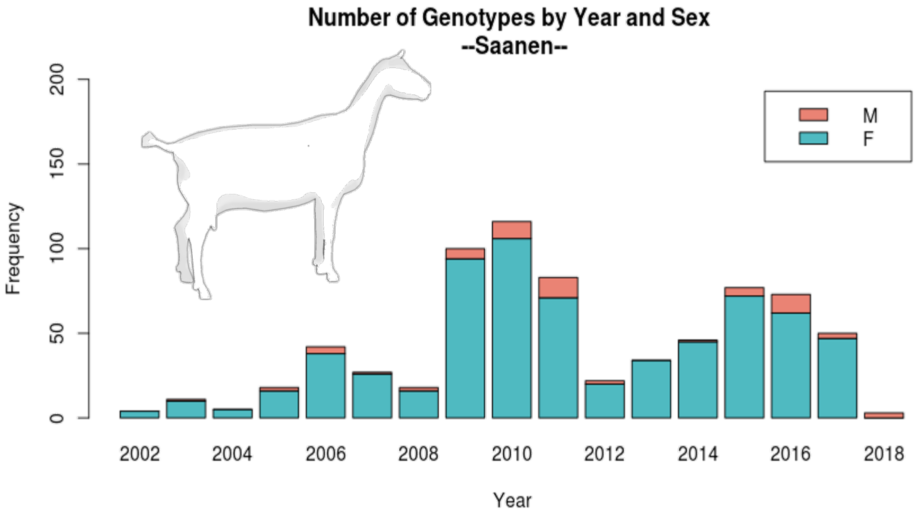
# Objective

Evaluate the gain in selection accuracy that can be expected from the implementation of genomic evaluations for milk production traits of Canadian Alpine and Saanen goats.

# Sample Collection and Genotyping

- **Genotypes**
  - **1,267** Alpine and Saanen goats from **13** herds across Canada
  - **720** genotypes from a previous project
- **Criteria for Sampling:**
  - Herds participating in milk testing
  - Registered bucks
  - Registered does with milk records



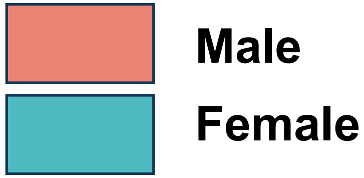
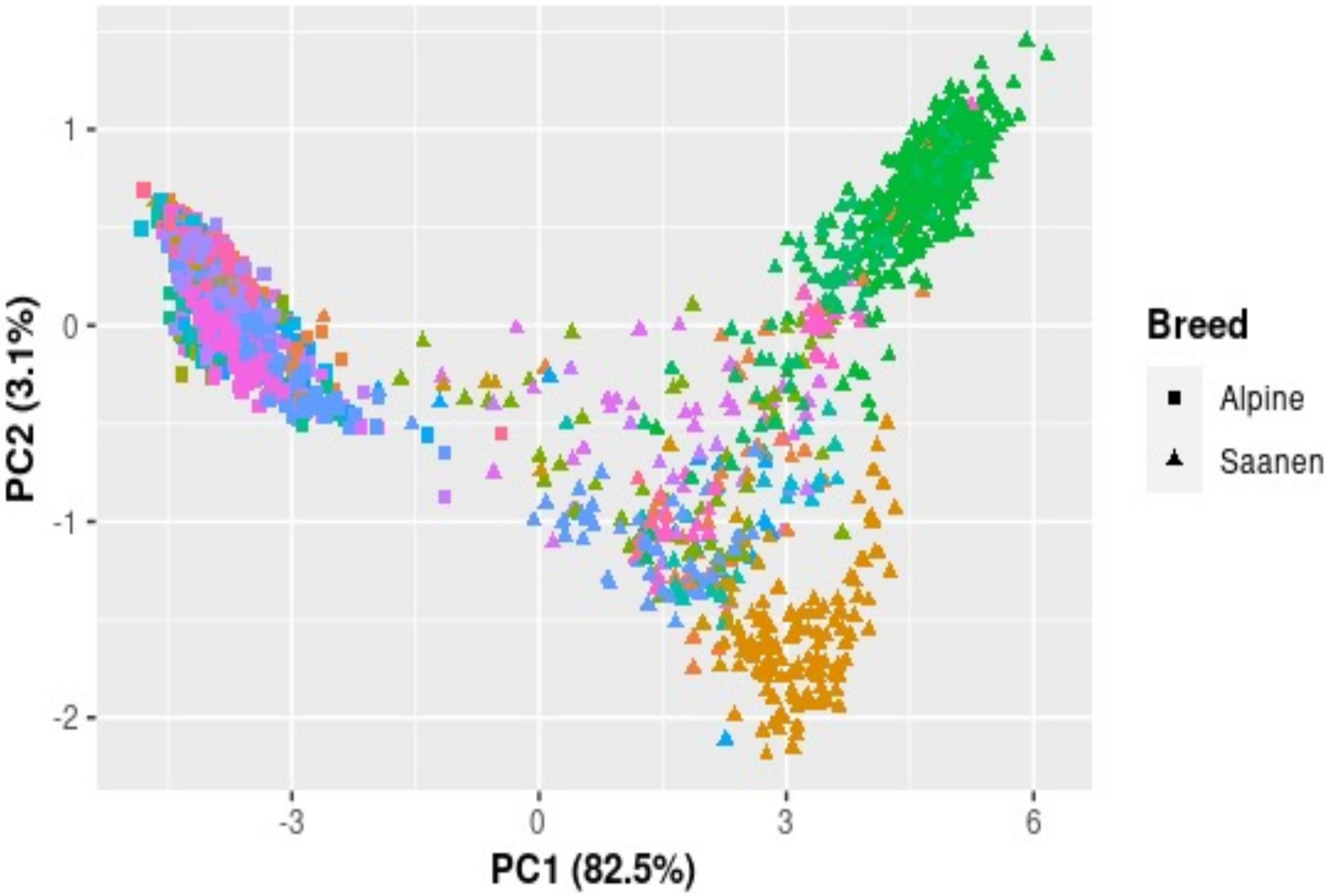




Image Source: Canadian Goat Society, Classification Manual, 2020

# PCA of Genomic Relationship Matrix




*Genotyped animals are coloured by herd of origin.*

# Methods – Genetic Evaluations

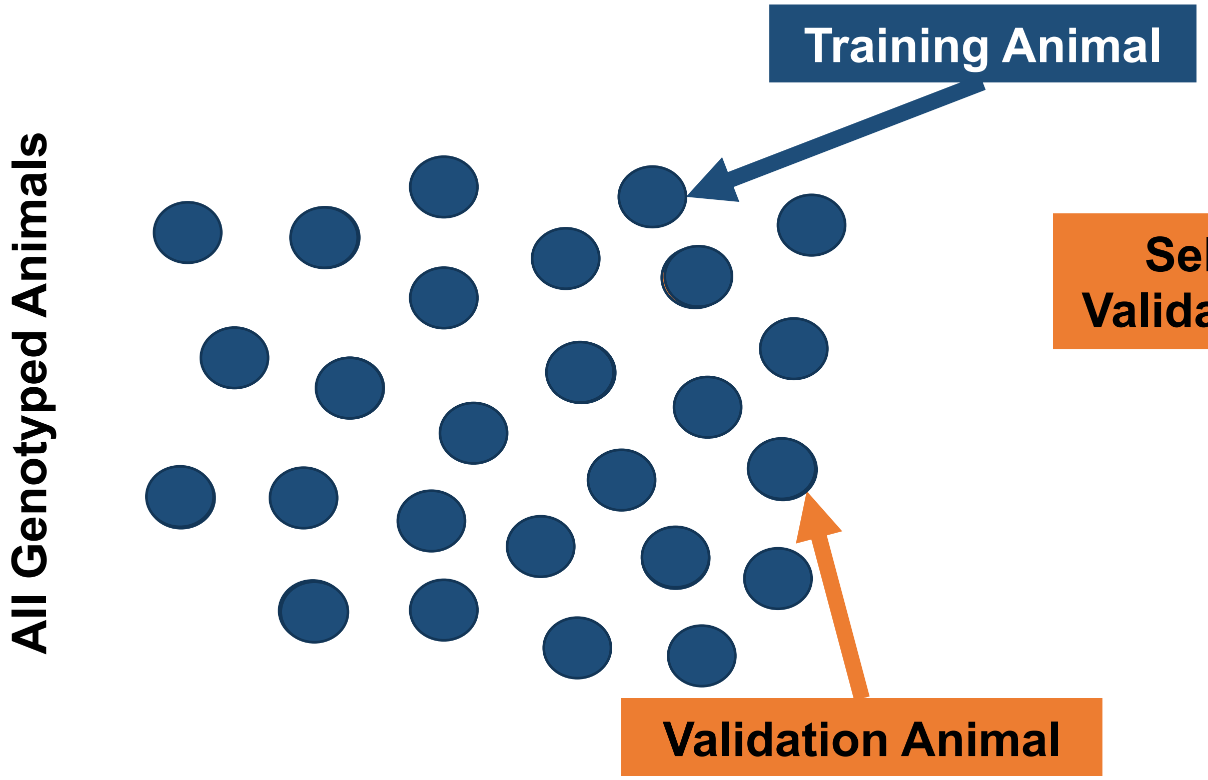
- BLUPf90 family programs used to estimate genetic parameters and predict (G)EBV
  - Optimal scaling parameters: tau = 1.0 and omega = 0.8

- **Genetic Evaluation Models:**
  - 305-day phenotypes were pre-adjusted for the effects in the routine genetic evaluation models
    - Only fixed effect of trait mean was modelled
  - Multiple-trait models within trait group (yield or content) and lactation
  - (G)EBV were predicted using both full and validation datasets, where phenotypic information was removed for selection candidates and their descendants
  - Compared single-breed and multiple-breed analyses

# Methods - Validation Design

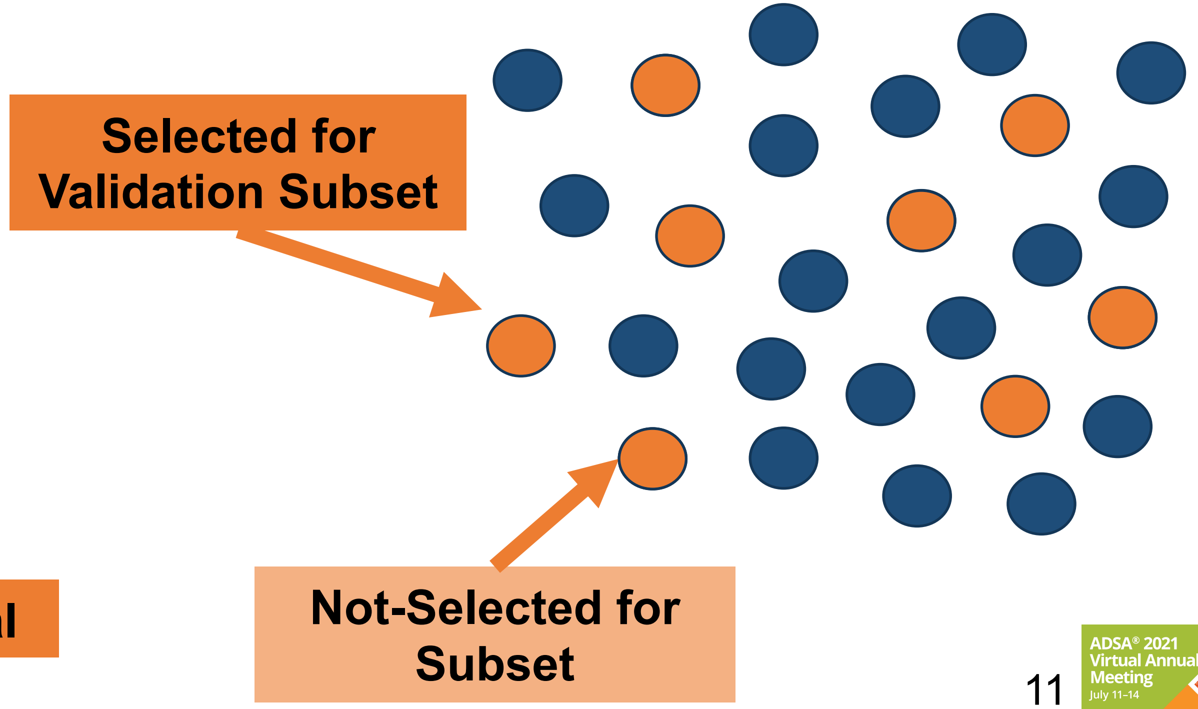
## Forward Validation

- All animals born > 2012 with average full dataset EBV accuracy > 0.50




## Forward Cross-validation

- Subsets of 100 animals eligible for validation population
- Results averaged over 10 replicates



# Methods – Theoretical Accuracy

- Theoretical accuracy (ACC) of (G)EBV was calculated from the standard error of prediction (*s*), accounting for inbreeding (*f*):

$$\mathrm{ACC}_i = \sqrt{1 - \frac{(s_i)^2}{(1 + f_i)\sigma_a^2}}$$

(Van Vleck, 1993)

- Average (G)EBV accuracy of each trait was calculated for selection candidates, using the reduced validation datasets

- The average expected gain in theoretical accuracy of GEBV compared to EBV was assessed for various subsets of the population for both genotyped and non-genotyped animals

# Phenotypes and Heritability Estimates

| | | | Alpine | | | Saanen | | |
|---|---|---|---|---|---|---|---|---|
| Lactation | Trait* | Abr. | N | Mean ± SD | $h^2$ | N | Mean ± SD | $h^2$ |
| First | Milk Yield, kg | MY1 | 12,024 | 887 ± 168 | 0.33 ± 0.03 | 7,427 | 890 ± 223 | 0.35 ± 0.04 |
| | Protein Yield, kg | PY1 | 12,024 | 27 ± 5 | 0.36 ± 0.03 | 7,427 | 28 ± 7 | 0.36 ± 0.04 |
| | Fat Yield, kg | FY1 | 12,024 | 30 ± 6 | 0.32 ± 0.03 | 7,427 | 30 ± 8 | 0.38 ± 0.04 |
| | Protein Percentage, % | PP1 | 12,024 | 3 ± 0.2 | 0.66 ± 0.02 | 7,427 | 3 ± 0.2 | 0.55 ± 0.04 |
| | Fat Percentage, % | FP1 | 12,024 | 3 ± 0.4 | 0.57 ± 0.03 | 7,427 | 3 ± 0.5 | 0.43 ± 0.04 |
| Later | Milk Yield, kg | MY2+ | 21,409 | 888 ± 194 | 0.21 ± 0.02 | 10,418 | 885 ± 242 | 0.17 ± 0.03 |
| | Protein Yield, kg | PY2+ | 21,409 | 28 ± 6 | 0.24 ± 0.02 | 10,418 | 27 ± 7 | 0.18 ± 0.03 |
| | Fat Yield, kg | FY2+ | 21,409 | 30 ± 7 | 0.22 ± 0.02 | 10,418 | 30 ± 9 | 0.20 ± 0.03 |
| | Protein Percentage, % | PP2+ | 21,409 | 3 ± 0.2 | 0.61 ± 0.02 | 10,418 | 3 ± 0.2 | 0.61 ± 0.03 |
| | Fat Percentage, % | FP2+ | 21,409 | 3.4 ± 0.4 | 0.55 ± 0.02 | 10,418 | 3 ± 0.5 | 0.44 ± 0.03 |

*305-day phenotypes, adjusted for the effects used in the routine genetic evaluation models

# Accuracy of Selection Candidates

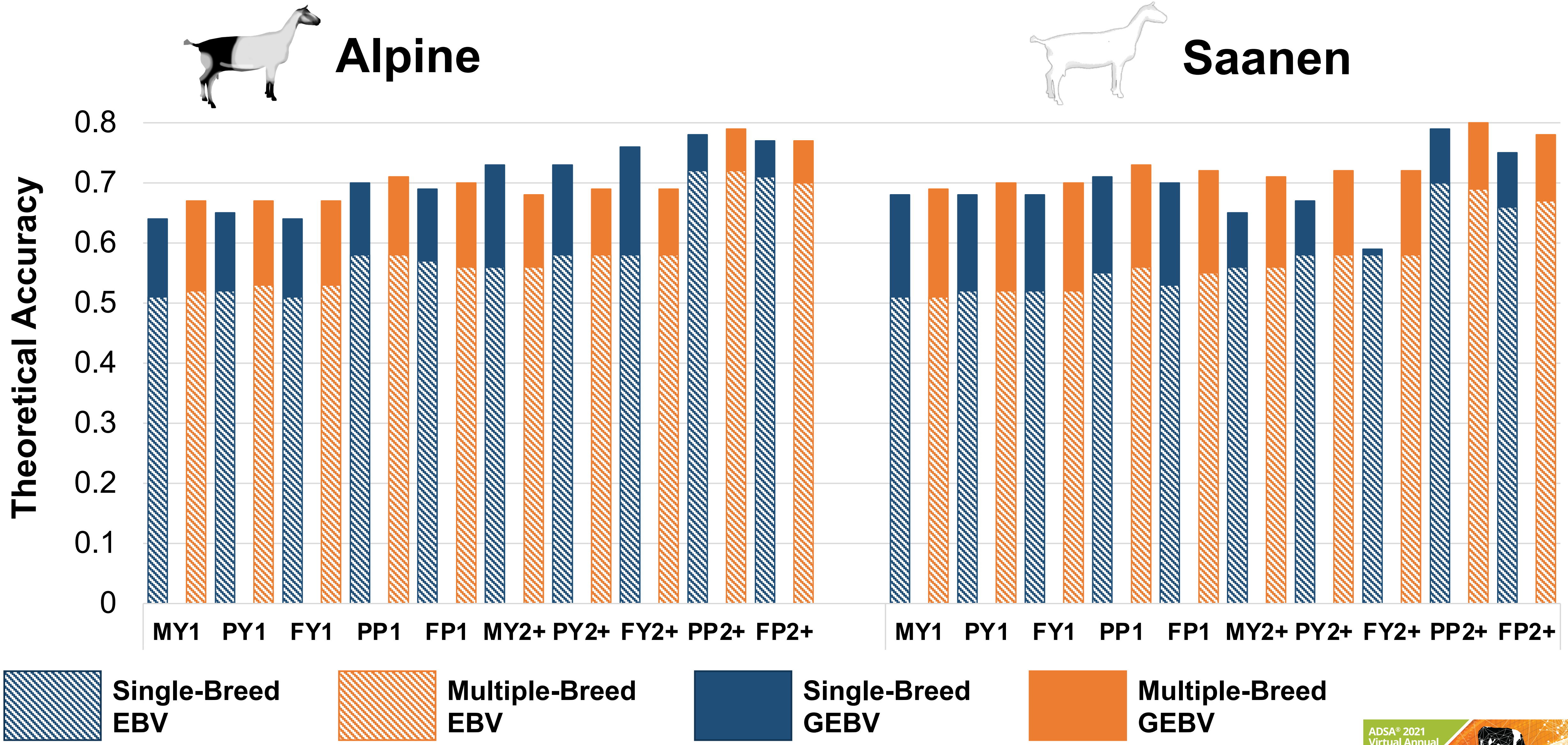



Image Source: Canadian Goat Society, Classification Manual, 2020

# Gain in Accuracy from GEBV

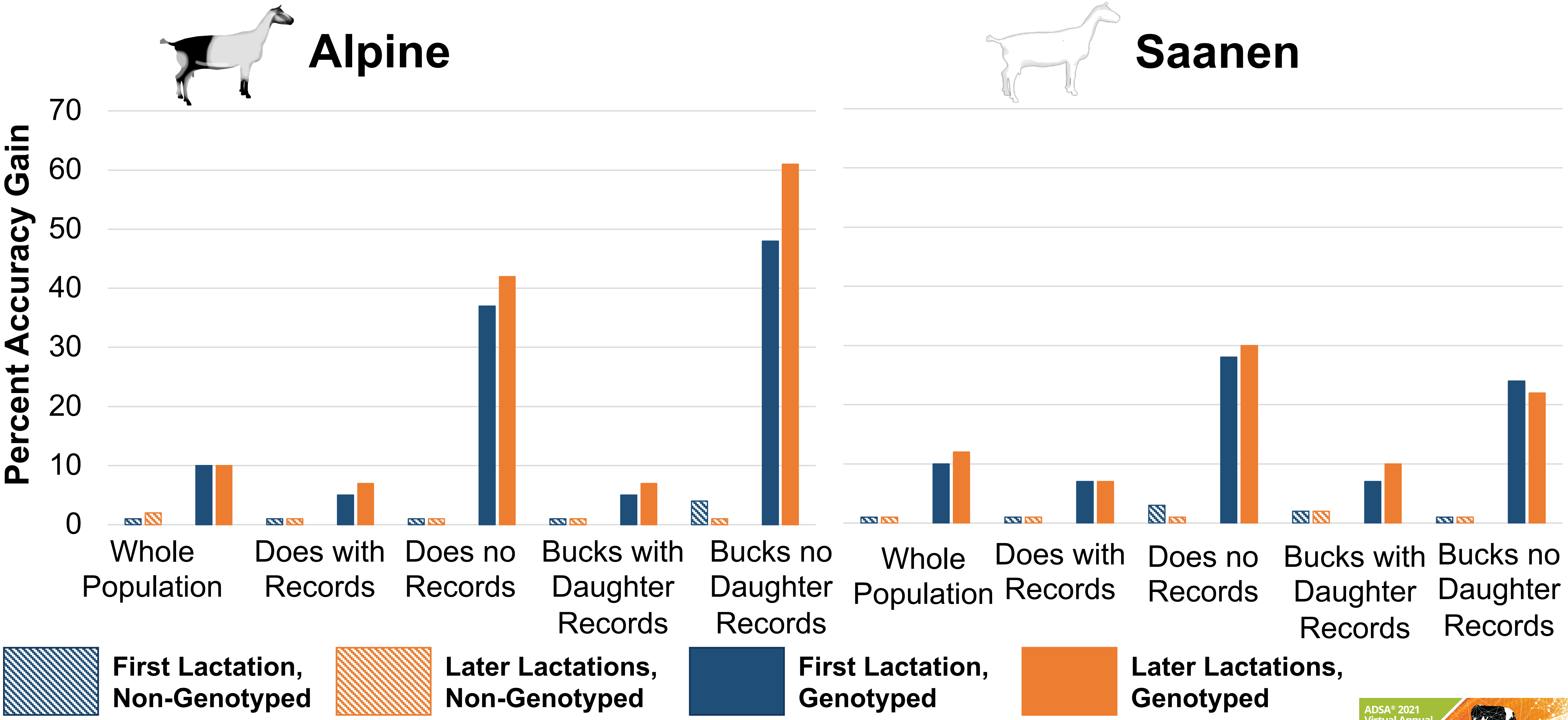



Image Source: Canadian Goat Society, Classification Manual, 2020

# Conclusions

1. Increasing the productivity of Canadian dairy goats is critical to the profitability of the sector.

2. Genomic selection is feasible for milk production traits of Canadian Alpine and Saanen goats with the expanded training population.

3. Substantial gains to selection accuracy are expected from the implementation of genomic selection, especially for does without records (28 to 42%) and bucks without daughter records (22 to 61%).

# Acknowledgements

## Project Team:

**Centre for Genetic Improvement of Livestock:**
Erin Massender
Hinayah Rojas de Oliveira
Flavio Schenkel
Christine Baes

**Purdue University:**
Luiz Brito

**Canadian Centre for Swine Improvement:**
Laurence Maignel
Mohsen Jafarikia
Brian Sullivan

## Data Provision:

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# Thank YOU!

**Erin Massender**
**Ph.D. Candidate,**
**Centre for Genetic Improvement of Livestock,**
**University of Guelph**
**emassend@uoguelph.ca**