Genetic and genomic analysis of superovulatory response in Canadian Holsteins

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ciaq CGIL Holstein Canada Réseau laitier canadien Canadian Dairy Network NSERC CRSNG

Embryo industry

Dairy embryos produced in vivo

Total: 340,000

(IETS,2013)

Exportation

Source: Canadian Dairy Information Center (www.dairyinfo.gc.ca)

Opportunities and challenges

- Variability of superovulatory response
- High cost of superovulation and embryo transfer
- No genetic or genomic analyses for superovulatory response in Canada

Are EBVs for superovulatory response useful to the industry?

Objectives

- Estimate genetic parameters of superovulatory response traits
- Estimate breeding values (EBVs) for superovulatory response traits
  - examine their relationship with other routinely evaluated traits in Canada
- Perform GWAS on novel traits

Data set

- Provided by Holstein Canada

- Originally:
  - 168,855 records
  - 1980 to 2014 (March)

- After editing:
  - 137,446 records
  - 1992 to 2014 (March)

- Only successful flushes kept (min. 1 embryo)

- Data editing:
  - Complete and unique records
  - Age of the donor: 8 to 180 months
  - Clinics with min. 50 records

Traits

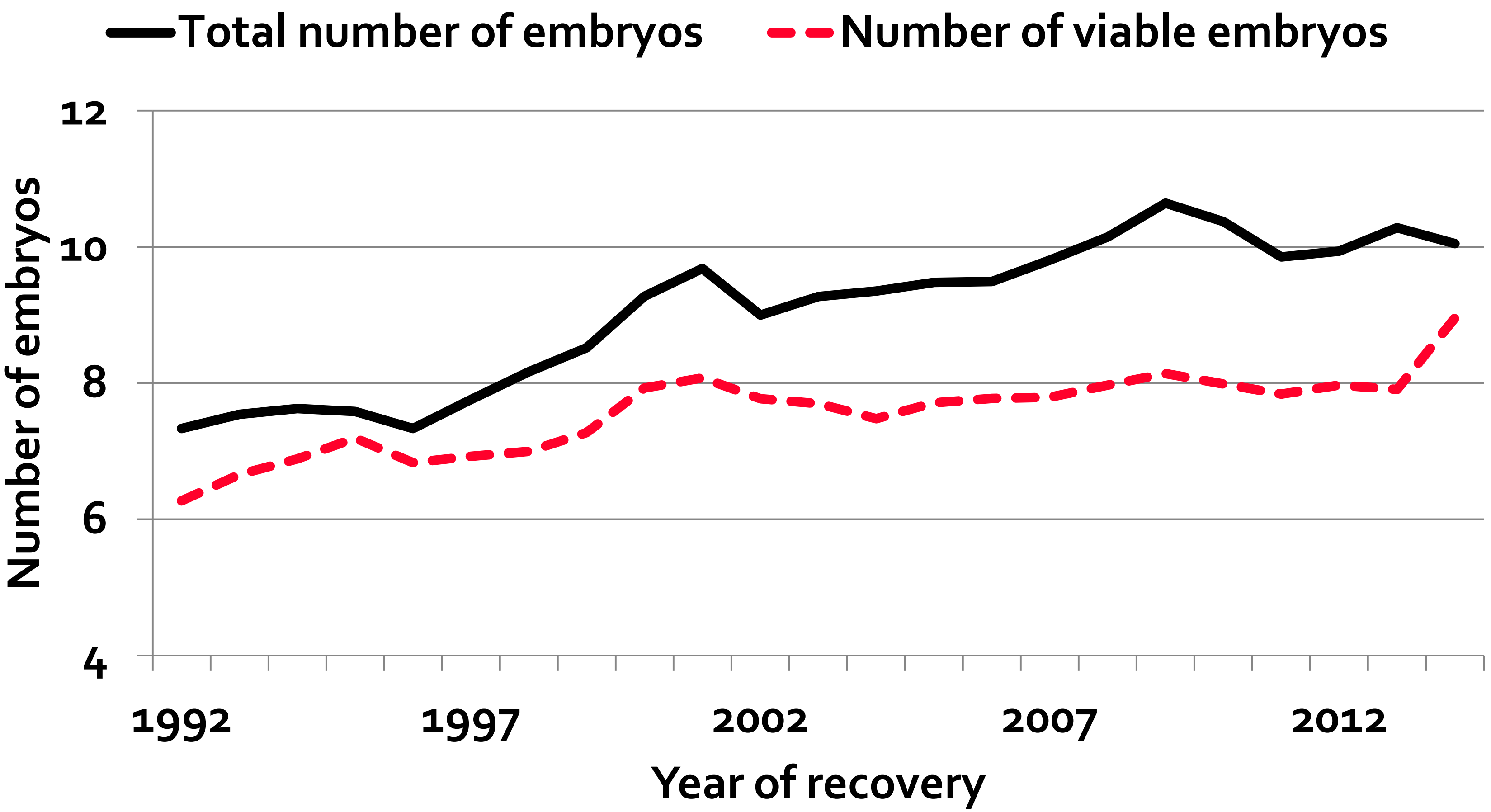
- **Total number of embryos:**
  - All embryos recovered from a flush
  - Includes degenerated or dead embryos

- **Number of viable embryos:**
  - Embryos recovered that have been notified to Holstein Canada as transplanted or frozen

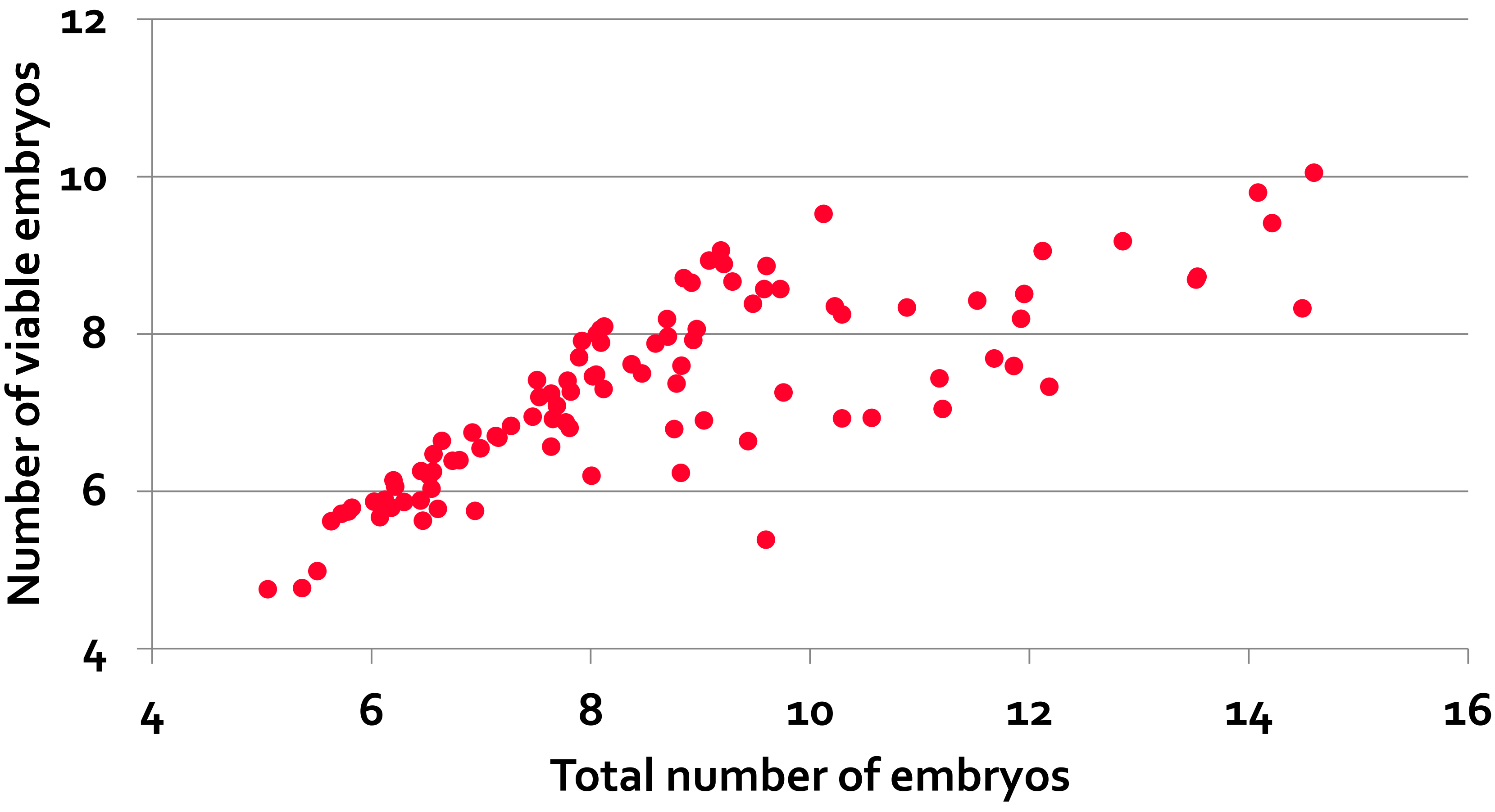
Descriptive statistics

	Total (N)	Average	SD	Min	Max
Records (flush)	137,446	-	-	-	-
Donors	54,463	-	-	-	-
Sires	3,513	-	-	-	-
Service sires	2,250	-	-	-	-
Clinics	100	-	-	-	-
Total Embryos	1,265,333	9.21	7.24	1	87
Viable embryos	1,044,416	7.60	5.92	0	58

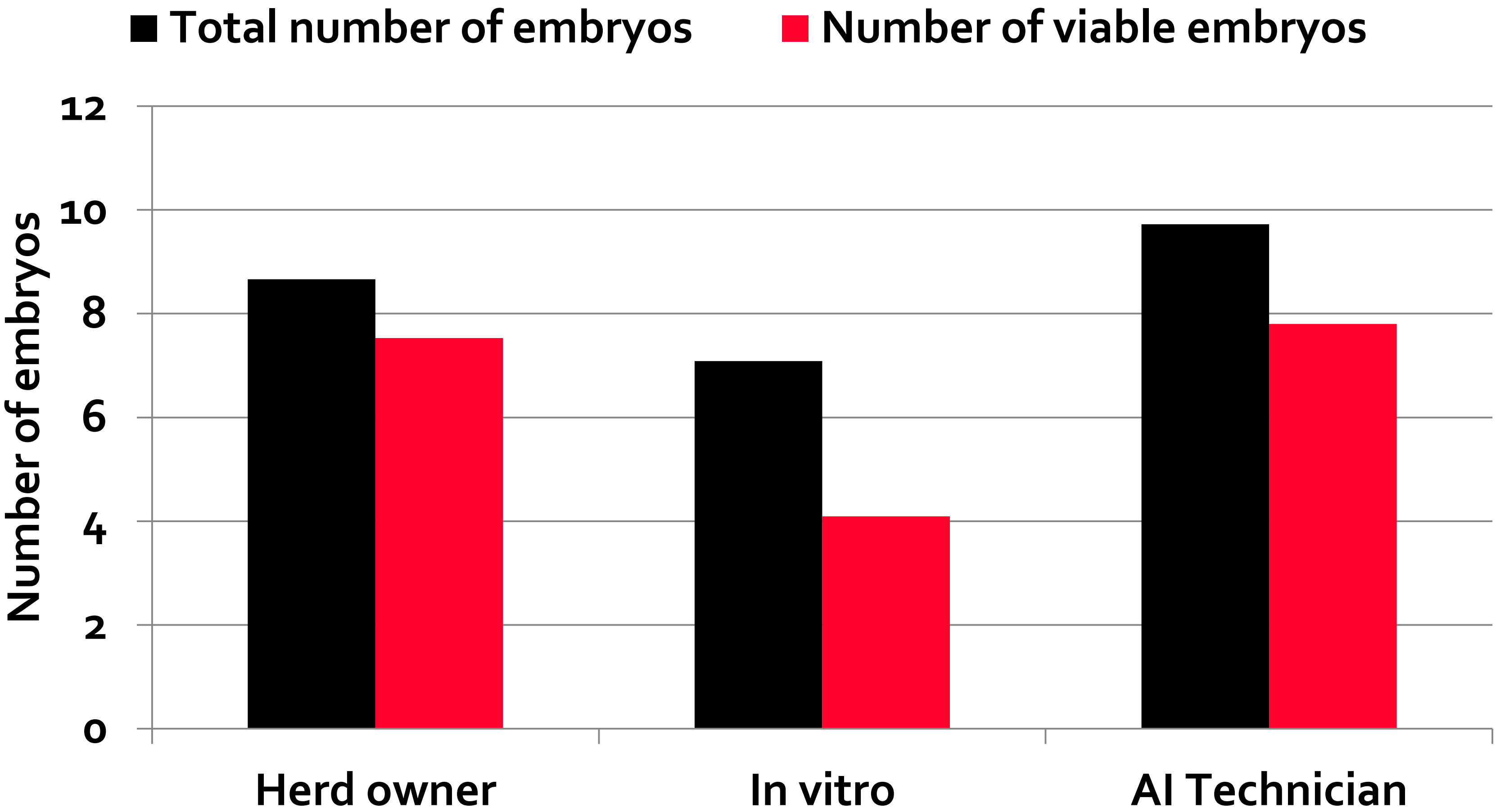
Year of recovery



Clinic


12
10
8
6
4
Number of viable embryos
4
6
8
10
12
14
16
Total number of embryos

Service type



Model

$$y = X\beta + Z_d d + Z_{ss} ss + Z_{pe} pe + e$$

Where:

y = total number of embryos or number of viable embryos

β = vector of fixed effects (age-service type, age²-service type, year-month, clinic-year, and service type)

d = vector of random animal additive effect of the donor

ss = vector of random animal additive effect of the service sire

pe = vector of permanent environmental effects of the donor

e = Vector of random residuals

X, Z_d, Z_{ss}, and Z_{pe} = corresponding incidence matrices

Genetic parameters *(SE)*

	Trait	h_d^2	h_{ss}^2	r_d
Log	Total Embryos	0.148 *(0.007)*	0.007 *(0.001)*	0.240
	Viable Embryos	0.135 *(0.007)*	0.014 *(0.002)*	0.229
Anscombe	Total Embryos	0.174 *(0.008)*	0.006 *(0.001)*	0.281
	Viable Embryos	0.144 *(0.007)*	0.014 *(0.002)*	0.243

EBV correlations

	Trait	Total Embryos (n = 1,391)	Viable Embryos (n = 1,251)
	LPI	-0.23	-0.14
Production	Milk yield	-0.26	-0.21
	Protein yield	-0.29	-0.24
	Fat yield	-0.21	-0.15
Reproduction	Daughter fertility	0.20	0.20
	56-d non-return rate	0.16	0.16
	Number of services	0.20	0.21
	First service to conception	0.19	0.20
	Calving to first service	0.12	0.12
	Days open	0.21	0.21

Best and worst donors

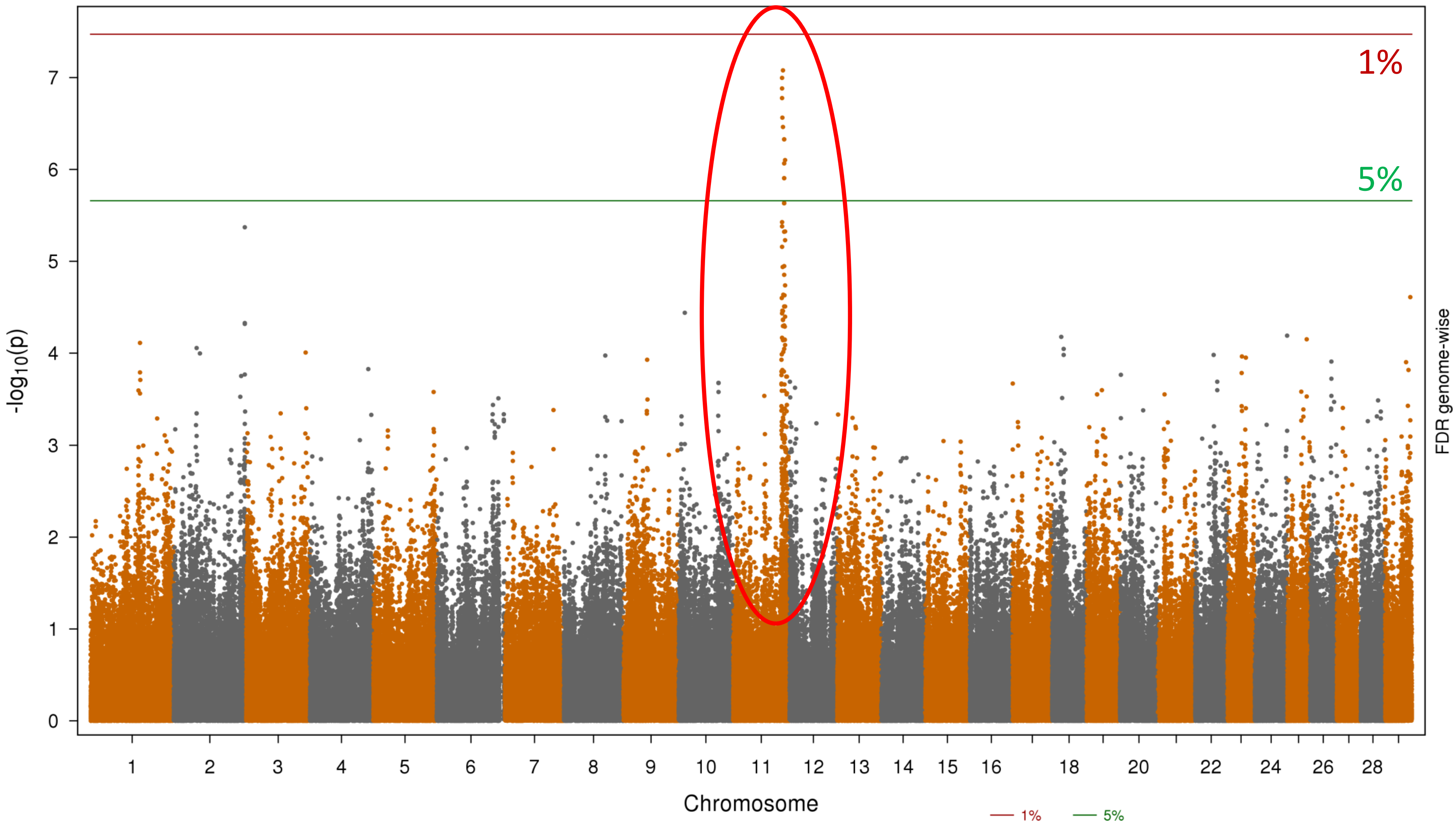
		Mean number of embryos			
Trait	No. donors	Mean	Top 10%	Bottom 10%	Difference
Total Embryos	32,403	9.23	15.61	4.27	11.3
Viable Embryos	29,554	7.62	13.40	3.49	9.9

Genome-wide association study

- 57,976 cows and sires:
  - 5,535 genotyped (≥50K panel)
  - Imputation of genotypes to HD (FImpute → Sargolzaei et al., 2014)
- De-regressed EBVs
  - Threshold reliability >10%
  - 4,186 individuals considered
    - 763 males
    - 3,423 females
- Single-SNP regression (SSR) using genomic relationship matrix

GWAS

Number of viable embryos



Pros & Cons for dairy producers

- Invest in females that have more potential to respond to superovulation
- Additional information for the purchase of a donor

- Not all dairy producers use superovulation (10-20%)
- Elite dairy cows will be superovulated regardless of their genetic evaluation for superovulation

Potential benefits for industry

- Added value for AI industry
  - bulls with daughters that should produce more embryos
- Veterinarians could customize superovulatory protocols of donors based on genetic potential for superovulation (research)

Conclusions

- Selection for superovulatory response in Canadian Holstein cows is possible
- Superovulatory response is a novel trait and mostly uncorrelated with other performance traits
- Additional information for breeding decisions

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Thank you!