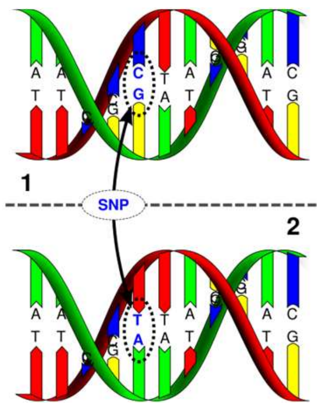
Selecting Replacement Heifers

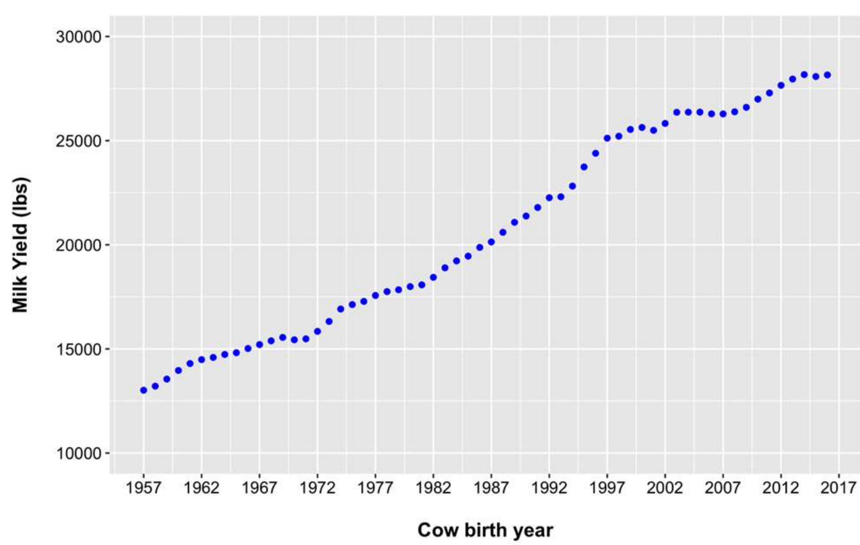


Francisco Peñagaricano

UNIVERSITY of FLORIDA

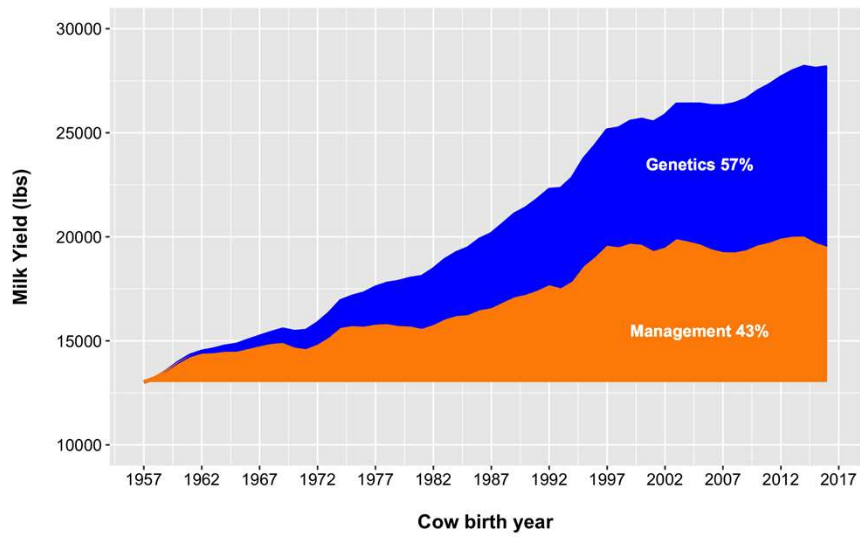
Selecting replacement heifers

What is the importance of genetic selection?



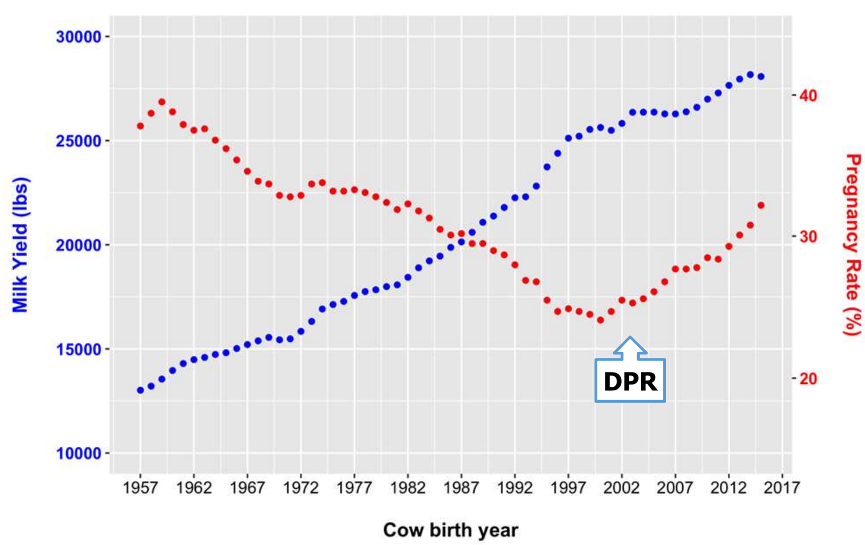
Selecting replacement heifers

What is the importance of genetic selection?



Selecting replacement heifers

What is the importance of genetic tools?



Selecting replacement heifers

How do we identify the best/worst animals?

Economic Selection Indices

Traits	NM$ (2018)	CM$ (2018)	FM$ (2018)	GM$ (2018)
Milk	−0.7	−7.9	18.4	−0.7
Fat	26.8	22.8	27.1	22.9
Protein	16.9	20.9	0	14.4
Productive Life	12.1	10.3	12.2	6.6
Somatic Cell Score	−4.0	−4.4	−2.3	−3.5
Body Weight Composite	−5.3	−4.5	−5.3	−5.8
Udder Composite	7.4	6.3	7.5	7.4
Feet & Legs Composite	2.7	2.3	2.8	2.8
Daughter Pregnancy Rate	6.7	5.7	6.8	17.8
CA$ (calving trait subindex)	4.8	4.1	4.8	4.5
Heifer Conception Rate	1.4	1.2	1.4	2.4
Cow Conception Rate	1.6	1.4	1.7	4.3
Livability	7.3	6.2	7.4	4.9
HTH$ (health trait subindex)	2.3	1.9	2.3	2.1

Selecting replacement heifers

Dairy cattle breeding: 4 paths of selection

- ❑ selection of **sires of bulls**
- ❑ selection of **dams of bulls**
- ❑ selection of **sires of cows**
- ❑ selection of **dams of cows**

  - large population of cows on commercial farms
  - low selection intensity and low selection accuracy
  - **negligible effect on the genetic gain**

Selection of dams of cows

recent advances have modified the importance of this selection path:

- **improvements in herd management**

  ↓ **involuntary culling rates** and ↑ **reproductive efficiency**
- **use of sexed semen** (produce a **surplus of heifers**)

the selection of replacement heifers is feasible !

Selection intensity

proportion of selected heifers:

$$\frac{\textbf{number of heifers selected}}{\textbf{total number of heifers available}}$$

- **repro performance** determines the number of **replacements**
- **culling rates** determine the number of **heifers selected**
- **sexed semen** can generate a considerable **surplus of heifers**

↓ proportion → ↑ selection intensity → ↑ genetic gain

Selecting replacement heifers

Selection accuracy

estimate **as precisely as possible** the **genetic merit** of a heifer:

↑ **selection accuracy** → ↑ **genetic gain**

Selecting replacement heifers

Selection accuracy

estimate **as precisely as possible** the **genetic merit** of a heifer:

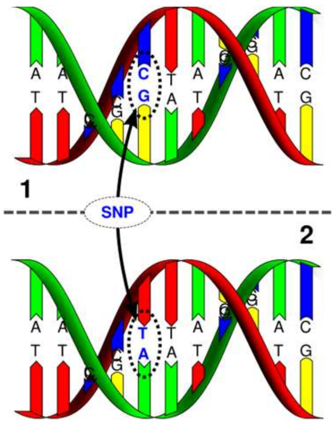
- **WITHOUT extra information:**

selection (culling) decisions are based on **parent average**

reliability ranges from **0** to **0.40**

Selecting replacement heifers

Genomic testing: the latest revolution



the use of genetic markers across the genome to predict breeding values

allows to select animals at an early age

JOIN THE REVOLUTION

Selecting replacement heifers

Selection accuracy

estimate **as precisely as possible** the **genetic merit** of a heifer:

- **WITHOUT extra information:**

  selection (culling) decisions are based on **parent average**

  reliability ranges from **0** to **0.40**

- **WITH genomic testing:**

  selection (culling) decisions are based on **genomic-predicted genetic merit**

  reliability ranges from **0.65** to **0.85**

Selecting replacement heifers

Genotyping strategy

- **full genotyping** or **selective genotyping**
- alternative strategies for **selective genotyping**:

❑ genotyping only the **top-ranked heifers** when:

the best heifers need to be identified

use of sexed semen, donors in IVF or ET programs

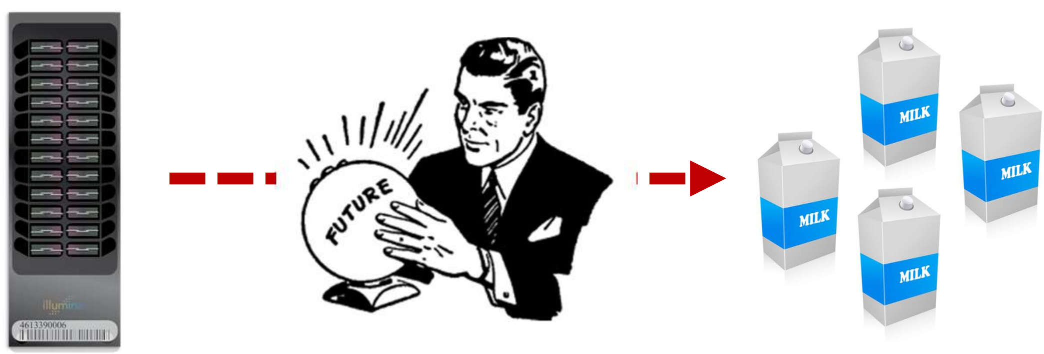
❑ genotyping only the **bottom-ranked heifers** when:

the worst heifers need to be identified

early culling, use of beef semen

Selecting replacement heifers

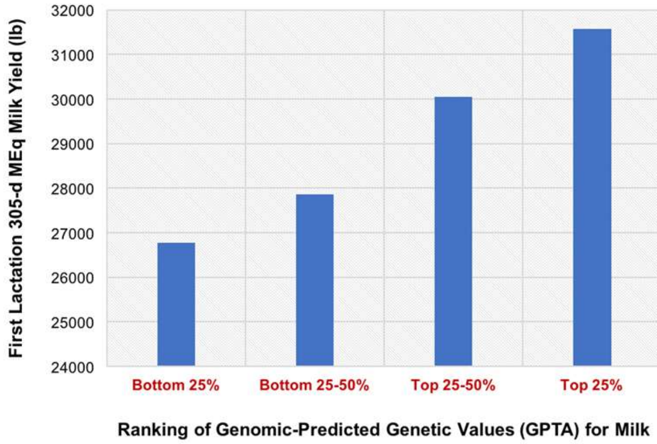
Can genomic testing predict future performance?



genomic testing

Selecting replacement heifers

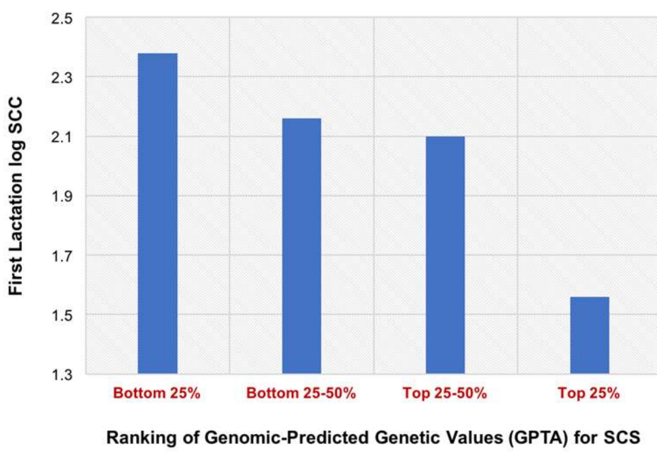
Predicting production using genomic testing



Weigel et al. (2015) Western Dairy Management Conference

Selecting replacement heifers

Predicting udder health using genomic testing



Weigel et al. (2015) Western Dairy Management Conference

Selecting replacement heifers

Predicting fertility using genomic testing

- **fertility traits are among:**

  the most **complex**, **hard to measure**, **lowly heritable** traits

  fertility traits can benefit the most from genomic testing

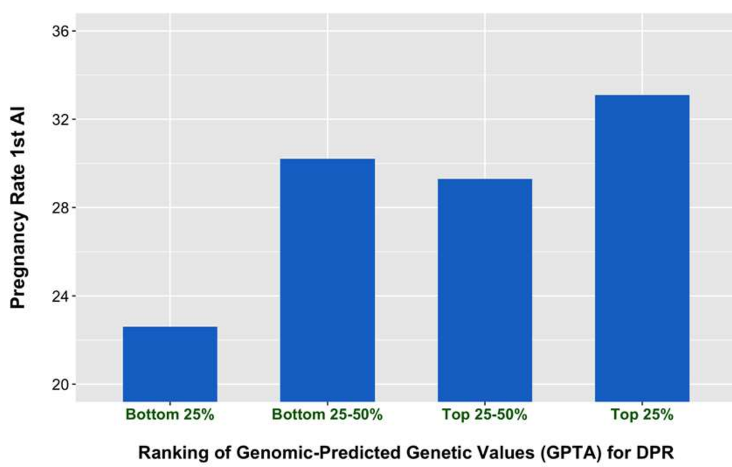
- **Daughter Pregnancy Rate (DPR):**

  the **primary trait** for **selection** for **cow fertility**

  can we predict repro performance using genomic DPR?

Selecting replacement heifers

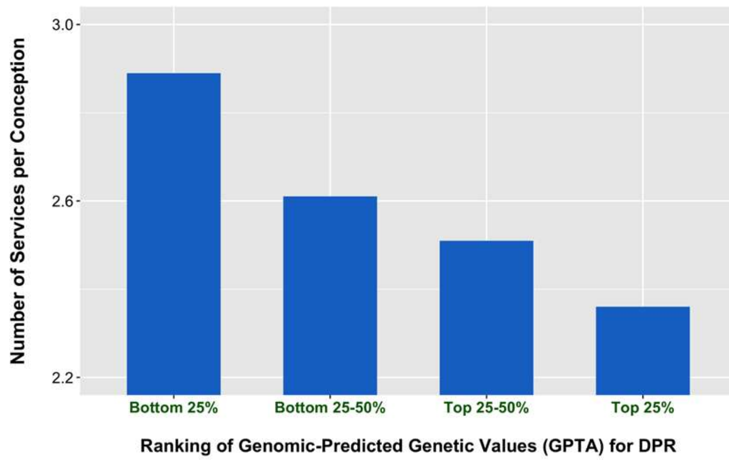
GDPR vs Pregnancy 1st AI



F. Lima, F. Silvestre, F. Peñagaricano and W. Thatcher (2019)

Selecting replacement heifers

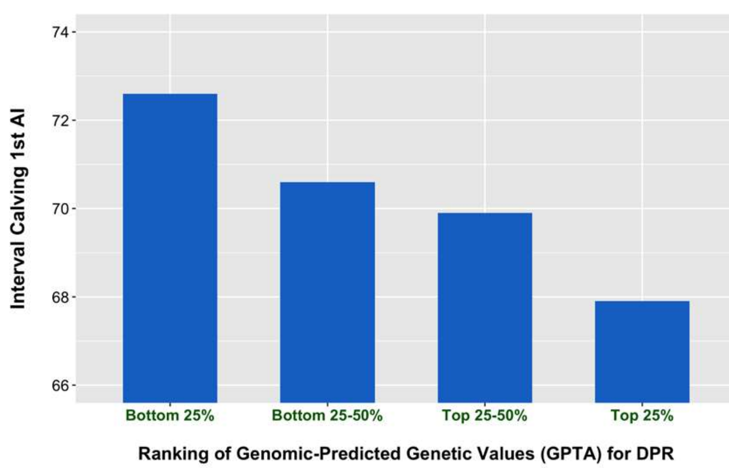
GDPR vs Number Services per Conception



F. Lima, F. Silvestre, F. Peñagaricano and W. Thatcher (2019)

Selecting replacement heifers

GDPR vs Interval Calving 1st AI

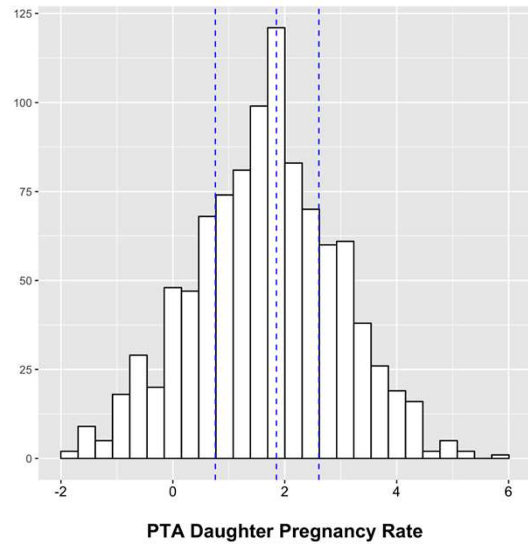


F. Lima, F. Silvestre, F. Peñagaricano and W. Thatcher (2019)

Selecting replacement heifers

UF UNIVERSITY of FLORIDA

GDPR vs Estrous Behavior & Fertility



Holstein heifers ($n \approx 1{,}000$)

GDPR quartiles: **top** vs **bottom**

- longer synchronized estrus
- more intense synchronized estrus
- **higher pregnancy rate at 1st AI** (62.7 vs 43.6)

A. Veronese, R. Chebel, F. Peñagaricano, R. Bisinotto et al. (2019)

Selecting replacement heifers

UF UNIVERSITY of FLORIDA

GDPR vs Physiological Responses

high GDPR (3.26 ± 0.76) vs **low GDPR** (-0.17 ± 0.75)

Item	GDPR High (n = 48)	GDPR Low (n = 51)
Estrous cycle day at $PGF_{2\alpha}$ treatment	12.1 ± 0.8	11.7 ± 0.8
Progesterone at $PGF_{2\alpha}$ treatment, ng/mL	4.58 ± 0.48	3.37 ± 0.48
Detected in estrus,[1] % (no.)	89.6 (43)	80.4 (41)
Progesterone on d 0,[2] ng/mL	0.03 ± 0.01	0.01 ± 0.01
Estradiol on d 0,[2] pg/mL	4.53 ± 0.23	3.79 ± 0.23
Ovulation according to ultrasound,[3] % (no.)	90.7 (39)	75.0 (30)
Ovulatory follicle diameter, mm	16.3 ± 0.3	14.6 ± 0.4
Ovulation according to progesterone,[4] % (no.)	100.0 (43)	97.6 (40)

A. Veronese, R. Chebel, F. Peñagaricano, R. Bisinotto et al. (2019)

Selecting replacement heifers

Genomic testing of replacement heifers

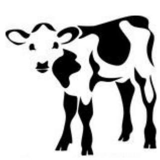
- genomic testing can be effectively used to predict performance
- genomic testing is more accurate than using sire's PTA values
- genomics can be used to make proper selection/culling decisions

Selecting replacement heifers

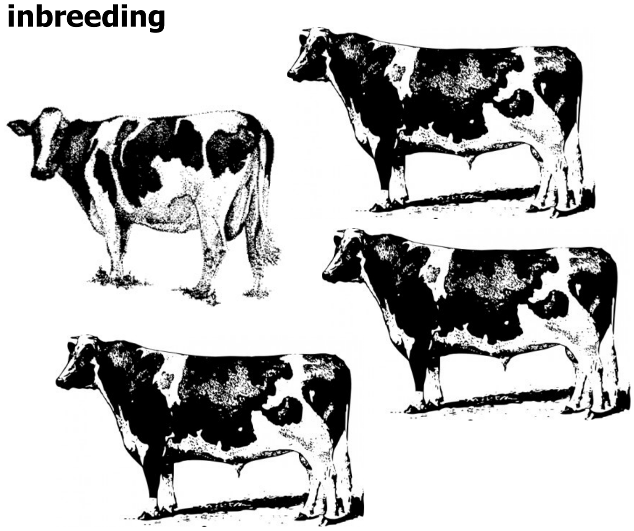
Genomic mating

the use of genomics to control inbreeding

genomic inbreeding?



select the sire that
minimizes the inbreeding



Selecting replacement heifers

UF UNIVERSITY of FLORIDA

What if we purchase the replacements?

- **use objective information:**

genomic PTAs > parent average > sire information > lottery

Selecting replacement heifers

UF UNIVERSITY of FLORIDA

Take home messages

- genetic selection is a very powerful tool
- best selection tool: economic selection index
- genomics has transformed dairy cattle breeding worldwide
- replacement heifer selection: use of genomic testing
- genomic predictions can effectively predict future performance
- extra benefits of genomic testing:

  parentage verification, control inbreeding, tracking genetic disorders

Thanks for your attention!

Contact Information:

Phone: +1 (352) 294-6988

E-mail: fpenagaricano@ufl.edu

Website: fpenagaricano-lab.org

NOTES