Department of Animal and Aquacultural Sciences

Correlated Selection Responses in Fertility after Selection for Increased Protein Yield or Against Mastitis in a Selection Experiment with Norwegian Red cows

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Genetic relationships

- Antagonistic genetic relationship between milk production and female fertility
  - Selection for increased milk yield → genetic deterioration of fertility
- Positive genetic correlations between health and fertility
  - Selection against mastitis → some genetic improvement of fertility as correlated responses

Selection experiment with Norwegian Red

- Started in 1989
- Collaboration between Geno, Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences and 8 herds (agricultural schools)
- 2 selection groups:

  HPY = High Protein Yield

  LCM = Low Clinical Mastitis

  – In each herd approx same no cows in the 2 groups

Proven sires from Norwegian Red breeding program used as sires

HPY: The 2 - 4 highest ranking sires for protein yield each year

LCM: The 2 – 4 highest ranking sires for mastitis resistance

Proven sires from the active breeding program →

single trait selection (milk or mastitis) of sires pre-selected for Norwegian Red's breeding objective

Selection experiment

Previous studies has shown

- Large genetic differences in mastitis resistance
- Correlated selection responses for resistance to other diseases
  - Ketosis, retained placenta
- Correlated selection responses for SCC

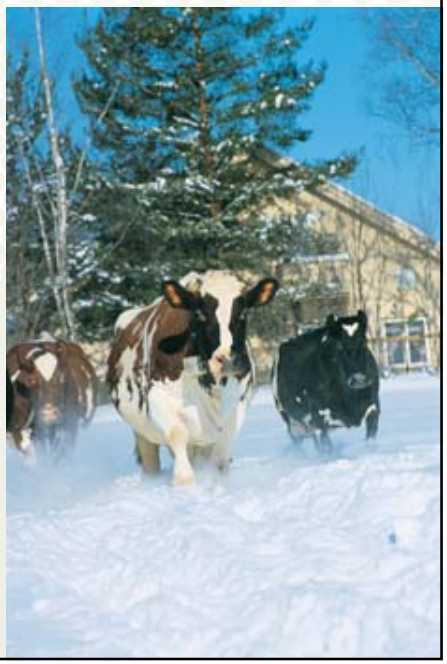
- Genetic difference between HPY and LCM after 5 cow generations
  - 10 %-units clinical mastitis
  - 25 kg 305-day protein yield

Objective

Estimate correlated responses in female fertility after selection for increased protein yield in HPY and selection against mastitis in LCM

Fertility traits

- Non-return rate within 56 days (**NR56**)
  - Scored as 1 or 0 based on whether or not the cow had a second insemination (other than double inseminations, i.e. a new insemination 0–5 days after a first one) within 56 days after the first insemination
  - 3 traits: Heifers
    1st lactation cows
    2nd and 3rd lactation cows
- Interval from calving to first insemination (**CFI**)
  - Number of days from calving to first insemination
  - 2 traits: 1st lactation cows
    2nd and 3rd lactation cows
- Calving interval (**CI**)
  - Number of days between 1st and 2nd calving.



Data

Cow fertility EBVs from the September 2009 routine genetic evaluation

Trait		No of observations	Average
NR56	heifers	2,709,741	0.75
	1st lactation cows	2,545,107	0.68
	2nd+3rd lactation cows	2,843,292	0.69
CFI	1st lactation cows	2,448,426	81
	2nd+3rd lactation cows	2,817,553	77
CI	1st to 2nd calving	1,917,845	381

Data

- Cow fertility EBVs from the September 2009 routine genetic evaluation
- 5001 selection experiment cows with EBV for fertility traits
- 68 sires in HPY and 57 sires in LCM
- 7 cow generations

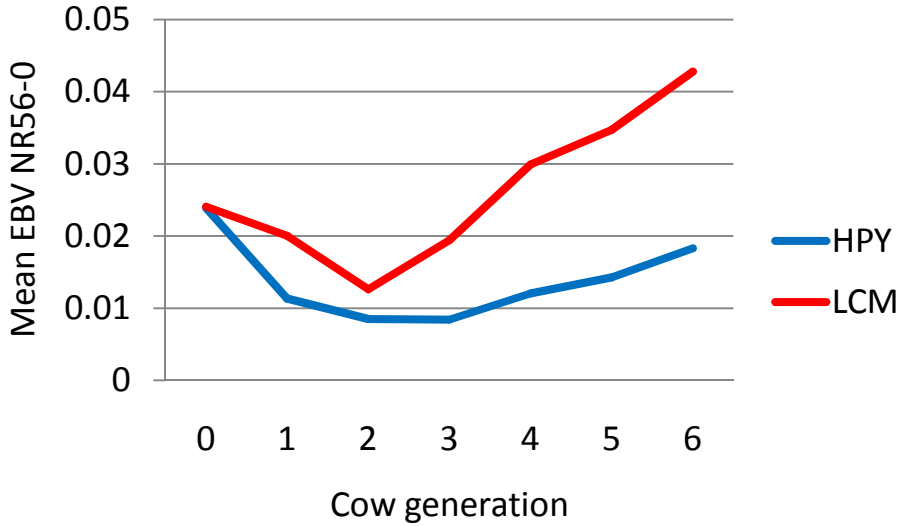
Cow generation	HPY	LCM
0	470	299
1	737	497
2	520	435
3	430	369
4	329	314
5	214	196
6	88	77
7	18	8
Total no	2806	2195

Genetic trends

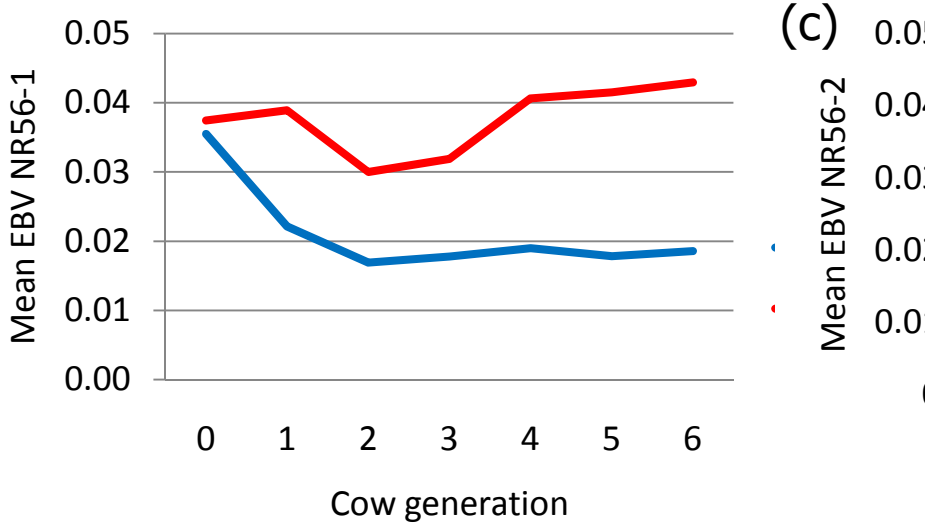
- Mean EBV per cow generation

Genetic trends for NR56

(a)



(b)



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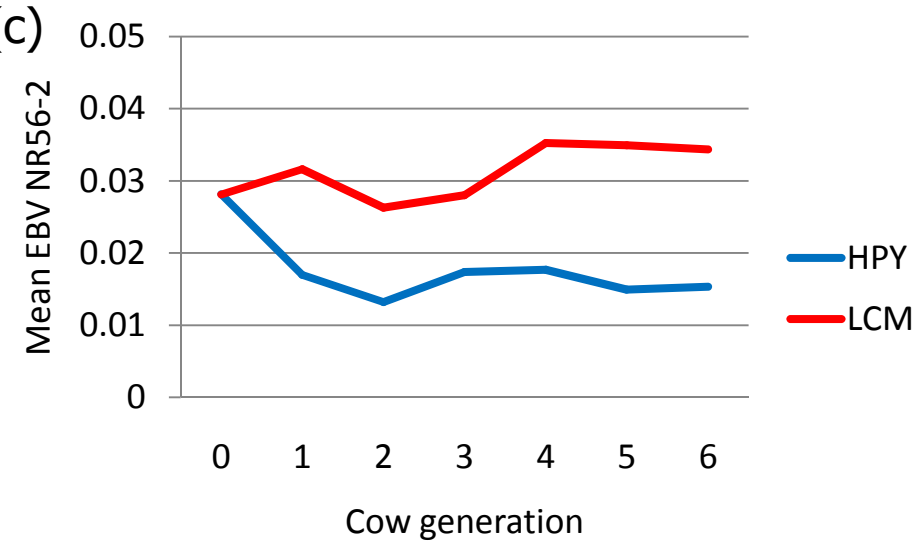
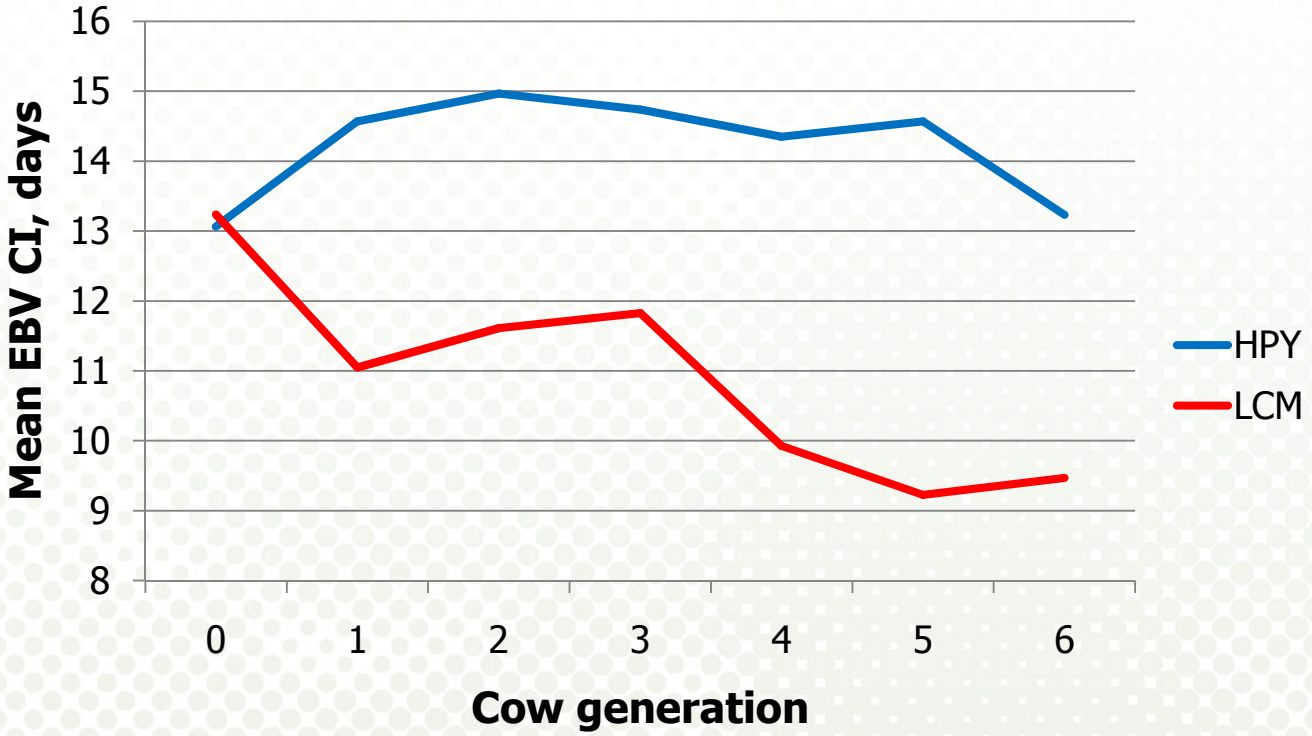


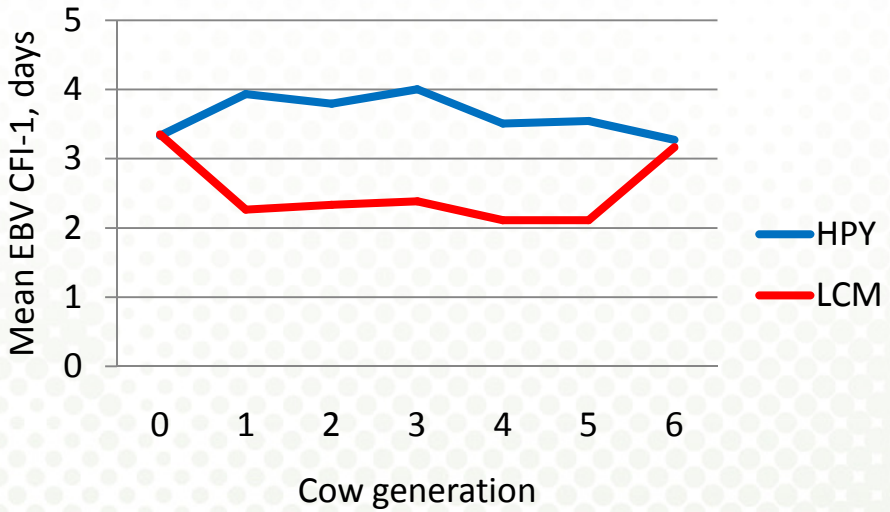
Mean EBV for NR56 in (a) heifers, (b) first lactation cows and (c) 2nd and 3rd lactation cows per cow-generation for HPY and LCM cows

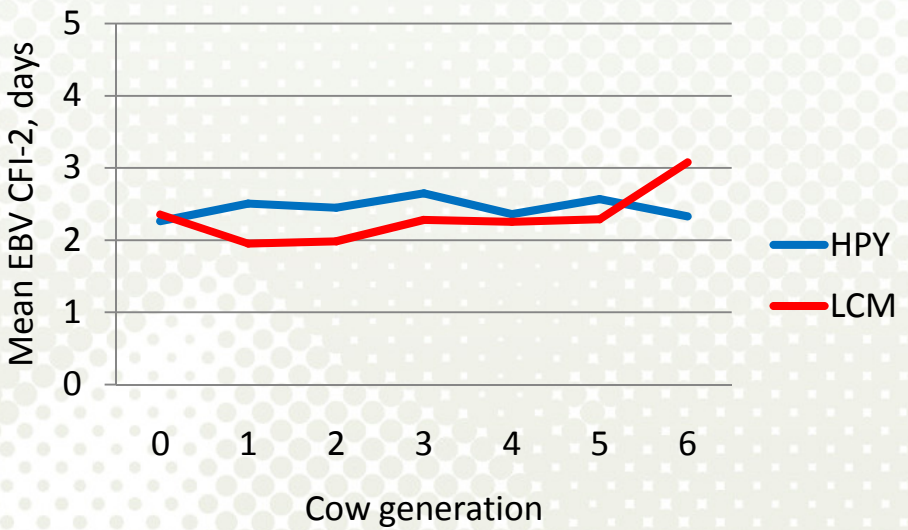
Genetic trends for calving interval



Genetic difference after 6 cow-generations = 4 days

Genetic trends for interval from calving to 1st insemination (CFI)



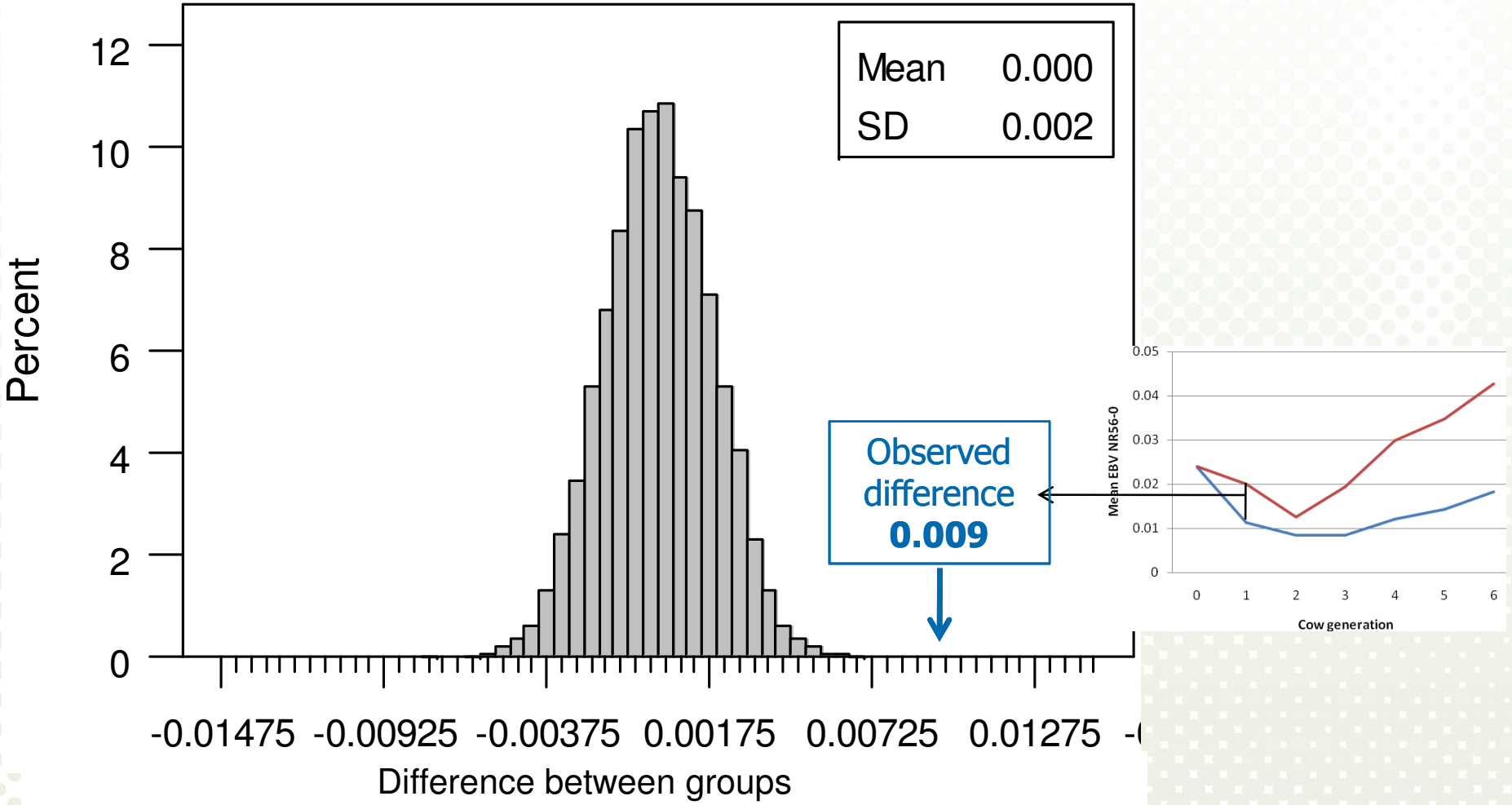


Significant genetic differences between HPY and LCM?

Permutation test

- 10.000 permutations with line (HPY or LCM) assigned randomly to cow
- Compared observed difference between HPY and LCM per cow generation, with differences between EBVs in 2 randomly assigned groups

The distribution of the difference in mean cow EBV for NR56 in heifers, cow generation 1, based on 10.000 permutations, with line (HPY or LCM) assigned randomly to cow



Permutation tests

- Significant differences between LCM and HPY
  - from cow-generation 1 onwards
  - for all traits except for CFI for 2nd and 3rd lactation cows, and 1st lactation CFI, cow generation 6
- Observed differences between LCM and HPY, with few exceptions, far outside the range from permutation tests
  - Significant different ($p<0.0001$)

Conclusions

- Correlated selection responses for female fertility detected
- LCM cows genetically better for fertility than HPY cows
  - Higher NR56 for heifers and cows
  - Shorter calving interval
  - Shorter CFI in 1st lactation
  - No significant differences in CFI for older cows
- Genetic difference between HPY and LCM cows after 6 cow generations:
  - 2.5 %-units NR56 in heifers
  - 2 %-units NR56 in cows,
  - 4 days calving interval

Conclusions

- Selection for increased milk yield results in unfavorable correlated selection responses in CM, KET, RP, LSCS, and female fertility
- Selection against mastitis = indirect selection for more robust cows
  - increased resistance to other diseases
  - reduced lactation mean somatic cell count
  - improved fertility
- Genetic correlations works as expected