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Book of abstracts page 382

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Genetic Analysis of Stillbirth and Calving Difficulty in Norwegian Red cows

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Objectives

- Infer genetic parameters for calving difficulty and stillbirth using a bivariate sire-maternal grandsire threshold model
- Evaluate phenotypic and genetic change for these traits for Norwegian Red cows

Traits

Stillbirth is a binary trait:

0 = born alive
1 = dead at birth or within 24 hours

Calving difficulty in 3 categories:

1 = easy calving
2 = slight problems
3 = difficult calving

Stillbirth

Available for all calving records since 1978

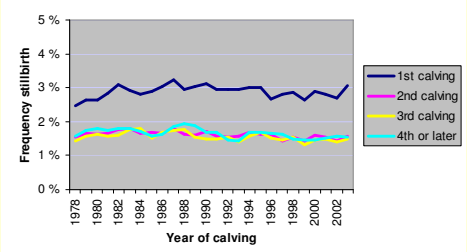


Figure 1. Frequency of stillbirth (SB) for Norwegian Red heifers and cows by year of calving

Calving difficulty 1st calving

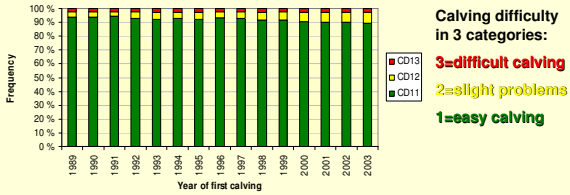


Figure 2. Frequency of calving difficulties (CD) in Norwegian Red heifers by year of calving.

Routinely recorded since 1989
Available for 98 % of calving records

Calving difficulty 2nd and later calving

CD score similar for all parities after 1st calving

Overall mean:

97 % easy calving

2 % slight problems

1 % difficult calving

Data

528,475 first-lactation calving records

- First calving 1989-2004
- Age at first calving 21-34 mo
- From herd-year classes with at least 5 first lactation cows
- Known Norwegian Red A.I. sire as sire of calf and sire of cow (maternal grandsire)
  - 1548 Norwegian Red sires with records
  - 2155 in pedigree-file

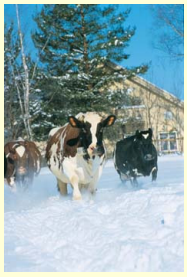
Data

Distribution of records over SB categories

SB		No of records	Frequency
0	born alive	514,393	97.3 %
1	dead at birth or within 24 hours	14,082	2.7 %

Distribution of records over CD categories

CD		No of records	Frequency
1	Easy calving	475,945	90.1 %
2	Slight problems	27,142	5.1 %
3	Difficult calving	12,684	2.4 %
4	Unknown	12,704	2.4 %



Model

- Bivariate sire - maternal grandsire threshold-liability model for one binary (SB) and one ordered categorical (CD) trait
- Bayesian approach using MCMC methods

Bivariate sire - mgs threshold-liability model

$$\boldsymbol{\lambda} = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}_h\mathbf{h} + \mathbf{Z}_u\mathbf{u} + \mathbf{e}$$

- $\boldsymbol{\lambda}$ vector of unobserved liabilities of SB and CD
- $\boldsymbol{\beta}$ vector of systematic effects
  sex of calf (2 levels), age (14 classes) and mo-yr (168 classes) of first calving
- $\mathbf{h}$ vector of herd-year of calving effects (85,255 levels)
- $\mathbf{u}$ vector of effects of the sire (s) and maternal grandsire (mgs) of the calf $\mathbf{u}' = [\mathbf{s}'_{CD}\ \mathbf{mgs}'_{CD}\ \mathbf{s}'_{SB}\ \mathbf{mgs}'_{SB}]$
- $\mathbf{e}$ vector of residual effects

$\mathbf{X}$, $\mathbf{Z}_h$, and $\mathbf{Z}_u$ incidence matrices

Heritability - stillbirth

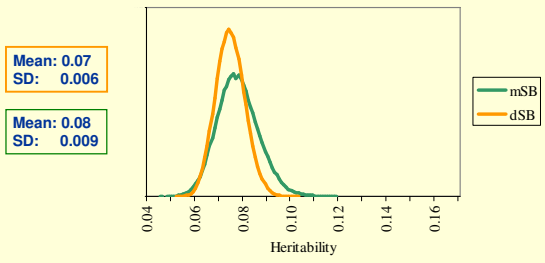


Figure 3a. Posterior distribution of direct (d) and maternal (m) heritability of liability to stillbirth (SB)

Heritability - calving difficulty

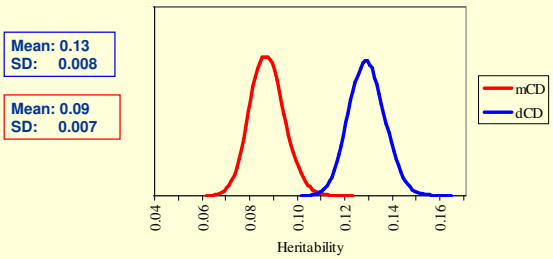


Figure 3b. Posterior distribution of **direct (d)** and **maternal (m)** heritability of liability to calving difficulty (CD)

Genetic correlations between direct and maternal effects

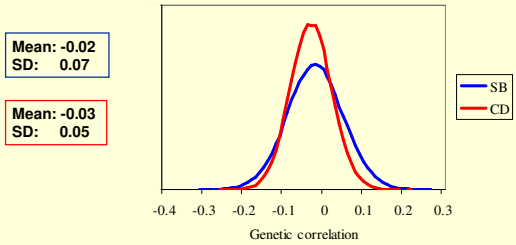


Figure 4. Posterior distributions of genetic correlations between direct (d) and maternal (m) effects for **calving difficulty (CD)** and **stillbirth (SB)**

Genetic correlation between direct and maternal effects

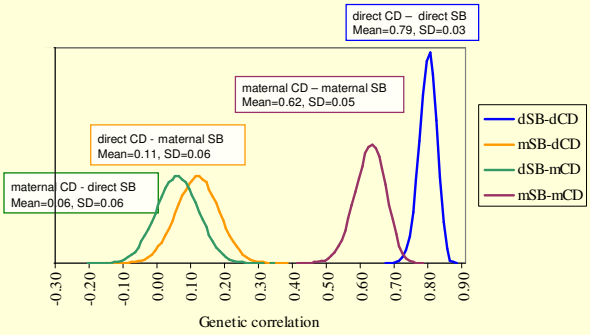


Figure 5. Posterior distributions of genetic correlations between direct (d) and maternal (m) calving difficulty (CD) and stillbirth (SB)

Genetic change

- Average sire posterior means by birth year of progeny (direct) or year of calving of daughters (maternal).
- All 1st calving records of the 1548 sires/mgs (900.000 records) were used for assessment of genetic change.
- Sires were weighted according to their number of daughters, so this measure reflects sire usage as well as possible genetic change in the Norwegian Red population.

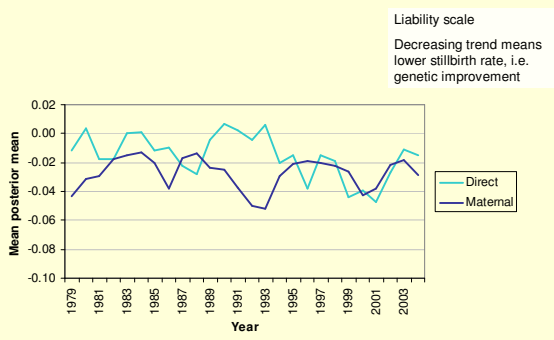


Figure 6. Genetic change for stillbirth at first calving in Norwegian Red given as average sire posterior mean by birth year of progeny (**direct effect**) and average genetic evaluation of sire for **maternal effect** by year of calving of daughters.

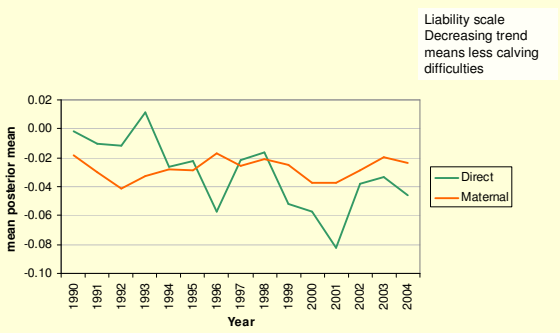
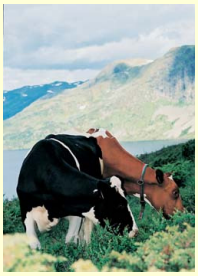


Figure 7. Genetic change for calving difficulty at first calving in Norwegian Red given as average sire posterior mean by birth year of progeny (**direct effect**) and average genetic evaluation of sire for **maternal effect** by year of calving of daughters.

Summary and conclusions

- Low levels of stillbirth and calving difficulty in the Norwegian Red population (2% SB, 95% easy calving)
- No genetic change for SB and a slight genetic improvement for CD were found in the Norwegian Red population.



Heringstad, B., Y. M. Chang, M. Svendsen, and D. Gianola. 2007. Genetic analysis of calving difficulty and stillbirth in Norwegian Red cows. Journal of Dairy Science 90: 3500-3507.