Heterogeneity of genetic parameters for calving difficulty in Holstein heifers in Ireland

J.M. Hickey[1,2,5], M.G. Keane[1], D.A. Kenny[2], A.R. Cromie[3], P. R. Amer[4] and R.F. Veerkamp[5]
[1]Grange Beef Research Centre, Teagasc, Dunsany, Co. Meath, School of Agriculture, Food and Veterinary Medicine, College of Life Sciences, University College Dublin, Belfield, Dublin 4, [3]Irish Cattle Breeding Federation, Shinagh House, Bandon, Co. Cork, [4]Abacus Biotech Limited, PO Box 5585, Dunedin, New Zealand, *[5]Animal Sciences Group, PO Box 65, 8200 AB Lelystad, The Netherlands.*

Introduction
For specific situations, genetic parameters for calving difficulty, across parity, may be influenced by the maturity of the dam (Groen et al. 1998). In Ireland large differences exist in the ages at which heifers first give birth. The objective of this study was to estimate genetic parameters for calving difficulty in first parity Holsteins and to determine if the estimates differed with different age of dam at first parturition.

Materials and Methods
Field data, collected in Ireland, by the Irish Cattle Breeding Federation, between 2002 and 2006, on 18,798 calving performances of first parity Holstein heifers, which were between 600 and 1100 days of age at parturition, were analyzed. Edits ensured that each record had pedigree information, as well as having a sire and dam which were ≥ 87.5% Holstein. Records from herds where all calvings were scored as the same value were removed. Calving difficulty was recorded as four categories according to the amount of assistance applied. The data were transformed to a linear scale assuming an underlying normal distribution with a mean of zero and a standard deviation of one. The transformed scores were 0, 1.86 and 3.14 for none, some and the two classes reflecting serious assistance, respectively. Univaritate (UN), multitrait (MT) and random regression (RR) sire maternal-grandsire models were fitted in ASReml (Gilmour et al., 2006) with the direct (sire of calf + ½ maternal-grandsire of calf) and maternal (maternal-grandsire of calf + ½ maternal-grandsire of dam) genetic components accounted for. Fixed effects were contemporary group of birth of calf, type of birth (single or twin/triplet birth) and gender. One MT model divided the direct component into four traits depending on the age of the dam of the calf at parturition while a second partitioned both the direct and maternal components. These models only converged when fixing the genetic correlations between the direct and maternal components to zero and within the direct and maternal components to 0.99. The RR models were fitted with random regressions on the dam age fitting either a single or four residual variance classes for dam age. Models were compared using likelihood ratio tests, Aikaike and Bayesian information criterion.

Results and Discussion
Large differences were not observed in the mean incidence of serious calving difficulty in different dam age groups. Population average estimates of the heritability were low for both the direct (0.12) and maternal (0.04) components. The direct-maternal genetic correlation was -0.47. The MT model which divided the maternal component into four traits was less optimal than assuming a single trait. Models which fitted random regressions for the maternal component failed to converge. Overall, the model with a second order random regression for the direct component, a single maternal genetic component and a single residual component was best, suggesting that significant heterogeneity of variance existed for the direct component but not for the maternal and residual components. Heritability estimated from the most optimal RR model (Figure 1) reduced initially followed by a steady increase in slope along the dam age trajectory. At youngest dam age the direct heritability was 0.20. This decreased to a low of 0.11 before increasing to 0.37 at oldest dam age. The genetic correlations between the direct effects had a smooth surface along the dam age trajectory. The correlations declined from unity with increasing interval between dam ages. Re-ranking and re-scaling of sires along the dam age trajectory occurred. Possible reasons for such re-ranking could be age exacerbated feto-pelvic incompatibility or an interaction between a propensity for bulls to produce malpresented offspring at birth and dam age. Secretion of oestrogenic hormones by the foetal membranes might be related to dystocia (Osinga, 1978). Maternal preparation for parturition might come under the influence of foetal genotype. It could be speculated that foetal hormone production interacts with hormone levels in the dam. Hormone levels in the dam could be affected by her age.

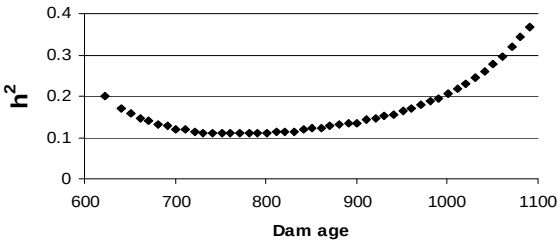

Figure 2. Estimated direct heritability (h^2) for transformed calving difficulty estimated across different dam ages at parturition.

Conclusions
Data on calving difficulty recorded by farmers in Ireland allows the estimation of genetic parameters. The direct and maternal heritabilities were low, but considerable genetic variation exists. There was heterogeneity of direct genetic variance depending upon the age of the dam at parturition.

References
Gilmour, A. R., B. R. Cullis, S. J. Welham, and R. Thompson. 2006. Asreml User Guide (release 2.0). VSN International Ltd, Hemel Hempstead, HP1 1ES, UK.
Groen, A. F., J. P. J. M. Van Aubel, and A. A. Hulzebosch. 1998. In: 6th World Congress of Genetics Applied to Livestock Production, Armidale, Australia. pp 387-390.
Osinga, A. 1978. Theriogenology10: 149-166.

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Teagasc Beef Research Centre, Grange
University College Dublin
Animal Sciences Group, The Netherlands
Irish Cattle Breeding Federation
Abacus Biotech Ltd., New Zealand

Introduction

- Calving difficulty
  - Affects welfare and profit
  - Direct and maternal
  - Included in Irish breeding goal
  - Large differences in age heifers calve
    - 600 to1100 days
  - Genetic parameters can differ across a trajectory
  - Current genetic evaluation assumes homogeneity
- Objective
  - Test heterogeneity of genetic parameters

Data

- Calving performance for Holstein heifers
- Commercial farms
- January 2002 and May 2006
- Edits
  - Missing pedigree
  - <600 or >1100 days at parturition
  - Contemporary groups with solely extreme categories
- 18,798 records

Data

Dam age at parturition	% of total records	% severe calving difficulty
600-725	17.4	11.5
726-850	46.8	10.6
851-975	23.3	9.5
976-1100	12.5	11.4

Statistical models - Fixed effects

- Significant
  - HYS of birth of calf
  - Type of birth (single or twin/triplet birth)
  - Gender of calf
- Not significant
  - Dam age
    - Confounded with HYS
  - Interaction terms

Statistical models - Random effects

- Univariate sire-maternal-grandsire model
  - Direct
    - Sire of calf
    - Maternal-grandsire of calf
  - Maternal
    - Maternal-grandsire of calf
    - Maternal-grandsire of dam

Statistical models - Random effects

- Multitrait model
  - 8 dam age at parturition dependent traits
  - 600 - 724, 725 - 849, 850 – 974, 975 -1100 days
  - 4 residual components
  - Convergence not attained for full model
  - Reduced models tested
    - Genetic correlations fixed to 0 or 0.99
    - 1 vs 4 maternal components

Statistical models - Random effects

- Random regression models
  - Legendre polynomials of dam age
    - 1 vs 4 residual components
  - Convergence not attained for full model
  - Reduced models tested
    - Maternal component
      - Single trait
  - 1^{st} and 2^{nd} order polynomials

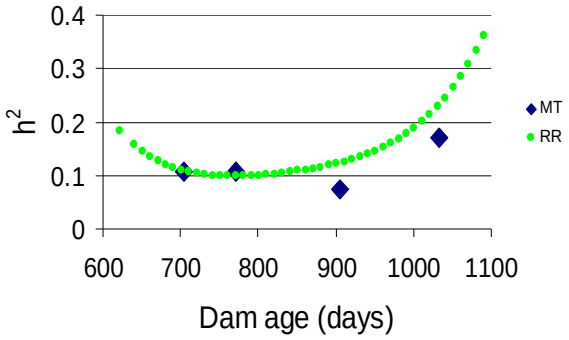
Statistical models - Testing

- Models compared using LRT, AIC and BIC
- Optimal multitrait model
  - Single maternal components
  - Correlations constrained to 0.99
- Optimal model
  - 2nd order random regression - direct component
  - Single maternal component
  - Single residual component

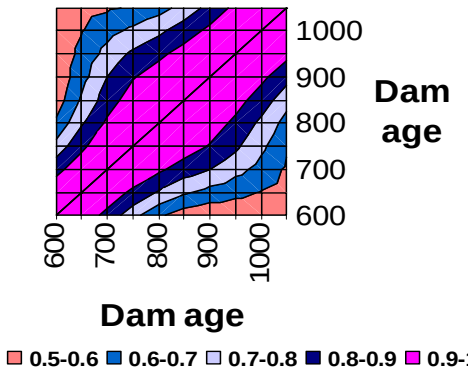
Results

Parameter	Estimate
Direct h^2	0.13
Maternal h^2	0.04
r_a	-0.47

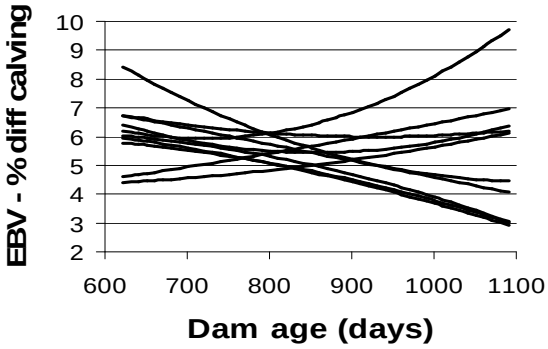
Results - Heritability



Results – Direct genetic correlations



Results – Breeding values



Conclusions

- Direct and maternal heritabilities were low
- Heterogeneous direct genetic variance
- Homogeneous maternal and residual variance
- Re-ranking and re-scaling of sires

Genetic evaluations for calving ease could be enhanced by accounting heterogeneity of direct genetic variance dependent upon dam age.

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