# Economic value and genetic parameters for calving performance in Dutch dairy cattle breeding

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## 1. Introduction

Dystocia refers to calving performance - degree of difficulty of giving birth. Dystocia is well accepted as a reproductive problem in dairy cattle. Direct cost associated with dystocia include veterinary fee, farmer labor and loss of calf. Indirect cost include increased health and fertility problems and reduced production, and as a result increased culling rate, decreased animal welfare, and increased concern on consumer acceptance of dairy products. Factors affecting calving performance can be separated in to fetal and maternal components (Meijering, 1984). The fetal component refers to the ability of a calf to be born easily, and is largely defined by the size of the calf. The maternal component is the ability of a cow to give birth easily, largely a function of the size of the dam, her pelvic area and her contribution to fetal growth. The sire of the calf has a **direct** genetic effect on the fetal component; the maternal component of the sire is expressed by his daughters, and is often referred to as the **indirect** genetic effect. In most dairy cattle breeding programmes, sires are only evaluated for their direct effect on dystocia (Interbull, 1992). This information is used for directional mating of virgin heifers to calving ease sires (Meijering, 1986; Dekkers, 1994).

A study was undertaken to reconsider the use of calving performance data in Dutch dairy cattle breeding programmes. This paper describes estimated direct cost associated with dystocia, and estimated (co)variances for direct and indirect effects for dystocia and gestation length.

## 2. Economic aspects

In The Netherlands, calving performance is scored by farmers on mark-sense cards, and forwarded to the Royal Dutch Cattle Syndicate (NRS). Each record consists of herd identification, dam and sire of calf, parity of dam, sex and number of calves, congenital defects, viability, gestation length, dystocia score, and an estimate of birth weight. Dystocia is scored in 6 classes: easy, normal, hard pull, veterinary help, Caesarean, and fetotomy. Frequencies and direct additional cost per class are in Table 1. Information on veterinary fees was supplied by the Royal Society for Veterinarians. Cost of calf loss were calculated considering still birth frequencies per sex of calf, parity of dam and breed of calf (Janssen, 1995). Average additional cost of dystocia were 21.02 $Dfl.cow^{-1}.year^{-1}$. The economic value of dystocia (per % increase in calvings occuring in classes hard pull + veterinary help + Caesarean + fetotomy) was -1.33 $Dfl.cow^{-1}.year^{-1}.\%^{-1}$.

Table 1. Frequencies of dystocia in Dutch dairy cattle (combined Black & White and Red & White data, years 1985-1995, only second parity dams) and direct additional cost associated with dystocia per class (Dfl.calving$^{-1}$).

| | Frequency | Direct additional cost | | |
|---|---|---|---|---|
| | | Veterinary fee[i] | Farmer labor[i] | Calf loss |
| Easy | 43.45 | 0.00 | 0.00 | 5.30 |
| Normal | 45.78 | 0.00 | 0.00 | 8.15 |
| Hard pull | 8.59 | 0.00 | 25.50 | 51.35 |
| Veterinary help | 0.77 | 99.98 | 51.00 | 96.59 |
| Caesarean | 1.35 | 367.19 | 76.50 | 0.00 |
| Fetotomy | 0.06 | 337.82 | 76.50 | 407.56 |

i : basic cost in class easy were assumed to be zero

## 3. Genetic aspects

### *Material*

Birth records from July 1985 to February 1995 for dystocia and gestation length on second parity dams with calves sired by young unproven AI-bulls were obtained from the NRS. Because of low frequencies (Table 1), observations in classes veterinary help and fetotomy were assigned to hard pull and Caesarean, respectively (NRS-procedure, Gerben de Jong, 1995, personal communication). Two data sets were created: a Black & White data set including records with sires having ≥75% Holstein Friesian (HF) and dams having ≥50% HF, and a Red & White data set including records with MRIJ and HF sires and dams having ≥25% MRY. Other restrictions removed records with incomplete pedigree information, twining births and with extreme gestation length (<265 and >295 days; Meijering, 1986). Average and standard deviations for dystocia and gestation length in the data sets are in Table 2.

### *Method*

VCE programmes by Groeneveld (1993) were used to estimate (co)variance components. The following sire/maternal grandsire model was applied

$$y_{ijklm} = hys_i + sex_j + sire_k + mgs_l + e_{ijklm}$$

where $y_{ijklm}$ is the observation, $hys_i$ is the fixed effect of herd-year-season, $sex_j$ is the fixed effect of sex of the calf, sire and mgs are random effects of the sire and maternal grandsire of the calf, and $e_{ijklm}$ is the random residual effect. Two seasons, May-September and October-April, were defined to create hys-classes (9454 classes for Black & White; 7388 for Red & White).

## 4. Results

Estimated (co)variance components are in Table 3. Heritabilities for the direct effect on dystocia are 0.15 and 0.18, which is higher than recent literature estimates in dairy cattle using sire/maternal grandsire models (Dwyer *et al.*, 1986; Weller & Gianola, 1989; Manfredi *et al.*, 1991a, 1991b). Also the heritability estimates for gestation length (0.68-0.71) are relatively high (Nadarajah *et al.*, 1989). Estimated heritabilities for the indirect effect on dystocia fit well within literature. Estimated genetic correlations between direct and indirect effects are at the upper part of the literature range (Meijering, 1984).

## 5. Discussion and Conclusions

Dystocia is an important trait to dairy producers, not only from an economic point of view, but also from aspects of animal welfare and consumer acceptance. Both direct and indirect genetic effects are lowly to moderately heritable (0.15 and 0.10, respectively), indicating that a relatively large amount of data will be required for accurate sire evaluation. The genetic correlation between direct and indirect effect is strongly negative. Sire evaluation for direct genetic effects in breeding programmes (especially for mating strategies) is profitable and widely practised (Meijering, 1986; Dekkers, 1994). Given the negative genetic correlation between direct and indirect effects, it seems advisable to evaluate sires for indirect genetic effects as well as direct genetic effects for dystocia. This would allow dairy breeds to better control genetic trend in dystocia.

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Table 2. Number of observations, sires and maternal grandsires, and averages and standard deviation (SD) for dystocia and gestation length in the Black & White and Red & White data sets.

| | | Black & White | Red & White |
|---|---|---|---|
| Dystocia (class 1-4) | Average (SD) | 1.72 (0.66) | 1.66 (0.68) |
| Gestation length (days) | Average (SD) | 281.3 (4.8) | 280.9 (5.1) |
| Number of calvings | | 24,581 | 20,198 |
| Number of sires | | 1459 | 507 |
| Number of grandsires | | 826 | 723 |

The sire effect is half the direct effect, and the maternal grandsire effect is half the indirect effect plus a quarter of the direct effect. Variance components on the direct ($\sigma^2_D$) and indirect genetic effects ($\sigma^2_I$), and the covariance between direct and indirect effect ($\sigma_{DI}$) were estimated as (Manfredi *et al.*, 1991b) $\sigma^2_D = 4\,\sigma^2_{sire}$ , $\sigma^2_I = 4\,\sigma^2_{mgs} + \sigma^2_{sire} - 4\sigma_{sire/mgs}$ and $\sigma_{DI} = 4\sigma_{sire/mgs} - 2\sigma^2_{sire}$ where $\sigma^2_{sire}$ is the sire variance, $\sigma^2_{mgs}$ is the maternal grandsire variance, and $\sigma_{sire/mgs}$ is the covariance between sire and maternal grandsire. Expectations E(y) = Xb (X and b are incidence matrix and solution vector for fixed effects), E(sire) = E(mgs) = E(e) = 0, and variances are:

$$Var\begin{bmatrix} sire \\ mgs \\ e \end{bmatrix} = \begin{bmatrix} A\sigma^2_{sire} & A\sigma_{sire/mgs} & 0 \\ A\sigma_{sire/mgs} & A\sigma^2_{mgs} & 0 \\ 0 & 0 & I\sigma^2_e \end{bmatrix}$$

where A is the additive genetic relationship matrix containing both sires and maternal grandsires, and $\sigma^2_e$ is the error variance.

Table 3. Variance and covariance estimates for sire ($\sigma^2_{sire}$), maternal grandsire ($\sigma^2_{mgs}$), residual ($\sigma^2_e$), and sire-maternal grandsire ($\sigma_{sire/mgs}$) effects, heritabilities for direct ($h^2_D$) and indirect effect ($h^2_I$), and genetic correlation between direct and indirect effect ($r_{DI}$) for dystocia and gestation length in the Black & White and Red & White data sets.

| | Black & White | | Red & White | |
|---|---|---|---|---|
| Parameter | Dystocia | Gestation length | Dystocia | Gestation length |
| $\sigma^2_{sire}$ | 0.016 | 3.786 | 0.015 | 4.155 |
| $\sigma^2_{mgs}$ | 0.006 | 1.133 | 0.006 | 1.002 |
| $\sigma_{sire/mgs}$ | -0.002 | -0.660 | 0.001 | -0.139 |
| $\sigma^2_e$ | 0.347 | 17.650 | 0.379 | 19.453 |
| $h^2_D$ | 0.175 | 0.713 | 0.149 | 0.683 |
| $h^2_I$ | 0.132 | 0.516 | 0.087 | 0.358 |
| $r_{DI}$ | -0.722 | -0.793 | -0.567 | -0.737 |