# Genetic Parameters for Subjective Milking Speed Scores

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# GENETIC PARAMETERS FOR SUBJECTIVE MILKING SPEED SCORES

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## SUMMARY

Farmer-supplied subjective ratings of cows' milking speed, scored in 5 categories as 'very fast', 'fast', 'average', 'slow' or 'very slow' were analysed. Scores were affected by herd- year- season of calving, age at calving and stage of lactation when scored but not by test day milk yield. Heritability estimates were 0.21 and 0.14 for scores up to day 110 of lactation for Canadian Holsteins and Ayrshires, respectively, and 0.17 and 0.16 for scores at the end of lactation. The estimate of repeatability of scores for the same cow in different lactations was 0.42 for Holsteins and 0.37 in Ayrshires.

## INTRODUCTION

Ease of milking or milkability is one of the auxiliary traits considered in numerous dairy selection programmes. Milking speed in particular has been of interest and various measures including two-minute yield, peak and average flow and total milking time (TMT) have been investigated; see Blake and McDaniel (1978) for a review. In Canada sires have been rated for milking speed measured as TMT. McClelland (1983) compared TMT recorded by stopwatch with a subjective evaluation of the cow's milking speed given by the farmer. Estimates of 0.25 and 0.24 for the heritability of TMT and subjective scores, respectively, together with a genetic correlation of 0.92 suggested that such scores could provide an inexpensively 'measured' selection criterion for milking speed. This paper reports estimates of genetic parameters for subjective milking speed scores recorded under field conditions.

## MATERIAL AND METHODS

### Data

Data consisted of farmer-supplied subjective scores for milking speed, scored as "very fast", "fast", "average", "slow" or "very slow", collected by Agriculture Canada under the Record of Performance milk recording programme between 1982 and May 1985. Edits eliminated records with missing herd, sire or breed identity, invalid test or dry dates, test day yield (a.m. and p.m.) outside the range 0-60 kg, invalid calving date or age at calving less than 18 or greater than 156 months. Subjective scores were to be recorded twice per lactation, score 1 (MS1) at the second test after calving and score 2 (MS2) at the end of the lactation. Inspecting the distribution of records over stage of lactation at test, records up to day 110 after calving were defined as MS1. They had to be regular test day records with non-zero test day production. MS2 had to be recorded at the first test after drying off, 260 to 439 days after calving, with zero test day yield. This gave a total of 190,455 (MS1) and 148,536 (MS2) records for Holsteins (HOL) and of 20,909 (MS1) and 19,012 (MS2) for Ayrshires (AYR). For Holsteins, one analysis included all records (MS), i.e. MS1 and MS2 and regular test records later than day 110 as well as dry records before day 260 (375,072 in total).

Records for the most widely used sires were extracted for the estimation of variance components. For Holsteins 599 sires with 25 or more MS1 records were identified. Scores throughout the lactation (MS) for these sires, including repeated records but excluding MS2 without corresponding MS1, 236,859 records for 131,890 cows (HOL) made up data set I. Set II comprised the first MS1 record available for the daughters of these sires, 120,341 in total. Set III was extracted from II, considering heifer records only, 43,553 records for 552 sires. MS1 records (first available) for 96,097 daughters of 596 HOL sires with at least 20 daughters formed data set IV. The first available pair of MS1 and MS2 records in a lactation or, if unavailable, the first MS1 score (for calvings earlier than July 1984) were extracted for each cow. The subset of 103,199 MS1 and 42,404 MS2 records for 310 sires (HOL) with 30 or more MS1 records then yielded set V. Set VI for Ayrshires corresponded to I for Holsteins, considering however only MS1 (repeated) records for 338 sires with at least 8 daughter records, 18,302 for 14,131 cows (AYR) in total. MS1 (first available) records for 13,95[illegible] daughters of 318 Ayrshire bulls with 7 or more daughters made up data set VII. Correspondingly, data set VIII contained 11,036 MS2 (first available) records for 268 sires (AYR) with a minimum of 6 daughters.

**Analysis**

Variance components between and within sires and, for data sets I and VI, between cows were estimated by Restricted Maximum Likelihood (REML). For the analysis scores were coded from 1 ("very fast") to 5 ("very slow"). The categorical nature of the trait under consideration was ignored as McClelland (1983) had shown that a transformation to ´normalize´ the data (e.g. Snell, 1964) had little effect on the estimates. The model of analysis included herd- year- season of calving (HYS) as fixed, sires as random effects and stage of lactation at test and age at calving as linear and quadratic covariables. Seasons were defined as March to August and September to February. For all data sets except I and VI,

$$Y_{ijk} = h_i + s_j + b_{11} (X_{1ijk} - \bar{X}_1) + b_{21} (X_{1ijk} - \bar{X}_1)^2 + b_{12} (X_{2ijk} - \bar{X}_2) + b_{22} (X_{2ijk} - \bar{X}_2)^2 + e_{ijk}$$

where $h_i$ denotes the effect of the i-th HYS, $s_j$ the effect of the j-th sire, $X_{1ijk}$ and $X_{2ijk}$ the stage of lactation and age at calving pertaining to $Y_{ijk}$, respectively, $\bar{X}_1$ and $\bar{X}_2$ the corresponding means, $b_{1m}$ and $b_{2m}$ the linear and quadratic regression coefficients of Y on X and $e_{ijk}$ the residual error. For data sets I and VI, the model was extended to include cow effects (random) in addition,

$$Y_{ijkl} = h_i + s_j + d_{jk} + b_{11} (X_{1ijkl} - \bar{X}_1) + b_{21} (X_{1ijkl} - \bar{X}_1)^2 + b_{12} (X_{2ijkl} - \bar{X}_2) + b_{22} (X_{2ijkl} - \bar{X}_2)^2 + e_{ijkl},$$

where $d_{jk}$ denotes the effect of the k-th daughter of sire j. Both sires and cows were assumed to be unrelated. Univariate analyses were carried out for data sets I, III, IV, VI and VIII. For sets II and V

MS1 and test day milk yield (a.m. + p.m.) were considered simultaneously in multivariate analyses and contrasted to corresponding univariate analyses in- and excluding test day yield as an additional, linear and quadratic covariable. For set V a multivariate analysis treated MS1 and MS2 within a lactation as different traits. For each analysis, sire solutions and estimates of regression coefficients were obtained at the last round of iteration. Specialised REML algorithms utilised are described by Meyer (1985a,b,c).

## RESULTS AND DISCUSSION

Table 1 gives the distribution of records over milking speed scores for HOL (N=375,072) together with subclass means for age, stage of lactation and test day yield. Slower milking cows tended to be older and, disregarding extremes, have a higher test day yield. Cows rated slower than average were scored at an earlier stage of lactation, indicating a need to adjust scores for stage of lactation. Fitting HYS as fixed effects explained 17% (HOL, set II) and 20% (AYR, set VII) of the total sums of squares (SS) for MS1 and 21% (HOL, set IV) and 25% (AYR, set VIII) of ss for MS2. Covariables, fitted after HYS, explained more variation in Ayrshires, 5.0% of SS for MS1 (set VII) and 6.3% of SS for MS2 (set VIII), than in Holsteins with respective values of 1.0% (MS1, sets II and III) and 3.3% (MS2, set IV).

Table 1 : Distribution of records over milking speed scores for Holsteins with means for stage of lactation, age at calving and test day milk yield (MY).

| Score | | No. of records | Freq. [%] | Stage [days] | Age [months] | MY [kg] |
|---|---|---|---|---|---|---|
| V. Fast | 1 | 9,646 | 2.6 | 174.4 | 47.3 | 38.3 |
| Fast | 2 | 120,614 | 32.2 | 179.1 | 49.2 | 37.7 |
| Average | 3 | 195,354 | 52.1 | 176.2 | 55.1 | 38.5 |
| Slow | 4 | 44,899 | 12.0 | 156.3 | 60.4 | 39.4 |
| V. Slow | 5 | 4,559 | 1.2 | 130.5 | 58.3 | 38.6 |

The effect of calving age on milking speed has been reported before, e.g. Sharaby *et al.* (1979) or Williams *et al.* (1984). McClelland (1984) found a major effect on subjective milking speed scores. When test day milk yield was not included in the model of analysis, calving age explained most of the variation in subjective scores due to yield. Estimates of regression coefficients showed a decrease in milking speed with age, a larger effect at the end (MS2) than at the beginning (MS1) of the lactation and a stronger influence in Ayrshires than in Holsteins. Regression coefficients on stage of lactation showed a decrease in milking speed with increasing stage at the beginning of the lactation (MS2), while cows at drying off were considered faster milkers as lactation length increased (MS2).

Variance component estimates between and within sires togeth with the resulting heritabilities are summarised in Table 2.

Scores at the end of lactation (MS2) were less variable than at th beginning (MS1) in both breeds and there was consistently le variation among Holsteins than among Ayrshires. For Holsteins t heritability estimate of 21% for MS1 (considering all cows, set II) w somewhat lower than the corresponding value of 24% reported b McClelland (1983). Considering heifer records only there was a sligh increase to 23%. Univariate analyses in- and excluding test day yiel gave identical heritability estimates. This was consistent wit estimates of the genetic and phenotypic correlation between MS1 an test day yield which were essentially zero, indicating that farmer make allowance for production when rating their cows. Scores at th end of lactation (MS2) for Holsteins were not only less variable b with a heritability estimate of 17% also less heritable (set IV). A bia due to culling of slower milking cows during lactation could b responsible in part. The multivariate analysis treating MS1 and MS within a lactation as seperate traits would account for such bias, b with an increase in heritability estimates for both MS1 and MS2 (se Table 2) evidence was inconclusive. The estimate of the geneti correlation of 0.96 from this analysis confirmed that subjective score at different times in the lactation describe the same genetic variabl The corresponding phenotypic correlation estimate, the within lactation repeatability of scores taken on the same cow, was 0.43 (Se V). This estimate agreed closely with a repeatability estimate of 4 from the univariate analysis including a cow effect and considering a available records per cow (MS) in all lactations (HOL, set I).

Table 2 : Estimates of variance components between ($\hat{\sigma}_S^2$) and with ($\hat{\sigma}_W^2$) sires, phenotypic standard deviations ($\hat{\sigma}_P$) and heritabilities ( for milking speed (MS1 : Score 1, MS2 : Score 2, MS : all scores) an test day milk yield (MY).

| Data Set | Trait | $\hat{\sigma}_S^2$ | $\hat{\sigma}_W^2$ | $\hat{\sigma}_P$ | $\hat{h}^2$ |
|---|---|---|---|---|---|
| I | MS | 0.02367 | 0.29434 | 0.71205 | 0.187 |
| II | MS1 | 0.02785 | 0.50841 | 0.73233 | 0.208 |
| | | ±.00216 | ±.00220 | | ±.016 |
| | MY | 1.8406 | 57.158 | 7.6811 | 0.125 |
| III | MS1 | 0.03052 | 0.50298 | 0.73041 | 0.229 |
| | | ±.00349 | ±.00401 | | ±.026 |
| IV | MS2 | 0.01798 | 0.41153 | 0.65537 | 0.167 |
| | | ±.00158 | ±.00205 | | ±.015 |
| V | MS1 | 0.03238 | 0.51437 | 0.73943 | 0.237 |
| | MS2 | 0.02077 | 0.40638 | 0.65357 | 0.195 |
| VI | MS1 | 0.01548 | 0.30429 | 0.69607 | 0.128 |
| VII | MS1 | 0.01667 | 0.46450 | 0.69366 | 0.139 |
| | | ±.00304 | ±.00552 | | ±.025 |
| | MY | 1.5644 | 32.641 | 5.8485 | 0.184 |
| | | ±.26144 | ±0.388 | | ±.031 |
| VIII | MS2 | 0.01581 | 0.37199 | 0.62274 | 0.163 |
| | | ±.00335 | ±.00549 | | ±.035 |

Estimates for Ayrshires were based on considerably less data. ritability estimates of 14% for MS1 (Set VII) and 16% for MS2 (Set I) suggested that subjective scores for this breed were somewhat s effective in identifying genetic differences in milking speed than r Holsteins. The repeatability estimate across lactations (MS1) here s 37%(Set VI). The genetic correlation between MS1 and test day lk yield (Set VII) was 0.17 (±0.15) which agrees with other studies ich reported a slight antagonistic relationship between milking speed d milk yield (e.g. Williams *et al.*, 1984).

## CONCLUSION

With a heritability in the order of 0.2, farmer-supplied subjective ores appear to be a suitable citerion to distinguish between bulls th transmitting abilities for fast and slow milking daughters. Sire oofs based on the first available score early in the lactation were idently sufficiently accurate (Meyer and Burnside, 1985). A national cording programme with an associated sire evaluation scheme based subjective scores will be implemented in Canada.

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