GENETIC PARAMETERS FOR CALVING PERFORMANCE IN SIMMENTAL CATTLE

Paramétros genéticos de parición de bovinos Simmental

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Most breeding goals in dairy and dual purpose cattle include production traits (milk, fat, growth), because they are important to maximize net returns of dairymen. Recently, more interest has been put on reproduction traits (fertility, calving performance). The value of an easy calving and a live calf increases when herd size gets larger and difficulties arise in hiring qualified herdsmen. The calf losses have, especially in dual purpose breeds, where calves are sold for beef production at a high price, a weighty financial consequence.

An investigation was carried out on purebred Swiss Simmental cattle with the objectives of estimating environmental influences and genetic parameters of direct and maternal effects on different traits related to calving performance (3).

Materials and methods

Calving reports were sent to dairymen only for progeny of young bulls who entered the testing program. Information requested from calving were: date of calving, birth weight (mostly estimated), live calf or stillbirth, normal or difficult calving, cause of calving difficulty, multiple births and defects (stillbirth = calf dead at birth or within 24 hours after birth; difficult calving = assistance of two or more persons). Incomplete calving reports, twins, triplets and calves with malformations were discarded for the evaluation. Further, only progeny groups with 40 and more calves were considered. Table 1 shows figures of the evaluated data.

Table 1 Structure of material

Dam	Direct effect		Indirect effect	
	Number of sires	Number of calvings	Number of maternal grandsires	Number of calving
Heifer	178	16'355	60	4'521
Cow	177	40'267	65	3'734

The statistical evaluations were carried out separately for heifers and cows with a least squares procedure (4). The following model was used to evaluate direct effects:

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$$y_{ijklmnz} = M + G_i + s_{ij} + C_k + H_l + S_m + A_n + e_{ijklmnz}$$

where

$y_{ijklmnz}$ = dependent variable
M = constant common to all observations
G_i = fixed effect of year of calving
s_{ij} = random effect of sire of calf within year of calving
C_k = fixed effect of month of calving
H_l = fixed effect of herd level group for milk production
S_m = fixed effect of sex of calf
A_n = fixed effect of calving age class of the dam
$e_{ijklmnz}$ = random error

When indirect effects were analysed the same model was used; the s_{ij} effect, however, was canceled and replaced by p_j, which represents the random effect of maternal grandsire of the calf. Genetic correlations between traits which could not be measured on the same individuals were estimated by product moment correlations between progeny test results (2, 3, 6).

Results and discussion

Frequencies of stillbirth, difficult calving and caesarean section (6.9, 9.4 and 3.3 %) are much higher in heifers than the corresponding figures for cows (2.5, 4.3 and 0.5 %). The average gestation length of heifers and cows is 287.2 and 289.0 days, and the mean birth weight is 40.3 and 44.9 kg.

Influences of the fixed effects can be summarized as follows:

- Significant differences between year of calving were only found in birth weight.
- Calving month affects mainly gestation length and birth weight; they are reduced in late fall and winter. The other traits, except calving difficulty in cows, are not significantly influenced by calving season.
- Stillbirth and calving difficulty rates increase an average of .20 and .24 % in heifers, and .08 and .17 % in cows when herd level increases by 100 kg milk.
- Sex of calf has the greatest influence on calving performance; bull calves cause 2.3 and 2.0 times more stillbirths and 3.1 and 3.7 times more difficult calvings.
- Age at first calving affects only gestation length and birth weight. Cows calving for the second time show more calving problems than older cows.

Heritability estimates (h^2) of the direct effects in heifers and cows are given in Table 2; they correspond well with other studies (1, 2, 6, 8, 9). The h^2 of stillbirth, calving difficulty and caesarean section are higher in heifers than in cows. If these h^2 are corrected for the different frequencies with

Table 2 Heritabilities (h^2) and genetic correlations (r_g) between different traits of the calf in heifers and cows

Traits	Stillbirth	Calving difficulty	Caesarean section	Gestation period	Birth weight
Still-birth	.04 (.01) .02 (.00)	.92 (.06)	.75 (.11)	.38 (.11)	.69 (.09)
Calving difficulty	.80 (.07)	.09 (.01) .06 (.01)	.86 (.07)	.30 (.09)	.83 (.04)
Caesarean section	1.04 (.18)	1.16 (.17)	.05 (.01) .01 (.00)	.32 (.10)	.82 (.07)
Gestation length	.23 (.11)	.33 (.08)	.20 (.15)	.52 (.05) .58 (.05)	.38 (.07)
Birth weight	.69 (.08)	.90 (.03)	.99 (.16)	.38 (.07)	.21 (.03) .20 (.02)

above diagonal: results in heifers on diagonal $= h^2$

below diagonal: results in cows off diagonal $= r_g$

Table 3 Genetic correlation between production and calving performance traits (direct effects)

Traits	Calving difficulty		Birth weight	
	Heifers	Cows	Heifers	Cows
Milk production	.04	.07	.13	.15
Butterfat percent	.12	.11	.27	.25
Height at withers	.31	.34	.34	.32
Heart girth	.34	.28	.43	.45
Growth rate	.32	.31	.34	.39

Standard errors vary between .07 and .13

a probit transformation (5), then differences between parity groups become small, except for caesarean section (stillbirth .14 vs .11, calving difficulty .27 vs .30, caesarean section .29 vs .14). Difference of h^2 for calving difficulty between heifers and cows is, in contrast with Bar-Anan (2), not large, so that it seems worthwhile, at least in this population, to use also information from cows in the progeny test program. This can be done all the more easily as the genetic correlation between calving difficulty in heifers and cows is large (.94 $\pm$ .05) indicating that in both parity groups similar genetic factors are involved. A recent study (9) showed similar results and conclusions.

Estimates of h_m^2 for the maternal effects were calculated indirectly and reached .03 for stillbirth and calving difficulty in heifers. Thompson et al. (9) had similar results for dystocia. It was not possible to compute h_m^2 in cows because some needed covariances were not estimable. The h_m^2 for gestation length and birth weight were low in both parity groups (.06 and .08, .03 and .05 resp.).

Genetic correlations (r_g) between calving performance criteria of the calf are all positive (Table 2). Differences between both parity groups are not significant. Low r_g between the gestation length and all other traits were also reported by Philipsson (6). Close genetic relationships are shown between stillbrith, calving difficulty and birth weight (.69 to .92). Partial r_g between stillbirth and birth weight, corrected for calving difficulty, are, however, negative (-.35 and -.11), i.e., too light calves are on the average less viable at birth than heavier ones, when no calving problems occur. The other partial r_g are somewhat lower than the simple correlations (3). The r_g between caesarean section and the other measures are high. The values above 1.0 in cows are due to very small genetic variances of the corresponding criteria. The estimated r_g are somewhat larger than the findings of Philipsson (6).

Genetic correlations between maternal effects (r_m) were calculated indirectly. Values of .80 between stillbirth and calving difficulty and .59 between birth weight and calving difficulty were found in heifers (3). These figures are smaller than the r_g between the corresponding direct effects but show, even if further apart, the same tendency.

Antagonistic genetic relationships were found between direct and maternal effects in heifers, namely stillbirth -.68, calving difficulty -.63, gestation length -.51 and birth weight -.11. These values agreed in sign but are larger than those of other studies (6, 9). These negative direct-maternal correlations affect a long term selection program against the direct effects of calving performance in a lower response than expected.

The r_g between criteria of calving performance and production traits were estimated with progeny test results of 150 to 170 sires (3). These figures are shown in Table 3. Calving difficulty as well as birth weight are positively correlated with production traits. Differences between parity groups are small. Significant r_g can be observed between body measurements of females (height at withers and heart girth at 36 months of age) and calving difficulty (.28 to .34) as well as birth weight (.32 to .45). The two latter criteria also show significant r_g (.31 to .39) with beef performance of bulls (growth rate). Only low genetic relations are found between milk production and calving performance, but significant r_g between birth weight and butterfat percent (.27 and .25).

In the previously mentioned study (3) it is shown with the method of selection index, that the criteria of calving performance have only a very small influence on the aggregate genotype in the Swiss Simmental breed. Stillbirth and calving difficulty rates increase in spite of selection index because of antagonistic genetic relationships between beef and calving performance, and the important economic weights of the production traits in the index.

Conclusions

Culling bulls on progeny test results for direct effects will improve calving performance, but on long term show a lower response than expected, because of the antagonistic genetic relationship between direct and maternal effects. The amount of emphasis on selection that should be given on calving performance depends on the breeding goals, the mean frequency of the traits and their relative economic weights. Sire evaluation for direct effects, however, should be carried out at least for each AI bull, according to the recommendations of Philipsson et. al. (7) in order to advice dairymen.

Summary

The genetic parameters of direct effect of stillbirth, calving difficulty, caesarean section, gestation length, and birth weight were estimated separately for heifers (16'355 births) and cows (40'267 births). The calves were sired by 178 bulls. Besides the heritabilities (h^2) of the different calving performance traits, the genetic correlations were calculated between calving performance traits and between calving performance and other production traits.

The h^2 and r_g of the maternal effects were estimated indirectly and separately for heifers (4'521 births) and cows (3'734 births). Genetic relationships between direct and maternal effects have also been calculated.

Résumé

Les paramètres génétiques pour l'effet direct des mort-nés, vêlages difficiles, césariennes, durée de gestation et poids à la naissance ont été estimés séparément pour les génisses (16'355 vêlages) et les vaches (40'267 vêlages). Les veaux étaient issus de 178 taureaux. En plus de l'héritabilité (h^2) des différents critères de l'aptitude au vêlage, on a calculé les corrélations génétiques (r_g) entre ces critères ainsi qu'entre l'aptitude au vêlage et des critères de productivité.

h^2 et r_g pour les effets maternels ont été évalués indirectement, séparément pour les génisses (4'521 vêlages) et les vaches (3'734 vêlages). Les relations entre effets directs et maternels ont également été calculés.

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