Aspects of Milk Yield Adjustment in the Parameter Estimation for Genetic Evaluation of Survival

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Introduction

Presently, the national evaluation for fertility in Ireland is carried out for calving interval and survival using a 13 trait animal model. Breeding values are predicted from a joint analysis of calving interval, survival and milk yield in the first 3 lactations and 4 linear type traits (Angularity, Body condition score, Foot Angle and Udder depth) as predictors of calving interval and survival (Olori et al., 2002 and Pool et al., 2002).

Animals with the worst fertility have no calving interval in a seasonal calving system. For this reason, a simultaneous analysis of calving interval and survival was proposed (Olori et al., 2002). Animals that re-appear in the data have a calving interval and are survived; animals that do not re-appear within a certain period are identified as being culled (for many reasons, including fertility). Hence, breeding values for survival (i.e. probability of surviving to the next lactation) and calving interval estimated simultaneously are expected to cover most of the genetic variation in fertility that can be recovered from calving dates. Milk yield plays an important role in censoring of fertility data and insemination decisions of the farmer and therefore milk yield was included in the model as an additional trait (Olori et al., 2002). Additionally, breeding values for survival are made independent of milk yield by a genetic regression because economic values are defined for involuntary culling.

Although most countries adjust their longevity breeding values for actual milk yield, if adjustment should be at the genetic or phenotypic is an issue that is still debated in the literature (Visscher et al., 1999). Meuwissen et al. (2002) showed that a multi trait analysis of survival and milk yield with a genetic adjustment for yield gave the same results as a phenotypic adjustment of survival for milk yield.

In our situation parameter estimates were inaccurate when a phenotypic pre-adjustment for survival was used (Pool et al., 2002). This can be explained because only animals surviving had a calving interval, i.e. there is no environmental covariance between survival and calving interval in the same lactation or between survival in the current and next lactation. However with a sire model (which was used for the parameter estimation) still ¾ of the genetic covariance is included in the residual covariances. Estimating this component became difficult with pre-adjusted records, as all the variation in survival for animals that survived lactation one for example, came from the adjustment for milk. Hence, results showed unreliable parameter estimates, highly dependent on the phenotypic association that type traits had with milk yield. Therefore survival EBVs were adjusted for milk yield afterwards using a genetic regression and form now together with calving interval part of the national index for selecting of dairy bulls in Ireland (Veerkamp et al., 2002)

However it could be hypothesized that selection for milk yield has not only an effect on functional survival, but has also impact on the farmers decision regarding fertility traits. For this reason we investigated the effect of including a trait as milk yield in the model in order to account properly for the milk yield related selective censoring in fertility data.

Materials and Method

Statistical model

A multivariate sire model was developed for fertility evaluation in Ireland (Pool et al., 2002). The multivariate sire model included calving interval and survival in lactation 1, 2 and 3, 305-day milk yield in lactations 1,2 and 3, as well as Foot Angle, Angularity, Udder depth and Body condition score. Records in later lactations were included to improve accuracy (Olori et al., 2002) while the linear type traits allowed early proofing of young bulls before their daughters calve the second time. Traits included were adjusted for the fixed effects of herd-year-month, age at calving within lactation and Holstein percentage of the cow and sire was included. Model parameters were estimated performing multiple bi-, tri-, 4 and 6 variate runs using ASREML (Gilmour et al., 2000).

Survival (SU) was measured as a bivariate trait (1,0) whether the cow survived or not. If a cow had a next calving date she was scored a 1. A cow was assumed culled (0) if the difference between her last test-date and the herd last test-date was more than 140 days apart and otherwise censored. The interval of 140 days was chosen such that it includes the dry period and allows the cow to return in the milk recording on time. Survival was adjusted for milk yield at the genetic level (Meuwissen et al., 2002).

Calving interval (CIV) was defined as the interval between two successive calving dates. Cows not having a following calving date received a missing value in the analysis.

Milk yield was included as the cumulative 305-day milk yield or as the extended records if only part lactation information was available.

Type traits: Angularity, Foot angle, Udder depth, and Body condition score were chosen based on their relationship with the two objective traits (CIV and SU).

Breeding values for SU were adjusted for milk yield afterwards on the genetic scale, and single lactation EBVs for CIV and SU were averaged across lactations.

Data were supplied by ICBF and contained 2,082,561 lactation records from 738,910 different cows over a period of 25 years. Type data was available for 91,984 first lactation records on 1,142 herds, mainly year-round calving herds. Parameters were estimated from a sub set with edits for: birth-year (cows born after 1980); calving interval (300 to 600 days); animals with pedigree information; and herds with offspring from sires that had at least 50 daughters in the data set to ensure connectedness. To avoid dependency with herd-type, conformation data was used from the year-round calving herds and production data was taken from the non-conformation herds with more than 50 lactations over a period of fifteen years. To reduce the number of equations and to avoid many small fixed effect classes, all records from sires with 9 or less daughters were deleted (i.e. a reduction from 7,178 to 2,071 sires with on average 66.4 daughters). Furthermore herd-year-month classes were combined within trimesters if the number of observations was less than 5 for first parities and 2 for the second and third parity. Data for parameter estimation contained lactations from 263,975 cows on at least 600 herds (Table 1).

Table 1. Characteristics of the Irish data used for parameter estimation.

Trait	Lactation	Records	Mean	min.	max.
Survival	1	138,317	0.788	0	1
Survival	2	155,199	0.736	0	1
Survival	3	115,394	0.705	0	1
Calving interval	1	106,247	384	301	600
Calving interval	2	111,742	381	301	600
Calving interval	3	79,773	380	301	600
305d milk yield	1	152,037	5,051	1,001	15,922
305d milk yield	2	162,741	5,778	1,001	16,656
305d milk yield	3	121,367	6,058	1,001	17,372
Angularity	1	37,731	5.7	1	9
Foot angle	1	37,731	5.1	1	9
Udder depth	1	37,731	6.0	1	9
Body condition score	1	27,236	4.4	1	9

Table 2. Correlations between 4 linear type traits with first lactation survival (SU1, unadjusted) and calving interval (CIV1) in a multiple trait sire model with and without including the trait milk yield (M305d1) to account for censoring of fertility data.

Traits	without milk (tri variate analyses)		milk yield included (four variate analyses)		
	SU1	CIV1	SU1	CIV1	M305d1
Foot Angle	0.17	0.18	0.17	0.14	-0.01
SU1		-0.23		-0.16	0.45
CIV1					0.46
Udder Depth	-0.14	-0.02	-0.10	-0.01	-0.27
SU1		-0.23		-0.16	0.45
CIV1					0.46
Body Condition	0.07	-0.08	0.04	-0.18	-0.36
SU1		-0.24		-0.16	0.45
CIV1					0.46
Angularity	-0.06	0.25	-0.04	0.38	0.59
SU1		-0.24		-0.17	0.44
CIV1					0.46

Results and Discussion

The multiple trait sire model was described in detail by Olori et al. (2002) and Pool et al. (2002). Heritabilities ranged from 0.39 for milk yield to 0.01 for milk yield corrected survival and .05, .03 and .03 for respectively CIV 1, 2 and 3. A high milk yield was associated with a longer calving interval and a higher survival rate. Correlations of calving interval with unadjusted survival were between –0.24 and 0.11 (results from Pool et al., 2002). When survival was adjusted for milk yield (i.e. genetic correlations with yield become zero), the association between SU and CIV became more negative and the correlation of SU with udder depth, body condition score and angularity changed remarkable. The large association of milk yield with survival and calving interval, and the remarkable change in genetic correlations when adjusting survival for milk yield were reason to look in more detail to the results of the bi-, tri- and 4 variate analyses. Several analyses were performed with and without milk yield included as the fourth trait in a multiple trait analysis of survival, calving interval and one of the linear type traits (udder depth, angularity, foot angle and body condition score). Results in table 2 show a rather large impact on the correlations of linear type traits with first lactation survival (unadjusted) and calving interval when milk yield was included as the 4th trait. The largest difference observed was for the correlation between first lactation CIV (CIV1) and angularity which changed from 0.25 to 0.38 when milk yield was added as the 4th trait in the model. Not only the correlation with CIV1 changed but also between SU and CIV and, SU and the type traits was affected by including milk yield. For angularity different analysis with SU1, CIV1 and 305d milk yield (M305d1) are worked out in table 3. Correlations from the tri-variate analysis of SU1, CIV1 with angularity were equal to the first three bi- variate analyses (SU1+CIV1, SU1+angularity and CIV1+angularity). The same was seen for the tri-variate analysis of SU+CIV+M305d1 and the four-variate analysis. The differences in correlation between the first set and second set of correlations are all the result of including milk yield in the model. When SU was adjusted for milk yield the same effect was observed whether milk yield was included in the multiple trait model or not. As an example, the correlation between CIV and SU adjusted for milk yield changed from -0.66 to -0.28 when milk yield was included in the multiple trait model.

Table 3. Comparison of correlation between traits from a bi-, tri- or four variate analyses**.**

x-variate	Traits	Correlation					
bi-	SU1 + CIV1	-0.24					
bi-	SU1 + angularity		-0.06				
bi-	CIV1 + angularity			0.25			
tri-	SU1 + CIV1 + angularity	-0.24	-0.06	0.25			
bi-	SU1 + M305d1				0.56		
bi-	CIV1 + M305d1					0.49	
bi-	Angularity + M305d1						0.58
tri-	SU1 + CIV1 + M305d1	-0.17			0.44	0.46	
four-	SU1 + CIV1 + M305d1 + angularity	-0.17	-0.04	0.38	0.44	0.46	0.59

Conclusion

Milk yield as a 4th trait in a multiple trait model with survival, calving interval and one of the linear type traits did affect the correlation between survival, calving interval and the linear type traits remarkable. Those results suggest that milk yield needs to be included as a 4th trait in the multiple evaluation for fertility to ensure proper accounting for the selective censoring of fertility data especially in the case of a seasonal calving system as in Ireland.

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