Genetic Parameters for Stillbirth in the Netherlands

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1. Introduction

Stillbirth in dairy cattle is one of the functional traits that receives more and more attention. In Sweden the rate of stillbirth has gradually increased during recent years due to the introduction of American Holstein Friesian genes (Berglund, 1996). Research in the USA did not show any trend in the rate of stillbirth in recent years. The overall mean was 6.7%. Stillbirth was higher in heifers (10.1%) as opposed to cows (5.0%) (Berger *et al.*, 1997).

Economic values of stillbirth are often part of the economic value of dystocia. Dystocia has an economic value of 1,33 Dfl per cow per year per % increase in difficult calvings (Groen *et al.*, 1995). This economic value is based on the extra costs due to veterinary fee, farmer labor and stillbirth. Furthermore dystocia and stillbirth have indirect costs as well. These costs are associated with health and fertility problems, reduced production, increased culling rate, decreased animal welfare and increased concern on consumer acceptance of dairy products (Groen *et al.*, 1995).

Although dystocia and stillbirth are related traits they are not the same trait. According to Philipsson (1996) about half of all stillborn calves are born without difficulty. He also suggests to divide stillbirth in four different traits, first parity versus later parities and the sire effect versus the maternal effect. Groen *et al.* (1995) define a direct effect and an indirect effect. In their definition the direct effect is the effect of the sire on his offspring, which is the same as the sire effect in the definition of Philipsson (1996). The indirect effect is the effect of the sire on his daughters and this is equal to the maternal effect minus a half times the sire effect.

In the Netherlands information on stillbirth is collected for young bulls together with the dystocia scores. On average 200 – 250 records per bull are collected based on calvings of second parity cows. This number is not enough to estimate a reliable breeding value for stillbirth due to the low heritability of the trait. Heritabilities are between 0.02 and 0.05 for heifers (Philipsson, 1996). Furthermore the information considering stillbirth is collected for second parity cows only, while the highest incidence of stillbirth is found in heifers (Berglund, 1996). Genetic correlations between first and higher parities range from 0.2 to 0.6 (Philipsson, 1996) indicating that the trait in heifers is different from the trait in cows.

This paper describes the investigations on the feasibility of a genetic evaluation for stillbirth in the Netherlands.

2. Material and Methods

In the analysis stillbirth is defined as a deadborn calf or a calf that died within 24 hours after birth. Farmers in the Netherlands have to report their deadborn calves but they do not have to tag them with a lifetime number. As a consequence deadborn calves do not enter the national database. A deadborn calf was therefore identified as the offspring of a dam with a calving date but without any offspring born on that day. Also calves born alive but culled from the farm within 1 day and without an arrival date on any other farm were considered to have died within 24 hours after birth. The sire of these animals was determined through the inseminations of the dam 9 months before the calving date. Due to the indirect determination of a deadborn calf the sex of the animal is unknown and could therefore not be used as a fixed effect in the analysis.

Data from animals born from july 1993 onwards was used. Before 1993 farmers did not have to report the bull calves that would be culled for veal production. This of course overestimates stillbirth rates. Data from the first 6 months of 1993 was discarded because it is likely that some farmers did not apply the new rules directly.

Records from herdbook registred Holstein calves, born alive or dead as previously described, with a gestation length between 260 and 300 days were used in this study. The age at first parity of the dam had to be between 640 and 1075 days and multiple births were discarded. Finally records that originated from herds with less than 75 calves born in 2 years or from sires with less than 150 records were skipped. The original dataset had 12.9 million records and after data editing 3.8 million records could be used for the analysis.

Five different analyses were performed in this study, with the following characteristics:

1. Stillbirth is the same trait in all parities
2. Stillbirth in parity 1 as an effect of the sire
3. Stillbirth in parities > 1 as an effect of the sire
4. Stillbirth in parity 1 as an effect of the maternal grandsire
5. Stillbirth in parities > 1 as an effect of the maternal grandsire

The model used in the different analyses were:

$$Y_{ijklmno} = P_i + A_j + G_k + M_l + H_m + Y_n + S_o + E$$

where

Y = stillbirth of the calf (0=alive, 1=dead)
P = parity in analysis 1,3 and 5 (fixed, maximum 7 levels)
A = age at calving in analysis 2 and 4 (fixed, 28 levels)
G = gestation length (fixed, 8 levels)
M = month of birth (fixed, 12 classes)
H = herd*2 year period (fixed, 35914 levels)
Y = year of birth (fixed, 6 classes)
S = sire in analysis 2 and 3 and maternal grandsire in analysis 4 and 5 (random)
E = residual (random)

In matrix form:

Y = Xb + Zu + e with E[Y] = Xb and $\mathrm{Var}\begin{bmatrix} u \\ e \end{bmatrix} = \begin{bmatrix} A\sigma_g^2 & 0 \\ 0 & I\sigma_e^2 \end{bmatrix}$,

where A is the numerator relationship matrix and σ_g^2 and σ_e^2 are the variance of genetic and residual effects.

The number of (maternal grand)sires with at least 150 records in each analysis was 316, 3363, 373 and 1278 for analysis 1, 2, 3 and 4 respectively. The large difference in the number of sires between analysis 1 and 2 is due to the fact that young bulls are tested on second calvers and only calving ease sires are used on heifers. The difference in analysis 3 and 4 is due to the fact that only second crop bulls get more than 150 daughters in parity 1.

Contemporary groups were defined as all calves born within a herd during a 2 year period. This was done to ensure that contemporary groups were large enough. The 2 year period began on July 1st and ended on June 30th 2 years later.

Variance components were estimated with a ReML procedure assuming a normal distribution of the trait. Correlations between the different traits were computed using the solutions from bulls with a reliability of at least 70%. Genetic correlations were approximated using the method of Calo *et al.* (1973). Genetic correlations for the following combination of traits were computed:

1. Sire effect in parity 1 and parities > 1
2. Maternal effect in parity 1 and parities > 1
3. Sire effect in parity 1 and maternal effect in parity 1
4. Sire effect in parities > 1 and maternal effect in parities > 1
6. Indirect effect in parity 1 and indirect effect in parities > 1
7. Direct effect in parity 1 and indirect effect in parity 1
8. Direct effect in parities > 1 and indirect effect in parities > 1

3. Results and Discussion

The results from analysis 1,2 and 3 showed that the fixed effects have different solutions for stillbirth in parity 1 and stillbirth in higher parities. The raw means for the different parities are in table 1. The resulting overall mean for all parities is 6.9%. The raw means correspond well with the values found by Berger *et al.* (1995) except for the heifers. Heifers in the Netherlands have a 1,3% higher rate of stillbirth in comparison with US heifers.

Figures 1 and 2 show the raw means and solutions for the fixed effects gestation length and month of birth from the first 3 analyses. Figures 1 and 2 show a different pattern for both the raw means and the solutions for parity 1, the higher parities and all parities as the same trait. All animals with short (< 270 days) gestation lengths have a high percentage stillbirth. Heifers with a long gestation length show a much larger increase in percentage stillbirth in comparison with cows of parities greater than 1. This might be due to a higher increase in the calf size relative to dam size for heifers compared to cows. Philipsson (1996) stated that this is a reason why stillbirth in heifers is biologically a different trait than stillbirth in cows.

Figure 2 shows the different pattern for the different parities for month of birth. The decrease in stillbirth during the summer is much larger for heifers than for cows. This might be due to the difference in birth weight between summer and winter (Meijering, 1984). This might influence heifers more than cows.

The effect of year of birth of the calf can be found in table 2. For parity 1 there are differences in the raw means but it is difficult to discover a real trend in the raw means. The raw mean of 1999 is quite high but only the first 6 months of 1999 have been included in the analysis. Looking at the least square estimates for parity 1 there seems to be a positive trend for stillbirth in heifers. The year 1995 has the lowest estimate and after 1995 stillbirth is gradually increasing with only a small decrease in 1998. The difference in the estimates between 1999 and 1995 is over 3%. Six years is of course a short period to discover real trends. The next years should indicate whether the stillbirth rate in heifers is truely increasing. The differences in the raw means and least square estimates are small for the higher parities and there is no trend in the rate of stillbirth over the years.

All the effects in the model were significant at the 1% level. The models for parity 1 explained more variation than the models for the higher parities. The fixed effects herd by 2 year and gestation length explained most of the variation in stillbirth in all analyses.

Table 3 shows the heritabilities and approximated genetic correlations for the different sire and maternal traits. The heritabilities and genetic correlations are in accordance with the values reported by Philipsson (1996). He also stated that correlations between parities might be higher for the sire effect than for the maternal effect. This is not found in this study (0.52 versus 0.78) but in the Netherlands only calving ease sires are used on heifers and this might influence the results. Calving ease and stillbirth have a positive correlation so the sires used in parity 1 is a pre-selected group which on average have less stillbirth. This might influence the results of this study. The genetic correlations between the traits indicate that stillbirth in heifers is indeed a different trait from stillbirth in cows.

The approximated genetic correlations between direct and indirect effects are in table 4. The correlations between the direct an indirect effect for both parity 1 and higher parities are almost 0. This is again in accordance with literature (Philipsson, 1996).

A correlation of almost 0 between direct and indirect effects offers good possibilities to reduce stillbirth. The offspring of bulls that sire less deadborn calves do not have the disadvantage of having more deadborn calves themselves as is often the case with dystocia.

Genetic trends for the different traits can be found in table 5. They are computed as the average solution of bulls born in a certain year. The trend for the sire effect parity 1 is difficult to interpret, mainly because the low number of bulls with daughters in parity 1 in a certain year. The bulls are mostly calving ease bulls but they still show quite some differences in stillbirth.

The trend for the maternal effect parity 1 is much more stable although the number of bulls for this trend is even lower. They are a different group of bulls though. Bulls with enough daughters in parity 1 are mostly second crop bulls.

The genetic trend for the sire effect for the higher parities contains all the young bulls tested in the Netherlands. This explains why some bulls born in 1997 already have a breeding value for this effect. The trend for this trait is very stable over the last 10 years. Finally the trend for the maternal effect for the higher parities. This trait also has a very stable trend. One of the reasons might be the low heritability of the trait.

Overall it might be concluded that the genetic trends for the different traits do not really show an increase nor a decrease. The standard deviations of the estimates within a year (not shown) is always higher than the difference between years.

4. Applications

A genetic evaluation for stillbirth in the Netherlands is possible based on the indirect determination of a deadborn calf. The next step will be to set up a routine genetic evaluation for stillbirth in the Netherlands and to publish breeding values for stillbirth.

References

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Table 1. Percentage of stillbirth per parity

Parity	# records	Raw Mean
1	1048145	11.4
2	951313	5.3
3	686775	5.1
4	472213	5.2
5	300232	5.4
6	175400	5.5
7	193362	5.8

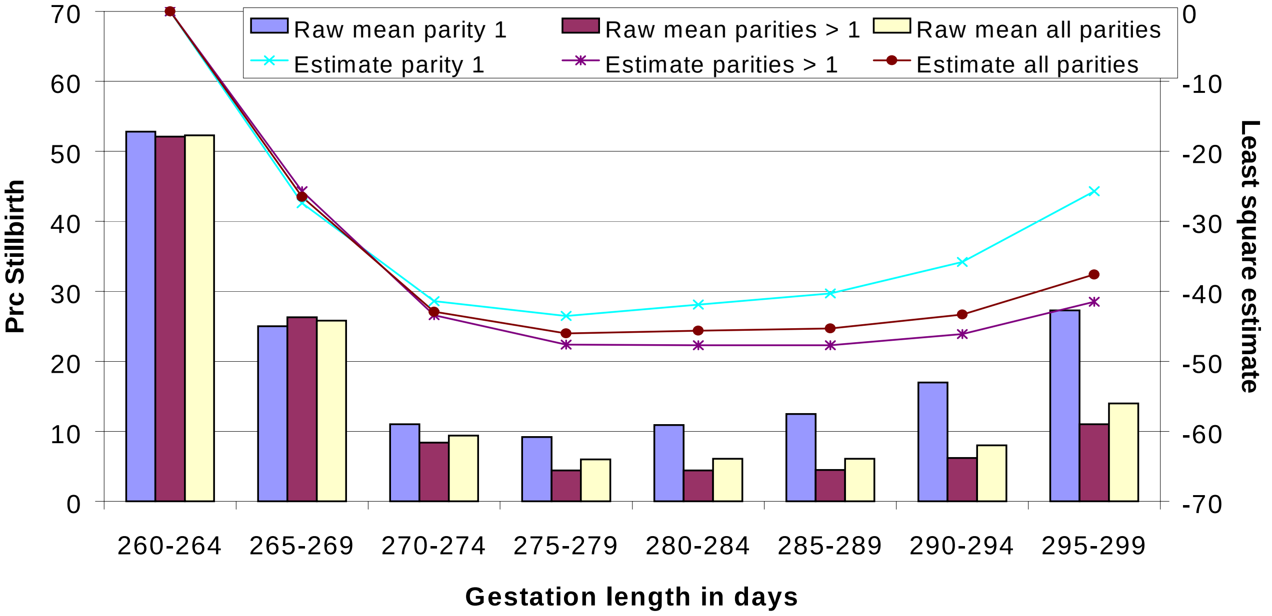

Figure 1. Raw means and least square estimates for stillbirth per class of gestation length for different parity classes

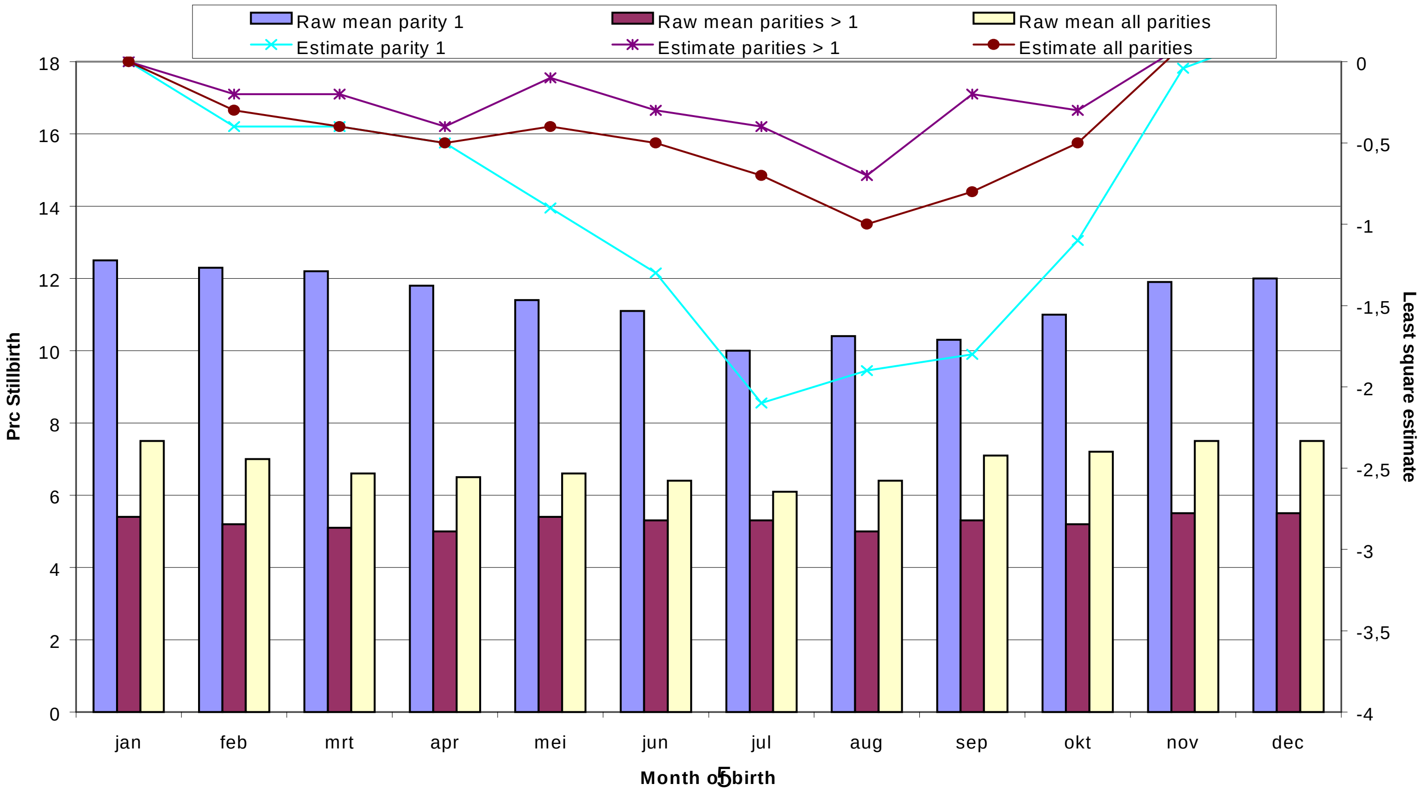

Figure 2. Raw means and least square estimates for stillbirth per month of birth

Table 2. Stillbirth per year of birth

Year of birth	Parity 1			Parity > 1		
	# records	Raw mean	Estimate	# records	Raw mean	Estimate
2nd half 1993 + 1994	261073	11.8	0	616073	5.9	0
1995	161241	10.1	-1.2	412305	5.4	-0.5
1996	169496	11.8	0.7	457153	5.4	-0.3
1997	192503	11.9	1.9	441789	5.1	-0.2
1998	194463	10.9	1.6	462831	4.6	-0.4
1999 (jan – jun)	69189	12.2	2.4	206186	4.5	-0.5

Table 3. *Heritabilities* (on diagonal) and approximated genetic correlations (upper triangle) for stillbirth for sire and maternal traits with the number of bulls in brackets

	Sire parity 1	Sire parities > 1	Maternal parity 1	Maternal parities > 1
Sire parity 1	*0.027*	0.52 (118)	0.32 (139)	–
Sire parities > 1		*0.014*	–	0.60 (198)
Maternal parity 1			*0.047*	0.78 (201)
Maternal parities > 1				*0.007*

– correlation not computed

Table 4. Approximated genetic correlations for stillbirth for direct and indirect traits with the number of bulls in brackets

	Indirect parity 1	Indirect parities > 1
Direct parity 1	-0.07 (118)	–
Direct parities > 1		-0.18 (198)
Indirect parity 1		0.73 (201)

– correlation not computed

Table 5. Genetic trend for stillbirth based on solutions of the bulls (transmitting abilities)

Birthyear of bull	sire effect parity 1		maternal effect parity 1		sire effect parities > 1		maternal effect parities > 1	
	# of bulls	average solution	# of bulls	average solution	# of bulls	average solution	# of bulls	average solution
1986	61	0.34	50	-0.48	52	-0.02	80	-0.08
1987	46	-0.07	32	-0.53	35	-0.16	78	0.06
1988	66	-1.11	46	-0.17	52	-0.44	197	-0.03
1989	57	0.00	39	-0.03	50	-0.04	148	0.05
1990	75	0.79	39	0.06	74	0.09	193	0.01
1991	84	-0.57	27	0.03	277	0.05	162	-0.29
1992	56	-0.07			434	-0.19	32	-0.28
1993	30	0.45			399	-0.29		
1994					502	-0.35		
1995					480	-0.41		
1996					505	-0.45		
1997					131	-0.30		