Developing a Genetic Evaluation for Calf Survival during Rearing in The Netherlands

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Abstract

Little is known about calf survival during the rearing period. Therefore, a genetic evaluation for calf survival during rearing has been developed in The Netherlands. The trait of interest is calf survival of replacement heifers in the period day 3 to 365. Two other traits, day 3 to 14 for all calves and day 15 to 180 for veal calves, are used as predictor traits. The existing system for identification and registration yields a data set of nearly 33 million records of 17.5 million calves. Heritabilities are ranging from 0.005 to 0.011. With a genetic standard deviation of 2.49% for day 3 to 365 it is possible to distinguish good and bad bulls for calf survival. Although heritabilities are low, young test bulls will have a reliability of approximately 64% before the first daughter is lactating due to large progeny groups. The economic importance of calf survival justifies the implementation of a breeding value estimation.

Keywords: calf survival, genetic parameters, Holstein, rearing

1. Introduction

In most countries genetic evaluations for still birth and longevity are in place. The same situation is applicable for The Netherlands. Therefore it is possible for farmers to breed for more life-born calves with breeding values for livability or still birth. And with the breeding value for longevity it is also possible to breed cows that stay productive for a long time once they started producing milk. However, little is known about survival of the calves during the rearing period. From an economic point of view it is favorable to minimize the number of calves that die during the rearing period. But also for a durable and animal welfare-friendly dairy industry calf mortality should be minimized.

In The Netherlands farmers are obliged to eartag life-born calves with an unique identification number and register all their calves, male and female, in a national identification and registration system since 1993. Furthermore, farmers have to report all movements of the animals. These movements include for instance date of birth, selling, buying, cattle exhibition shows, export, slaughter and dying at the farm. With this information it is known whether an animal is alive at a certain age. Because the information is available for all animals, this offers possibilities for monitoring and analyzing calf survival in the population both at phenotypic and genetic level.

The aim of this paper is to report the results of the development of a breeding value estimation for calf survival during rearing in The Netherlands.

2. Material and Methods

2.1 Trait definition

Previous studies (Fuerst-Waltl and Sørensen, 2010; Hansen *et al.*, 2003; Harbers *et al.*, 2002) have shown that survival of calves is different at different stages of life and may be controlled by different genes. Three different traits have been defined. Death at day 1 is considered still birth and death at day 2 was excluded for reasons of data quality. The first trait is calf survival of replacement heifers from day 3 to 365. This trait is the breeding goal. The other two traits are used as predictors. The second trait is calf survival from day 3 to 14 for all calves, both male and female. The upper bound of 14 days is chosen because Dutch farmers are obliged to keep calves at the farm of birth until the age of 14 days before the calves are allowed to be moved. The third trait is calf survival from day 15 to 180 for veal calves, both male and female. The upper bound of 180 days is chosen because calves are not slaughtered yet when they are six months old and most data can be used. Animals were scored 100 if they survived within the respective period and 0 otherwise, resulting in a binary data structure.

2.2 Data for breeding value estimation

Data of animals born since July 1993 are used in the breeding value estimation for calf survival. Records from herdbook registered calves with a known pedigree are used for the breeding value estimation. Herds can be classified as rearing herds or as specialised veal herds. Slaughtered and exported animals did not die at the herd and are therefore excluded from the data. Animals that were slaughtered or exported in a defined period and those too young to theoretically reach the maximum age of the respective period were set to missing for this period, while their records were kept for the preceding period.

The number of observations and mean survival rate are shown in Table 1. In the first year of rearing 5.57% of the calves dies of which almost 2% dies before day 15. The total number of observations is 32,932,957 from 17,510,993 calves.

Table 1. Number of records and mean calf survival rate for three traits used in breeding value estimation for calf survival.

Trait	No. observations	Survival (%)
Day 3 – 365	7,903,915	94.43
Day 3 – 14	17,510,993	98.13
Day 15 – 180	7,518,049	97.47

2.2 Statistical model

The breeding values for calf survival are estimated with a multiple trait animal model. The statistical models used, are:

For day 3 – 365:

$$Y_{ijklmno} = HY_i + YM_j + P_k + H_l + R_m + a_n + e_{ijklmno}$$

For day 3 – 14:

$$Y_{ijklmnop} = HY_i + YM_j + P_k + S_l + H_m + R_n + a_o + e_{ijklmnop}$$

For day 15 – 180:

$$Y_{ijklmno} = HYM_i + P_j + S_k + H_l + R_m + a_n + e_{ijklmno}$$

where

Y	observation of the calf for calf survival in the period day 3 – 365, day 3 – 14 or day 15 – 180;
HY	herd x year of arrival of the calf (fixed);
YM	year x month of arrival of the calf (fixed);
HYM	herd x year x month of arrival of the calf (fixed);
P	parity of the dam of the calf (fixed);
H	heterosis of the calf (covariable);
R	recombination of the calf (covariable);
a	additive genetic effect of the calf (random);
e	residual (random)

Calves could have stayed in more than one herd for the periods day 3 – 365 and day 15 – 180. Only one observation is used per trait. The herd in which a calf stayed the longest period is used for the herd x year effect or the herd x year x month effect. Pedigree data of all calves with an observation are included.

3. Results and Discussion

3.1 Genetic parameters

Table 2 shows the heritabilities, genetic correlations and genetic standard deviations used in the breeding value estimation for calf survival. Heritabilities range from 0.005 to 0.011. The genetic standard deviation ranges from 1.12% to 2.49%. Variation between bulls is large enough to improve calf survival, despite the low heritabilities.

The genetic correlation between day 3 – 14 and day 3 – 365 is high (0.85). The genetic correlation between day 3 – 365 and day 15 – 180 is moderate (0.66). Because of the large progeny groups both traits are good predictors for day 3 – 365 and add reliability. The residual correlation between day 3 – 14 and day 3 – 365 exists because overlap in the period exists, whereas for the two other correlations there is no overlap in periods or data.

Table 2. Heritabilities (bold on diagonal), genetic correlations (below diagonal), residual correlations (above diagonal) and genetic standard deviations for calf survival.

	Day 3 – 365	Day 3 – 14	Day 15 - 180	Gen.sd (%)
Day 3 – 365	**0.011**	0.62	0.00	2.49
Day 3 – 14	0.85	**0.006**	0.00	1.20
Day 15 – 180	0.66	0.37	**0.005**	1.12

3.2 Effects

In figure 1, 2, and 3 the solutions of the effect of parity, sex and heterosis are shown. With increased parity number the calf survival improves to a maximum of 1.4% in ninth and higher parity for calf survival from day 3 to 365 (Figure 1). For day 3 – 365 the effect of sex is zero, because sex is not included in the model. When compared to male calves, female calves have a 0.38% and 0.62% higher survival rate for day 3 – 14 and day 15 – 180 respectively (Figure 2). Compared to purebred calves, crossbred calves with 100% heterosis have a 1.50%, 0.22% and 0.61% higher survival rate for day 3 – 365, day 3 – 14 and day 15 – 180 respectively (Figure 3).

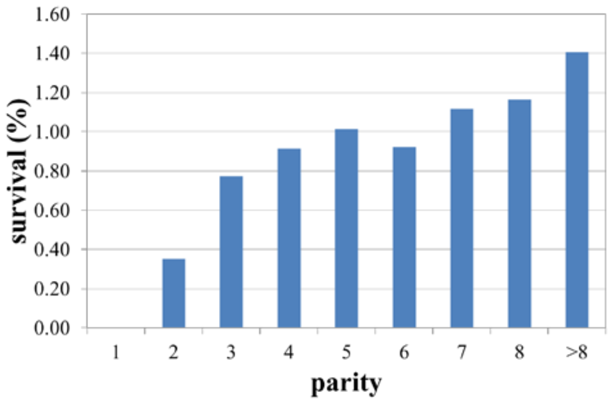

Figure 1. Effect of parity of the dam on calf survival for day 3 - 365, expressed relative to parity 1 in percentage.

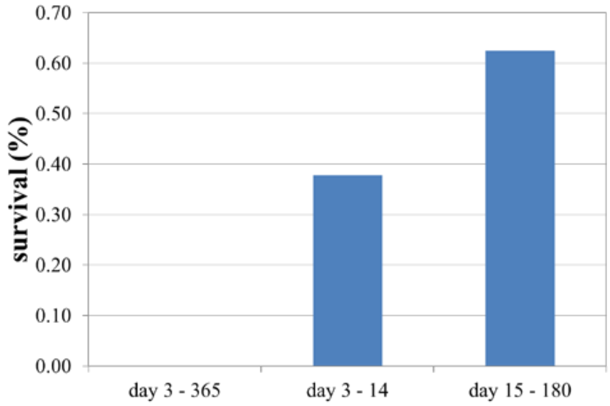

Figure 2. Effect of sex on calf survival, expressed as female minus male in percentage.

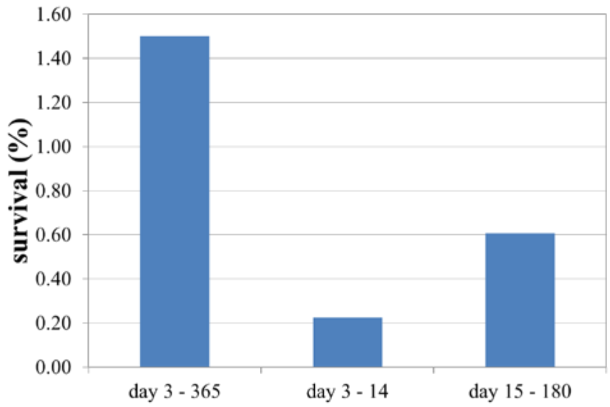

Figure 3. Effect of 100% heterosis on calf survival in percentage.

3.3 Genetic trends

Figure 4 shows the annual genetic trends for calf survival for Holstein bulls. The trait day 3 – 365 shows a decline of just one percent until birth year 2000 and stabilized in more recent years. The trait day 3 – 14 shows an increase of half a percent. The trait day 15 – 180 is stable over all years. It was expected that genetic trends were neutral, because no selection has been done on calf survival. It is not known yet how calf survival is correlated with other traits.

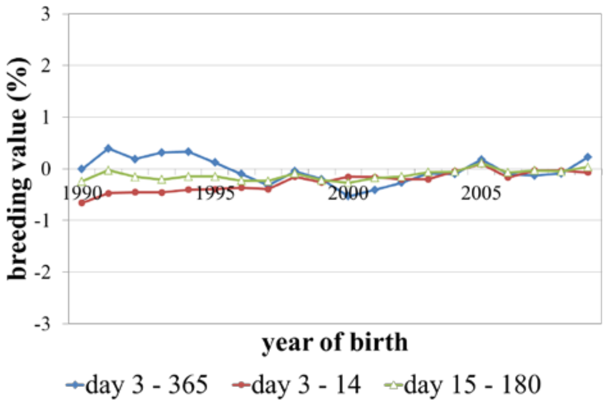

Figure 4. Annual genetic trends for calf survival for black & white Holstein bulls.

Breeding values of black & white Holstein bulls born between 1985 and 2009 are normally distributed in a range of +/- 3 standard deviations (Figure 5). Around 14% of the bulls have a favorable breeding value for day 3 – 365 of plus one standard deviation or higher. This results in at least one percent higher survival rate in the first year of rearing in the progeny groups of these bulls.

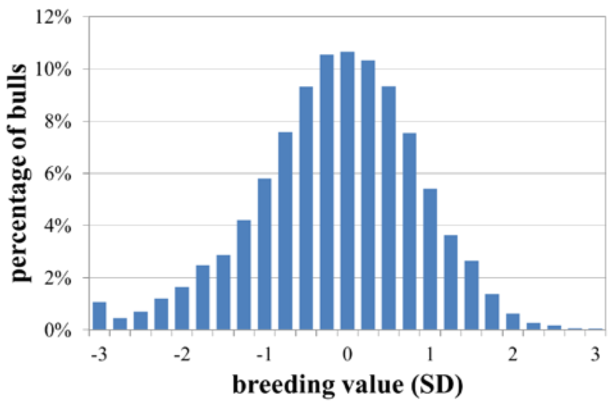

Figure 5. Distribution of breeding values for calf survival from day 3 to 365 expressed in standard deviations. Bulls are black & white Holstein born between 1985 and 2009.

3.4 Reliabilities

In Table 3 reliabilities are shown for calf survival for six different sire types. The different sire types are chosen to reflect how the number of progeny increases during the life a bull. In The Netherlands young bulls will end up with 400 to 500 progeny from the test period (*Y3*) for day 3 – 14. At this stage the reliability for day 3 – 365 is 62%, which is at the same level as other traits with a low heritability but less progeny. When a bull becomes a proven bull, the reliability rapidly increases to 70% (*P1*) or higher.

Table 3. Reliabilities for breeding values for calf survival for different sire types for black & white bulls born between 1996 and 2009.

	No. of progeny			Reliability		
	Day 3 – 365	Day 3 – 14	Day 15 - 180	Day 3 – 365	Day 3 – 14	Day 15 - 180
Y1	0	319	0	44	48	32
Y2	0	324	78	46	49	37
Y3	184	411	198	62	61	50
P1	313	810	334	70	69	57
P2	4,889	10,913	4,909	94	95	88
P3	24,849	51,388	22,753	98	99	97

Categories are: *Y1)* young bulls with at least 100 progeny for day 3-14 only; *Y2)* young bulls as *Y1* plus progeny for day 15-180; *Y3)* young bulls as *Y2* plus up to 250 progeny for day 3-365 and at most 750 progeny for day 3-14; *P1)* proven bulls as *Y2* plus 251 to 1500 progeny for day 3-365; *P2)* proven bulls as *Y2* plus 1501 to 10,000 progeny for day 3-365; *P3)* proven bulls as *Y2* plus more than 10,000 progeny for day 3-365.

4. Conclusions

A breeding value estimation for calf survival is possible with a multiple trait animal model. Data is available through the already existing system for identification and registration. Young bulls will have a reliability for calf survival for day 3 – 365 of 62% before the first daughters start lactating. Variation between bulls exists and makes it possible to breed for a higher calf survival rate. For day 3 – 365 the genetic standard deviation is 2.49% and it is possible to distinguish bulls with good and bad calf survival. For farmers calf survival is of economic importance, because of calf losses, costs for feed, labour and housing, and makes it worthwhile to calculate breeding values for this trait.

5. References

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