Statistical Indicators
E-32
Breeding value Calf survival

■ Introduction

A sustainable, welfare-friendly dairy industry requires calves with good vitality. Calf mortality during rearing leads not only to economic losses but also to a poor image for the sector and less job satisfaction for the farmer.
In the first year of rearing, mortality is 7 to 8 percent. Research shows that various factors influence the chances of survival in the first year of life. Besides management (e.g. housing, hygiene and the provision of colostrum), the genetic disposition of the calves also plays a role. For the farmer, it is interesting to know which bulls give low calf mortality during rearing. It is for this purpose that the breeding value calf survival has been developed. With the aid of this information, the farmer can reduce the number of calves lost in his herd during rearing.

■ Traits and breeding goal

For the purposes of the breeding value estimation, calf survival is defined as:

- Survival from day 3 to day 365 for rearing calves (day 3-365): this relates only to female calves intended for the replacement of older animals. The majority of heifer calves are of dairy or dual purpose breeds and only a minority come from beef breeds. The calves from beef breeds are mainly heifer calves being reared for use as suckler cows. This trait is the breeding goal trait.

In addition, two indicator traits (predictors) are defined:

- Survival from day 3 to day 14 for all calves (day 3-14): it is a statutory requirement that animals must remain in the herd of birth until day 14. After this age, they may be moved to other herds or locations. Both heifer and bull calves can be selected for this trait. Male Jersey calves are not included, because it is common to euthanize these calves.
- Survival from day 15 to day 180 for calves intended for white or pink veal production (day 15-180): this mainly concerns bull calves from the dairy sector, but heifer calves are also included for this trait.

The first indicator trait gives a very early indication of calf survival. The second trait provides information about how the calves will perform in the meat production sector.

■ Data

Observations

Data from 1 July 1993 are included in the breeding values estimation for calf survival because from this date it is compulsory to ear-tag all live-born calves in the Netherlands and to register them with the I&R system. In addition, all movements of live animals must be registered with the I&R system. This makes it possible to compose a data set containing animal-specific information, e.g alive/dead, location.

Selection of data for the breeding value estimation

A calf's data are included in the breeding value estimation if the following requirements are met:

1. The calf is registered in the I&R system, so all of its locations, past and present, are known;
2. The calf is a pedigree animal;

3. For each trait, the calf must be able to be assigned to a farm rearing calves for replacement or to a specialised veal calf farm;
4. The calf must have survived for the stated period. The calf is at least 14, 180 or 365 days old for the three traits;
5. If the calf has been slaughtered or exported during a period, the animal is not taken into account for the trait in question.

■ Statistical model

The calculation of the breeding values is done with an animal model, following the BLUP technique (Best Linear Unbiased Prediction). For that, correlations between all traits are used. The breeding value estimation is thus a 'multiple trait' breeding value estimation. The statistical model through which the breeding values for calf survival are estimated:

Day 3-365: $Y_{ijklmno} = HY_i + YM_j + P_k + H_l + R_m + a_n + e_{ijklmno}$

Day 3-14: $Y_{ijklmnop} = HY_i + YM_j + P_k + S_l + H_m + R_n + a_o + e_{ijklmnop}$

Day 15-180: $Y_{ijklmno} = HYM_i + P_j + S_k + H_l + R_m + a_n + e_{ijklmno}$

Where

Y	observation for calf for calf survival for day 3-365, day 3-14 or day 15-180;
HY	herd x year of arrival of calf;
YM	year x month of arrival of calf;
HYM	herd x year x month of arrival of calf;
P	parity of the dam;
S	sex of calf;
H	heterosis of calf;
R	recombination of calf;
a	additive genetic effect or breeding value for calf; and
e	residual, which is not explained by the model

The effects *a* and *e* are random effects, heterosis and recombination are co-variables and the other effects are included in the model as fixed effects.

The effects in the model

The effects in the model are:
1. Herd x year of arrival of calf;
2. Herd x year x month of arrival of calf;
3. Year x month of arrival of calf;
4. Parity of the dam;
5. Sex of calf;
6. Heterosis of calf;
7. Recombination of calf; and
8. Additive genetic effect or breeding value for calf

Herd x year of arrival of calf / herd x year x month of arrival of calf
There are differences in calf survival between herds. In addition, the level of calf survival in a herd can change over time. These factors are taken into account by comparing calves within a herd and over a season of one year or one month. For the traits 'survival day 3-14' and 'survival day 3-365', a season is defined as a calendar year. For the trait 'survival day 15-180', a season is defined as one month.

Year x month of arrival of calf

The percentage of surviving calves appears not to be the same in each month. Calf survival percentages are lower in the winter months than in the rest of the year.

Parity
The parity of the dam is taken into account in the calf survival breeding value estimation. The parity of the dam has an effect on the survival of the calf (Figure 1). Calves born to first and second parity cows in particular have lower survival rates.

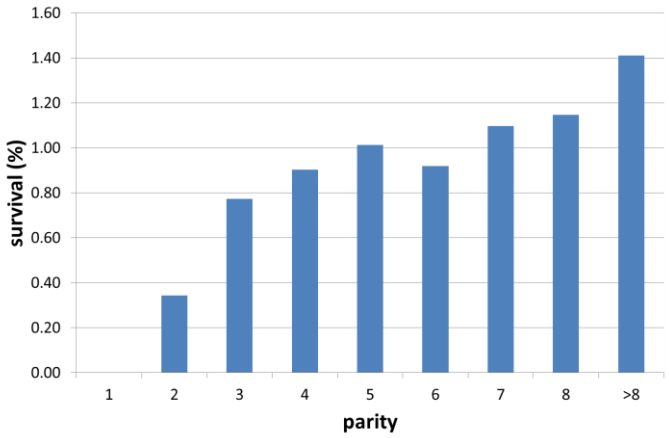

Figure 1. Effect of parity on calf survival from day 3 to day 365. The effect of parity 1 (heifers) is set at zero.

Sex of calf
The sex of the calf is taken into account in the calf survival breeding value estimation. The sex of the calf has an effect on survival (Figure 2). Bull calves have lower survival rates than heifer calves. There is no effect for survival from day 3-365, because only female animals are used for this trait.

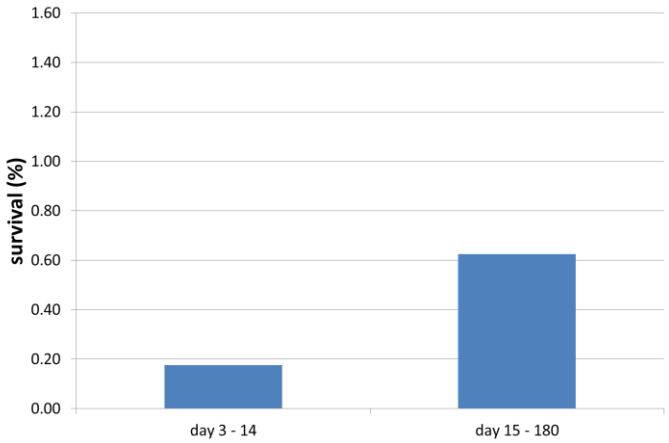

Figure 2. Effect of sex (female / male) on calf survival for the traits ‘survival day 3-14’ and ‘survival day 15-180’

Heterosis and recombination of the calf
Heterosis and recombination effects play a role in the combining of breeds. These are genetic effects that are not transmitted to the offspring. Research has shown that a correction must be made to these effects. The amount of the heterosis is defined as the difference in level or the trait in the crossing with the average of the parent breeds. Recombination is the loss of the usually positive effect of heterosis and occurs when the earlier achieved crossing product is crossed back with one of the parent breeds.
In calves with 100% heterosis, the survival in the first year of rearing is 1,5% higher than for calves without heterosis.

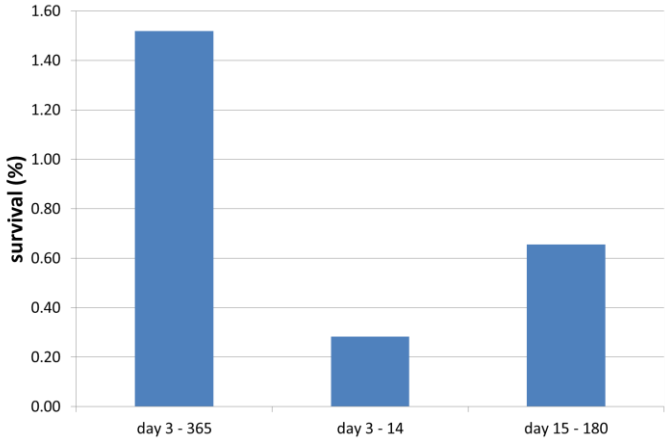

Figure 3. Effect of heterosis on calf survival

Additive genetic effect of the calf
This is the additive genetic effect of the breeding value, the effect that matters in the end. The variable animal contains the (genetic) contribution of an animal to the observation and determines the breeding value of an animal. In addition, when determining the breeding value, all of the information from predecessors and offspring is used as well. The heritabilities used are shown in Table 1.

■ Parameters

A total of three traits are analysed in the breeding value estimation. These are survival from day 3 to day 365 for rearing calves (day 3-365), survival from day 3 to day 14 for all calves (day 3-14) and survival from day 15 to day 180 for calves intended for white or pink veal production (day 15-180). Survival from day 3-365 is the breeding goal and this breeding value is published. Survival from day 3-14 is a predictor. This trait correlates highly with day 3-365 and thus makes a contribution to the breeding value and reliability. Survival from day 15-180 is included to monitor phenotypic and genetic trends. The heritabilities, genetic standard deviations, genetic correlations and error correlations are given in Table 1. Heritability is a measure of the fraction of the differences between animals that is explained by genetics. Taking the binary nature of the trait into account, the heritability on the underlying scale is 4% for survival from day 3 to day 365 instead 1.1% on the linear scale.

Table 1. Heritabilities (in bold), genetic correlations (below diagonal), error correlations (above diagonal) and genetic standard deviations for calf survival

trait	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

■ Base

Breeding values for calf survival are published based on the 2015-base. Cows born in 2010 determine the base of 2015. There are four different bases: Milk goal Black, Milk goal Red, Dual purpose and Belgian Blue. The definitions of these bases are as follows:

Milk goal Black (Z)
Herdbook-registered animals born in 2010 with at least 87.5% HF-blood and up to 12.5% FH-blood and hair colour black pied, with at least one observation in the genetic evaluation.

Milk goal Red (R)
Herdbook-registered animals born in 2010 with at least 87.5% HF-blood and up to 12.5% MRY-blood and hair colour red pied, with at least one observation in the genetic evaluation.

Dual purpose (D)
Herdbook-registered animals born in 2010 with at least 75% MRIJ-blood and 25% or less HF blood, with at least one observation in the genetic evaluation.

Belgian Blue (B)
The Belgian Blue base is determined by the animals that determine the Dual purpose base.

An observation is an animal that has at least one observation for survival day 3-14.
The distribution of breeding values is determined by the Milk goal Black base animals. The distribution in breeding values is calculated and standardised to a reliability of 80 percent. This means that 4 points of distribution is equivalent to 0.9 x genetic distribution. The advantage of a single distribution for all bases is that there is only a difference in level between the bases, and no difference in distribution.

Every five years, in a year dividable by 5, the reference year for the base is moved 5 years.
The base differences are shown in Table 2. The base differences of the Dual purpose base apply on the Belgian Blue base.

Table 2. Base differences for calf survival

	Z → R	*R → Y*	*Z → Y*
Caf survival	0	4	4

■ Publication

Presentation

The breeding values for calf survival are presented as relative breeding values with an average of 100 and a standard deviation of 4. It is important to remember that figures above 100 are desirable. A breeding value for calf survival of more than 100 indicates that survival from day 3 to day 365 in the progeny group will be higher. Table 3 shows the effect of a breeding value of 104 on the progeny of a bull mated with an average cow. The bull breeding value is calculated as a half breeding value and indicates the actual effect on the progeny. Sire and dam each pass on half of their breeding value to the progeny.

Table 3. Effect of relative breeding values for calf survival in progeny

Trait	Relative breeding value	Half breeding value (effect on progeny)
Calf survival	104	1.12%

A breeding value of 104 for calf survival means that calves will have a 1.12% higher survival rate up to the age of 365 days. The economic value of calf survival is 1 euro for just rearing cost, to 1.50 euro for a nuka of 50 euro and 3 euro for a nuka of 200 euro. Improving calf survival by 1% on a farm with 100 calves born in one year will result in an extra profit of 100 to 300 euro.

Publication requirements

The publication requirement for all bulls from dairy and dual purpose breeds is a minimum reliability of 25% for the calf survival. For bulls from beef breeds the breeding value for calf survival is not published. For sampled AI bulls, the index is based on a minimum of one descendant. Bulls are considered AI bulls when they have an AI code and an owner who is not registered as a farmer. For non- AI bulls, the minimum requirement is 10 descendants. See Chapter E-26 for further information about publication rules.