

# Genetic evaluation for perinatal piglet survival Preliminary report

Canadian Centre for Swine Improvement, April 2004

## Context

CCSI has been performing national genetic evaluation for litter size for almost 10 years. The use of Number Born EBVs by breeders has provided significant genetic improvement on sow productivity traits in breeding herds, which represents an important share in economic improvement for commercial producers.

While increasing litter size, Canadian breeders also noticed a slightly higher rate of piglet mortality. University of Guelph, on the basis of data collected in Ontario, carried out a study on different sow productivity traits. Following a decision made by the Genetics Committee of CCSI in April 2003, a genetic evaluation for perinatal piglet survival was implemented by CCSI, based on data collected by breeders participating in the National Swine Improvement Program, and on models developed at CGIL.

## Data available

The current national genetic evaluation for litter size is carried out every month by CCSI, based on litter records available in herds participating in the national program. Figure 1 shows the number of litters known at CCSI, according to farrowing year, and litter breed (left) or sow breed (right). Year 2003 may not be complete, because of delays in data recording and transfers. Nevertheless, the number of litters has been continuously increasing since the beginning of the program. In the last years, the proportion of crossbred litters is higher, due to more data coming from multiplier herds.

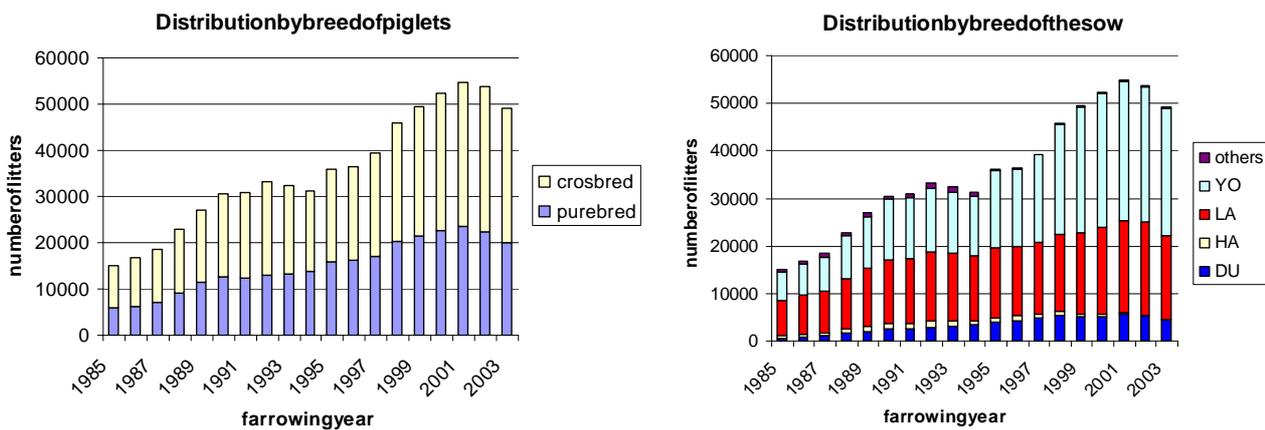


Figure 1. Number of litters available in CCSI database (April 2004)

On the next page, figure 2 shows the distribution of litter size for all available litters known at CCSI (left), and the evolution of perinatal piglet survival (right) according to total piglets born in the sample. Perinatal survival is computed as the ratio between piglets alive at 24h and total piglets born. Survival is lower in small litters, probably because these small litters may be due to health problems, which also affects survival. Piglet survival seems to be maximal for litters between 6 and 11 piglets, and then decreases non linearly when litter size increases. This information is quite consistent with what CGIL found on Ontario data.

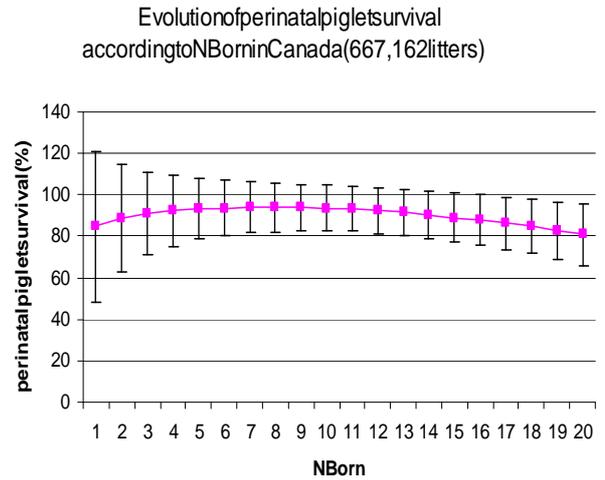
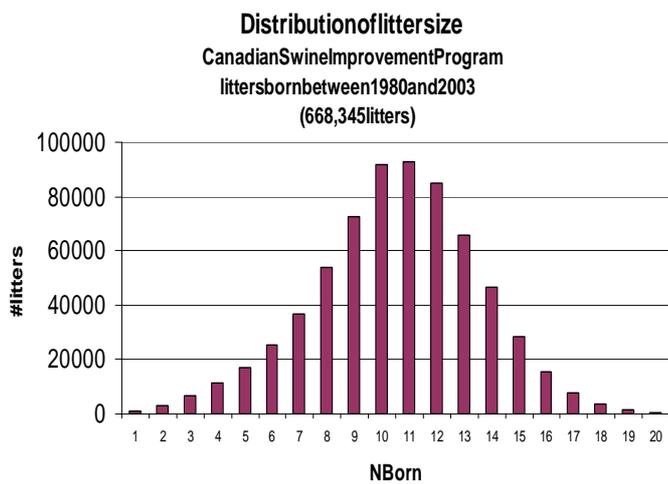


Figure 2.D Distribution of litter size (left) and relationship between litter size and piglets survival (right)

Figure 3 shows phenotypic trends for litter size (left) and piglet survival (right) between 1980 and 2003, in Hampshire, Duroc, Landrace and Yorkshire breed lines. The increase in litter size, especially in the last 6 years for maternal lines, is clear. In parallel, a trend to slightly decrease piglet survival is seen over the same period, but this decrease only represents 2.5 to 3.0% survival in more than 20 years in maternal lines. Furthermore, these values are not adjusted for litter size.

Figure 3. Phenotypic trends in litter size and perinatal piglets survival from 1980 to 2003

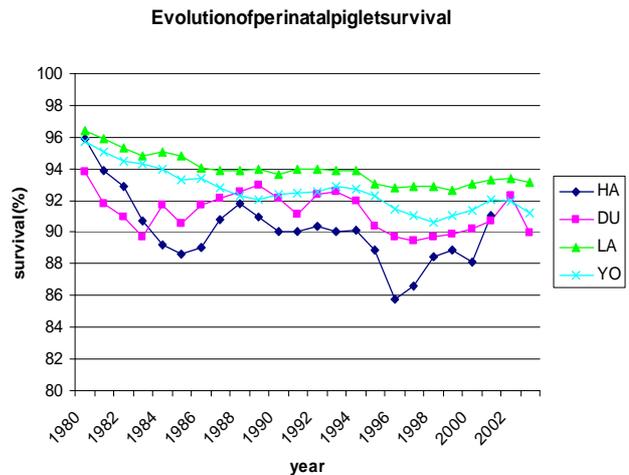
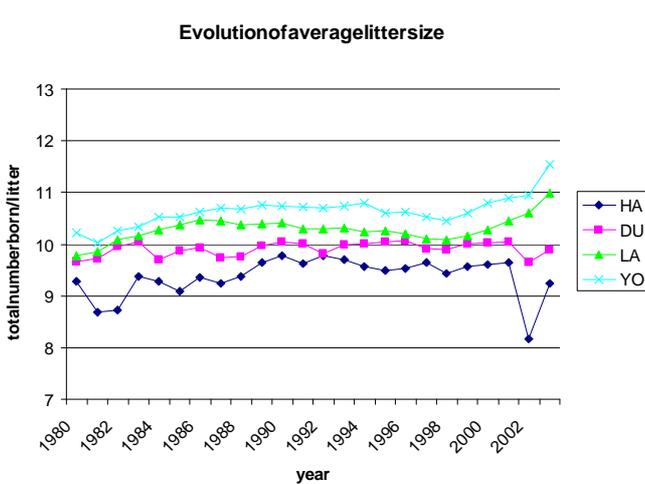


Table 1. Simple statistics on data used in the new evaluation system

|                                       | Breed     |        |          |           |
|---------------------------------------|-----------|--------|----------|-----------|
|                                       | Hampshire | Duroc  | Landrace | Yorkshire |
| <b>Litter Size (piglets born)</b>     |           |        |          |           |
| Number of records                     | 14,711    | 62,264 | 270,169  | 311,452   |
| Mean                                  | 9.58      | 10.01  | 10.39    | 10.85     |
| Standard deviation                    | 2.89      | 2.91   | 2.95     | 3.17      |
| Range                                 | 0-21      | 0-26   | 0-27     | 0-30      |
| <b>Perinatal piglets survival (%)</b> |           |        |          |           |
| Number of records                     | 14,671    | 61,905 | 269,605  | 310,526   |
| Mean                                  | 89.71     | 90.35  | 93.46    | 91.78     |
| Standard deviation                    | 14.20     | 13.80  | 10.89    | 12.50     |
| Range                                 | 0-100     | 0-100  | 0-100    | 0-100     |

## Statistical Model

The model used to predict breeding values for piglet survival was developed at CGIL. Both traits, Number Born (NB) and Perinatal Piglet Survival (PPS) are evaluated jointly in a 2-trait BLUP model. PPS is computed as follows:

$$PPS = 100 * (\text{Number Alive at 24h} / \text{Number Born})$$

Prior to evaluation, PPS is first adjusted for litter size, and then transformed using natural logarithm.

### Adjustment factors

Perinatal survival decreases as an increasing rate as the total number born increases. Adjustment factors are required to remove the quadratic effect of litter size at birth prior to variance component estimation and evaluation. The adjustment factors were derived from a phenotypic model fit to the proportion of piglets that survived in the Canadian sow productivity database, as follows:

$$s_{iklm} = hysf_i + t_k + par_l + nb_m + nb_m^2 + e_{iklm}$$

where  $s_{iklm}$  represent the proportions surviving in litter  $m$ ,  $hysf_i$  represents herd-year-season of farrowing,  $t_k$  represents the type of litter (pure bred or cross bred),  $par_l$  is the parity code,  $nb_m$  represents the total number born in litter  $m$  and  $e_{iklm}$  is residual error.

The analysis was carried out on all litters farrowed since 1990, one each breed separately (Yorkshire, Landrace, Duroc and Hampshire), and across breeds. Litters with less than 7 piglets were excluded from the analysis, because of the fact that survival was more often low in these litters, possibly due to health problems of the sow.

Linear and quadratic adjustment factors were found to be significant in all breeds, as well as in the across breed analysis. Estimates of the linear and quadratic regression coefficients are given in table 2.

Table 2. Adjustment factors for perinatal survival rate

|           | a      | Linear(b) | Quadratic(c) |
|-----------|--------|-----------|--------------|
| Yorkshire | -4.278 | +1.096    | -0.0702      |
| Landrace  | -5.084 | +1.244    | -0.0761      |
| Duroc     | -4.452 | +1.223    | -0.0840      |
| Hampshire | -6.514 | +1.796    | -0.1238      |

These factors are used to adjust perinatal survival as follows:

$$adjPPS = PPS - a - bl - cl^2$$

where  $b$  and  $c$  are the linear and quadratic adjustment factors estimated previously,

$L = -b/(2c)$  is the litter size for which the predicted survival rate is maximal,

$a = -(bL + cL^2)$  is a correction factor

### Transformation

Adjusted perinatal piglet survival ( $adjPPS$ ) was then transformed as following, in order to get a variable which distribution is close to normality (Log transformation was actually applied to mortality rate rather than survival rate):

$$T(adjPPS) = \text{Log}(100 - adjPPS + 10)$$

The distribution of this trait is shown in figure 4 :

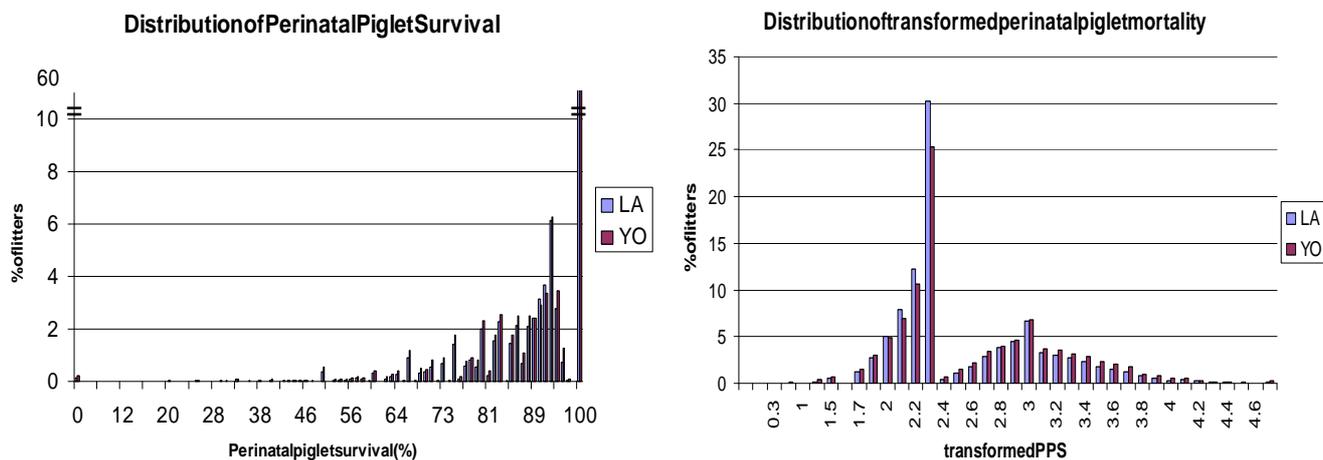


Figure 4. Distribution of perinatal piglet survival (left) and perinatal piglet mortality rate after transformation (right)

The trait plotted here is in fact the transformed mortality rate, thus lower values are favourable. In the data available, about 50% of litters have a survival rate of 100%, which corresponds to a value of 2.3 in the transformed scale. In the distribution above, litters with a value lower or equal to 2.3 have a maximal survival rate (their value for transformed PPS may differ according to litter size).

#### Model used for the estimation of breeding values

Litter size and perinatal piglet survival were analysed jointly in a 2-trait BLUP evaluation. The same effects were used for both traits:

##### Fixed effects:

- herd-year-season of farrowing
- mating type: natural service or artificial insemination
- breed of service sire
- parity number

##### Covariates:

- farrowing age of the sow (for first and second parity only)
- inbreeding coefficient of the sow
- inbreeding coefficient of the litter
- lactation length for previous parity

##### Random effects:

- birth litter of sow
- random permanent environmental effect of sow
- random genetic effect of sow

Genetic parameters used in the sow productivity evaluation are those estimated by Margaret Quinton from Guelph University.

## Results

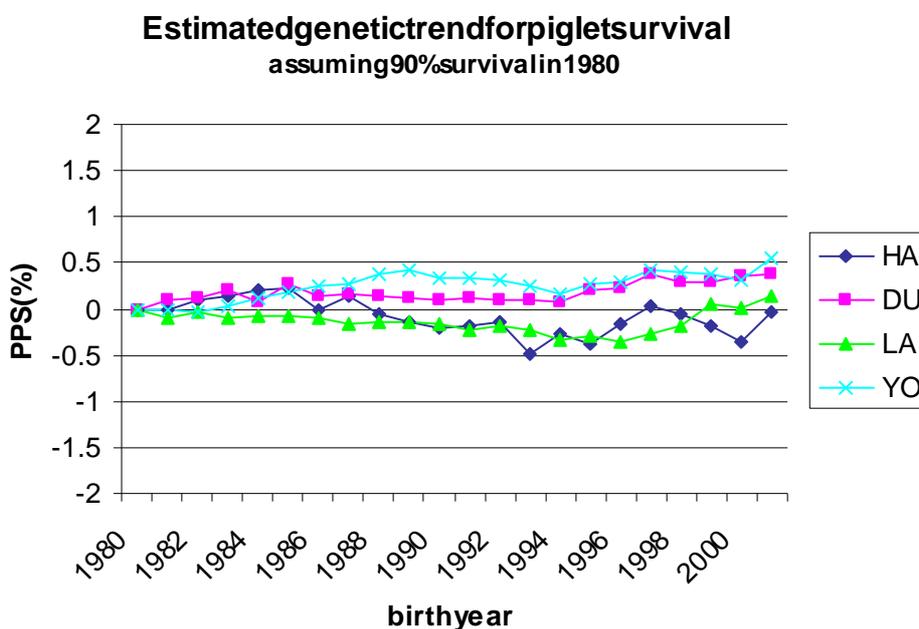
Test runs have been carried out in March and April 2004, giving the opportunity to check data included in the evaluation, and do some fine-tuning on programs. Table 3 shows simple statistics on PPS EBVs computed in four breeds (test run, April 2004).

Table 3. General statistics on PPSEBVs (raw values, logscale)

|                            | Breed           |                 |                 |                 |
|----------------------------|-----------------|-----------------|-----------------|-----------------|
|                            | Hampshire       | Duroc           | Landrace        | Yorkshire       |
| Number of animal with EBVs | 7,314           | 30,031          | 93,388          | 114,113         |
| Mean                       | 0.001           | 0.001           | 0.003           | 0.001           |
| Standard deviation         | 0.059           | 0.064           | 0.065           | 0.076           |
| Range                      | -0.279 → +0.272 | -0.277 → +0.318 | -0.258 → +0.355 | -0.390 → +0.461 |

Figure 5 shows estimated genetic trend for piglet survival, back-transformed into % units, assuming that the average survival rate was 90% in 1980. These results need further investigations, but it seems that there has been a positive, although very slight, genetic trend for survival rate in Yorkshire and Landrace breeds in the recent years.

Figure 5



### Further work

Several parts need to be implemented :

- calculation of accuracies for PPSEBVs ;
- checking the reliability of survival data included in the evaluation ;
- work with some “pilot herds” as an example to check the usefulness and reliability of these new EBVs;
- inclusion of these new EBVs in online tools and softwares ;
- further work on how to express PPSEBVs and education tools for technicians and breeders on these new EBVs ;
- in order to improve the evaluation model, other effects such as the level of assistance to the sow during farrowing should be tested. Further discussion is needed on this point to determine how to quantify this level of assistance.
- More precise data collection based on the information provided in Appendix 1.



## Recording litter size and perinatal piglet survival

- The trait currently used in genetic evaluations for litter size is the **total number of piglets born per litter**, including stillborn but not mummies.
- Genetic evaluations for **perinatal survival rate** will be added to the current system for sow productivity traits. The perinatal survival rate is estimated through the difference between the total number of piglets born per litter and number of piglets alive at 24 hours and is expressed as a percentage of the former
- Therefore, there is a need to record the following in addition to total number of piglets born per litter:
  - the number of stillborn piglets (optional)
  - the **number of piglets alive after 24 hours**
  - whether the sow was assisted before or during farrowing (Y/N)
  - the level of assistance to the sow (optional)
- The **number of stillborn piglets** is the number dead at farrowing, or at the first time the litter is observed (day 0). Ideally, it is the number of piglets which did not breathe after being born. Every piglet dead when the litter is observed, but showing evidence that it was alive at birth must be excluded from the number of stillborn piglets. Dead born piglets are usually found at the rear of the sow, but some of these piglets may also have breathed for a while.
- For **litters born unobserved**, for example during the night, the number of stillborn piglets, if recorded, should be equal to the number of piglets dead the first time the litter is observed, excluding dead piglets for which there is evidence of respiration.
- The **number of piglets alive at 24 hours** is equal to the number still alive the day after farrowing, observed as close as possible to 24 hours after farrowing.
- The number of stillborn piglets and piglets alive at 24 hours must be recorded **before any cross fostering**.
- Some piglets may die because of being **crushed by the sow** during the first 24 hours. These piglets have to be excluded from the number of piglets alive after 24 hours. Perinatal piglet survival must include the ability of the sow to give birth to viable piglets, but also her capacity to keep them alive.
- Piglets dying from **accidental reasons independent from the sow**, for example by getting stuck in the farrowing pen, should be counted as piglets alive after 24 hours.

| Trait | Definition                        | Comments  |
|-------|-----------------------------------|---|
| TNB   | Total number of piglets born      | Total piglets born, including stillborn, excluding mummies  |
| NSP   | Number of stillborn piglets       | Piglets born dead   |
| NPA1  | Number of piglets alive after 24h | TNB minus stillborn<br>minus piglets dead during the first 24 hours<br>but including piglets dead from accidental reasons<br>independent from the sow |
| PSR   | Perinatal Survival Rate           | $(TNB - NPA1) \times 100 / TNB$   |