Genetic Evaluation of Calving Traits in Denmark, Finland, and Sweden

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Introduction

The cattle organisations of the three Nordic countries Denmark, Finland, and Sweden have set the goal to jointly evaluate breeding values for certain groups of traits within the framework of Nordic Cattle Genetic Evaluation (Nordic abbreviation NAV). After milk yield, fertility, type traits and udder health, the latest group of traits to be worked on has been calving performance. Data are analysed separately in two groups, the Holstein group comprising the breeds Holstein (in all three countries) and Red Holstein (only Denmark). The Red Dairy Cattle group includes Red Danish, Finnish Ayrshire and Swedish Red and White. Procedures and the results for Holstein will be presented in this paper.

Material and Methods

Definition of traits

Calving performance has been recorded in the three countries for many years, see Table 1. Survival was registered as a binary trait - a stillborn calf or dying within 24 hours after calving was considered dead. The survival rate did not vary much across countries, it was about 92-93% for first calvings in Holstein and between 97-98% for later calvings. Calving Ease described the progress of calving from easy without help to difficult with veterinary assistance. Denmark and Finland used four categories, the latter only from 2004 onwards, while Sweden applied a scale with only two. Tests revealed that EBVs of data obtained from data on scale with either to or four categories, were highly correlated. Therefore data were kept on their original scales, i.e. four classes for Denmark and Finland, and two classes for Sweden. In all three countries, less difficult calvings were recorded for older cows than for first-calvers. Size of Calf was recorded in Denmark only and comprised four categories from small to big. Altogether, twelve traits – Survival, Calving Ease, and Size of Calf for first and later lactations with a maternal and direct effect each – were simultaneously analysed.

Table 1. Calving Traits in the three Nordic countries

	Denmark	Finland	Sweden
For all traits	1st and later calvings direct and mat. effect	1st and later calvings direct and mat. effect	1st and later calvings direct and mat. effect
Survival	Since 1985 categories 0 – 1	Since 1992 categories 0 - 1	Since 1982 categories 0 - 1
Calving Ease	Since 1985 categories 1 - 4	Since 2004 categories 1 - 4	Since 1982 categories 1 - 2
Size of Calf	Since 1985 categories 1 – 4	none	none

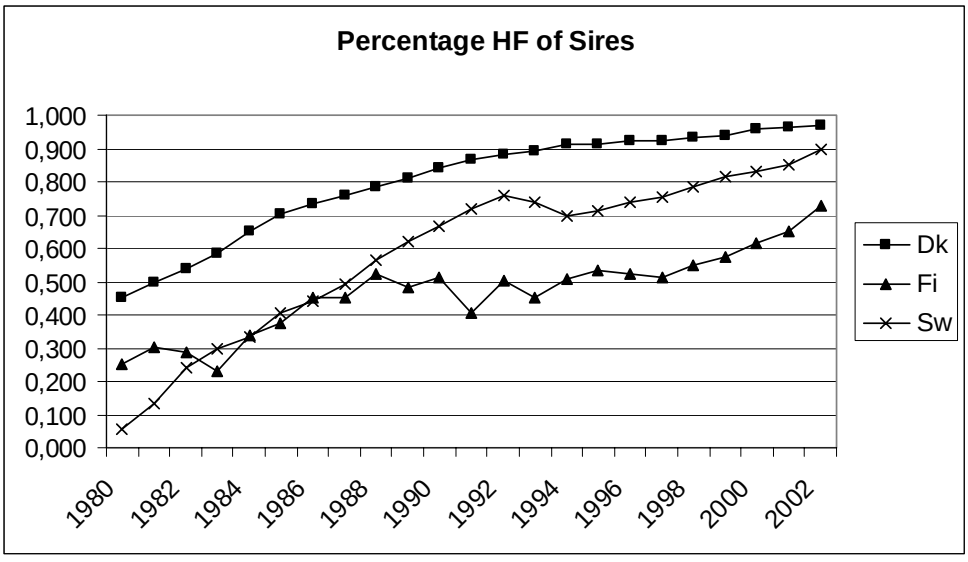
Data editing and pre-correction:
Data were edited according to national editing rules. Sire and maternal grandsire had to be known and both had to be either Holstein or Red Holstein. Multiple births and calvings based on ET were excluded. Length of gestation varied between 260 and 300 days. Data included records from first to fifth parity, first parity and later parities (2-5) were treated as different traits. Data were standardised to the same phenotypic standard deviation across countries and years. Pedigree information was traced five generations back with the help of a common Nordic pedigree file. The number of observations per trait and country are shown in Table 2.

Table 2. Number of observations per trait and country

Trait	Denmark	Finland	Sweden
Survival, 1. clv	2,985,115	354,739	997,264
Calving Ease, 1. clv	2,461,835	24,535	954,736
Size of Calf, 1. clv	2,444,121	-	-
Survival, ≥2. clv	4,650,886	682,585	1,622,512
Calving Ease, ≥2. clv	3,811,787	15,596	1,552,926
Size of Calf, ≥2. clv	3,817,211	-	-

The black-and-white population has undergone substantial changes in the last three decades through the import of HF-genes. Therefore, the proportion of HF genes and total heterosis were included in the model as regressions. As an example, the increase of HF genes in the sires used is demonstrated in Figure 1.

Figure 1. Percentage of HF genes in sires born from 1980 onwards



A multi-trait Sire-MGS BLUP model was applied. The DMU-package as developed by Madsen and Jensen (2003) was employed.

The following model was applied:

Y =

Age at calving in months (heifers) or lactation number (cows) * country	Fixed
+ Year of calving*month of calving* country	Fixed
+ Sex of calf*year of calving* country	Fixed
+ Herd*5year period*country	Fixed
+ Year within 5year-herd-country-group	Random
+ Breed effects for maternal and direct effect	Regression
+ Total heterosis for maternal and direct effect	Regression
+ Sire (for direct genetic effect)	Random
+ Maternal Grandsire (for maternal genetic effect)	Random
+ Residual	Random

The random "year within 5year-herd-country-group" variation was set to 15 % of the phenotypic variation.

Genetic parameters for the maternal (calving) and direct (birth) index did not vary much between the countries and an average was chosen for the common model. Those parameters for later lactations and Size of Calf which were non-existent in the other countries, were based on the Danish figures. All values are given in Tables 3 and 4 below:

Table 3. Heritabilities and genetic correlations for trait used in the Calving Index, heritabilities on diagonal, genetic correlations over diagonal.

Calving Traits (maternal)

	1. calving			≥ 2. calving		
	Survival (SU)	Calving Ease(CE)	Size of Calf (CS)	Survival (SU)	Calving Ease(CE)	Size of Calf (CS)
SU 1. clv.	**0.035**	0.60	-0.02	0.60	0.34	0.05
CE 1. clv.		**0.06**	-0.45	0.64	0.74	-0.26
CS 1. clv.			**0.04**	-0.43	-0.43	0.70
SU ≥ 2. clv.				**0.01**	0.60	-0.39
CE ≥ 2. clv.					**0.03**	-0.39
CS ≥ 2. clv.						**0.04**

Table 4. Heritabilities and genetic correlations for trait used in the Birth Index, heritabilities on diagonal, genetic correlations over diagonal.

Birth Traits (direct)

	1. calving			≥ 2. calving		
	Survival (SU)	Calving Ease(CE)	Size of Calf (CS)	Survival (SU)	Calving Ease(CE)	Sizeof Calf (CS)
SU 1. clv.	**0.04**	0.72	-0.55	0.62	0.55	-0.53
CE 1. clv.		**0.08**	-0.75	0.60	0.63	-0.70
CS 1. clv.			**0.20**	-0.53	-0.77	0.79
SU ≥ 2. clv.				**0.01**	0.65	-0.53
CE ≥ 2. clv.					**0.05**	-0.75
CS ≥ 2. clv.						**0.18**

The genetic correlations between maternal and direct traits were set to zero.

Calculation of Breeding Values:
The maternal effect was influenced by the effect, the maternal grandsire would have expressed, if he was the sire and not the maternal grandsire to the calf. Therefore, the maternal breeding value was corrected by the subtraction of half of the direct effect. Moreover, the breed effects were added to the solutions.

Direct BV = 2 * effect of sire of calf + direct breed effects
Maternal BV = 2 * effect of sire of cow + maternal breed effects – 0.5 * direct BV

On a national level, Sweden has calculated the MGS-effect so far, i.e. half of the direct effect is not subtracted. This had to be taken account of when correlating national with NAV EBVs.
The breeding values are standardised to an average of 100 and a standard deviation of 10 index units. The standardisation factors were calculated from the sire population born 1997 - 1998.

Results
The common NAV-model showed changes to the national models as summarized in Table 5. Both Finland and Sweden included data from later lactations, and Finland deleted records of Calving Ease before 2004. The NAV-model is a multi-trait model in the sense that the three traits Survival, Calving Ease, and Size of Calf as well as first and later lactations are simultaneously analysed. Finland used mainly first lactation records (for Survival, records from lactation 2 and 3 were included and treated as a repeatability model), while Sweden ran exclusively single trait (either SU or CE)-first lactation models only. The fixed effects changed slightly, the main change for Denmark and Sweden constituted in the addition of a random herd effect which accounted for the small Finnish herd sizes. The inclusion of breed effects and heterosis and subsequent correction of the breeding values has not been practiced in Finland and Sweden so far. The genetic parameters changed very slightly for some traits in some of the countries. Sweden had based its calving index on the maternal grandsire effect, so changing to the pure maternal effect will substantially affect the maternal trait. The new base population will be common and dominated by Denmark providing approximately 70 % of the records, 20 % of the data come from Sweden and the remaining 10 % from Finland.

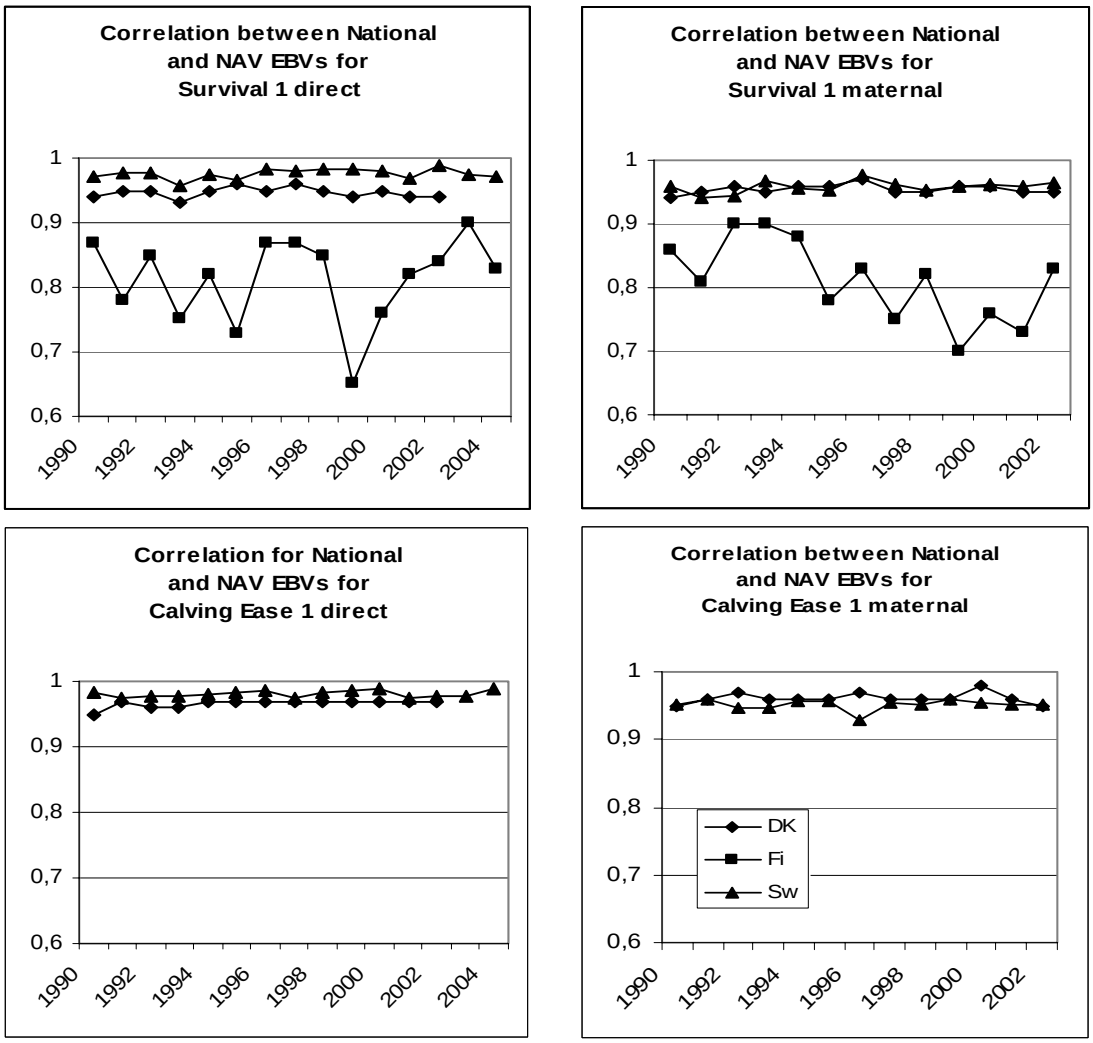
Table 5. Changes between previous national models and the new NAV model

	Denmark	Finland	Sweden
Data set		x	x
Multi-trait (1st and later lactations)		x	x
Multi-trait (SU+CE+Size)			x
Random and fixed effects in model	x	x	x
Inclusion of breed proportions		x	x
Genetic parameters	x	x	x
Maternal – MGS effect			x
Base population (national vs NAV)	x	x	x

National and NAV EBVs
The correlations between the national and new NAV EBVs were presented in Figure 2. Only the most important traits – Survival and Calving Ease in heifers – were

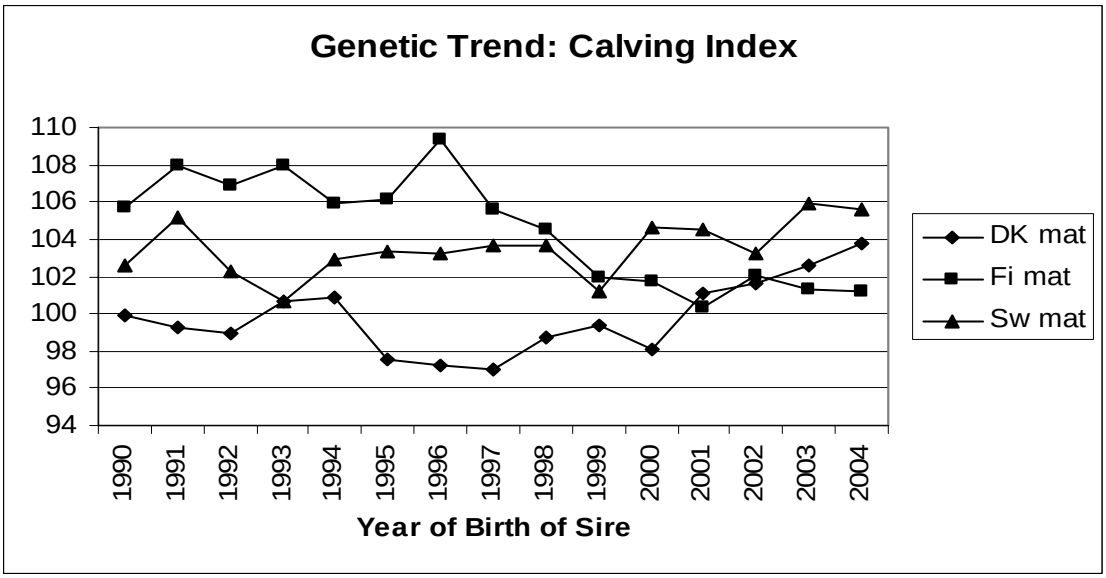
chosen for presentation. Generally, correlations for Danish and Swedish EBVs are high, around 0.95 and higher. In order to be able to compare Swedish values for the maternal effect, the MGS effect was calculated within NAV and correlated with the national Swedish MGS effect. A test revealed that correlations between the maternal and MGS effect ran up to approximately 0.8, which will cause considerable changes in the ranking of Swedish bulls for the calving index.
Finnish correlations for Survival lay between 0.7 and 0.9. The relatively low correlation between the Finnish and NAV EBVs may be due to the use of common sires across countries. Data for Calving Ease included only three years and were scarce, and consequently, correlations not stable and therefore not presented.

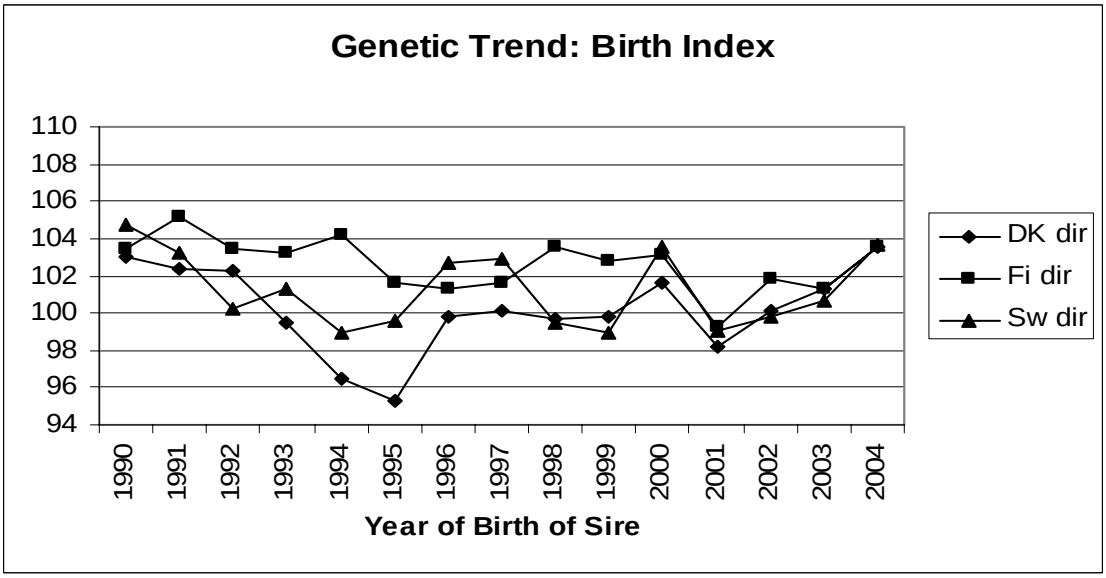
Figure 2. Correlation between National and NAV EBVs for the traits Survival 1 maternal and direct, and Calving Ease 1 maternal and direct



The genetic trend of either the calving or birth index (Figure 3) was based on NAV results and included all six maternal or direct traits, respectively. Differences between countries were more distinct for sires born in the early 1990ies, with Finland being the best and Denmark the worst country. Countries have become more similar in the last few years.

Figure 3. The Genetic Trend for Calving and Birth Index (NAV)





Current State:
The NAV-model was developed both for Holstein and Red Dairy Cattle. Data were submitted to the Interbull test run in March and ran through smoothly, but currently breeding values are still based on national evaluations. While we consider the Holstein model ready for common breeding value estimation, some work is still under progress for Red Dairy Cattle.

References:
Madsen, Per, and J. Jensen, 2003. A User's Guide to DMU, Version 6, Release 4.4, DIAS, Denmark