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**Evaluation of Calving Performance
of Danish Dairy Sires**

by

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Summary

A new index has been developed for calving performance. This index combines the following 6 maternal calving traits:

- * Vitality of calf, first calving
- * Calving ease, first calving
- * Size of calf, first calving
- * Vitality of calf, later calvings
- * Calving ease, later calvings
- * Size of calf, later calvings

An index for birth performance traits (direct traits) has been developed as well. For the time being this index is not published and not included in the Danish total merit index (S-index), but an alternative version that includes heterosis is used for selection of sires for heifer inseminations.

Introduction

Since the late 1960's a figure has been published for Danish dairy sires, showing "per cent stillborn calves with the sire as maternal grandsire". Since 1982 breeding values for this trait has been calculated by means of a very simple model. This index forms part of the Danish total merit index (S-index) with a relative weighting of approximately 0.18 compared to relative weights of milk yield traits of 0.70 (Aarstatistik, 1994).

In the same period a figure was calculated showing "per cent calves with the bull as sire". In the early 1980s this figure was further developed into a so called "birth index". Right from the start the birth index was based on both vitality, calving ease and calf size. A BLUP-single-trait model was used to estimate the direct effect of sires for each of the three traits and the selection index theory was used to calculate the birth index by combining solutions from the single-trait-model (Pedersen et al., 1988).

Materials and methods

Data The estimation of the new breeding values for calving and birth performance is based on data on all calvings, collected since 1985. In the Danish recording system codes for vitality are required registration at all calvings. Calving ease and size of calf are reported for about 80% of all calvings. The following basic information is included and the bracketed figures are the values used for prediction of breeding values:

Vitality: The following codes can be reported:

0. Defective calf, considered stillborn (value = 0)
1. Liveborn, premature (value = 1)
2. Liveborn (value = 1)
3. Died within 24 hours after birth, considered stillborn (value = 0)
4. Died after 24 hours after birth, considered liveborn (value = 1)
5. Stillborn (value = 0)
6. Miscarriage - is not used
7. Sold as newborn calf - without ID (value = 1)

Calving ease: The following codes can be reported:

1. Easy (value = 4)
2. Easy, assisted (value = 3)
3. Difficult, without vet assistance (value = 2)
4. Difficult, with vet assistance (value = 1)

Size: The following codes can be reported:

1. Small (value = 1)
2. A little below medium (value = 2)
3. A little above medium (value = 3)
4. Large (value = 4)

In total 700,000 calvings are recorded per year. The number of purebred calves are 65,000 Red Danish, 420,000 Danish Frisian and 85,000 Danish Jersey. The remaining calves are crossbred or from the small Red and White breed. When calculating breeding values for birth and calving traits the following data are deleted:

- * All multiple calvings
- * All calvings involving embryo transfer
- * If neither sire nor maternal grandsire are registered in the herdbook for Red Danish, Danish Frisian or Danish Jerseys.
- * Records from herds with less than 4 calvings per year

Model The effect of sire of calf and sire of cow is estimated in a six-trait model for each of the three breeds. Within a breed data is included if either the sire or the maternal grandsire belong to the breed. Then crossbred calves are included in the calculations for two breeds.

The dependant variables of the model are:

- * Vitality of calf, first calving
- * Calving ease, first calving
- * Size of calf, first calving
- * Vitality of calf, later calvings
- * Calving ease, later calvings
- * Size of calf, calvings

The fixed effects are:

- * Herd x year
- * Season x year
- * Age of cow x region
- * Sex of calf x year
- * Breed effects in calf
- * Breed effects in cow
- * Heterosis effects in calf
- * Heterosis effects in cow

The random effects are:

- * Sire of the calf
- * Sire of the cow (maternal grandsire of the calf)
- * Residual

Fixed effects The first four are all defined as classes. The regions (10 classes) are included because the heifers are reared a little differently in the different geographical areas. Region is only included in connection with data on first calvings. Normally, there is no reason to believe that the effect of sex will vary from year to year. However, it has turned out that the registration of especially size and calving ease has changed in the period 1985-90. Therefore it has been necessary to include calving year by sex interaction when correcting for sex impacts.

The last four are all defined as linear regressions on breed proportions or degrees of heterozygosity. Up to now data has been pre-corrected for effect of breed and heterosis. It is planned to include them in the estimation of breeding values as described later on. The pre-correction for breed and heterosis effects was made to keep the costs of estimation at a reasonable level. The breed groups included are:

Red Danish: Original Red Danish, American Brown Swiss, Red Holstein, other breeds

Danish Frisian: Original Danish Frisian, Holstein Frisian, other breeds

Danish Jersey: Original Danish Jersey, New Zealand Jersey, American Jersey, other breeds

Random effects The relationship between sires are trace as far back as possible. The basic genetic parameters are shown in the tables 1 and 2. They based on some simple analyses of the data and results from literature. The environmental parameters are shown in the tables 3 and 4. The two sire effects are assumed to be correlated. Therefore each sire has six solutions for maternal effects and six solutions for direct effects. The variances and covariances of the sire effects (V_{DS} = direct sire, V_{MS} = maternal sire) are calculated from the genetic variances and covariances (V_D = direct, V_M = maternal, $COV_{M,D}$ = covariance between direct and maternal) by:

$$V_{DS} = 0.25 * V_D$$

$$V_{MS} = 0.25 * V_M + 0.0625 * V_D + 0.25 * COV_{M,D}$$

$$COV_{DS,MS} = 0.25 * COV_{D,M} + 0.125 * V_D$$

The residual variances and covariances (V_R) are calculated from the variance of phenotype (V_P) and of the sire effects (V_{DS} , V_{MS} and $COV_{DS,MS}$) by:

$$V_R = V_P - V_{DS} - V_{MS} - 2 * COV_{DS,MS}$$

Computations The DMU-programmes developed by Jensen & Madsen (1993) are used for the calculations. In table 5 some basis statistics about the computation process are listed. Solutions from the previous run are used as starting values. The system converges in 100 - 250 rounds when the stopping criteria is:

$$|s^i - s^{i-1}| / |s^i| < 0.000001 \text{ where } s^i \text{ is the vector of sire solutions in round } i$$

Repeatability The repeatabilities (r^2_{AI}) are estimated by means of a simple selection index method. For each trait the number of progeny with observations is counted (calves or daughters). For each bull the repeatability is calculated combining information from the bull itself, the sire, the paternal grandsire, and AI-sons by means of the method described by Christensen (1980).

Index for birth performance, birth index and calving performance

Index for birth performance The estimated breeding values for birth performance (EBP) traits are calculated from the estimates of effect of sire of calf by:

$$EBP = 2 * \text{effect of sire of calf} + \text{direct breed effects}$$

The birth performance index is then calculated as the sum of the six EBP's multiplied by their economic weights shown in table 6. The index is standardized by to an average of 100 and a standard deviation of approximately 5 index units. The economic value of one index unit is:

- * Red Danish 20 DKK
- * Danish Frisian 15 DKK
- * Danish Jersey 7 DKK.

Birth index The values included in the "birth index" are calculated by:

$$\text{Birth performance value} = EBP + \text{effects of heterosis when mated to an average heifer}$$

The birth index is then calculated as the sum of the six birth performance values multiplied by their relative weighting factors (table 6). Due to the focus on heifer calvings in the birth index only vitality and calving ease at first calving are influencing the birth index in Red Danish and Danish Frisian. The birth index is standardized to an average of 100 and a standard deviation of 5 index units.

Index for calving performance The estimated breeding values for calving performance (ECP) traits are calculated from the estimates of effect of sire of cow and effect of sire of calf by:

$$ECP = 2 * \text{effect of sire of cow} + \text{maternal breed effects} + 0.5 * EBP$$

The calving performance index is then calculated as the sum of the six ECP's multiplied by their economic value (table 6). The index is standardized to a an average of 100 and a standard deviation of approximately 5 index units. The economic value of one index unit is :

- * Red Danish: 16 DKK (compared to 65 DKK for the milk yield index)
- * Danish Frisian: 17 DKK (compared to 66 DKK for the milk yield index)
- * Danish Jersey: 5 DKK (compared to 72 DKK for the milk yield index)

The base The standardization of the birth index and the index for birth and calving performance refers to the bulls included in the base. A rolling base is used and in 1995 the base

included bulls born in 1989-90. Additionally it is required that the repeatability of the birth and calving performance index is at least 35% in Red Danish and Danish Frisian (25% in Danish Jersey). For the birth index the limit is a repeatability of 50%. These limits on repeatability apply to the publication of the indexes as well.

Results

Genetic trend in the index for birth and calving performance The genetic trends are illustrated by the mean of the indexes for calving performance depending on year of birth. The results are shown in table 7. Only bulls with a repeatability of 35% or more are included (Jersey 25%). Furthermore, they must have at least 25 calves/calvings in the data set, meaning that only the bulls which have been tested in Denmark since 1985 are included. The results indicate a negative genetic trend for calving performance for Danish Frisian and Danish Jersey. Table 7 also shows the results for the birth performance index. There have been no appreciable changes in the genetic level in the period from 1980 onwards.

Effect of breed Most of the genetic trend for calving performance is probably due to importation of genes. Red Danish has imported American Brown Swiss and Red Holstein. Danish Frisian has imported Holstein Frisian from mainly USA and Danish Jersey has imported genes from New Zealand and USA. Table 8 shows the mean of indexes for calving performance of bulls born in the period 1980-89. The bulls are grouped depending on their breed combination. On the basis of this table it can be concluded that:

- * Crossbreeding with American Brown Swiss has improved the calving performance in Red Danish.
- * Crossbreeding with Red Holstein has had a negative effect on calving performance in Red Danish.
- * Crossbreeding with Holstein Frisian has depreciated calving performance in Danish Frisian.
- * Crossbreeding with American and New Zealand Jersey has had a negative effect on the calving performance in Danish Jersey.

Table 9 shows a survey of an index for birth performance of sires born 1980-92 and like in table 8 they are grouped according to their breed combination. Generally speaking, the import of genes has had no significant impact on the birth performance traits.

References

- Aarstatistik, 1994.* (Annual report on dairy cattle breeding 1994-95; In Danish). Report 42 Landsudvalget for Kvæg, Danish Agricultural Advisory Centre, Skejby, Udkaersvej 15, DK-8200 Aarhus, Denmark.
- Christensen L. G., 1980.* Direct Updating as a method for estimating breeding values in cattle. Report 489 from the National Institute of Animal Science, Landhusholdningsselskabets forlag, Rolighedsvej 26, DK-1958 Frederiksberg, Denmark, 270pp.
- Jensen J.; Madsen P.; 1993.* A User's guide to DMU. A package for analyzing multi variate mixed models. Danish Institute of Animal Science, Research Center Foulum, Box 39, DK-8830 Tjele, Denmark, 19pp.
- Pedersen J.; Jensen J.; Høj S.; 1988.* (The birth index. A description of the estimation method; In Danish). Danish Agricultural Advisory Centre, Udkaersvej 15, Skejby, DK-8200 Aarhus N, 38pp.

Table 1. Genetic parameters for Red Danish and Danish Frisian, heritabilities on the diagonal, genetic correlations above the diagonal

		Abbreviations	Calving traits						Birth traits					
			MV11	MCE1	MCS1	MV12	MCE2	MCS2	DV11	DCE1	DCS1	DV12	DCE2	DCS2
Calving traits	Vitality, 1st calving	MV11	0.03	0.08	-0.25	0.50	0.30	-0.03	0	0	0	0	0	0
	Calving ease, 1st calving	MCE1		0.06	-0.60	0.30	0.50	-0.24	0	0	0	0	0	0
	Size, 1st calving	MCS1			0.07	0.00	-0.23	0.60	0	0	0	0	0	0
	Vitality, later calvings	MV12				0.01	0.40	0.20	0	0	0	0	0	0
	Calving ease, later calvings	MCE2					0.03	-0.25	0	0	0	0	0	0
	Size, later calvings	MCS2						0.07	0	0	0	0	0	0
Birth traits	Vitality, 1st calving	DV11							0.06	0.35	-0.10	0.20	0.14	-0.05
	Calving ease, 1st calving	DCE1								0.10	-0.70	0.14	0.60	-0.49
	Size, 1st calving	DCS1									0.18	-0.05	-0.49	0.80
	Vitality, later calvings	DV12										0.15	0.35	-0.10
	Calving ease, later calvings	DCE2											0.06	-0.70
	Size, later calvings	DCS2												0.18

Table 2. Genetic parameters for Danish Jersey, heritabilities on the diagonal, genetic correlations above the diagonal

		Abbreviations	Calving traits						Birth traits					
			MV11	MCE1	MCS1	MV12	MCE2	MCS2	DV11	DCE1	DCS1	DV12	DCE2	DCS2
Calving traits	Vitality, 1st calving	MV11	0.01	0.08	-0.40	0.50	0.33	-0.05	0	0	0	0	0	0
	Calving ease, 1st calving	MCE1		0.02	-0.60	0.33	0.50	-0.25	0	0	0	0	0	0
	Size, 1st calving	MCS1			0.06	-0.01	-0.27	0.60	0	0	0	0	0	0
	Vitality, later calvings	MV12				0.01	0.50	0.30	0	0	0	0	0	0
	Calving ease, later calvings	MCE2					0.01	-0.40	0	0	0	0	0	0
	Size, later calvings	MCS2						0.07	0	0	0	0	0	0
Birth traits	Vitality, 1st calving	DV11							0.02	0.40	0.15	0.20	0.12	0.08
	Calving ease, 1st calving	DCE1								0.03	-0.50	0.12	0.40	-0.28
	Size, 1st calving	DCS1									0.10	0.08	-0.26	0.80
	Vitality, later calvings	DV12										0.02	0.40	0.15
	Calving ease, later calvings	DCE2											0.01	-0.40
	Size, later calvings	DCS2												0.10

Table 3. Environmental correlations for Red Danish and Danish Frisian

		VI1	CE1	CS1	VI2	CE2	CS2
Vitality, 1st calving	VI1	-	0.250	-0.119	-0.015	-0.019	0.008
Calving ease, 1st calving	CE1		-	-0.311	-0.014	-0.077	0.102
Size, 1st calving	CS1			-	0.003	0.074	-0.248
Vitality, later calvings	VI2				-	0.194	0.000
Calving ease, later calvings	CE2					-	-0.164
Size, later calvings	CS2						-

Table 4. Environmental correlations for Danish Jersey

		VI1	CE1	CS1	VI2	CE2	CS2
Vitality, 1st calving	VI1	-	0.291	-0.196	-0.009	-0.005	-0.003
Calving ease, 1st calving	CE1		-	-0.394	-0.008	-0.015	0.029
Size, 1st calving	CS1			-	-0.004	0.016	-0.142
Vitality, later calvings	VI2				-	0.225	0.095
Calving ease, later calvings	CE2					-	-0.041
Size, later calvings	CS2						-

Table 5. Statistics from the computations

Breed	No of observations	No of fixed effects	No of animal equations	Rounds to convergence*
Red Danish	681,020	33,626	48,228	150
Danish Frisian	3,414,661	108,990	252,888	223
Danish Jersey	762,892	29,322	70,440	106

* Stop criteria: $\|s^i + s^{i+1}\| / \|s^i\| < 0.000001$, s^i is the vector of sire solutions in round i
Solutions from previous run are used as starting values

Table 6. Economic weights used for calculation of index for calving performance, birth performance and birth index

Trait	Weight for birth index		Weight for calving and birth performance	
	Red Danish	Danish	Red Danish	Danish
	Danish Frisian	Jersey	Danish Frisian	Jersey
Vitality, 1st calving	850	500	850	500
Calving ease, 1st calving	165	0	165	135
Size, 1st calving	0	0	12.25	12.50
Vitality, later calvings	0	500	1,225	1,000
Calving ease, later calvings	0	0	135	250
Size, later calvings	0	0	10	15

Table 7. Average of index for calving and birth performance. Subscripts are number of sires

Calving performance index				Birth performance index		
Year of birth	Red Danish	Danish Frisian	Danish Jersey	Red Danish	Danish Frisian	Danish Jersey
1980-81	99.8 ₁₈₄	103.3 ₅₄₇	102.3 ₁₃₁	101.3 ₂₆	101.3 ₈₁	100.4 ₁₈
1982-83	99.7 ₁₈₅	102.7 ₇₆₄	101.3 ₁₉₁	99.6 ₇₂	99.9 ₂₀₈	101.1 ₁₀₇
1984-85	99.3 ₁₉₆	101.5 ₈₈₅	100.4 ₂₀₀	100.9 ₁₁₁	100.5 ₃₂₁	100.6 ₁₅₅
1986-87	99.2 ₁₆₇	101.4 ₈₈₉	99.3 ₁₈₀	100.2 ₁₀₀	99.4 ₂₄₈	100.2 ₁₃₈
1988-89	100.0 ₁₃₆	100.3 ₆₁₃	99.8 ₁₆₂	99.3 ₆₃	100.0 ₂₁₁	99.8 ₁₆₁
1990-91	-	-	-	98.8 ₅₇	191.0 ₁₉₁	100.6 ₁₂₈

Table 8. Average index of calving performance of sire born 1980-89. Subscript are number of sires

Breed	% genes from the breed question				
	0-12.5	12.5-37.5	37.5-62.5	62.5-17.5	87.5-100
Original Red Danish	102.0 ₄₀	99.2 ₉₃	100.8 ₃₄₉	99.1 ₂₅₁	97.5 ₁₅
American Brown Swiss	96.6 ₂₀₉	99.8 ₂₃₅	100.5 ₃₂₅	101.8 ₈₆	102.6 ₃₂
Red Holstein	100.3 ₇₁₇	96.9 ₁₆₄	93.4 ₅	-	81.0 ₁
Original Danish Frisian	99.6 ₇₉₅	101.7 _{2,259}	103.8 ₉₅₆	104.1 ₁₄₃	107.1 ₂₀
Holstein Frisian	109.3 ₈	104.2 ₈₅	104.2 ₆₉₄	102.3 _{1,796}	100.3 _{1,590}
Original Danish Jersey	94.0 ₂	97.0 ₁	96.6 ₈₉	99.0 ₁₃₁	102.3 ₄₉₂
Jersey from New Zealand	101.8 ₅₅₇	98.1 ₁₅₁	88.6 ₇	-	-
American Jersey	101.3 ₅₆₈	103.1 ₆₃	97.1 ₈₁	97.0 ₁	94.0 ₂

Table 9. Average index of birth performance of sires born 1980-89. Subscript are number of sires

Breed	% genes from the breed question				
	0-12.5	12.5-37.5	37.5-62.5	62.5-17.5	87.5-100
Original Red Danish	99.6 ₄₇	99.6 ₁₁₆	100.5 ₂₈₄	100.2 ₂₃₇	101.0 ₇₆
American Brown Swiss	102.2 ₁₃₉	99.9 ₂₂₄	100.5 ₂₅₇	99.0 ₁₀₉	99.4 ₃₁
Red Holstein	99.9 ₅₆₈	101.2 ₁₈₃	104.8 ₆	-	104.0 ₃
Original Danish Frisian	98.6 ₇₂	99.4 ₆₈	99.7 ₄₆	98.6 ₁₂	101.5 ₄
Holstein Frisian	92.8 ₇	100.7 ₂₆	100.9 ₄₁₇	100.4 _{1,709}	99.9 _{1,799}
Original Danish Jersey	101.9 ₈	100.0 ₂	99.3 ₁₁₂	101.7 ₉₆	100.4 ₃₉₃
Jersey from New Zealand	100.0 ₄₆₆	101.6 ₁₄₁	104.5 ₄	-	-
American Jersey	100.7 ₄₅₁	100.0 ₄₁	99.1 ₁₁₀	103.0 ₁	101.9 ₈