Data Collection and Genetic Evaluation of Health Traits in the Nordic Countries

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Abstract

Nordic countries have had a systematic registration of diseases in dairy cattle for more than 20 years. The registrations are stored in central national databases and used for both management and breeding purposes. All Nordic countries have estimated breeding values for disease resistance and weighted disease resistance in the breeding goal for more than 15 years.

1. Introduction

Diseases reduce animal welfare and result in economic losses for the farmer in the form of extra veterinary treatments, labour, decreasing milk production, discarded milk and involuntary early culling. A reduction in the frequency of diseases is desirable from a general ethical point of view, it might increase consumer acceptance and it is of course of economic importance to the farmer.

For both management and breeding purposes, a good registration system is essential for the reduction of disease frequency. In this paper, the Danish situation is used as an example, but the systems in Finland, Sweden and Denmark are very identical.

In 1990, the Danish Cattle Federation and the Danish Veterinarian Society began their co-operation on systematic registration of diseases. The overall dataflow to the national cattle database can be illustrated by Figure 1. Slaughterhouses, dairies, AI-centres, veterinarians, classifiers, labs, the milk recording scheme and farmers all deliver input data to the cattle database. The data can be delivered by voice response, internet, EDP-software, or as electronic data transfer from other databases.

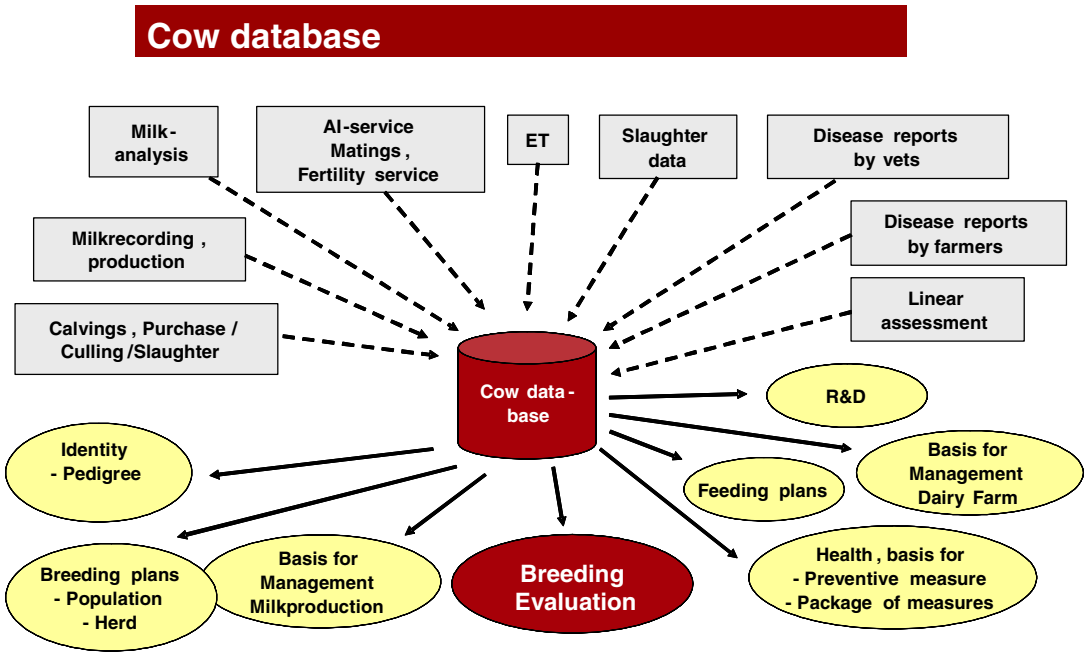

Figure 1. Data flow in relation to the central data base

2. Recording system

The recording of disease diagnosis can be done in various ways:

- Transfer from different invoicing systems used by veterinarians to the data base. The only requirement is the registration number, which is quoted on the invoice and sent to the farmer.
- Registrations by the herd manager and veterinarians by use of a pencil in a standard system used also for other purposes (e.g. calving, sale)
- Direct registration in the central database by use of common EDP-software used by data processing centres for milk recording, farmers, advisors and veterinarians.

Recording of disease diagnoses can be made both by veterinarians and herd managers, but double registrations are automatically avoided. More than 80 different disease codes are used to describe the diagnoses. For management and breeding purposes, the codes are usually pooled within four categories: Udder diseases, reproductive diseases, digestive diseases, and feet and leg diseases.

3. Extent of disease recording

In Denmark, disease recording in the cattle database is voluntary, but all disease treatments with antibiotics of cows have to be done by a veterinarian and are therefore recorded. In some cases, farmers are allowed to make subsequent treatments. Since the recording is voluntary, we do not know the exact figures of diseases, but by setting up simple data rules we know which herds are under systematic disease recording. The proportion of cows in herds with a systematic disease recording has increased over years (Figure 2), and today more than 90 % of all cows are in herds with a systematic disease recording.

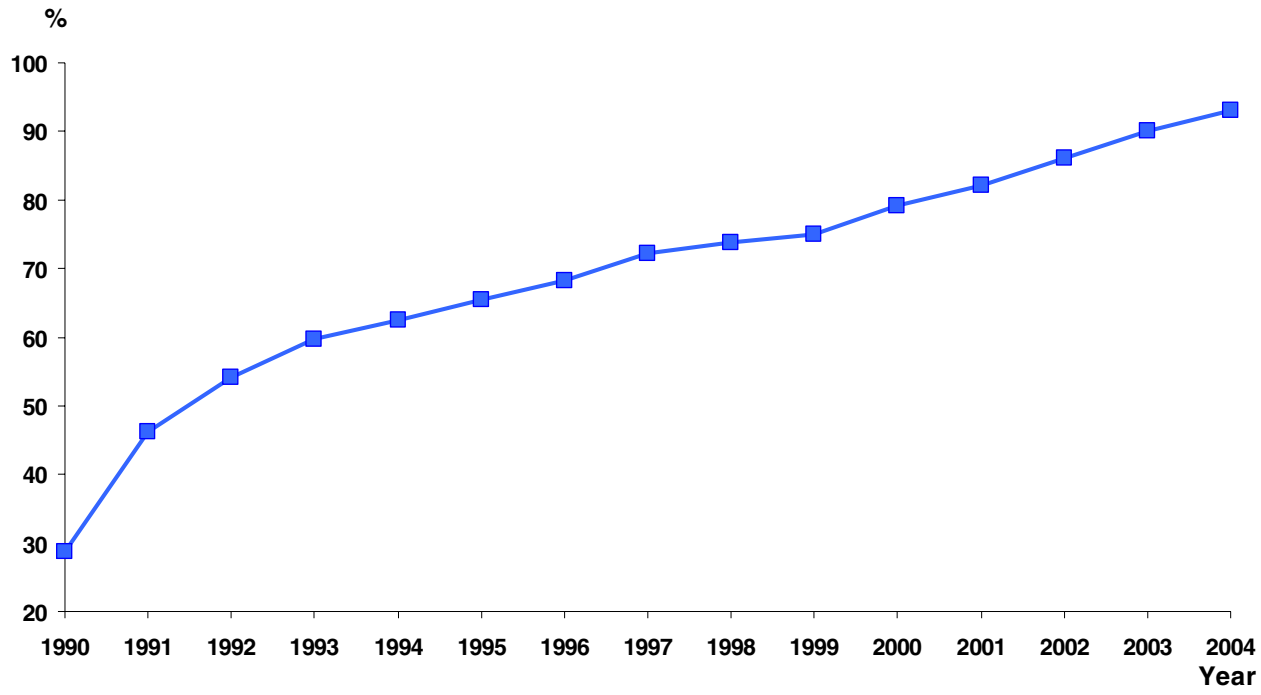

Figure 2. Proportion of cows in herds with regular disease registration, Danish Holstein

In Finland, the disease recording is also voluntary while the disease recording in Sweden is mandatory.

4. Ownership and access to data
Veterinarians are not paid for the registration of disease diagnoses, and the data are owned by the farmer. But it is a clear advantage for the veterinarians to record disease diagnoses. Farmers can give permission to his own veterinarian and his other advisors to use all recorded data from milk recording, dairies, and AI-societies, and the veterinarians have access to several printouts about the herd, combining different registrations stored in the central cattle data base.

5. Use of the disease records
For both management and breeding purposes, a good registration system is essential for the reduction of disease frequency. For the single farmer, herd statistics, key figures etc. are very important for the management of the herd, especially for large herd sizes. Furthermore, it is very important for the motivation of farmers and veterinarians to continue the registration of disease diagnoses, that they get a direct benefit from it. Use of disease recording in estimation of breeding values is a very important spin-off.

6. Estimation of breeding values for mastitis resistance
The company Nordic Cattle Genetic Evaluation (NCGE), which has the responsibility for development and routine genetic evaluation for Finnish, Swedish and Danish dairy cattle, was established 1 January 2002. The final goal for NCGE is to estimate EBVs based on data from all three countries for all traits in our breeding goal. In 2005, NCGE publish the first joint Nordic breeding values for fertility traits, type traits, milk ability and temperament, based on registrations from all three countries. In 2006, NCGE will also publish joint Nordic EBVs for yield traits and mastitis.

Today, the EBVs for mastitis resistance in all three countries are still based on national data only. All three countries have had an index for mastitis resistance for more than 15 years. In order to provide better tools for selection, the index has been improved by including traits which are correlated to mastitis.

Currently, Sweden and Finland both have a mastitis resistance index based on SCC and Clinical mastitis (CM) (Table 1). The current Danish index uses information from CM, SCC and udder conformation.

Table 1. Traits used in the mastitis index in Denmark, Sweden and Finland

	Denmark	Sweden	Finland
CM	x	x	x
SCC	x	x	x
Udder conformation	x		

The coming Nordic index for mastitis resistance will basically be constructed like the current Danish index. Information concerning mastitis is treated as four different traits. The following four traits defining mastitis will be included.

- 15 days before calving until 50 days after calving in first parity
- 51 days after calving until 300 days after calving in first parity
- 15 days before calving until 150 days after calving in second parity
- 15 days before calving until 150 days after calving in third parity.

Mastitis in each of these periods is recorded as a binary trait. Linear type classifications for fore udder support and udder depth in first parity done by classifiers, and somatic cell count in

the period 5-150 days after calving in lactation 1 to 3 will be used as correlated traits when estimating the EBVs for mastitis resistance.

The heritability for CM is approx. 4 %. The genetic correlations between the four CM traits are high (0.70-0.95). The genetic correlation between CM and SCC is approx. 60 %. Correlations between mastitis and linear type traits, which are used as indicator traits, are on average 40 %. The correlated traits increase the reliability of the mastitis resistance index considerably, when a bull gets his first proof. On the other hand, it is important to remember that the mastitis diagnoses are essential for the mastitis resistance index, e.g. the reliability of a mastitis resistance index based on SCC alone can never be higher than 36%, given the genetic correlation between CM and SCC of 0.60.

By splitting mastitis into two traits in the first lactation, the period up to 50 days in 1st lactation can be closed early for many daughters and in that way, we get information about CM from mastitis diagnoses at the same time a sire gets his first proof for yield traits. The index for mastitis resistance is published, when the reliability is at least 40 %. Bulls quickly obtain a reliability of 60-65 % based on 1st lactation daughters. In many cases, bulls obtain their first index for udder health simultaneously with their first index for production, which is very important since many breeding decisions are taken at an early stage. The overall index for mastitis resistance is calculated by weighing the EBVs for CM in the different lactations together.

Future development of the estimation of breeding values for mastitis resistance has to focus on even better use of the SCC, udder conformation and mastitis data to get more accurate EBVs for both sires and cows. The future development might include moving from a lactation model to a TD model for SCC or the use of models which consider the nonlinear magnitude of the CM data.

7. Effect on mastitis

The index for mastitis resistance has been very successful and is paid a lot of attention when both farmers and AI-organisations select bulls. The effect of the overall index for mastitis resistance is very well illustrated by dividing cows into groups according to their sires' index for mastitis resistance. Percentage of cows with mastitis in the period 10 days before calving until 100 days after calving in first and third parity has been calculated (Table 2). In the group where the sire has an index below 86, the frequency of mastitis is about twice as high as in the group, where the sire has an index above 113.

Table 2. Percentage of cows with at least one diagnose of mastitis in the period 10 days before calving to 100 days after calving, depending on the sire's[1)] index for mastitis. Holstein

Sire's index for udder health	Percentage of cows with mastitis			
	1st parity	No of cows	3rd parity	No of cows
≤ 85	21.7%	5,893	28,9%	2,499
86-95	18.3%	22,926	26.0%	14,244
96-105	15,3%	52,973	23.8%	42,552
106-113	13.9%	73,582	21.0%	23,051
≥ 114	10.7%	53,757	17.0%	8,798

1) Standard deviation of the index is approx. 10

8. Index for other health traits

Today, all three countries nationally calculate an index for other health traits. The Danish index for other health traits consists of reproductive diseases, digestive diseases, feet and leg diseases in the period 10 days before calving to 100 days after calving in first, second, and third parity. Mastitis in first parity is used as a correlated trait. A multi-trait linear sire model with a total of 10 traits is applied. Sweden basically uses some of the same information in their index for other health traits. In general, the heritabilities are in the range of 0.01-0.03 for these groups of traits, but we still have considerable genetic variation.

We have not started a joint Nordic development of an index for other health traits, but it will take place in the future.

The reliabilities for an index for other health traits are lower than for udder health, because the heritabilities in general are lower than for mastitis, and because the genetic correlations between the different disease traits are moderate. Bulls with only the first batch of daughters seldom obtain an index with reliability above 65%.

Effect on health
The effect of the index for other health traits has been examined in the same way as for mastitis resistance. The effect of the index on the daughters' health increases from first parity to third parity. Third parity daughters, which have a sire with an index under 86, have 7% more diseases than daugthers after a sire with an index above 113.

Table 3. Percentage of cows with at least on diagnose in the period 10 days before calving until 100 days after calving, depending on the sire's[1)] index for other health traits. Holstein

Sire's index for other health traits	1st parity					3rd parity				
	Percentage of cows with a diagnose				No of cows	Percentage of cows with a diagnose				No of cows
	Rep.	Dig.	Feet & Legs	Sum		Rep.	Dig.	Feet & Legs	Sum	
≤ 85	12.3%	2.1%	3.5%	17.9%	5,893	14.4%	12.5%	2.6%	29.5%	2,499
86-95	11.6%	1.7%	3.3%	16.5%	22,926	14.6%	9,7%	3,3%	27,6%	14,244
96-105	10.9%	1,3%	3,1%	15,2%	52,973	15.9%	9.3%	3.1%	28.4%	42,552
106-113	9.9%	1.4%	3.0%	14.3%	73,582	14.6%	8.3%	2.8%	25.6%	23,051
≥ 114	9.6%	1.2%	3,1%	13.9%	53,757	12.9%	7.0%	2.7%	22.6%	8,798

1) Standard deviation of the index is approx. 10

9. Health traits in the Nordic Total Merit Indices
In the Nordic Total Merit Indices, considerable weight is put on health and reproduction traits (Table 4-5). By selecting for the total Merit index within each country, all countries will achieve a progress in mastitis resistance from 18% to 44% of the maximum response given mastitis resistance was the only trait in the breeding goal. For comparison, the response in yield traits is 45% to 74% of the maximum response.

The overall breeding goal expressed in the Total Merit Index is a national responsibility and not included in the NCGE work.

Table 4. Correlation between Total Merit Index and EBVs for health traits in Sweden, Finland and Denmark, Holstein

	Denmark	Sweden	Finland
Yield	0.67	0.45	0.74
Fertility	0.18	0.40	-0.03
Mastitis	0.35	0.43	0.18
Other disease	0.37	0.24	-

Table 5. Correlation between Total Merit Index and EBVs for health traits in Sweden, Finland and Denmark, Red breeds

	Denmark	Sweden	Finland
Yield	0.73	0.56	0.72
Fertility	0.15	0.20	0.03
Mastitis	0.44	0.34	0.19
Other disease	0.32	0.19	-

It is necessary to give substantial weights to the functional traits in the breeding goal, otherwise we will get more diseases and poorer fertility since these traits are unfavourable correlated to yield traits.

Several studies have shown that mastitis is the single trait which has the strongest correlation to longevity in dairy cows. The correlations between the Danish index for functional longevity and the index for mastitis resistance are also relatively high - between 38-57% for the three Danish dairy breeds (Nielsen et al. 2005). The disadvantage with longevity is that the trait is complex and the information about the trait is available relatively late in a cow's life. Because of that it is difficult to select for mastitis resistance by selecting for longevity.

The genetic trend for mastitis resistance has been negative for the Holstein populations in the Nordic countries (Figure 3), while the red breeds have been able to keep the same genetic level (Figure 4) despite a substantial positive genetic trend for production. The unfavourable trend for Holstein is due to selection of bull sires outside the Nordic countries without taking mastitis resistance into account. The example with the Red populations illustrates that it is possible and needed to select for both yield and disease resistance simultaneously.

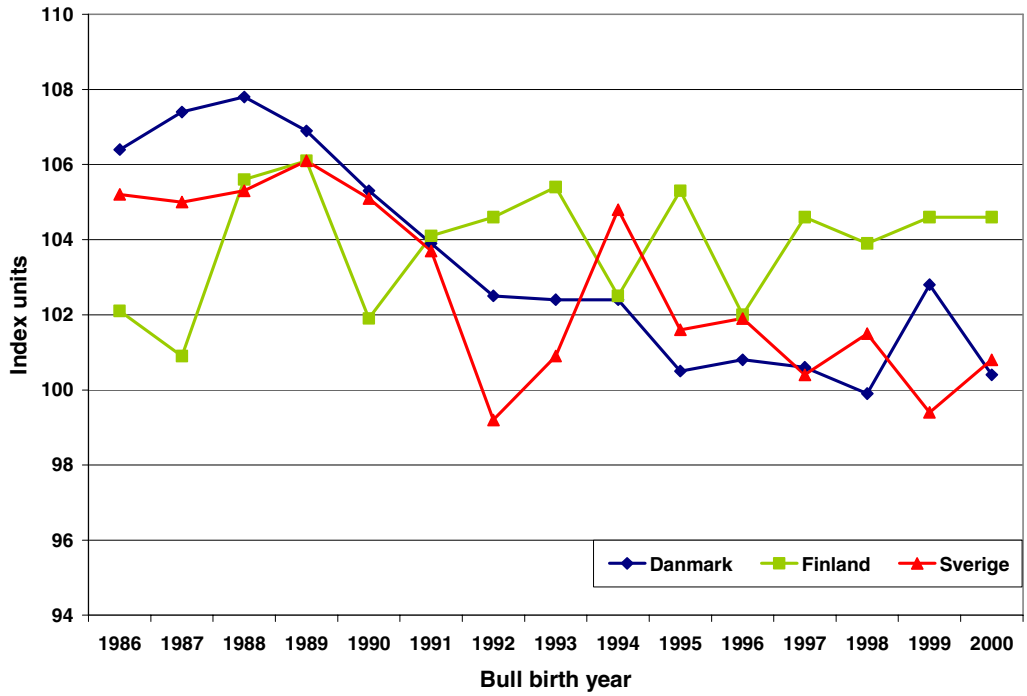

Figure 3. Genetic trend in mastitis resistance Nordic Holstein
(Interbull November 2005 – Danish scale - Standard deviation of the index is approx. 10)

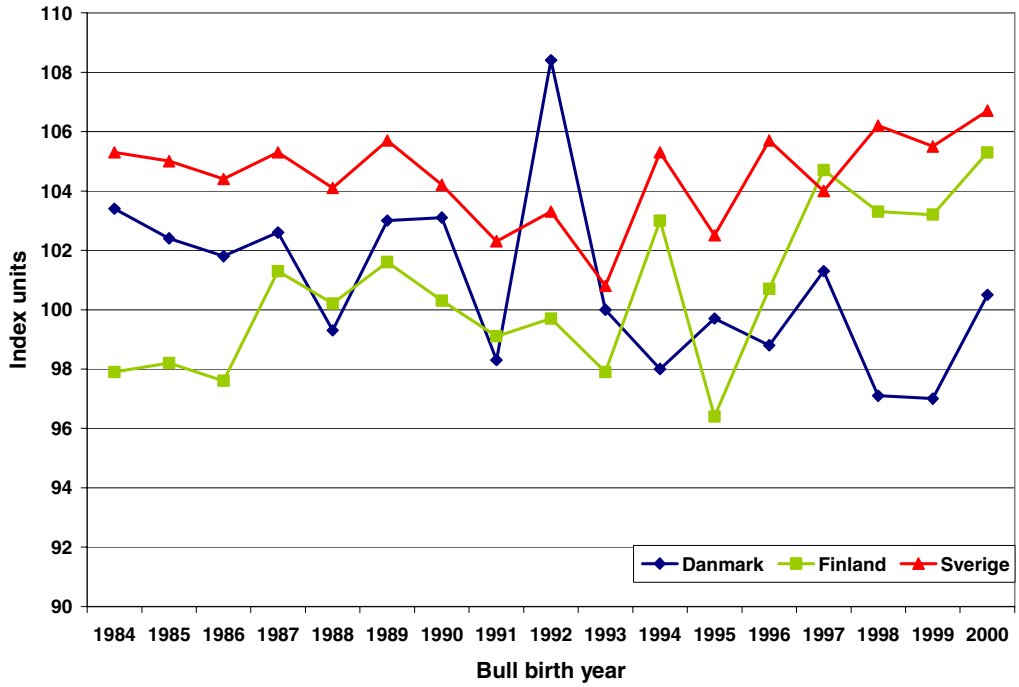

Figure 4. Genetic trend in mastitis resistance Nordic Red Breeds
(Interbull November 2005 – Danish scale - Standard deviation of the index is approx. 10)

10. Future challenges

Disease resistance is a very important trait in the current breeding goal in the Nordic countries. The Nordic AI companies today pay a lot of attention to EBVs for disease traits when they select proven sires and bull sires. It is a very important task to consider all available information about disease resistance for sires tested outside the Nordic countries to ensure a future positive genetic trend in disease resistance.

The Nordic countries have a unique registration system. A future challenge in the Nordic countries is to keep and improve this system. As an example, Sweden investigates the possibilities for including registrations from hoof trimmers in the breeding work. Within estimation of breeding values, the challenge is to improve the statistical model we use in practice today, so the registered data are used more efficiently.

In the future QTLs for mastitis resistance might give more information about the breeding value for mastitis resistance, but it is very important to remember that the fundament for finding QTLs is that accurate disease registrations in practice are available.

Nielsen, U.S., F. Strudsholm, M. B. Almskou, A. Fogh, M. Hansen & J. Pedersen. Årstatistik Avl 2004-2005. Report no. 111. 119 pp.

Nielsen, U.S., G.P. Aamand & T. Mark, 2000. National Evaluation of Udder Health and Other Health Traits in Denmark. Interbull open meeting, Bled, Slovenien 14-15 maj. 2000. Interbull Bulletin no 25, 143-153.