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Session: Improving the health traits by recording and evaluation

Use of health data in genetic evaluation and breeding

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Abstract

An increasing number of countries have implemented national genetic evaluations for udder health in recent years. Most countries consider indicator traits like SCC data and udder conformation traits in their genetic evaluation. Additionally the Nordic countries also include diagnoses of clinical mastitis in their genetic evaluation of udder health. Further the Nordic countries also use diagnoses of other diseases in genetic evaluation for resistance against other diseases.

Breeding goals have significantly changed in many countries during the last years. Functional traits have been given more weight at the expense of milk yield. Especially mastitis resistance has got a lot of attention. Many countries today focus on the possibilities to register diseases, since an efficient breeding work for health traits requires registration of diseases

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, an accurate 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 Norway, 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 is illustrated in 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, PDA-software, EDP-software, or as electronic data transfer from other databases.

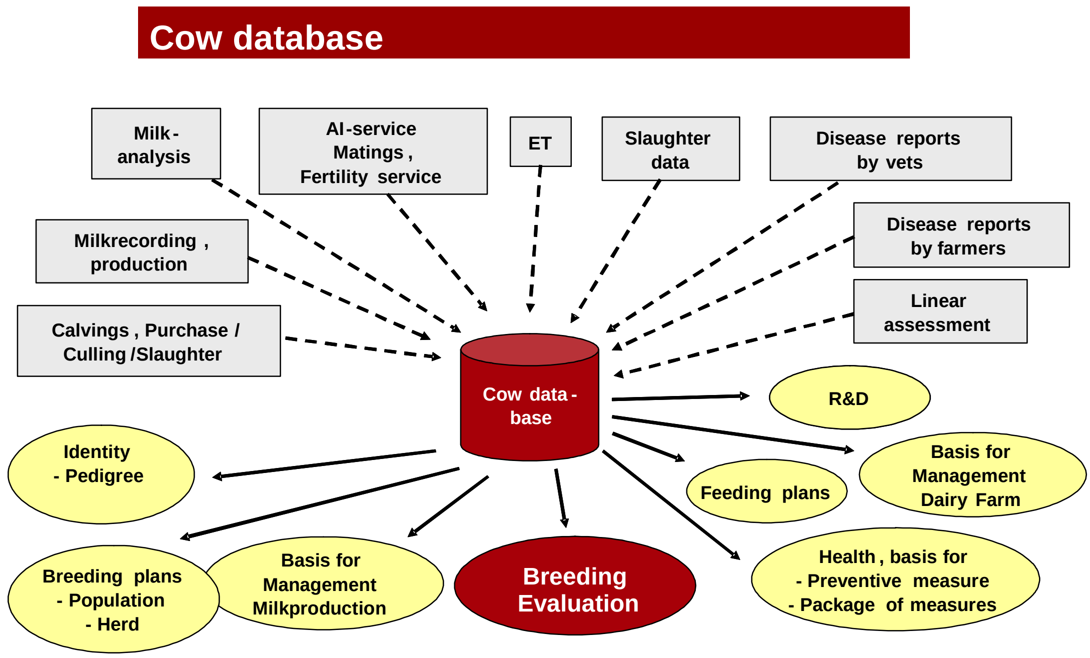

Figure 1. Illustration of data flow in relation to a central data base

2. Recording system

The recording of disease diagnoses 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 numbers of treatments, 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.

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

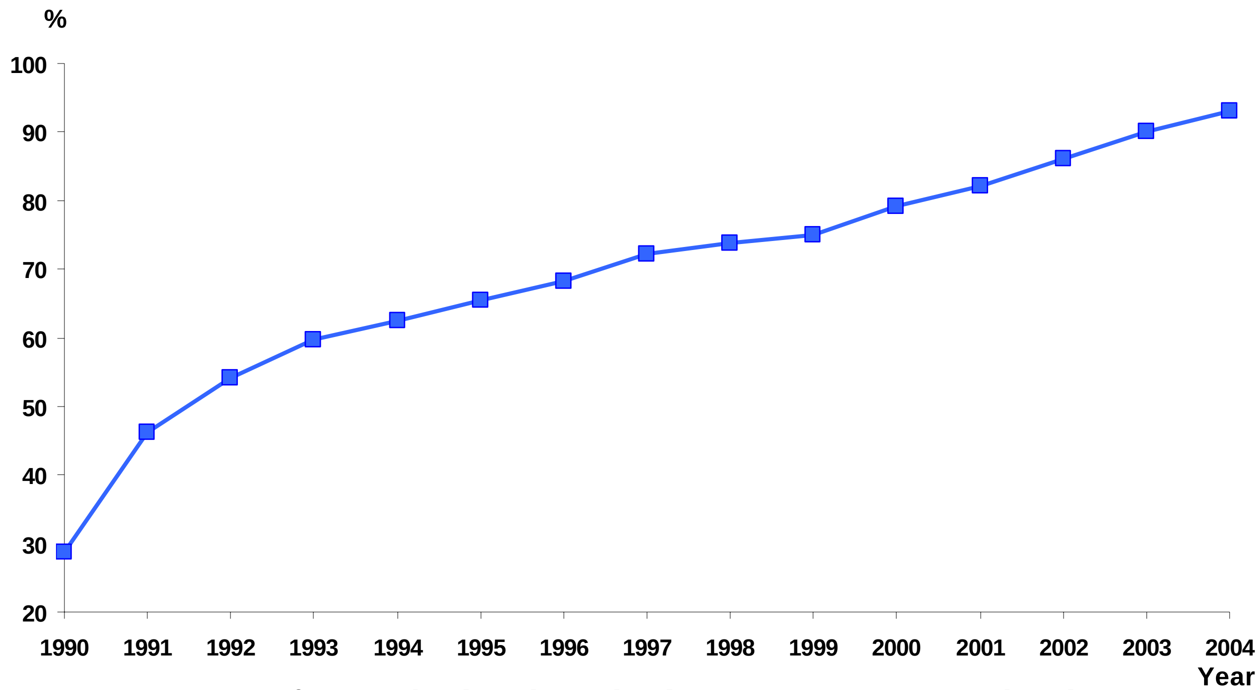

Figure 2. Proportion of cows in herds with regular disease registration, Danish Holstein

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, an accurate 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, getting a direct benefit from registering disease diagnoses is very important for the motivation of farmers and veterinarians in order to continue doing so. Use of disease recording in estimation of breeding values is a very important spin-off.

6. Estimation of breeding values for mastitis resistance

In total, 21 countries participated in the international genetic evaluation for Somatic Cell Count (SCC) and Clinical Mastitis (CM) in May 2006 (Interbull, 2006). 17 countries participate with SCC information whereas Denmark, Finland, Norway and Sweden include both SCC and CM information.

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

Table 1. Traits used in the udder health EBVs in the Nordic countries

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

Denmark, Finland and Sweden have developed a joint Nordic index for mastitis resistance, which basically is constructed like the current Danish index (Johansson et al., 2006). The joint Nordic index will be published in the autumn 2006. 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.

An incidence of 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. Nielsen et al. (1996) found that the genetic response in mastitis resistance will increase by 22%, by adding mastitis registrations to an EBV for udder health based on SCC and udder conformation traits.

By splitting mastitis into two traits in the first lactation, the period up to 50 days in first lactation can be closed early for many daughters and in that way, information about CM from mastitis diagnoses are available at the same time a sire gets his first proof for yield traits. This definition of mastitis traits is currently used in Denmark and will be used in the joint Nordic genetic evaluation as well (Johansson et al., 2006). The index for mastitis resistance is published, when the reliability is at least 40%. Bulls quickly obtain a reliability of 60-65% based on first 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 a simultaneously better use of SCC, udder conformation and mastitis data e.g. moving from a lactation model to a

Test Day model for SCC and 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 in the Nordic countries and is paid a lot of attention when both farmers and AI-organisations select bulls. The effect of the Danish 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. Danish Holstein (Mod. e. Aamand, 2006)

	Percentage of cows with mastitis	
Sire's index for udder health	1st parity	3rd parity
≤ 85	21.7%	28,9%
86-95	18.3%	26.0%
96-105	15,3%	23.8%
106-113	13.9%	21.0%
≥ 114	10.7%	17.0%

1) Standard deviation of the index is approx. 10

8. Index for other health traits

Today, only Denmark, Finland, Norway and Sweden calculate an index for other health traits. The EBVs basically include information about three groups of diseases: reproductive diseases, digestive diseases, feet and leg diseases (Aamand, 2006). 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.

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 that have only first batch of daughters seldom obtain an index with reliability above 65%.

Effect on health

The effect of the Danish 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 daughters 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. Danish Holstein (Mod. e. Aamand, 2006)

Sire's index for other health traits	1st parity				3rd parity			
	Percentage of cows with a diagnose				Percentage of cows with a diagnose			
	Rep.	Dig.	Feet & Legs	Sum	Rep.	Dig.	Feet & Legs	Sum
≤ 85	12.3%	2.1%	3.5%	17.9%	14.4%	12.5%	2.6%	29.5%
86-95	11.6%	1.7%	3.3%	16.5%	14.6%	9,7%	3,3%	27,6%
96-105	10.9%	1,3%	3,1%	15,2%	15.9%	9.3%	3.1%	28.4%
106-113	9.9%	1.4%	3.0%	14.3%	14.6%	8.3%	2.8%	25.6%
≥ 114	9.6%	1.2%	3,1%	13.9%	12.9%	7.0%	2.7%	22.6%

1) Standard deviation of the index is approx. 10

9. Health traits in the Total Merit Indices

Selection goals have changed world wide over the last 10 years, shifting the focus on production to a more balanced selection goal (Miglior, 2004). In the Nordic Total Merit Indices, considerable weights are 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.

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 with 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 of 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), whereas the red breeds have been able to keep a constant 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.

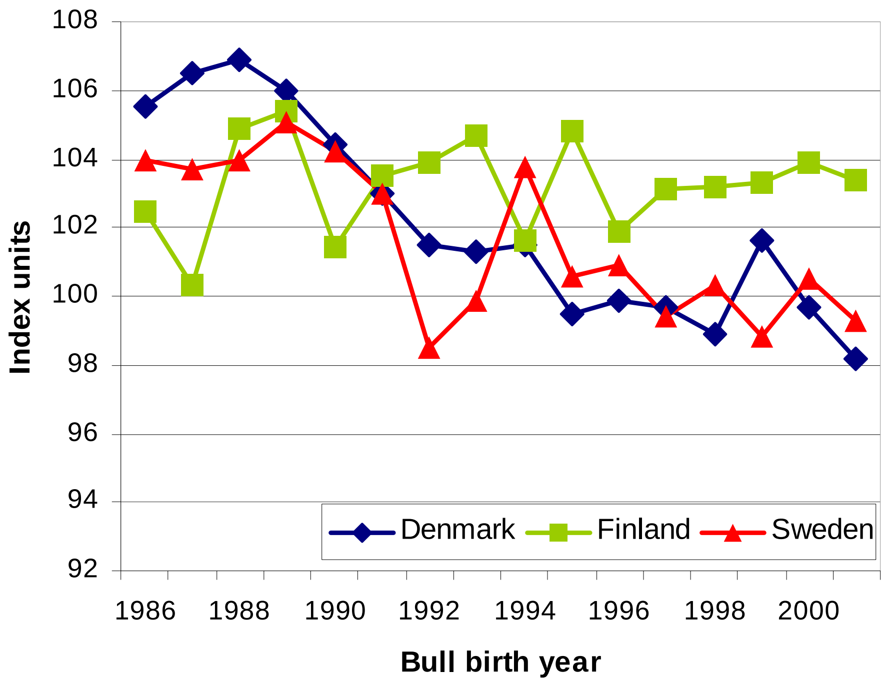

Figure 3. Genetic trend in mastitis resistance Nordic Holstein (Interbull May 2006 – Danish scale - Standard deviation of the index is approx. 10)

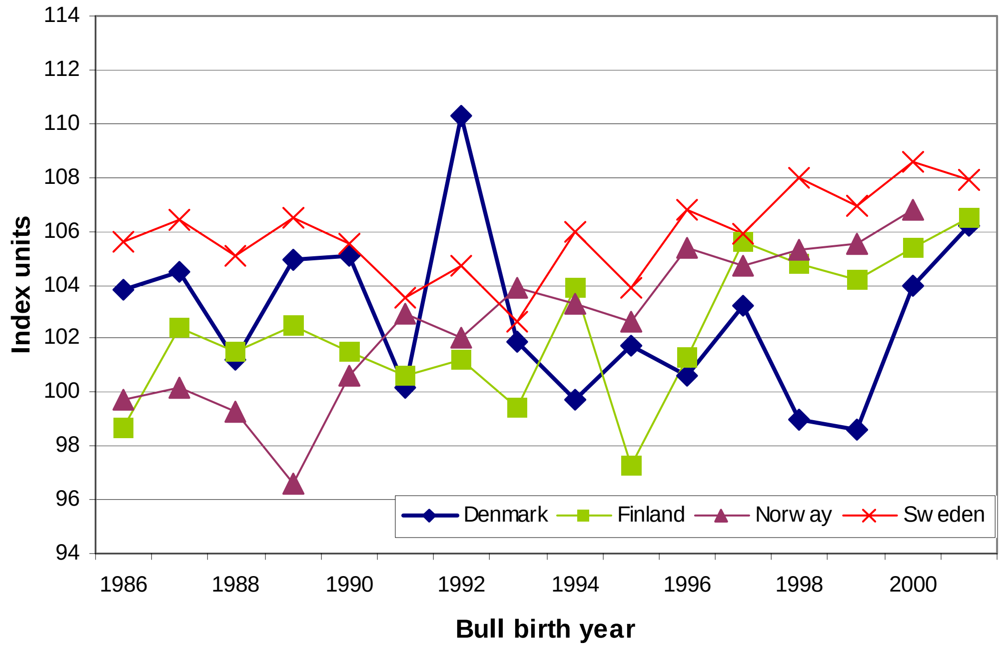

Figure 4. Genetic trend in mastitis resistance Nordic Red Breeds
(Interbull May 2006 – Danish scale - Standard deviation of the index is approx. 10)

10. Future challenges

Disease resistance is very important trait in the current breeding goal worldwide and will be even more important in the future. Farmers wish to have healthy cows. AI companies pay a lot of attention to EBVs for disease traits when they select proven sires and bull sires. Today mastitis is the disease which gets most attention in the practical breeding work, but in the future other disease might get much more attention as well.

It is a very important task to get the most reliable EBVs for diseases resistance. Systematic registration of diseases is a basic for an efficient selection for improved disease resistance. Several countries are looking at the possibilities for establishing a registration program for diseases.

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, the possibilities for including registrations from hoof trimmers in the breeding work are investigated in Sweden (Eriksson, 2006). In the future, inline measurements of milk from automatic milking systems might also add some valuable information about diseases. Within estimation of breeding values, the challenge is to improve the statistical model we use in practice today, such 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.

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