

Breeding for Health and Fertility in Dairy Cattle

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Introduction

It has gradually become evident from both research and practice that one-sided selection for production leads to increased problems with health and fertility of dairy cows. In Scandinavia, where for long data have been available on female fertility and health traits for genetic analyses and evaluation of sires, it has been shown that the genetic correlations between these traits and production are unfavourable, around 0.2 – 0.4 (Roxström, 2001; Philipsson and Lindhé, 2003).

However, in many dairy cattle breeding programs conformation has been given equal emphasis in selection as production, especially in countries where cattle shows have a long tradition. Thus, as far as conformation traits are related to cow health, selection for desired conformation might counteract the negative effects of production on health and fertility. It is plausible to think that good udder conformation prevents the cow from udder diseases, at least those that may have a traumatic background. Similarly, good feet and legs would minimize risks for lameness if we can apply the right selection criteria when judging feet and legs. Research shows though, that much of the variation in fertility and health of dairy cows are not effectively counteracted by selection for conformation (Rogers et al., 1999; Mark et al., 2005). On the contrary, there are even detrimental effects of the generally practised selection for dairy type on health and fertility. Thus, there is a great need to reconsider some conformation evaluation practices and develop methods for direct selection for fertility and health in dairy cows. This is emphasized by the fact that mastitis and fertility problems are the two most common reasons for involuntary culling of dairy cows, whatever the breed is.

The objective of this paper is to illuminate some of the existing problems with health and fertility in the context of selection of bulls at both domestic and international level. The aim is also to describe the opportunities for practical consideration of health and fertility traits in breeding programs, especially what the Interbull collaboration has brought to the dairy industry. Special thoughts will be given to the challenges and opportunities of the Guernsey breed.

Considerable genetic variation in health and fertility traits!

Despite the fact that most of the health and fertility traits in dairy cows show low heritabilities, often 2-5 %, there are large differences in these functional traits between daughter groups. The occurrence of clinical mastitis may vary between 10 and 25 %, i.e. in some progeny groups every fourth daughter has a clinical mastitis in her first lactation, whereas only one out of ten daughters by the best sires may have been affected by mastitis. Stillbirth rates may

vary between 2 and 20% among Holstein bulls as sires or maternal grandsires of calves at first parity calvings. As regards female fertility, daughters of poor bulls may have more than two weeks longer calving interval than daughters of the best bulls. Thus, there is a large genetic variation to exploit in these traits.

The generally low heritabilities originate from the fact that several of these traits are of an all-or-none nature, e.g. a live vs. dead calf, a healthy vs. sick cow etc, and the deviation from recording the traits on a quantitative scale contributes to a larger random error in “measuring” these traits, and thus, a lower heritability. Also some of these traits are observed subjectively with less precision than if measured. Anyway, what is most important is that the genetic variation is large. In fact the additive genetic variation in health and fertility is considerable, as previously demonstrated, and not much less than in production. So genetic improvements are possible, provided appropriate evaluation and selection procedures are applied. The two most important challenges to meet are to have a good recording of the traits in question, and to be able to progeny test the bulls on enough many daughters. As regards the genetic evaluation methodology applied it is of great importance to use the Animal Model of BLUP, when progeny groups are small and there is a special need to make use of as much information as possible of all relatives. This favours family selection and may lead to a narrow genetic base. This must be counteracted by giving priority to the use of rather unrelated bulls to sire new generations of bulls.

Development of national and international evaluations

Generally in dairy cattle disturbances with mastitis, fertility, locomotion, calvings and some metabolic diseases are the most important problems to consider in breeding. Luckily, many countries have today well functioning recording schemes to consider mastitis (or at least somatic cell count as an indicator of mastitis), calving traits and fertility. Furthermore, many countries have developed procedures for sire evaluation of the longevity of cows. Most countries also evaluate feet and legs as part of the conformation evaluations. In Table 1 the number of countries practising genetic evaluations and participating in international genetic evaluations in

Table 1. Number of countries with genetic evaluations for different trait groups and participating in Interbull evaluation Feb. 2007

Trait group	No. countries	year of start	No. countries with Guernsey evaluations
Dairy Production	26	1994	6 AUS, CAN, GBR, NZL, USA, ZAF
Conformation	22	1999	4 AUS, CAN, GBR, USA
Mastitis/SCC	23	2001	5 AUS, CAN, GBR, NZL, USA
Longevity	18	2004	5 AUS, CAN, GBR, NZL, USA
Calving/Stillbirth	13	2005	-
Female Fertility	12	2007	3 GBR, NZL, USA

Feb. 2007 for different trait groups are summarised.

International evaluations have gradually been developed for functional traits during the past 10 years. In 2001 evaluations for Clinical mastitis and Somatic cell counts were introduced and in the recent 2007 run 23 countries participated in this evaluation with five breeds. For Guernsey five countries participated and consequently farmers can compare breeding values for SCC of all Guernsey bulls from these countries on the national scales of each country.

Calving traits and longevity were introduced in 2004-2005, and have included 13 or more countries. Calving traits are especially important to consider for the Holstein breed, as still-birth rates of that breed have become alarmingly high. Thus, the Interbull system now provides global opportunities to reduce these problems.

The latest trait group to be included in the Interbull evaluations has been female fertility. Ten countries participated in the first routine Holstein evaluation conducted in February 2007, whereas another 6-8 countries are refining their methods for expected inclusion in the evaluations in the next year. For the coloured breeds research runs are conducted on a pilot scale and as regards the Guernsey breed fertility data have been provided by GBR, USA and New Zealand.

Bulls rank differently in various environments or countries

It is a fact that all bulls don't rank the same with their daughter performance in all countries. This is because environments and production systems vary, giving rise to true genotype and environment interactions. E.g. daughters of some bulls fit grazing systems much better than daughters of other bulls, whereas the opposite may be true in intensive TMR systems. Re-ranking may also occur as a result of different definitions of traits and models for genetic evaluation. The degree of such re-ranking of bulls between countries is expressed through the genetic correlations estimated between results obtained in these countries. The more the correlation deviates from 1.00 the larger will be the re-ranking.

In table 2 genetic correlations are presented as averages for the different trait groups. Also the range in values is given. For production traits and udder health the correlations are in the region 0.85-0.9, i.e. quite high. For the other traits correlations are 0.7 to 0.8, a little lower than the others but still indicating that very valuable information can be obtained about the BV:s of foreign bulls. For the Guernsey breed the correlations are

Trait		All Holstein populations		Guernsey populations	
		Mean rG	Range of rG	Mean rG	Range of rG
Protein yield	27	0.85	0.19	0.84	0.76 - 0.93
SCC	23	0.89	0.23	0.88	0.79 - 0.95
Clinical mastitis	4	0.85	0.18		
Longevity	18	0.70	0.66	0.59	0.30 - 0.89
Calving ease	12	0.76	0.83		
Stillbirth	7	0.71	0.47		
Calving interval	10	0.81	0.35	0.69	0.54 - 0.85

comparable with the Holsteins for production and somatic cells, but they are lower for the other traits. However, the New Zealand correlations are usually a little lower than the others, because their grazing system and seasonality in calving pattern differ most from any of the other production systems. This affects especially the average Guernsey correlations, as they are based on rather few countries.

Global trends in production and functional traits

As the genetic correlations between production on one side and health and fertility on the other are unfavourable one may expect negative trends in health and fertility if these traits have not been explicitly considered in selection. Through the Interbull system it is now possible to monitor what is happening by breed in different traits at the global level. In the following, global trends are given for protein yield, somatic cell count (SCC) and longevity. The mean genetic values are calculated by birth year of bulls used world-wide and weighted with their number of daughters.

In Figure 1 the global trends are shown for the Holstein breed. Although a clear positive genetic trend is observed for protein there is a considerable variation among countries in the genetic change. For SCC and longevity the trend seems negligible.

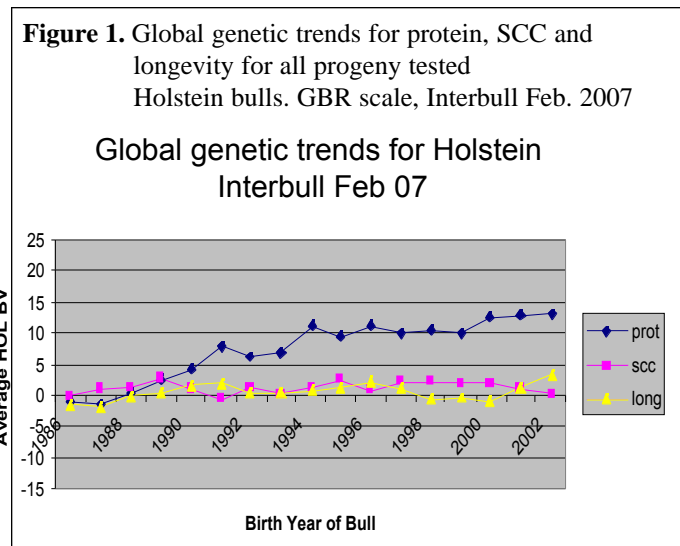
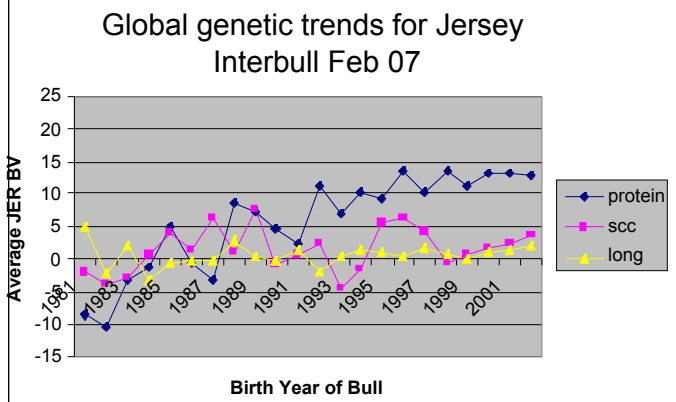


Figure 2 illustrates results for the same traits recorded for the Jersey breed. A large genetic progress has been obtained for protein, about the same as for Holstein. Contrasting to the Holstein trends the Jersey trend for SCC shows a slightly unfavourable (low values are desired) development, whereas the longevity values, despite some fluctuations, are unchanged over time.

Figure 3 demonstrates

Figure 2. Global genetic trends for protein, SCC and longevity for all progeny tested Jersey bulls. GBR scale, Interbull Feb. 2007



the development within the Red Dairy Cattle breed group. This group includes the Ayrshire-populations as well as other red dairy breeds, incl. the Scandinavian red populations. The genetic progress for protein has been slightly larger than in the other breeds, whereas the genetic changes in SCC and longevity have been minimal.

Finally in Figure 4 the Guernsey trends are illustrated. The

Figure 3. Global genetic trends for protein, SCC and longevity for all progeny tested Red Dairy Cattle bulls. GBR scale, Interbull Feb. 2007

Global genetic trends for Red Dairy Cattle Breeds
Interbull Feb 07

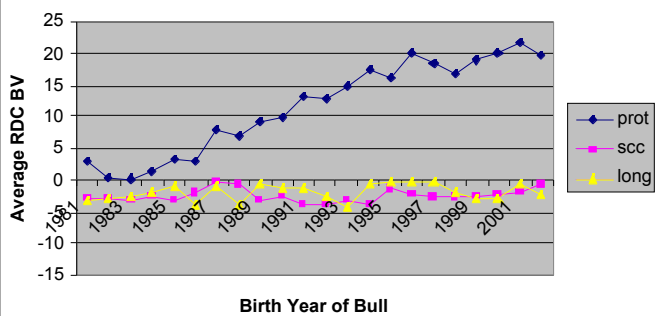
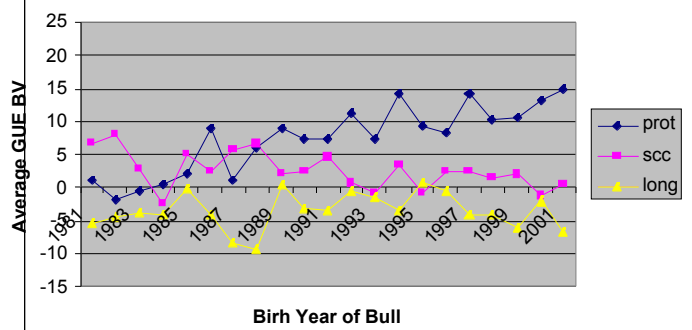


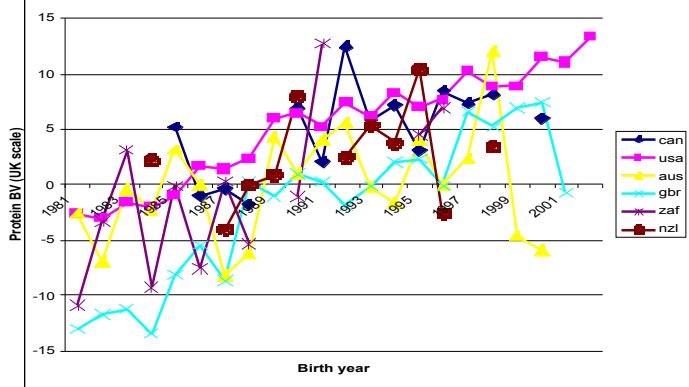
Figure 4. Global genetic trends for protein, SCC and longevity for all progeny tested Guernsey bulls. GBR scale, Interbull Feb. 2007

Global genetic trends for Guernsey
Interbull Feb 07



production development is positive but not quite as large as for the other breeds. The SCC trend is slightly positive, whereas the longevity trend is unchanged over time. Figure 5 shows the trends for protein for the different countries. Due to small number of bulls trends are rather erratic, but for USA there is a consistent upward trend, also for GBR. The genetic gap to the USA population is gradually reduced.

Figure 5. Genetic trends for protein yield in six Guernsey populations Interbull Feb 07, GBR scale



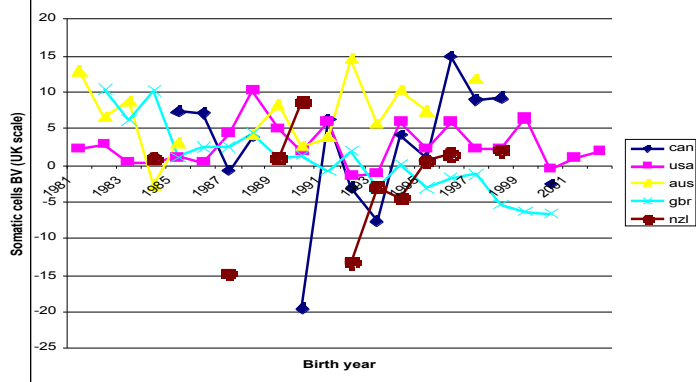
Selection for mastitis resistance and longevity

It is obvious that great progress in production, although at slightly different rates, have been obtained for all major dairy breeds. However, large variations exist between countries, as recording and evaluation practices have been quite different. The well established unfavourable genetic correlations between production on one side and health and fertility on the other call for urgency in considering these functional traits effectively in selection programs. The global trends, measured over all countries and considering the use of the bulls to produce daughters, seem to show that selection for udder health has been reasonably effective. Otherwise, declining trends would have been expected as a correlated response from selection for production.

The negative relationship between production and SCC and longevity may be illustrated for the Guernsey breed by the figures in Table 3 including the 20 top ranked bulls for protein with their ranks also for SCC and longevity. It is obvious that the most positive bulls for mastitis resistance and longevity are hard to find among the top production bulls. Table 4 summarises the average breeding values for the top production bulls as regards also SCC and longevity in relation to the average of all tested bulls. It is apparent that the SCC values are worse than average for the top production bulls, whereas the longevity values are rather close to average.

The trends shown in figure 6 clearly indicate the favourable SCC trend in the GBR population. This is the main reason for the slightly positive global Guernsey trend shown in figure 4.

Figure 6. Genetic trends in SCC in five Guernsey populations Interbull Feb 07, GBR scale



Genetic evaluation and selection for fertility

International research and Interbull studies conducted in the past 3-4 years on fertility traits have in summary shown the following:

- Genetic correlations show consistently unfavourable relationships with production, calling for the urgency of selection directly for improved fertility. Impaired fertility has been demonstrated especially in the Holstein breed.
- Many countries have been or are in the process of developing genetic evaluations for female fertility.
- Female fertility is composed of a complex of biologically different sub-traits that must be considered in the recording schemes and genetic evaluations. In short, one must be able to distinguish between pregnancy results in maiden heifers from lactating cows. Furthermore, cow fertility is made up of both a trait showing the ability of the cow to resume cycling and showing visible heat after calving, and the ability to conceive when inseminated.

After a special workshop (Interbull, 2006) held a year ago on the opportunities for international genetic evaluations Interbull decided to start test runs in September last year with the aim of having the first routine evaluations for Holstein and pilot runs for the coloured breeds by February this year. The plan has been followed and 10 countries participated with Holstein data in the routine run and pilot runs were conducted for the other five breeds. As previously shown only three countries participated at this stage with Guernsey data: GBR, NZL

and USA.

The most difficult task has been to define the traits to be included in the evaluations as the traits used were not yet as well harmonised between countries. Traits were grouped according to the biological principles mentioned above, but as several countries only had measures mixing the interval and pregnancy traits, a separate run was made for traits expressing days open or calving interval. It lacks maiden heifer information and is somewhat biased due to selection, but much better than having no information. In fact correlations with other traits seemed to be quite good as reported in Table 2. In the following only results reflecting calving interval will be reported.

Guernsey results

As results still are very fresh it may be a little early to go into too many details. However, the analyses show that also for the three Guernsey populations there are unfavourable correlations between production and various fertility measures of the order 0.2 - 0.4. Holstein data show even stronger negative genetic correlations between production and fertility.

Table 3. Top 20 bulls for protein yield on GBR scale and their ranks for Somatic cells and Longevity on the GBR scale (Interbull results Feb. 2007)

	Birth year	Country of test	P Rank	SCC Rank	Long Rank
GUEUSAM000000602750	1994	usa	1	289	189
GUEGBRM000000042251	1997	gbr	2	283	165
GUEUSAM000000603541	1998	usa	2	330	341
GUEUSAM000000604229	2000	usa	4	240	184
GUEUSAM000000604521	2001	usa	4	154	155
GUEUSAM000000603455	1997	usa	6	189	303
GUEUSAM000000603078	1995	gbr	7	230	112
GUEGBRM000000990009	1999	gbr	8	160	208
GUEUSAM000000603820	1998	usa	9	227	289
GUEGBRM000000042351	2000	gbr	10	66	112
GUEUSAM000000602751	1994	usa	10	289	142
GUEUSAM000000604269	2000	usa	12	220	203
GUEUSAM000000603468	1997	usa	13	212	296
GUEUSAM000000604313	2000	usa	14	257	189
GUEUSAM000000602797	1994	usa	15	203	285
GUEUSAM000000603872	1999	usa	15	46	223
GUEUSAM000000603094	1996	usa	17	220	192
GUEUSAM000000604259	2000	usa	18	111	184
GUEUSAM000000603307	1997	gbr	19	132	345
GUEUSAM000000601647	1991	usa	20	343	349

Table 4. Mean protein, SCC and longevity breeding values (GBR scale) for Top 20 and all Guernsey bulls born since 1990 (low BV preferred for SCC; high BV preferred for Long)

	Prot	SCC	Long
Top 20	16.2	4.6	-0.2
ALL	5.9	1.7	-0.1

Estimated genetic correlations between the fertility traits among participating Guernsey populations show very variable results:

USA with GBR: 0.19 with 49 common bulls; USA with

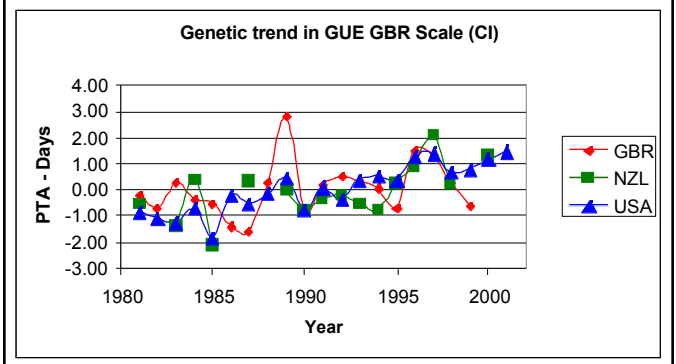
NZL: 0.04 with 30 common bulls, and GBR with NZL: 0.97 with 17 common bulls.

The correlations with the USA population are remarkably low, and much lower than the corresponding correlations for the same traits and countries of all the other breeds. The reasons for this have to be investigated by those who know the conditions for the progeny tests of all the Guernsey bulls in question. With the limited number of commonly used bulls one cannot either exclude the possibility that some “outlier” bulls with small daughter groups may cause strange correlations. Until this problem with strange correlations has been clarified no routine run for fertility of the Guernsey breed can be conducted, whereas these will be a reality for the other coloured breeds provided the March test run repeats the good results as were obtained in the pilot study. However, continued research evaluations will be run by Interbull for Guernsey with the hope that the results will be seriously scrutinized by the Guernsey people, clearing the way for routine evaluations. Also it is desired that more countries participate with Guernsey data.

It should be mentioned that the used correlations, as reported in Table 2, are processed from prior information on the same correlations for the other breeds. Thus, the level of the correlations for all the other breeds has influenced those practised for Guernsey in this research run.

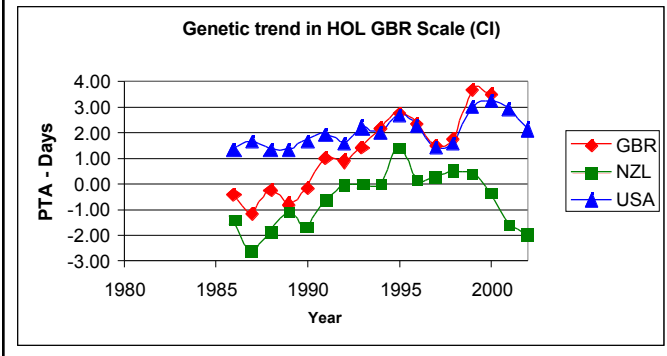
In figure 6a the genetic trends obtained from the research evaluation for the three Guernsey populations are shown. As the number of bulls in different years is limited the results fluctuate considerably. However, in total it is obvious that in the past 15 years there has been a genetically impaired fertility of Guernsey cows. This is again an effect of selection for production, but could also be an effect of favouring cows as bull dams with high scores for angularity or sharpness, as such cows are shown to have more problems with fertility than other cows, at least in Holsteins, where Rogers et al., (1999) estimated unfavourable genetic correlations of the order 0.4 – 0.6.

Figure 6a Genetic trends in female fertility for Guernsey. Calving interval in days on the GBR scale from the Interbull pilot run Feb. 2007



For comparison trends are shown in figure 6b for the Holstein breed. These show how the prolonged calving interval of the GBR Holstein population now has reached the genetic level of the USA population. This is an expected result of the “holsteinization” that has taken place in most black and

Figure 6b Genetic trends in female fertility for Holstein. Calving interval in days on the GBR scale from the Interbull routine evaluation Feb. 2007



white populations. The graph also shows the clearly better genetic fertility level of the NZL population, probably an effect of consistent selection of cows with the required fertility to cope with the seasonality in calving pattern.

The relationship between protein production and calving interval is illustrated by the results in Table 5. A steadily prolonged calving interval follows the higher rank of the bulls for production. However, there is a considerable variation in the BV:s for calving interval within each of the ranking groups. This means that there are opportunities to find bulls with positive BV:s for daughter fertility also among the top production bulls, but they are rather rare.

Table 5. Mean calving interval BV:s for groups of the 50 top ranked Guernsey bulls for protein. Interbull evaluation Feb. 2007

Bull's rank for Protein	Protein Mean	Calving interval, days		
		Mean	Min	Max
1--10	18.29	2.28	-0.22	5.34
11--20	15.19	2.16	0.25	3.98
21--30	14.24	1.70	-0.36	3.18
31--40	13.72	1.52	-2.81	4.83
41--50	12.76	1.04	-2.31	4.09

The recently held Interbull Steering Committee meeting, preceded by its Technical Committee meeting, decided to bring up all results and experiences from the national and international genetic evaluations for female fertility for discussion at its Open seminar 23-25 August in connection with the EAAP-meeting in Dublin. Hopefully, the Guernsey issue on correlations has been clarified at this occasion.

“New” traits:

Ease of milking, temperament, locomotion - claw health, body condition score

Research continues to develop both national and international evaluations for different traits of economic importance. According to an Interbull survey great interest has been expressed in developing an international evaluation procedure for milking speed and temperament. A research project on this matter is lead by the Italian Brown Swiss organization and

involves all breeds and countries having genetic evaluations for ease of milking. Results of this project will be discussed at the Dublin meeting in August. In a recent survey several countries expressed interest also in developing international evaluations for locomotion and body condition score.

The priorities for development of evaluations for these traits can be seen from the increasingly importance of these traits with increasing herd size, automated milking systems and the need for a more robust cow in general. Feet and leg problems are then important to reduce. The aims of classifying cows for their feet and legs are to select cows that are free from locomotion problems and any other disturbances as regards feet and legs. However, the subjective scoring of feet and legs mainly describes the conformation and angles of hock, pasterns and claws. Unfortunately, the correlations between these scores with longevity seem to be low (Eriksson, 2006). New approaches to improve locomotion and health of feet and legs are therefore needed. Several studies on direct recording of locomotion are under way, and some 10 countries are ready to participate in an international genetic evaluation for locomotion, and more countries will come along later.

A new interesting approach to improve methods for genetic evaluation of foot health is making use of observations by hoof trimmers. Such a recording of claw health has in Sweden recently been analysed for breeding purposes. Very promising results, both as regards the heritability of hoof lesions and their correlations with longevity, have been reported (Eriksson, 2007). Recording of locomotion as well as of claw lesions at trimming may be important new ways of improving the recording of traits related to better health of feet and legs as a basis for genetic evaluations and eventually better cow health.

Total Merit index to select for all economically important traits

As there are a number of economically very important traits to consider in selection of bulls and cows it is necessary to develop some kind of Total Merit Index (TMI) to use for optimal selection. Each trait needs to be economically assessed so that relative economic weights can be applied when the different traits are weighed into the index. It should be mentioned that the weights may also be designed in such a way that they will support a certain desired development, and also consider values that are not strictly of a monetary kind, e.g. ethical or cultural values. In Sweden a TMI was initially developed in 1973, and it has later on been completed with more traits. Today the TMI in Sweden includes:

- Production (Yields of protein and fat with a neg. weight on milk yield)
- Beef traits (Growth and carcass data from male progeny)
- Female fertility (heifers and cows)
- Calving traits (Calving difficulty and stillbirth as calf and dam traits)
- Udder health (Vet. treatment of clinical mastitis, somatic cell count, culling for mastitis)
- Other diseases (Vet. treatments)
- Udder conformation (International standards)
- Body conformation, feet and legs (International standards)

- Temperament (Interview)
- Longevity (Survival rate)

The principle is that the breeding values for all subtraits are published and weighted according to their relative “economic” importance. Also the relationships between traits are considered as for normal calculations of selection indexes. The TMI:s have been the main criterion for selection of AI bulls in Sweden for more than 30 years and has been extremely well accepted by the farmers. It has been used a long time also in the other Scandinavian countries, and is gaining acceptance the world over. The limiting factor in many countries has been the availability of records and breeding values for health and fertility traits. As has been demonstrated in this paper, many countries now do evaluate many more functional traits than they used to do previously, and thus they practise various forms of TMI. Several Guernsey countries practise different TMI:s, e.g. Australia, Canada, UK and USA, although weighting of traits are different. Thus, there are good opportunities in many countries, not least those that keep Guernsey cows, to apply various forms of TMI including important functional traits for a balanced selection of productive as well as healthy cows in the future.

Crossbreeding - an alternative to achieve more robust cows?

So far the presentation has only dealt with genetic evaluations and selection strategies as they relate to pure breeding. However, we know that crossbreeding effects, heterosis, are well known to have considerable effects on fitness traits in most species. We could expect that such traits as fertility and disease resistance, contributing to survival and longevity, would be improved by crossbreeding in dairy cattle through non-additive gene interactions. On the other hand we also know, as demonstrated through differences between daughter groups, that the additive genetic variation is substantial for health and reproduction traits in dairy cattle and can be successfully utilised for within breed improvement. In beef cattle crossbreeding has been proven important, both for use of non-additive genetic effects and for use of additive variation for complementary characteristics in different breeds, e.g. for use as maternal and terminal breeds to produce beef.

In dairy cattle crossbreeding has not been practised very much in the last decades, neither in research nor in practice, until a number of California breeders, in collaboration with Minnesota scientists led by prof. Les Hansen, started to cross their Holsteins with different red European breeds. The reason for this action was primarily that fertility and survival rate in their Holstein herds had gone down, and that there were no efforts at the time in selection for female fertility or controlling inbreeding in the USA Holstein population. The increasing inbreeding rate could effectively be broken by crossbreeding, while also harvesting other effects of crossbreeding. The more high yielding cows, the more needs to breed for robustness, and crossbreeding would possibly be a good alternative for that.

Results from the California herds have been widely presented and discussed in the past few years, although not yet

finally analysed (Heins et al., 2006). In summary some important results are presented in Table 6. As regards production in first lactation there were only small differences, 3-5% less production in the Holstein crosses with the Scandinavian Red breeds and Montbeliarde. This was achieved despite the fact that pure Holsteins conceived 2-3 weeks later than the crosses and that 7-10% fewer Holsteins than crosses survived 305 days. Stillbirths were also considerably reduced by crossbreeding. Altogether the study shows the potential of crossbreeding dairy cattle, especially when reproduction traits are neglected in purebreeding.

Table 6. Summarised crossbreeding results from six California herds (Heins et al., 2006)

Breed	Fat + Protein kg	Stillbirths %	Diff. calv %	Days open	Calving w. 14mths %	Survival 305 days %
Holstein	660	14.0	17.7	156	44	86
Normande x H	600	9.9	11.6	133	62	94
Montbeliarde x H	630	6.2	7.2	137	64	96
Scand. Red x H	640	5.1	3.7	142	60	93

Conclusions

for the Global Guernsey Breeding Plan

The Guernsey cow breeding population is put under pressure, as it has been continuously decreasing in size for many years. At the same time the needs to produce a robust Guernsey cow with good production, fertility and health have accentuated to be competitive with other breeds. Effective use of the global Guernsey resources is therefore necessary. As a result of the developments that have taken place in the last few years new opportunities have opened up for a more optimal selection of cows and bulls of the Guernsey breed. In summary the following steps are suggested to be part of a workplan for a successively improved Global Guernsey Breeding Plan:

- Make sure all countries are recording SCC, fertility and longevity
- Make sure accurate genetic evaluations are carried out and that these are included in the Interbull evaluations for global comparison of Guernsey bulls and that Interbull proofs are published in all relevant countries
- Check especially the BV:s for female fertility of Guernsey bulls being commonly used among Guernsey populations to clarify the correlations among countries
- Develop a harmonized TMI for the Guernsey breed of all countries based on Interbull evaluations including:
 - Fat and protein yield
 - Fat and protein %
 - SCC
 - Fertility
 - Longevity
 - Udder composite
 - Feet & Legs
- Relative economic weights should be discussed and developed in relation to the long-term breeding objectives of the breed
- Publish active bulls ranked for their TMI in each country,

but also ranked for individual traits

- Monitor developments in each important trait

As the Guernsey population is rather small main emphasis is put on the use of young bulls. The problem of considering health and fertility traits in this context is that progeny testing is the only method for reliable genetic evaluation of potential breeding stock for these traits. It is for the Guernsey population extremely important that the global selection of bull sires takes this into account and results of all Guernsey populations are utilised. Reasonably accurate proofs of bulls will follow the efficient use of a BLUPAnimal Model for genetic evaluation

of repeated fertility records in maiden heifers and lactating cows. Through the Interbull evaluations all bulls can be evaluated for all important sub-traits needed for efficient TMI-selection across countries. In this way all Guernsey bulls available globally can be compared on the domestic scale of each country. Guernsey breeders,

wherever they live, should then have very good opportunities to use young bulls with documented sires transmitting production with good health and fertility to their daughters.

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