Breeding in Europe under the competition at the global market (breeding goal, inbreeding)

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Abstract
The structure of the dairy cattle industry is changing in Europe. The number of cows is decreasing and the herd size is increasing. Breeding in a decreasing population is a problem for the A.I. Centres in Europe. The trade with semen and embryos across borders are increasing and in all markets there is more and more competition. With the increase in the international trade there is a need for reliable breeding values across countries. Due to lower milk prices and higher costs for the dairy farmer all traits of economic importance has to be included in total merit indexes for selection. Intensive selection and a decreasing population increase the risk of inbreeding and it is necessary to optimize the genetic gain and at the same time limit the increase in breeding. A.I centres and breeding organizations should strengthen their cooperation to develop better registration methods, better indexes, better progeny testing schemes and better breeding schemes in general for the benefits of the European dairy farmers.
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Introduction
Milk is produced in almost all countries world wide. However the production will change due to the ongoing liberalization of trade. Table 1 shows that the number of cows is decreasing by 2.4 mill. cows and the milk production is increasing by 1.2 mill. ton. (milk delivered).

Table 1. Milk production, deliveries and dairy herd in the EU-25, 2003 - 2011

Year	2003	2005	2007	2009	2011
Total production (mill. t)	143.7	143.8	144.7	145.0	144.9
EU 15	122.0	121.8	122.6	122.9	122.9
EUN10	21.7	22.0	22.1	22.1	22.0
Deliveries (mill. t)	130.9	131.5	132.8	134.1	134.7
Fat content (in %)	4.06	4.07	4.08	4.08	4.09
Protein content (in	3.35	3.35	3.36	3.36	3.37
Milk yield (kg/dairy cow)	5940	6199	6420	6567	6707
EU 15	6287	6505	6742	6866	6977
EU N10	4536	4922	5076	5285	5514
Number of dairy cows (mill.)	23.9	23.1	22.4	22.0	21.5
EU 15	19.3	18.7	18.1	17.8	17.5
EU N10	4.7	4.4	4.3	4.1	3.9

Source: europa.eu.int/comm/agriculture/ publi/caprep/prospects2004b/tabdairy.pdf

At the same time cows will move from smaller herds to larger herds. According to ICNF (Hemme, 2005) the Czech Republic and Ukraine have the highest number of cows per herd with more than 100 cows. In Denmark we have had a considerable increase in herd size during the latest 5 years, and we are very close to 100 cows per herd.
These changes are only a few of the challenges the cattle breeding industry is facing in the years to come. The challenges can be summarized as: lower milk prices, fewer cows, larger herds, higher costs for labour, higher total costs, higher prices for land and more environmental restrictions on the production.

Breeding organizations in Europe
For the last couple of decades there have been many mergers and acquisitions within the A.I. Industry. I will use Denmark as an example. In 1952 there were 106 A.I.-Centres in Denmark

and an average herd size of 7.2 cows. At that time, there were a total of 1.6 mill. 1st inseminations. Today there is only one A.I. Centre and 600,000 1st inseminations and an average herd size on 95 cows. The A.I. Industry in other European countries has undergone the same development. An overview of the inseminations and sold semen doses in different European A.I. centres are listed in table 2.

Table 2. A.I. centres in Europe with more than 200.000 1st inseminations (HI, 2004)

Name	Country	1. inseminations	Export doses
Aberikin	Spain	450,000	350,000
ABS	Italy	210,000	142,000
CIZ	Italy	850,000	210,000
CR-delta	Holland	1,500,000	1,500,000
Dansire	Denmark	470,000	150,000
Elpzoo-Zorlesco	Italy	500,000	120,000
Genes Diffusion	France	406,000	400,000
Genetica	Italy	600,000	Na
Genus	United Kingdom	1,000,000	200,000
GGI	Germany	4,000,000	500,000
Intermizzo	Italy	550,000	275,000
Munster	Ireland	265,000	Na
Oger	France	666,000	140,000
Progressive Genetics	Ireland	220,842	2,200
Semen Italy	Italy	93,400	352,000
Svensk Avel	Sverige	143,000	58,000
Swiss Genetics	Switzerland	603,000	89,000
Uneco	France	769,000	300,000
Urceo	France	417,000	190,000

The cattle breeding organizations in Western Europe are still dominated by farmers cooperations except for the market in United Kingdom. Up till now, there has only been a few major breeding organizations/A.I. centres owned by private investors. Within the latest 10 years more private owned organization have appeared, e.g. ABS/Genus, Cogent and Alta. I expect that this trend will continue.

How is the market for cattle breeding?

So far the farmers have been very loyal to their A.I. centres, and they still are, but with larger herds and more commercial dairy farmers, the tendency is that the farmers are less loyal than earlier - they tend to go shopping, and competition is increasing.

Competition is good - it keeps everybody awake, but it is also expensive. A.I. centres operate more and more across borderlines resulting in a development of increasing competition in all markets.

There is no official statistics on semen trade world wide. The magazine Holstein International prints an A.I. Guide. According to the A.I. guide 2004 all A.I. Centres had 30.5 mill. first inseminations on their domestic markets and the number of exported doses was 18.5 mill.

I consider the reliability on these figures for Holsteins doubtful.

My question is: Is it realistic that we all try to compensate for a decreasing domestic market by exporting?

Today many European A.I. centres have a very strong market position on their domestic market with a market share of 75-95%, and a lot of other A.I. Centres compete on the market shares left, trying to “steel” 1-2% from each other.

The Boston Matrix (figure 1) describes four situations depending on market growth and market share. In the situation described above the national A.I. Centre has the situation with cash cows, and when a foreign A.I. Centre enters their market, they are entering a market with low growth and a little or no market share – we have the "dog-situation" - and how wise is that? How do we develop and improve our breeding programs and find new emerging markets, new products etc.?

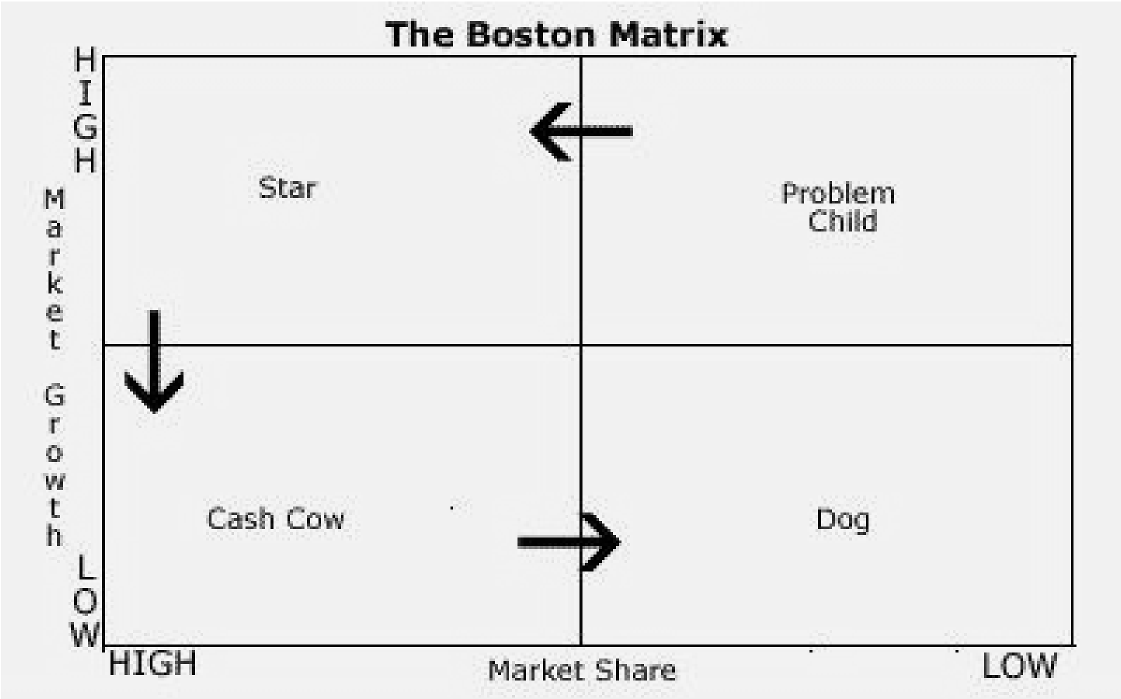

Figure 1. The Boston matrix (Lynch, 1997)

Breeding goal

The situation for dairy farmers in Denmark is: „We don't earn enough money! ". This is due to lower milk prices and incredibly increasing costs. The dairy farmers are chasing costs and working many hours. The overall goal including the breeding goal for any dairy farmer can be described as: "The highest possible net income per hour that my family and I invest in the farm" or in other words the dairy farmers want a sustainable cow, and she is only sustainable, if she has a high production, and the production can be reached with few costs and low investment of labour hours.

The breeding goal in Europe has changed towards more sustainable cows. Words as longevity, durability etc. have become more and more in focus. Nobody is any longer selecting only for production and some type traits.

Miglior, 2004 made a comparison between traits across countries. He found that there has been a change in the priority of traits and their weighting in total merit indexes (TMI). Figure 2 illustrates the selection indexes 10 years ago and today. In 1994 Denmark was the only country with a selection index including the four major areas: Production, durability, health and fertility. Today all the countries compared are including all traits.

The Nordic countries – Norway, Denmark and Sweden have selected for functional traits e.g. udder health, health in general and female fertility for the latest 20 years using a total selection index. Table 3 shows the weighting factors for the different traits in the total indexes from the Nordic profile

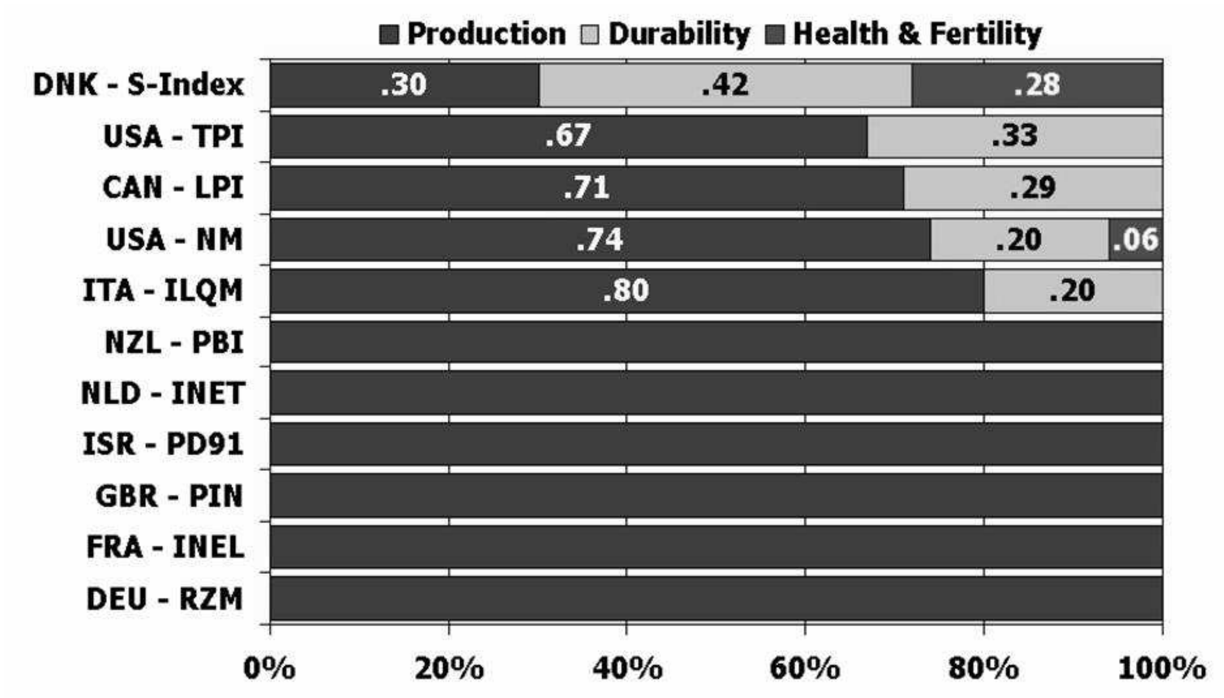

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Figure 2a.

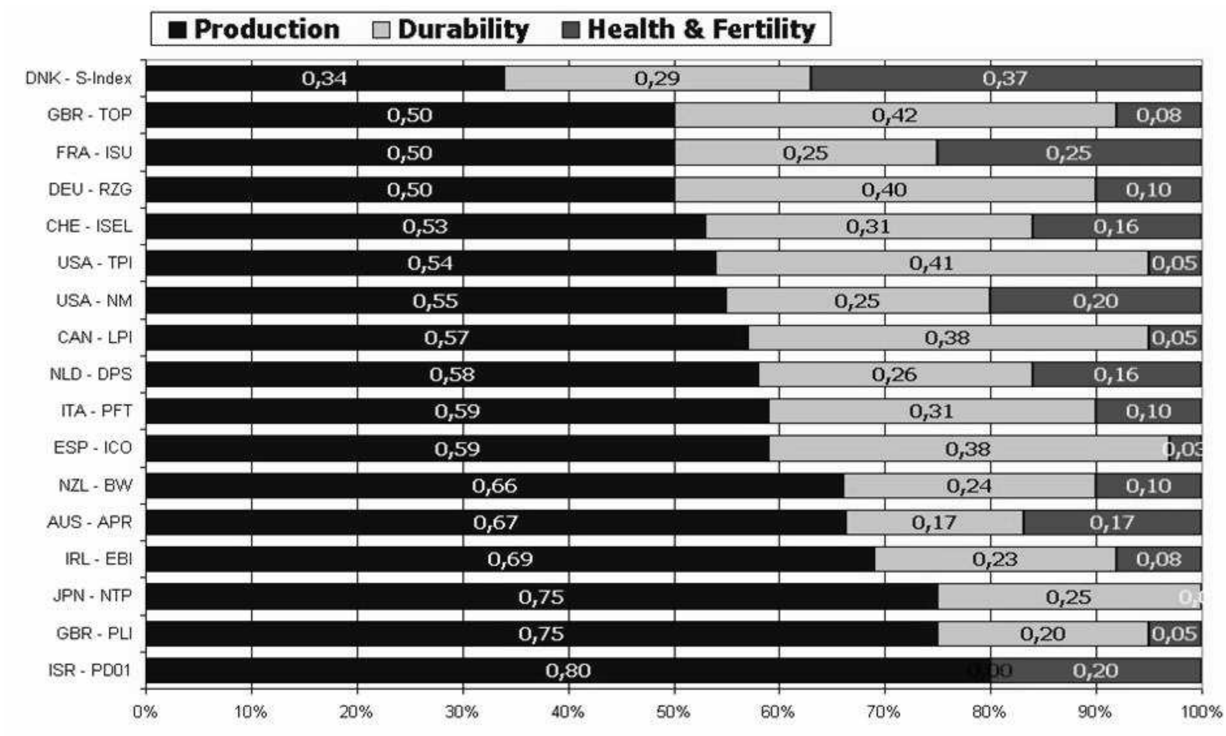

Figure 2b. Relative emphasis on production, durability and health in different countries total merit indexes year 1994 (2a) and year 2004 (2b) (Miglior, 2004)

Table 3. Selection traits and weighting in Nordic countries (SRB-Swedish red, NRF Norwegian Red)

Country	**Sweden-SRB**	**Norway NFR**	**Denmark Holsteins**
Trait	**Weighting**	**Weighting**	**Weighting**
Production	30%	24%	34%
Beef	6%	9%	5%
Fertility	10%	15%	9%
Calving ease - sire	3%	2%	6%
Calving ease - mgs	6%	-	-
Mastitis resistance	12%	22%	14%
Other diseases	3%	4%	2%
Body	-	-	2%
Mammary	12%	15%	9%
Feet and legs	6%	6%	5%
Milking speed	-	-	6%
Temperament	3%	4%	2%
Longevity	6%	-	6%
Stature	3%	-	-

Total Selection index

In Denmark we have used the S-index since 1983. The S-index includes the functional traits, since the functional traits are of great importance for the dairy farmer, but you can ask why include traits with only 3-4% heritability, will we ever have genetic progress? The goal is not only genetic progress. The goal can also be to avoid genetic loss for a trait. The genetic correlations between production and most of the functional traits are negative. By using the S-index as selection criteria, we can achieve genetic progress for the functional traits even if there is a negative genetic correlation to the production traits.

Figure 3 illustrate traits included in the S-index. If selection is only made for production (100% progress/gain), then negative progress will be observed for several important traits. When you use the S-index in your selection programme all the traits included will be improved at the same time.

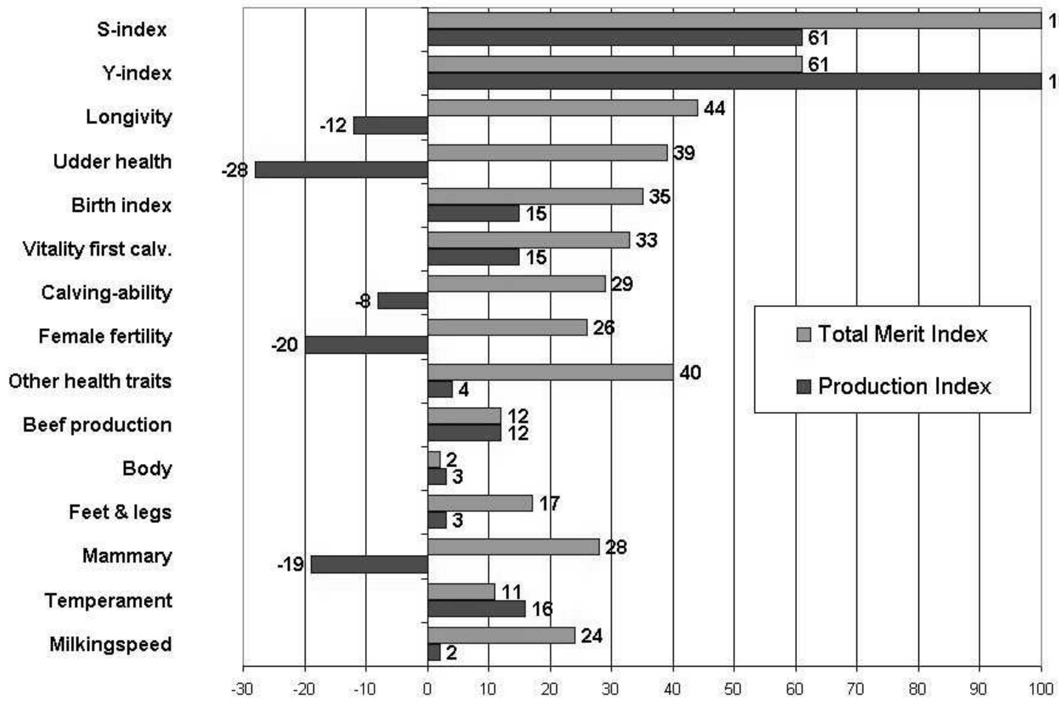

Figure 3. The Danish S-index. Each trait shows the percentage of maximal gain after using a selection index (Danish Cattle, 2003)

The S-index is an economic index which includes all traits of economic importance for the dairy farmer. Not only the economic importance today, but also the economic importance in the future is taken into consideration. Two types of economic values are calculated:

- Objective values based on calculation in mainly economic models, but ethic and organic aspects are in consideration.
- Non-objective values where the purpose is to maintain or create a desired genetic gain
- for a trait.

In the calculation of all objective values data simulation is used instead of data analysis. With data simulation it is possible to simulate the future conditions. With data analysis there is a risk only looking at the past. As an example the cost of mastitis, an incident of a reproduction disease and a difficult calving are shown in table 4. For mastitis half an hours extra work by milking separately etc. is estimated. The veterinarian cost including medicine is estimated and finally the farmer is unable to deliver the milk for a week, so he will loose 185-240 kg milk.

Table 4. Costs of Mastitis and reproduction diseases, Denmark (Pedersen et. al, 2002)

	Extra work for the dairy farmer (hours)	Treatment and medicine by a veterinarian, €	Loss of milk and temporary drop of milk in lactation, kg
Mastitis, 1st lact	0.50	90	185-240
Mastitis, later lactations	0.50	90	185-240
Reproduction, 1st lact	0.50	40	0
Reproduction, later lactation	0.50	40	0
Calving difficulties	1.0	185	0

If we should calculate the economic factors internationally there will be differences between countries because the costs of labour and the costs of veterinarian treatments are not the same. Table 5 shows the differences in salaries per hour from different countries.

Table 5. Salary per hour for season workers in agriculture - selected EU countries (SALA, 2004)

Country	€, per hour	Social costs %	Total € per hour
Greece	4.20	0.00	4.20
Germany	6.50	0.02	6.51
Belgium	6.78	8.00	7.32
Holland	9.40	2.28	9.61
Finland	7.82	27.09	9.94
Sweden	9.84	38.47	13.63
Denmark	15.30	15.00	17.60

For the western European countries there is a threat or challenge, that milk can be produced cheaper on new markets with very low costs, but ethic and organic aspects will be taken into consideration by the consumers.

Intensive selection leads to inbreeding

The success of the Holstein Breed during at least the last three decades leads to some concern. The loss of breeds and intensive selection for only a few traits lead to a narrowing of the genetic base and an increasing level of inbreeding within the Holstein breed. The widespread use of the "Animal Model" increases the problem, because the Animal model favours the same bloodlines. The effective population size has decreased. From 1960-1980 the effective population size was approximately 200 animals. From 1980-2000 the number has decreased to 40 animals. In year 2000, 25% of the genes in Danish Holstein young sires originate from only two sires of sons.

This incredible increase in inbreeding was a challenge for our breeding organizations. For the last 5 years the Danish Institute of Agricultural Sciences, Foulum, has developed new software with the purpose of reducing inbreeding in the population. The EVA programme optimizes the genetic gain and at the same time limits the increase of inbreeding. Based on all available data the programme takes previous parent combinations as well as potential parents for the following generation of offspring into consideration. (Figure 4).

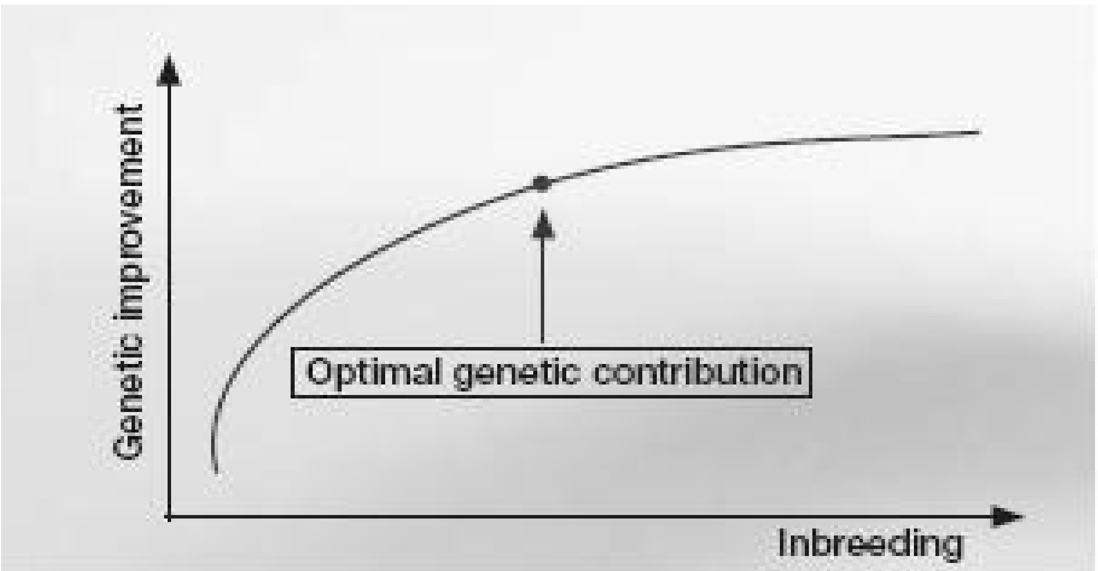

Figure 4. The Software EVA optimizes the genetic gain and limits inbreeding.

Breeding schemes in global

To serve the dairy farmers with the best genes as possible we need to trade or swap semen across countries. For that purpose we need reliable information and indexes. Interbull has done a great job trying to produce the Interbull indexes as reliable as possible. The problem is that the ranking of bulls differ from country to country. Since Interbull started with MACE evaluation in 1995, there has been a great improvement, but Miglior, 2004, investigated the lists of top 100 bulls in different countries. There were relatively large differences in the listings of bulls. The differences in the listing are due both to differences in national total merit indexes and to the fact that the estimated genetic correlations across countries are less than one. However, when a Danish bull rank # 1 in Denmark for S-index and the same bull is ranking #150 for TOP in great Britain – this is difficult for European dairy farmers to understand especially when we agree in almost the same breeding goal – a sustainable cow.

The study (Miglior, 2004) showed how many bulls there were in common in the different countries (table 6).

Table 6. Number of common bulls among top 100 listings (Miglior, 2004)

		AUS	CAN	CE	DEU	DNK	ESP	FRA	GBR	GBR	IRL	ISR	ITA	JPN	NLD	NZL	USA	USA
Country	Index	APR	LPI	ISEL	RZG	S-index	ICO	ISU	PLI	TOP	EBI	PD01	PFT	NTP	DPS	BW	NM	TPI
AUS	APR																	
CAN	LPI	8																
CHE	ISEL	21	23															
DEU	RZG	17	35	36														
DNK	S-index	10	32	38	47													
ESP	ICO	10	65	26	37	35												
FRA	ISU	24	37	38	38	36	36											
GBR	PLI	14	30	30	29	22	30	34										
GBR	TOP	9	33	28	30	21	35	30	69									
IRL	EBI	30	7	16	11	9	7	12	10	6								
ISR	PD01	24	17	35	30	28	17	35	20	20	17							
ITA	PFT	10	64	24	38	34	59	37	28	31	6	17						
JPN	NTP	10	43	27	33	25	40	30	30	33	6	19	40					
NLD	DPS	25	15	34	42	33	18	18	18	17	20	39	16	20				
NZL	BW	27	5	10	6	5	5	8	8	7	32	12	5	5	9			
USA	NM	10	32	22	28	38	27	23	23	20	7	35	34	28	24	3		
USA	TPI	7	55	27	36	38	48	28	28	29	6	19	59	41	14	5	46	
	Mean	**16.0**	**31.3**	**27.2**	**30.8**	**28.2**	**30.9**	**31.0**	**26.1**	**26.4**	**12.6**	**24.0**	**31.4**	**26.9**	**23.5**	**9.5**	**27.7**	**30.8**

Better comparisons

How could we improve the comparison of bulls and cows across countries? There are several attempts and I will just mention two described of Canavesi et al, 2003: GAM (Global Animal Model) and PROTEJE (Production traits European Joint Evaluation). The principles of the two systems are described at the European Holstein Conference 2003. GAM is trying to estimate breeding indexes in a global animal model using raw data and PROTEJE is a 3 year project trying to develop an alternative methodology for international breeding evaluation for both bulls and cows. To achieve a bright future it is very important that the A.I. Centres and with them the dairy farmers support any attempt to improve the principles in population genetics. At the same time it is extremely important that PROTEJE, GAM, INTERBULL or any other system for sire and cow evaluation do not compete against each other, but work together. For future development it is important to stay together, and that is why, it is very important that every body gets "a piece of the cake" in the future breeding evaluation for bulls and cows. When having " a piece of the cake" you will feel ownership to new principles, and from this ownership the confidence and engagement in the new system will grow. In the Nordic countries Nordic Cattle Genetic Evaluations (NAV) will be in effect this year. The principle in NAV is a common evaluation of cows and bulls in Sweden, Denmark and Finland. The first common indexes were published in April 2005, and the indexes were based on raw data using the same weighting factors, means and standard deviations in all three countries.

Selection of young sires: dilemma, paradox or just challenge
Progeny testing A.I. sires continues to be the main engine generating genetic progress in the dairy industry, and that's why testing of young sires is a must. To sample the best young sires we need accurate sire and cow evaluations so the best sire fathers and bull dams can be selected.
Selection occurs traditionally in four pathways, and the impacts of sires of sons are 50%, dams of sons 35%, sires of cows 12% and dams of cows 3% (VanTassel and VanVleck, 1991).
With the great impact of sires of sons it is essential that there is access to sires of sons tested for traits important for future breeding schemes including functional traits, otherwise if these traits are not included in breeding values for the sires of sons, we cannot obtain genetic progress for the traits.
Also the selection of bull dams has been under discussion. Due to preferential treatment or biased indexes within herds, it has been difficult for the A.I. Industry to do a correct selection of the bull dams. All studies find that the bull dams breeding values are overestimated in general. A study on our Danish selection of bull dams shows that many sons have lower breeding values than expected from the parent's average. We know that the breeding values for the bull dams are overestimated and it is observed that the standard deviation for indexes within the herd is higher than expected – there are a few high index cows, and these cows give biases on the normal distribution curve for indexes within the herd. I will emphasize that we will not blame the dairy farmer for showing more interest for a good cow – than a poor cow – that is human nature!
Sire analyst from the A.I Centres must know all information within the herd e.g. standard deviation on indexes within the herd, results for already proven bulls from the herd etc.
The research on preferential treatment on bull dams is preliminarily done on production traits and not on traits including in a total merit index. However it is necessary to avoid the fact that a dairy farmer takes good care of his best cow. A solution could be that the cow's own information is less important in future calculation of breeding indexes and stack of sires in the pedigree of the bull dam is more important than the cow's own records. We can also expect that with larger farms and more traits, preferential treatment will become less important than previous studies had shown.
Nucleus herds are used in some countries. Centralised breeding in nucleus herds may prevent preferential treatments on single bull dams and new tools e.g. test for functional traits can easily be implemented in the nucleus herds. However nucleus herds are very expensive and selecting bull dams in a nucleus herd is also narrowing the genetic pool for selection.
Selecting bull dams on stack of sires with high indexes for total merit combined with positive genetic markers on the bull dams themselves for functionality will be realistic.

Registration and data
Milk recording and databases with all relevant data is the basis for research and development within cattle breeding. To ensure genetic progress and calculation of good and reliable indexes a unique data registration system is necessary. The functional traits have a low heritability, and therefore a very careful registration is important. In other aspects, e.g. discovery of different QTL markers, valid data is also a must.
In Denmark all dairy farmers, inseminators, production and breeding consultants, veterinarians, slaughter houses and dairy plants have online access to "the cattle database". The database is the

background for cattle breeding in general and for all sire evaluations. Danish dairy farmers have also been very careful in sending in the milk recording records to the cattle database. The incredible change in the structure may be a threat to the system in future, not only in Denmark but also in many other countries. With larger and more extensive herds with their own computer systems there is a risk that these herds will not send data to a common database, and this is of course necessary for the breeding plan and research and development in the future.
Figure 5 shows the database wheel for all registrations.
In Denmark the cattle breeding organizations and the dairy farmers have been so fortunate, that all dairy farmers for the latest two decades voluntary have used 33% young sires. Young sires are used for all 1st lactation cows and 20% of the heifers without any payment and any special benefits. Everybody has got the benefits in good proven bulls. With the change in structure in dairy cattle breeding and computer technology young sire test herds can be necessary both domestically and internationally.

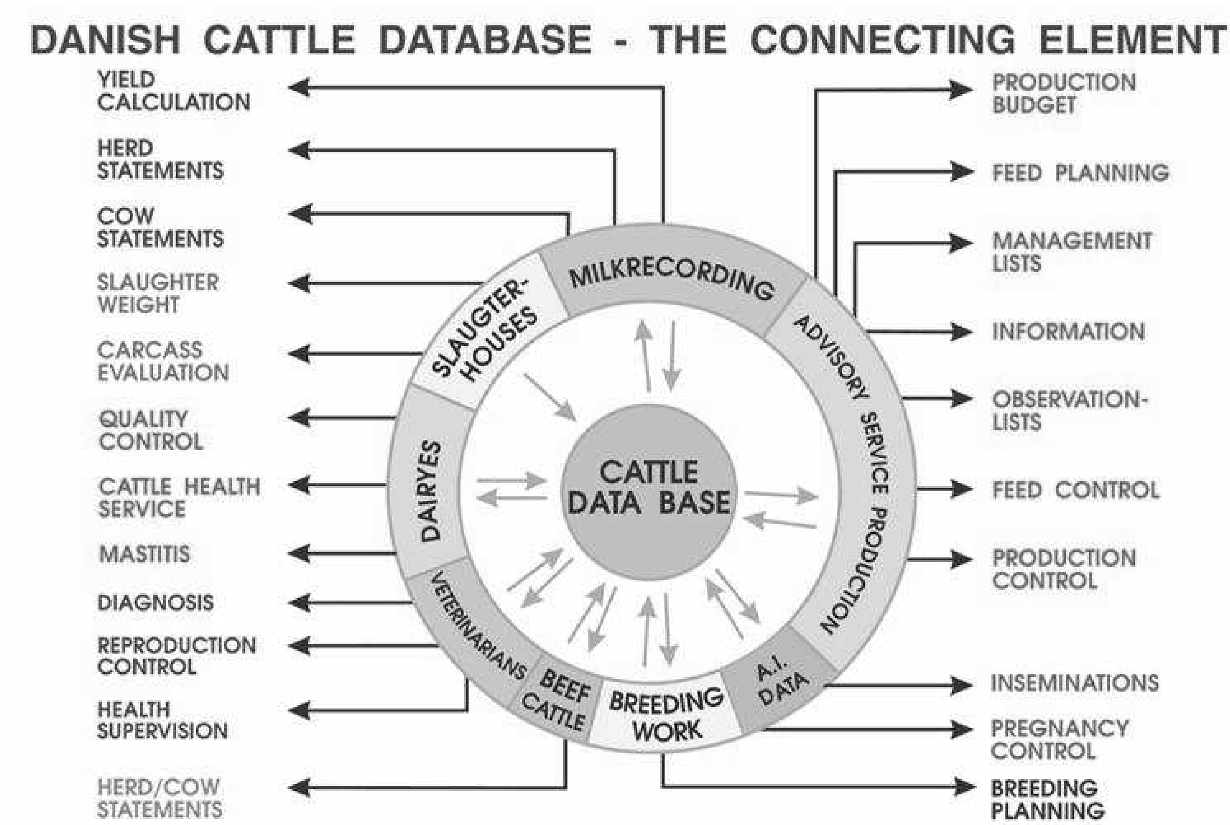

Figure 5. The Danish Cattle database

The future for cattle breeding in Europe

Population genetics including progeny testing will also be essential for the genetic progress and the tools to ensure dairy farmers the best genetics in the future. There will be a decreasing market in Europe, and new alliances, mergers and acquisitions will be emerging. It will not be realistic for everybody to compensate for a decreasing domestic market by exporting.
To breed sustainable cows in future we need an improvement in new products including sire and cow evaluations, gene markers, physiological predictors, better semen quality from the bulls, more knowledge on female fertility, development of new breeding schemes and progeny testing schemes, better and more reliable databases etc. Nobody can do that alone and if we do the development in competition, it will be more expensive and the progress in development will be

slower. Finally, nothing can be done and should be done if the dairy farmer in future is not in focus – everything we do should be done for him to breed better cows.

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