Report on Economic basis for a Nordic Total Merit Index
(Short version, May 2008 version)

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1. Introduction

An important step in design of breeding schemes is the definition of breeding goal. In the breeding goal each trait has to be weighted, expressing the direction and speed of genetic improvements for the trait. The economic value of a trait reflects the contribution of a unit genetic improvement for that trait to the improvement of total efficiency.

The breeding goal in the NAV countries Finland, Sweden and Denmark have for several years included both production and functional traits. In fact the Nordic countries have for more than 25 years been leading in that area with our “Nordic profile”.

During the last decade, the cooperation between the Nordic breeding organisations have been steadily more intensive, with some of the landmarks being the establishment of NAV in 2002, publication of the first common breeding values in 2005, and the establishment of the Swedish-Danish AI organisation Viking from January 2008.

Since the total merit indices in the NAV countries are quite similar, a natural continuation of the increased cooperation is to investigate the possibilities for a common NAV breeding goal. Therefore the present project was initiated. The objective of the project was to develop the economic basis for a Nordic total merit index. This includes:

- Assessment and analyses of the economic conditions for milk production in Sweden, Finland and Denmark from a perspective of dairy cattle breeding
- Development of an economic model that can evaluate the economic value of traits of interest
- Estimate and analyze economic values of the traits of interest for the Nordic Holstein breeds, the Nordic Red breeds and for the Jersey breed.

The result of this work is intended to serve as basis for a final evaluation of economic weights to be used in a Nordic Total Merit Index (NAV-TMI). The final evaluation will furthermore include breed policies as well as ethical and consumer aspects.

2. General assumptions

The basis for the economic values calculated in the present project is a deterministic economic model trying to mimic the economic situation on a dairy farm. It is the same type of model which in a simpler version has been used in the previous Danish calculations of economic values. The calculations are performed in an Excel sheet named “TMI”.

The model includes all important factors influencing the total economic output in dairy farming. The assumptions include basic figures on milk and feed pricing, pricing of other input and output factors, basic phenotypic levels for all traits, and work loads associated to handling of cows e.g. time used for a mastitis treatment or time used for an insemination. All these figures are given for the different breeds and the different production environments within the NAV area.

The breeds considered in the present analyses are Holstein, Red Dairy Cattle (RDM, SRB, FAY), and Jersey. The different production environments considered are Denmark, Sweden, Finland “South” and Finland “North”. Finland is divided in two regions due substantial differences in production circumstances.

In the project group the model assumptions have been discussed intensively, because differences in assumptions will of course create more or less different economic values. The most important assumptions are milk and feed prices and the assumed Marginal Feed Utilisation (MFU). These figures are important in relation to the balance between the weights given to production traits and functional traits. Increased feed prices (or reduced MFU), shifts the balance from production traits towards functional traits.

The assumed economic values are based on the economic situation in the first part of 2007 when the project was initiated. It would have been more optimal to use the economic values, which will be actual 5-10 years ahead, since offspring of breeding animals selected today first will exploit their genes 5-10 years ahead, but these are unknown. It has been decided not to use the actual increased milk and feed prices since they presumable not have reached a balance yet.

There are differences in the phenotypic levels for the different breeds and countries. Within Holsteins, these differences are mostly due to different management systems within the different countries, because the genetic background for the three breeds is very much the same.

The economic values calculated are marginal economic values, which mean the economic values of one unit improvement in the trait – keeping the remaining traits constant. The value of e.g. milk protein is therefore calculated as the economic profit of improving the yield with one kg of milk protein all other traits being constant.

In the following section there will be a short description of each of the evaluated trait groups.

3. Descriptions of trait group procedures

3.1 Production traits (yield)

In NAV there are 9 production traits evaluated: 305 day milk, protein and fat each in 1st, 2nd and 3rd lactation. As economy does not depend on 305 days yield, but on average yield from both culled cows and cows with a subsequent lactation, then a transformation of 305d production to herd production is needed. This is most easily obtained using a lactation curve model, in combination with the estimated herd structure, the distribution at different lactations, and the number of days in lactation for culled cows. These calculations are the basis for calculation of income from milk production and of feed requirements and finally feed costs.

The most important figures for estimating the value of milk production traits are the sales price of milk and marginal feed costs. In general higher feed prices compared to milk prices favourite functional traits in the breeding goal compared to yield traits, and higher protein prices decrease weights put on protein compared to weight put on fat. Furthermore an important factor that determines marginal feed cost is MFU.

Decreased MFU has the same effect as increased feed prices and visa versa. In the present situation it is the effect of increased yield capacity due to improved genetic level on MFU, which is of interest. The conclusions from the very few analyses of this problem are that the MFU due to genetic improvement is higher than the general MFU. All this leads to an assumption on a MFU of 65 %.

3.2 Beef production

Two beef production traits, net daily gain and EUROP form score, are evaluated. The economic value is evaluated on bull calves only, but it is important to have in mind that improvement of gain and form score in practice also have impact on slaughter value of females (heifers and cows).

Beef production systems are quite similar in Sweden and Finland. Most bull calves are raised in specialized herds to a slaughter weight of 320-330 kg. In Denmark 70 % of bull calves are raised in specialized herds and for RDM and SDM approximately 50% of the bull calves are slaughtered at a carcass weight just below 200 kg and the remaining part are slaughtered at an average carcass weight of 240 kg.

In practice a major part of Jersey bull calves are put to death at birth. The remaining part are slaughtered at a weight around 200 kg. In the calculation of value of beef production it is assumed that all Jersey bull calves are raised and slaughtered.

3.3 Fertility

The economic consequences of fertility are mostly due to a change in calving interval – this has effect on yearly production per cow. Furthermore the consequences are related to cost of AI – and work related to AI, and to cost of work related to heat detection.

The fertility traits currently evaluated in NAV are interval from first to last AI (IFL) for heifers, number of inseminations (AIS) for heifers, interval from calving to first insemination (ICF) for cows, IFL for cows, AIS for cows, and fertility treatments for cows.

The value of AIS depends only on AI-costs, and AI-costs are removed completely from the IFL value. Cost of AI has been discussed intensively. In the assumptions the costs of technician and handling and distribution of semen is included, but not the costs related to selection (payment to breeders, testing, and evaluation). In the current model AI-cost are similar (21 €/AI) in all countries.

An important relationship exists between fertility and yield. Fertility has an impact on yield through the effect of pregnancy. From around 120 days after conception milk yield is decreased with around 4-6 kg milk per day (Holstein and RDC). Another important question is, if a shorter calving interval will shorten days in milk (DIM) or days dry. In the basic assumptions, the average days dry are longer than the recommended 45-50 days. Therefore it is assumed, that a shorter calving interval will reduce average days dry and not average days in milk.

3.4 Calving traits

In the assessment of economic value of calving traits the costs of stillbirth and calving difficulty is taken into account. Cost of stillbirth is mostly lost income from raising heifers and bull calves but also from extra work and cost of destruction. Cost of calving difficulty is mostly extra work and veterinarian cost related to the difficult calving, but not cost due to subsequent complications since they are taken into account in the group of “other diseases”.

Stillbirth
General for all countries and breeds it is assumed that a stillborn calf require extra work of 0.25 hours. In Finland extra 0.50 hours is added because it is common practice (and allowed) to bury stillborn calves, whereas costs of destruction of stillborn calves are not included in Finland.

Calving difficulty
When percent difficult calvings are changed a proportional change in percent difficult calvings with veterinarian and without veterinarian assistance is assumed. It is assumed that 20 % of difficult calvings with veterinarian assistance require caesarean or dissections (higher cost). The same figure is used across countries and breeds. A "normal" difficult calving requires extra 1.5 hours work from the herdsmen. Caesarean and dissections require extra 3.0 hours work from the herdsmen. Besides, it is assumed that an easy calving **with help** require extra 0.20 hours(12 minutes) compared to an easy calving **without help**.

3.5 Somatic Cell Count (SCC)
Basically the economic value of SCC is a correction to the milk price.

Three different traits are evaluated: SCC 1st lactation, SCC 2nd lactation, SCC 3rd lactation (and later), whereas deductions in milk price due to SCC levels are made on total herd production.

This is solved by calculation of the average herd SCC. Based on this average – a distribution of herds on SCC-classes are calculated. Based on that distribution an average change in milk price is determined.

3.6 Mastitis resistance
The cost related to udder health is cost of veterinarian treatment, extra work for the herdsman, and amount of milk discarded due to treatment with antibiotics, hormones etc.

The basic assumptions on cost, extra work and days retained milk is generally picked up from the Danish advisory project "Health Economy". Costs of veterinarian treatments are assumed to be 10% higher in Sweden than in Denmark, and some of the Finnish costs are modified based on Finnish experiences.

The udder health traits currently evaluated in NAV are udder diseases before day 50 in 1st lactation, udder diseases 50-305 days in 1st lactation, udder diseases before day 305 in 2nd lactation, and udder diseases before day 305 in 3rd lactation, all measured as binary trait.

In the economic evaluation of udder health the importance is related to the total number of cases, and not to the occurrence measured as a binary trait. Therefore the relationship between those two figures must be known. Input to the calculation is average of the traits evaluated and the corresponding total number of cases. It is assumed that a change in the evaluated trait will change the total number of cases proportionately.

3.7 Resistance against other diseases
Calculation of costs related to other diseases is divided in costs related to metabolic diseases, feet and leg diseases, early reproductive diseases and late reproductive diseases. The calculations within groups follow same principles as described for mastitis above.

3.8 Conformation traits

The weights used to calculate breeding value for each of these three EBVs (Body, Feet & legs and Udder) from each of the linear traits has been set by the breed associations. The weights used can be found on NAV's homepage www.nordicebv.info

The task of the project group is not to re-estimate these weights – but only to estimate economic importance of the main characters Body, Feet & legs and Udder relative to other traits in the total merit index.

Therefore the setup for this trait group is somewhat different compared to the other traits groups. The traits to be analyzed are a kind of phenotype for Body, Feet & legs and Udder.

The basic economic assumptions are made by (subjective) assessment of the extra work-load in an average herd. In the original Danish setup this was made by subjective assessment in a herd of 70 milking cows. The current figures in the TMI-program are still the figures from the Danish 2002 report on economic weights:

- Body: It does not have any impact on work if all traits included in "Body" were linearly scored 1 point away from the optimum.
- Udder: If all traits included in "Udder" were linearly score 1 point away from the optimum, the extra work was assumed to be 15 minutes per day (91 hours per year).
- : Feet & legs: If all traits included in "Feet & legs" were linearly score 1 point away from the optimum, the extra work was assumed to be 10 minutes per day (61 hours per year).

For the two farmer-evaluated traits "Milking Speed" and "Temper" it is less complicated, because the recorded score can be evaluated directly. If milking speed of all cows are one unit lower it is assumed that the extra work would be 10 minutes per day. If tempers of all cows are 1 unit lower it was assumed that the extra work would be 5 minutes per day.

3.9 Longevity

The value of longevity is found via variation in the traits % culled in 1st lactation, % culled in 2nd lactation, and % culled in 3rd and later lactation. Changing culling rates will change the distribution of younger and older cows in the herd and also change number of calvings per year.

It is well known that breeding value of longevity is heavily influenced by fertility, udder health and other diseases and to some degree of conformation of Udder and of feet and legs. Therefore as much value as possible is transferred from longevity to the other trait in the TMI-index. This transfer is based on analyses of relationship between longevity and the other trait in the TMI-index.

4. Results for traits and sub indexes

The results from the TMI program is given in Euro per unit change of the trait. The results are of course dependent on the assumptions put into the program. Table 4.1 below gives the average values of the traits within Holstein and the deviation from the average for the different production environment. Table 4.2 and 4.3 show the corresponding results for Red Dairy Cattle and for Jersey.

Table 4.1 Average NAV-TMI economic values for **Holstein** and deviation from the values in different production environment.

Trait	Unit	Average EURO per unit	Denmark	Sweden	Finland "South"
MILK PRODUCTION					
Milk	Kg	**-0.030**	-0.049	-0.052	0.012
Fat	Kg	**1.28**	1.62	1.64	0.59
Protein	Kg	**4.60**	4.34	4.51	4.95
Standard milk	Kg	**0.181**	0.167	0.170	0.205
BEEF PRODUCTION					
Net daily gain	Kg/day	**201.3**	187.2	222.7	193.8
EUROP form score	Score	**13.8**	11.5	14.6	15.3
CALVING TRAITS					
% stillborn, 1st	%-units	**2.0**	1.7	2.2	2.2
Easy calving, 1st	4 point scale	**11.0**	11.2	11.7	10.1
% stillborn, later	%-units	**3.3**	2.7	3.3	3.9
Easy calving, later	4 point scale	**14.9**	20.0	11.1	13.5
FEMALE FERTILITY					
Heifer – first to last	Day	**0.73**	1.16	0.54	0.50
Cow – calv. To first	Day	**0.62**	0.43	0.61	0.81
Cow - first to last	Day	**2.35**	2.63	2.00	2.41
Heifer - no. of ins.	AIS	**10.17**	9.05	10.50	10.97
Cow – no. of ins.	AIS	**35.55**	39.13	31.40	36.11
MASTITIS*					
Mastitis, 1st	%-units	***1.50***	1.45	1.56	1.50
Mastitis, 2nd	%-units	***1.13***	1.15	1.09	1.15
Mastitis, 3rd+	%-units	***1.44***	1.42	1.35	1.55
Mastitis, all lact.	%-units	***4.07***	4.02	4.00	4.20
OTHER DISEASES**					
Metabolic	%-units	**1.88**	1.78	1.76	2.11
Feet & legs	%-units	**1.75**	1.77	1.62	1.88
Early reproductive	%-units	**2.00**	1.90	1.96	2.12
Late reproductive	%-units	**1.05**	0.88	1.06	1.21
LONGEVITY					
Average, culling	Day	**0.51**	0.51	0.42	0.63
CONFORMATION					
Body	Point	**0.0**	0.0	0.0	0.0
Udder	Point	**25.6**	25.6	25.6	25.6
Feet & legs	Point	**17.0**	17.0	17.0	17.0
Milking speed	Point	**17.0**	17.0	17.0	17.0
Temperament	Point	**8.5**	8.5	8.5	8.5

* The economic value calculated is the value of 1 % change in frequency (eg. from 15 % mastitis to 16 % mastitis) corrected for the number of animals in the different groups.

** The economic value calculated is the value of 1 % change in frequency.

Table 4.2 Average NAV-TMI economic values for **Red Dairy Cattle** and deviation from the values in different production environment.

Trait	Unit	Average EURO per unit	Denmark	Sweden	Finland "South"
MILK PRODUCTION					
Milk	Kg	**-0.029**	-0.049	-0.054	0.015
Fat	Kg	**1.33**	1.63	1.69	0.67
Protein	Kg	**4.81**	4.35	4.61	5.49
Standard milk	Kg	**0.190**	0.167	0.174	0.230
BEEF PRODUCTION					
Net daily gain	Kg/day	**222.8**	204.6	266.2	197.5
EUROP form score	Score	**13.6**	11.8	14.6	14.5
CALVING TRAITS					
% stillborn, 1st	%-units	**2.01**	1.71	2.22	2.09
Easy calving, 1st	4 point scale	**11.35**	12.95	12.21	9.02
% stillborn, later	%-units	**3.37**	2.99	3.44	3.68
Easy calving, later	4 point scale	**15.62**	23.66	10.46	12.93
FEMALE FERTILITY					
Heifer – first to last	Day	**0.61**	0.61	0.56	0.66
Cow – calv. To first	Day	**0.56**	0.56	0.62	0.51
Cow - first to last	Day	**1.78**	1.35	1.41	2.56
Heifer - no. of ins.	AIS	**10.14**	9.26	10.69	10.46
Cow – no. of ins.	AIS	**27.24**	17.94	20.38	43.41
MASTITIS*					
Mastitis, 1st	%-units	**1.46**	1.44	1.52	1.41
Mastitis, 2nd	%-units	**1.05**	1.07	1.00	1.08
Mastitis, 3rd+	%-units	**1.49**	1.63	1.41	1.44
Mastitis, all lact.	%-units	**4.00**	4.14	3.93	3.93
OTHER DISEASES**					
Metabolic	%-units	**1.87**	1.77	1.85	1.98
Feet & legs	%-units	**1.70**	1.78	1.55	1.77
Early reproductive	%-units	**1.93**	1.92	1.91	1.94
Late reproductive	%-units	**1.04**	0.92	1.06	1.14
LONGEVITY					
Average, culling	Day	**0.38**	0.43	0.32	0.41
CONFORMATION					
Body	Point	**0.0**	0.0	0.0	0.0
Udder	Point	**25.5**	25.5	25.5	25.5
Feet & legs	Point	**17.0**	17.0	17.0	17.0
Milking speed	Point	**17.0**	17.0	17.0	17.0
Temperament	Point	**8.5**	8.5	8.5	8.5

* The economic value calculated is the value of 1 % change in frequency (eg. from 15 % mastitis to 16 % mastitis) corrected for the number of animals in the different groups.

** The economic value calculated is the value of 1 % change in frequency.

Table 4.3 NAV-TMI economic values for the **Jersey**

Trait	Unit	Average EURO per unit
MILK PRODUCTION		
Milk	Kg	**-0.046**
Fat	Kg	**1.55**
Protein	Kg	**4.15**
Standard milk	Kg	**0.16**
BEEF PRODUCTION		
Net daily gain	Kg/day	**45.6**
EUROP form score	Score	**10.1**
CALVING TRAITS		
%stillborn, 1st	%-units	**0.79**
Easy calving, 1st	4 point scale	**15.7**
%stillborn, later	%-units	**1.46**
Easy, later	4 point scale	**33.7**
FEMALE FERTILITY		
Heifer – first to last	Day	**0.93**
Cow – calv. To first	Day	**0.28**
Cow - first to last	Day	**1.61**
Heifer - no. of ins.	AIS	**9.27**
Cow – no. of ins.	AIS	**27.14**
MASTITIS*		
Mastitis, 1st	%-units	**1.35**
Mastitis, 2nd	%-units	**1.01**
Mastitis, 3rd+	%-units	**1.75**
Mastitis, all lact.	%-units	**4.11**
OTHER DISEASES**		
Metabolic	%-units	**1.70**
Feet & legs	%-units	**1.69**
Early reproductive	%-units	**1.91**
Late reproductive	%-units	**0.94**
LONGEVITY		
Average, culling	Day	**0.40**
CONFORMATION		
Body	Point	**0.0**
Udder	Point	**25.6**
Feet & legs	Point	**17.0**
Milking speed	Point	**17.0**
Temperament	Point	**8.5**

* The economic value calculated is the value of 1 % change in frequency (eg. from 15 % mastitis to 16 % mastitis) corrected for the number of animals in the different groups.

** The economic value calculated is the value of 1 % change in frequency.

Based on these values for the individual traits the index weight for the standardized 13 sub-indexes included in the total merit index is calculated. Due to the standardisation the index weights also depends on the accuracy of the EBV's for the different traits. For the "non-NAV" indexes (beef production and longevity index) the weights are based on Danish standardization factors only. The results are presented in table 4.4-4.6

It is well known that most of the economic value given to longevity is due to other functional traits. This part of the economic weight is therefore redistributed to the traits where it belongs. In the tables the weights are rescaled so the weight for yield is set to 1 for all set of index weights.

The economic value of somatic cell count is not included in the udder heath index because it turned out that somatic cell count contribute only around 1% to the variation of udder health.

It is also important to point out that these results reflect the economic situation at the beginning of 2007. When the final decision on weight are made it will be important to include expectation to economic development at least 5 to 10 years ahead.

Table 4.4 Weight factors to be given to the different sub indices in the present total merit indices and the calculated NAV-TMI weights for **Holstein**. The weights are scaled such that weight on yield is equal to 1.

Trait	Denmark	Sweden	Finland	Holstein
	S-index	Tjur index	Kokonaisja-lostusarvo	Average NAV-TMI
Yield index	1.00	1.00	1.00	**1.00***
Beef production	0.14	-	-	**0.08**
Fertility	0.26	0.50	0.30	**0.41**
Birth index	0.17	0.19	-	**0.20**
Calving index	0.17	0.37	0.10	**0.22**
Udder health	0.42	0.48	0.50	**0.46**
Other disease	0.06	0.06	-	**0.16**
Body	0.06	-	-	**0.00**
Feet & legs	0.16	0.29	0.10	**0.10**
Udder	0.26	0.29	0.30	**0.12**
Milk ability	0.17	-	-	**0.11**
Temperament	0.05	-	-	**0.04**
Longevity	0.17	0.16	-	**0.15**

* The economic value of one index unit for yield in the Average NAV-TMI index is 7.61 €. The economic value per index unit for other traits in the Average NAV-TMI index has the same ratio compared to yield as the ratio between index weights (e.g. the economic weight for one index unit for udder health is 0.46*7.61 €=3.50 €)

Table 4.5 Weights factors to be given to the different sub indices in the present total merit indices and the calculated NAV-TMI weight for **Red Dairy Cattle**. The weights are scaled such that weight on yield is equal to 1.

Trait	RDM Denmark	SRB Sweden	FAY Finland	RDC Average NAV-TMI
	S-index	Tjur index	Kokonaisja-lostusarvo	
Yield index	1.0	1.0	1.0	**1.00**
Beef production	0.13	-	-	**0.11**
Fertility	0.19	0.43	0.33	**0.28**
Birth index	0.13	0.10	-	**0.15**
Calving index	0.10	0.13	-	**0.13**
Udder health	0.45	0.43	0.44	**0.34**
Other disease	0.09	0.06	-	**0.13**
Body	-	-	-	**0.00**
Feet & legs	0.13	0.20	0.11	**0.07**
Udder	0.10	0.30	0.44	**0.14**
Milk ability	0.16	-	-	**0.07**
Temperament	0.10	-	-	**0.03**
Longevity	0.15	0.14	-	**0.09**

* The economic value of one index unit for yield in the Average NAV-TMI index is 8.33 €. The economic value per index unit for other traits in the Average NAV-TMI index has the same ratio compared to yield as the ratio between index weights (e.g. the economic weight for one index unit for udder health is 0.34*8.33 €=2.85 €)

Table 4.6 Weights factors to be given to the different sub indices in the present total merit indices and the calculated NAV-TMI indices for **Jersey**. The weights are scaled such that weight on yield is equal to 1.

Trait	Jersey Denmark	Jersey
	S-index	NAV-TMI
Yield index	1.00	**1.00**
Beef production	-	**0.03**
Fertility	0.23	**0.23**
Birth index	0.04	**0.07**
Calving index	0.08	**0.06**
Udder health	0.33	**0.51**
Other disease	0.07	**0.05**
Body	-	**0**
Feet & legs	0.12	**0.06**
Udder	0.23	**0.15**
Milk ability	0.05	**0.11**
Temperament	0.02	**0.03**
Longevity	0.18	**0.14**

* The economic value of one index unit for yield is 6.00 €. The economic value per index unit for other traits has the same ratio compared to yield as the ratio between index weights (e.g. the economic weight for one index unit for udder health is 0.51*6.00 €=3.06 €)

5. “Genetic gain” using the proposed economic weights

The index weights described in the previous chapter do not effectively describe the genetic progress that can be obtained using the NAV-TMI. However, genetic correlations between the total merit index and the sub-indices for AI-bulls gives an estimate for the obtained genetic progress for the traits in the breeding goal, even though there is a tendency towards overestimation of the genetic gain for low heritability traits using this method, because it ignore bull dam selection. Another disadvantage of this approach is that it is quite sensitive to number of sires included in the analyses and to the number bull sires represented.

The correlations shown in the present chapter are correlations between total merit indices and sub indices based on EBV’s from progeny tested bulls born in 1999, 2000 and 2001 in Finland, Sweden and Denmark. As mentioned, the correlations are quite rough, and they are dependent on the number of sires included. If the number is low, as in the present situation (no groups above 1000 bulls) then the correlations will be dependent on some dominant sires of sons used in that group. That is probably the reason for the relatively large differences in correlations between NAV-TMI and sub-indexes in different countries in table 5.1 (Holsteins). For the correlations based on Red Dairy Cattle (table 5.2) the differences can also be due to different breed composition.

However, the correlations can be used as an indicator for the change in the direction of the genetic progress going from the national index to an average NAV-TMI index.

Table 5.1 Correlation between the total merit index and sub indices within country using present total merit indices or the calculated average NAV-TMI weights for **Holstein**.

Trait	Denmark		Sweden		Finland	
	S-index	Average NAV-TMI	Tjur index	Average NAV-TMI	Koko-naisja-lostusarvo	Average NAV-TMI
Yield index	0.53	0.48	0.42	0.64	0.75	0.62
Beef production	0.08	0.05	-0.13	0.05	-	-
Fertility	0.32	0.45	0.32	0.20	0.00	0.32
Birth index	0.31	0.35	0.44	0.43	0.06	0.20
Calving index	0.37	0.42	0.53	0.49	0.23	0.31
Udder health	0.41	0.43	0.39	0.23	0.48	0.38
Other disease	0.44	0.54	0.23	0.30	0.34	0.46
Body	0.02	-0.05	0.08	0.03	0.20	0.02
Feet & legs	0.14	0.09	0.29	0.04	0.11	-0.03
Udder	0.45	0.38	0.35	0.17	0.42	0.23
Milk ability	0.21	0.16	0.01	0.09	0.14	0.12
Temperament	0.05	0.00	-0.01	0.13	0.10	0.08
Longevity	0.49	0.52	0.44	0.46	0.36	0.45

Table 5.2 Correlation between the total merit index and sub indices within country using present total merit indices or the calculated NAV-TMI weights for Nordic Red Cattle

Trait	RDM – Denmark		SRB – Sweden		FAY– Finland	
	S-index	Average NAV-TMI	Tjur Index	Average NAV-TMI	Koko-naisja-lostusarvo	Average NAV-TMI
Yield index	0.64	0.70	0.52	0.76	0.66	0.79
Beef production	-0.02	-0.01	0.21	0.38	-	-
Fertility	0.08	0.21	0.34	0.29	0.19	0.17
Birth index	0.21	0.21	0.17	0.25	0.0	0.17
Calving index	-0.05	-0.02	0.32	0.31	0.15	0.25
Udder health	0.55	0.50	0.38	0.17	0.32	0.18
Other disease	0.43	0.49	0.09	0.16	0.09	0.14
Body	-0.12	-0.15	0.12	0.02	0.19	0.11
Feet & legs	0.02	0.00	0.14	-0.08	0.14	0.09
Udder	0.36	0.34	0.34	0.07	0.40	0.14
Milk ability	0.31	0.23	0.03	0.12	0.12	0.24
Temperament	0.16	0.09	-0.01	0.12	0.11	0.23
Longevity	0.61	0.51	0.49	0.44	0.27	0.23

Table 5.3 Correlation between the total merit index and sub indices using present total merit indices or the calculated NAV-TMI weights for Jersey.

Trait	Jersey – Denmark	
	S-index	NAV-TMI
Yield index	0.74	0.70
Beef production	0.15	0.19
Fertility	0.36	0.21
Birth index	0.20	0.22
Calving index	-0.16	-0.21
Udder health	0.43	0.50
Other disease	0.31	0.26
Body conformation	-0.21	-0.22
Feet & legs	0.24	0.23
Udder	0.24	0.23
Milk ability	-0.04	0.00
Temperament	0.34	0.33
Longevity	0.30	0.29

6. Comparison with results presented at workshop January 8th

Below a summary of changes made since January 2008 are listed, and in table 6.1 there is a comparison of index weights presented at the workshop in January 2008 and the index weights after revision.

Economy

- Finnish sales value of milk is increased (some subsidies included)
- Finnish sales value of beef (some subsidies included)

Model and basic biological assumptions

- Improved method for calculation of value of calving ease
- Heifer fertility: Maximum length of insemination period extended to 168 days (from 126 days)
- Fertility in general: Basic input parameters revised (Largest changes for RDM and for Swedish heifers)
- Reproductive diseases subdivided in “Early reproductive” and “Late reproductive diseases”
- For all diseases repeatability factors have been revised (repeatability = total number of cases/incidence of disease)
- Labour cost has been revised for all diseases (extra labour per case)
- Correction of calculation of amount of milk used for calf feed (milk production the first 4 days)
- Improved model for calculation of value of growth rate

Errors corrected

- Same value for days in milk of culled cows was used across breeds and countries (same lactation length for culled cows)
- Same sales value for beef from young bulls was used across breeds and countries

Table 6.1 Comparison of results presented at workshop January 8th, 2008 with new results after revision. The weights are scaled such that weight on yield is equal to 1.

	Average NAV-TMI					
	Holstein		**RDC**		**Jersey**	
Trait	**Workshop**	**New**	**Workshop**	**New**	**Workshop**	**New**
Yield index	1.00	1.00	1.0	1.00	1.00	1.00
Beef production	0.09	0.08	0.12	0.11	0.06	0.03
Fertility	0.42	0.41	0.38	0.28	0.22	0.23
Birth index	0.11	0.20	0.09	0.15	0.06	0.07
Calving index	0.15	0.22	0.09	0.13	0.05	0.06
Udder health	0.37	0.46	0.30	0.34	0.44	0.51
Other disease	0.15	0.16	0.17	0.13	0.04	0.05
Body conf.	-	0.00	-	0.00	0.00	0.00
Feet&Legs conf.	0.09	0.10	0.08	0.07	0.08	0.06
Udder conf.	0.10	0.12	0.14	0.14	0.14	0.15
Milk ability	0.10	0.11	0.07	0.07	0.09	0.11
Temperament	0.04	0.04	0.03	0.03	0.02	0.03
Longevity	0.13	0.15	0.09	0.09	0.13	0.14