NAV Nordisk Avlsværdi Vurdering
Nordic Cattle Genetic Evaluation

2018 Review of Nordic Total Merit Index Sensitivity Analyses
May 2018

By Lars Peter Sørensen, Jørn Pedersen, Morten Kargo, Ulrik Sander Nielsen, Freddy Fikse, Jan-Åke Eriksson, Jukka Pösö, and Gert Pedersen Aamand

Content

Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne:
Danmark og Europa investerer i landdistrikterne

Miljø- og Fødevareministeriet
Landbrugsstyrelsen

Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne

LDP 2020

Se EU-Kommissionen, Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne

1 Sensitivity analyses

The economic values, we have shown so far, are based on a fixed set of economic and biological or management assumptions. Many of the assumptions are associated with some uncertainty. The effect of this these uncertainties on the economic values must be addressed, i.e. how sensitive are the economic values to changes to the assumptions. At the January 2018 NAV Workshop, recommendations for some additional analyses were made and additional recommendations were received from the HOL, RDC and JER breeding organizations during Spring 2018.

In the following, results from these additional analyses are presented at two levels: (1) Those related to economic assumptions, and (2) those associated with biological/management assumptions. The results of the sensitivity analyses are calculated as averages across countries only and will be presented as deviations (both actual and percentage) from the economic values based on the standard scenarios using conventional assumptions if nothing else is mentioned. Deviations less than 3 % are considered minor and will not be discussed.

1.1 Change of economic assumptions

Below, the results of changed economic assumptions are described and explained. Overviews of all the results are shown in Table 1.1, 1.2, and 1.3 for HOL, RDC, and JER, respectively.

1.1.1 Sales value of milk

Changes to economic values, when the sales value of milk, fat and protein is decreased by 10 %, are shown. Increasing the sales value will have a similar effect but in the opposite direction. The total income from milk is decreased by 10 %, and if all costs are unchanged the profit from improving fat and protein yield decreases by 20 %. Weighting of fat, protein and milk yield for calculation of standard milk results in a decreased economic value of 1 kg of standard milk of 18.3 % for all breeds.

Improvement of ICF (interval from calving to first insemination) leads to more calvings and therefore higher annual milk production. With a lower milk price, the effect on the economic value of ICF is -0.06 €/day in all breeds. However, because the initial value for JER based on conventional assumptions is 4-5 times lower than for HOL and RDC, the proportional decrease is much higher in JER. The actual change in the economic values for IFL_{cows} (interval from first to last insemination) is similar to the value of ICF.

Improving longevity leads to a higher proportion of older cows and therefore higher milk production, but because this extra milk is sold at a lower price, the economic value of longevity decreases 0.04 €/day for all breeds.

Minor effects of decreased milk price were seen for the disease traits (4 % for udder health) and calving ease because less milk is discarded when these traits are improved – more milk can be sold but at a lower price. Calving ease includes costs related to difficult calvings with veterinary assistance which may involve cesarean or dissection of calves. This requires antibiotic treatment and some milk must be discarded because of this.

1.1.2 Feed costs

The effects on the economic values, when feed costs were increased by 10 %, are shown. The effects of decreasing the feed costs are similar but in opposite direction. Generally, changed feed costs only affect traits where improvement results in more milk or more animals for slaughter, i.e. milk, daily gain, survival rate, ICF and IFL_{cows} and young stock survival traits.

The largest proportional effect (-18.5 %) of increased feed costs was seen for ICF – the actual change is -0.12 €/day and was similar for IFL_{cows}. Improvement of ICF results in more annual calvings and, therefore, increased milk production, but also more calves (beef crosses) can be sold for slaughter. However, the profit per kg milk or per kg meat is decreased because production costs have increased. The proportional impact of feed costs on milk and daily gain was much less but still negative. Finally, improvement of survival of bull calves results in more bulls and beef crosses for slaughter. Improvement of heifer survival means that fewer replacement heifers need to be born; instead more cows can be inseminated with beef semen resulting in more animals for slaughter. The negative impact of increased feed costs was almost similar for the four young stock survival traits.

In JER, the effect of increased feed costs on traits, where improvement results in more animals for slaughter, is less than in HOL and RDC. The reason for this is that JER grows slower than HOL and RDC and needs more feed per kg gain. Also, very few JER bull calves are slaughtered at 10 months of age – most are young bulls (>10 months) which have a lower slaughter price per kg. This creates a lower (on average) slaughter price per kg in JER and as a result a lower impact when the feed price is increased because the difference in profit between improving and not improving a trait is less than in HOL and RDC.

Note that the economic values for the disease traits do not change when feed costs are changed. This is because the costs of producing the milk is the same whether the milk is sold or being retained/discarded. When calculating economic values for disease traits only the value of discarded milk is included, i.e. milk price.

1.1.3 Sales price of meat

Changes to economic values, when beef price is reduced by 10 %, are shown. Increasing the beef price will have a similar effect but in the opposite direction. The same traits as shown above (1.1.2. Feed costs) excluding milk are affected when the price of beef is reduced. Again, changes to economic values for HOL and RDC were larger than for JER (see explanation above). The effect of improving daily gain was reduced by approx. 25 % when the beef price was reduced by 10 %. The effects on ICF and IFL_{cows} were similar but the proportional change was much larger for ICF because of the much lower economic value per day compared to IFL_{cows}. The impact on changes to economic values for the young stock survival traits, when sales price for beef was reduced by 10 %, were much larger (×2) than observed when feed costs were increased by 10 %.

1.1.4 Veterinary treatment costs

A veterinary treatment consists of treatment fee (allowance for veterinarian and mileage) + costs related to materials and medicine. The veterinary treatment costs were increased by 10 % including treating costs (medicine and materials) for some claw health disorders. This resulted in increased economic values for traits including any veterinary treatment. The largest effects were seen for disease traits where the impact of health agreement schemes are smallest, i.e. metabolic and reproductive diseases (7-8%); whereas diseases with a larger degree of treatment by the herd manager were affected less, i.e. mastitis and feet & legs diseases (4-5 %). The effect of increased treatment costs on claw health disorders including treatment costs (sole ulcer, horn heel erosion, digital dermatitis, and interdigital hyperplasia) was modest ~4 %.

1.1.5 Labor costs

Labor costs were increased by 10 % and only include allowance for herd manager – claw trimmer allowance was not increased. Calculation of marginal economic values for the conformation, milking speed and temperament traits only includes extra work; thus, the economic values for these traits increased by 10 % for all breeds when labor costs were increased by 10 %. The impact on the economic values of calving ease and claw health traits were less; these were increased by 4-6 %. Only minor increased economic values of mastitis and other diseases were observed when labor costs were increased.

Table 1.1. Results for sensitivity analyses of conventional economic assumptions for Holstein. Actual differences in € are presented. Change in % is shown in ( ) if larger than 3 %.

TRAIT		ALTERNATIVE					
	Unit	Conv. average, €	Milk price ÷10 %	Feed price +10 %	Beef price ÷10 %	Vet. treatment costs +10 %	Labor costs +10%
MILK PRODUCTION							
Standard milk[1]	kg	0.191	÷0.035 (18)	÷0.02 (8)	0.00	0.00	0.00
BEEF PRODUCTION							
Daily gain	kg/day	0.213	0.00	÷0.036 (17)	÷0.055 (26)	0.00	0.00
EUROP form	score	11.1	0.00	0.00	0.00	0.00	0.00
CALVING TRAITS							
Survival rate 1st	%-unit	1.61	0.00	÷0.12 (8)	÷0.25 (16)	0.00	0.00
Survival rate later, maternal	%-unit	3.92	0.00	÷0.34 (9)	÷0.67 (17)	0.00	0.00
Survival rate later, direct	%-unit	2.55	0.00	÷0.22 (9)	0.00	0.00	0.00
Calving ease 1st	point	5.63	÷0.01	0.00	0.00	0.19 (3)	0.36 (6)
Calving ease later, maternal	point	26.58	÷0.09 (3)	0.00	0.00	1.15 (4)	1.43 (5)
Calving ease later, direct	point	15.67	÷0.05 (3)	0.00	0.00	0.69 (4)	0.83 (5)
FEMALE FERTILITY							
IFL heifers	day	0.80	-0.00	0.01	0.01	0.00	0.02
ICF cows	day	0.54	÷0.06 (12)	÷0.12 (23)	÷0.15 (27)	÷0.01	÷0.02 (4)
IFL cows	day	4.24	-0.06	÷0.12 (3)	÷0.15 (4)	÷0.01	0.14
UDDER HEALTH							
Udder health all parities	%-unit	4.34	÷0.17 (4)	0.00	0.00	0.19 (4)	0.08
GENERAL HEALTH							
Other metabolic, all parities	%-unit	3.16	÷0.05	0.00	0.00	0.23 (7)	0.04
Ketosis, all parities	%-unit	1.45	0.00	0.00	0.00	0.11 (7)	0.03
Feet & legs, all parities	%-unit	1.61	÷0.04	0.00	0.00	0.07 (4)	0.05
Early repro, all parities	%-unit	2.10	÷0.06	0.00	0.00	0.11 (5)	0.04
Late repro, all parities	%-unit	1.81	÷0.03	0.00	0.00	0.12 (7)	0.03
LONGEVITY							
Average culling[3]	day	0.31	÷0.04 (13)	0.00	0.01	0.00	0.00
CONFORMATION a.o.							
Frame	point	0.00	0.00	0.00	0.00	0.00	0.00
Udder	point	29.07	0.00	0.00	0.00	0.00	2.91 (10)
Feet & legs conf.	point	19.38	0.00	0.00	0.00	0.00	1.94 (10)
Milking speed	point	19.38	0.00	0.00	0.00	0.00	1.94 (10)
Temperament	point	9.69	0.00	0.00	0.00	0.00	0.97 (10)
CLAW HEALTH							
Sole ulcer, all parities	%-unit	0.586	0.00	0.00	0.00	0.022 (4)	0.031 (5)
Sole hemorrhage, all parities	%-unit	0.096	0.00	0.00	0.00	0.00	0.0057 (6)
Horn heel erosion, all parities	%-unit	0.148	0.00	0.00	0.00	0.0052 (4)	0.0058 (4)
Digital dermatitis, all parities	%-unit	0.148	0.00	0.00	0.00	0.0052 (4)	0.0058 (4)
Cork screw claw, all parities	%-unit	0.077	0.00	0.00	0.00	0.00	0.00
Interdigital hyperplasia, all parities	%-unit	0.295	0.00	0.00	0.00	0.010 (4)	0.012 (4)
White line disease, all parities	%-unit	0.96	0.00	0.00	0.00	0.00	0.0058 (6)
YOUNG STOCK SURVIVAL							
Survival heifers 1-30 d,	%-unit	3.43	0.00	÷0.24 (7)	÷0.50 (14)	0.00	0.00
Survival heifers 31-458 d	%-unit	3.68	0.00	÷0.16 (4)	÷0.44 (12)	0.00	0.00
Survival bulls 1-30 d,	%-unit	1.72	0.00	÷0.16 (9)	÷0.32(18)	0.00	0.00

Survival bulls, 31-184 d	%-unit	2.29	0.00	÷0.18 (8)	÷0.39 (17)	0.00	0.00

[1]4.20 % fat and 3.40 protein

[2]IFL, time between first and last insemination; ICF, time from calving to 1st insemination

[3]Average economic value of culling in 1st, 2nd and 3rd parity

Table 1.2. Results for sensitivity analyses of conventional, economic assumptions for RDC. Actual differences in € are presented. Change in % is shown in ( ) if larger than 3 %.

TRAIT			ALTERNATIVE				
	Unit	Conv. average, €	Milk price ÷10 %	Feed price +10 %	Beef price ÷10 %	Vet. treatment costs +10 %	Labor costs +10%
				MILK PRODUCTION			
Standard milk[1]	kg	0.189	÷0.035 (18)	÷0.02 (8)	0.00	0.00	0.00
				BEEF PRODUCTION			
Daily gain	kg/day	0.230	0.00	÷0.036 (16)	÷0.056 (24)	0.00	0.00
EUROP form	score	11.3	0.00	0.00	0.00	0.00	0.00
				CALVING TRAITS			
Survival rate 1st	%-unit	1.63	0.00	÷0.12 (8)	÷0.25 (15)	0.00	0.00
Survival rate later, maternal	%-unit	3.92	0.00	÷0.33 (8)	÷0.67 (17)	0.00	0.00
Survival rate later, direct	%-unit	2.55	0.00	÷0.21 (8)	÷0.43 (17)	0.00	
Calving ease 1st	point	5.79	÷0.01	0.00	0.00	0.19 (3)	0.37 (7)
Calving ease later, maternal	point	25.01	÷0.08 (3)	0.00	0.00	1.14 (5)	1.28 (5)
Calving ease later, direct	point	14.97	÷0.04 (3)	0.00	0.00	0.69 (5)	0.76 (5)
				FEMALE FERTILITY			
IFL heifers	day	0.94	0.00	0.01	0.00	0.00	0.02 (3)
ICF cow	day	0.64	÷0.06 (9)	÷0.12 (19)	÷0.16 (24)	÷0.01	÷0.02 (3)
IFL cows	day	3.46	÷0.06	÷0.12 (4)	÷0.15 (4)	÷0.01	0.14 (3)
				UDDER HEALTH			
Udder health all parities	%-unit	4.22	÷0.15 (4)	0.00	0.01	0.19 (5)	0.08
				GENERAL HEALTH			
Other metabolic, all parities	%-unit	3.17	÷0.05	0.00	0.00	0.23 (7)	0.04
Ketosis, all parities	%-unit	1.49	0.00	0.00	0.00	0.11 (7)	0.03
Feet & legs, all parities	%-unit	1.62	÷0.04	0.00	0.00	0.07 (4)	0.05
Early repro, all parities	%-unit	2.09	÷0.05	0.00	0.00	0.12 (7)	0.04
Late repro, all parities	%-unit	1.76	÷0.03	0.00	0.00	0.12 (8)	0.03
				LONGEVITY			
Average culling[3]	day	0.28	÷0.04 (13)	0.00	0.01	0.00	0.00
				CONFORMATION a.o.			
Frame	point	0.00	0.00	0.00	0.00	0.00	0.00
Udder	point	29.07	0.00	0.00	0.00	0.00	2.91 (10)
Feet & legs conf.	point	19.38	0.00	0.00	0.00	0.00	1.94 (10)
Milking speed	point	19.38	0.00	0.00	0.00	0.00	1.94 (10)
Temperament	point	9.69	0.00	0.00	0.00	0.00	0.97 (10)
				CLAW HEALTH			
Sole ulcer, all parities	%-unit	0.595	0.00	0.00	0.00	0.022 (4)	0.032 (5)
Sole hemorrhage, all parities	%-unit	0.097	0.00	0.00	0.00	0.00	0.0058 (6)
Horn heel erosion, all parities	%-unit	0.154	0.00	0.00	0.00	0.0054 (4)	0.0060 (4)
Digital dermatitis, all parities	%-unit	0.154	0.00	0.00	0.00	0.0052 (4)	0.0058 (4)
Cork screw claw, all parities	%-unit	0.077	0.00	0.00	0.00	0.00	0.00
Interdigital hyperplasia, all parities	%-unit	0.296	0.00	0.00	0.00	0.010 (4)	0.012 (4)
White line disease, all parities	%-unit	0.096	0.00	0.00	0.00	0.00	0.0058 (6)
				YOUNG STOCK SURVIVAL			
Survival heifers 1-30 d	%-unit	3.30	0.00	÷0.23 (7)	÷0.47 (14)	0.00	0.00
Survival heifers 31-458 d	%-unit	3.66	0.00	÷0.16 (5)	÷0.44 (12)	0.00	0.00
Survival bulls 1-30 d	%-unit	1.92	0.00	÷0.16 (8)	÷0.34 (18)	0.00	0.00
Survival bulls, 31-184 d	%-unit	2.09	0.00	÷0.16 (8)	÷0.35 (17)	0.00	0.00

[1]4.20 % fat and 3.40 protein

[2]IFL, time between first and last insemination; ICF, time from calving to 1st insemination

[3]Average economic value of culling in 1st, 2nd and 3rd parity

Table 1.3. Results for sensitivity analyses of economic conventional assumptions for JER. Actual differences in € are presented. Change in % is shown in ( ) if larger than 3 %.

TRAIT			ALTERNATIVE				
	Unit	Conv. average, €	Milk price ÷10 %	Feed price +10 %	Beef price ÷10 %	Vet. treatment costs +10 %	Labor costs +10%
				MILK PRODUCTION			
Standard milk[1]	kg	0.191	÷0.034 (18)	÷0.02 (8)	0.00	0.00	0.00
				BEEF PRODUCTION			
Daily gain	kg/day	0.192	0.00	÷0.022 (12)	÷0.043 (22)	0.00	0.00
EUROP form	score	6.1	0.00	0.00	0.00	0.00	0.00
				CALVING TRAITS			
Survival rate 1st	%-unit	0.85	0.00	÷0.09 (11)	÷0.17 (19)	0.00	0.00
Survival rate later, maternal	%-unit	3.13	0.00	÷0.36 (12)	÷0.68 (22)	0.00	0.00
Survival rate later, direct	%-unit	1.87	0.00	÷0.22 (12)	÷0.40 (21)	0.00	0.00
Calving ease 1st	point	10.76	÷0.03	0.00	0.00	0.56 (5)	0.48
Calving ease later, maternal	point	120.95	÷0.39 (3)	0.00	0.00	5.94 (5)	5.77 (5)
Calving ease later, direct	point	64.72	÷0.20 (3)	0.00	0.00	3.19 (5)	3.07 (5)
				FEMALE FERTILITY			
IFL heifers	day	1.26	0.00	0.03	÷0.01	0.00	0.03
ICF cows	day	0.18	÷0.06 (36)	÷0.10 (54)	÷0.10 (55)	-0.01 (8)	-0.02
IFL cows	day	2.56	÷0.06	÷0.10 (4)	÷0.10 (4)	-0.01	0.08
				UDDER HEALTH			
Udder health, all parities	%-unit	4.45	÷0.18 (4)	0.00	0.01	0.17 (4)	0.10
				GENERAL HEALTH			
Other metabolic, all parities	%-unit	3.10	÷0.05	0.00	0.00	0.22 (7)	0.04
Ketosis, all parities	%-unit	1.56	0.00	0.00	0.00	0.12 (8)	0.04
Feet & legs, all parities	%-unit	1.79	÷0.04	0.00	0.00	0.07 (4)	0.06
Early repro, all parities	%-unit	2.03	÷0.05	0.00	0.00	0.10 (5)	0.05
Late repro, all parities	%-unit	1.65	÷0.03	0.00	0.00	0.11 (7)	0.03
				LONGEVITY			
Average culling[3]	day	0.36	÷0.04 (11)	0.00	0.00	0.00	0.00
				CONFORMATION a.o.			
Frame	point	0.00	0.00	0.00	0.00	0.00	0.00
Udder	point	33.02	0.00	0.00	0.00	0.00	3.30
Feet & legs conf.	point	22.01	0.00	0.00	0.00	0.00	2.20
Milking speed	point	22.01	0.00	0.00	0.00	0.00	2.20
Temperament	point	11.01	0.00	0.00	0.00	0.00	1.10
				CLAW HEALTH			
Sole ulcer, all parities	%-unit	0.795	0.00	0.00	0.00	0.031 (4)	4.84
Sole hemorrhage, all parities	%-unit	0.114	0.00	0.00	0.00	0.00	1.14
Horn heel erosion, all parities	%-unit	0.1680	0.00	0.00	0.00	0.0054	1.14
Digital dermatitis, all parities	%-unit	0.168	0.00	0.00	0.00	0.0054	1.14
Cork screw claw, all parities	%-unit	0.091	0.00	0.00	0.00	0.00	0.91
Interdigital hyperplasia, all parities	%-unit	0.336	0.00	0.00	0.00	0.011	2.28
White line disease, all parities	%-unit	0.114	0.00	0.00	0.00	0.00	1.14
				YOUNG STOCK SURVIVAL			
Survival heifers 1-30 d	%-unit	1.56	0.00	÷0.14 (9)	÷0.28 (18)	0.00	0.00
Survival heifers 31-458 d	%-unit	2.05	0.00	÷0.09 (4)	÷0.27 (13)	0.00	0.00
Survival bulls 1-30 d	%-unit	0.75	0.00	÷0.09 (12)	÷0.17 (23)	0.00	0.00
Survival bulls, 31-184 d	%-unit	0.73	0.00	÷0.07 (9)	÷0.15 (20)	0.00	0.00

[1]4.20 % fat and 3.40 protein

[2]IFL, time between first and last insemination; ICF, time from calving to 1st insemination

[3]Average economic value of culling in 1st, 2nd and 3rd parity

1.2 Change of biological or management assumptions

In the following a brief description of alternative scenarios, where biological or management assumptions are changed, is presented.. Overviews of all the results are shown in Table 1.4, 1.5, and 1.6 for HOL, RDC, and JER, respectively.

1.2.1 Use of sexed semen

In the conventional scenario, the proportion of replacement heifers born from sexed semen (SS) was between 51.6 and 58.9 % (average around 52 %) depending on breed and country. It was investigated how more or less use of SS affected marginal economic values. Tables 1.4, 1.5 and 1.6 only include results from increasing the proportion of replacement heifers born from SS to approximately 62 %. In general, the effect of increasing the proportion of SS was minor. Decreasing the proportion to approx. 42 % had a similar effect but in the opposite direction. Most noticeable changes were seen for the beef production traits and young stock survival (bulls) because increasing or decreasing the use of SS changes the proportion of beef crosses for slaughter.

1.2.2 Replacement rate

In both the conventional and organic scenarios, a replacement rate of 32 % was used for all combinations of breed and country. However, at present time some combinations of production system, breed and country are already well below this level. Thus, it is important to investigate how varying replacement rates will affect the economic values for each trait. Replacement rates of 27 and 37 % were investigated –mainly the former will be discussed here. Generally, a lower replacement rate, given the present assumptions, results in a changed herd structure towards more older cows. Fewer replacement heifers are needed; thus, more beef crosses are born, and fewer purebred heifers and bulls are born.

Decreasing the replacement rate by 5 %-units had a major impact on several traits. (Table 1.4-1.6). A lower replacement rate will change the distribution between parities towards a greater proportion of older cows. The result of this is a higher annual yield but also higher frequency of diseases. From an economic point of view, higher yield and higher disease incidence more or less cancel out each other under the present circumstances. A lower replacement rate also causes fewer heifer calvings and because we see more stillbirths and more difficult calvings from heifers in general, these two traits will be improved at herd level. However, because of fewer 1st calvings, survival rate and calving ease for 1st parity is expressed fewer times; thus, the economic values decrease for these two traits with 15 %., whereas the values in later parities increases but only 4 and 8 % for survival rate and calving ease, respectively. For similar reasons, the economic values for $IFL_{heifers}$ decrease and IFL_{cows} increase when replacement rate is lowered. Improving ICF (and IFL) results in more calvings and more animals for slaughter. However, at a lower replacement rate the improvement of ICF with one day results in fewer extra animals for slaughter compared to a higher replacement rate; thus, we see a negative impact on the economic value. The effect is positive when replacement rate is increased but at a much lower level. Also, the values for young stock survival (heifers) decreases a bit (~5 %) because fewer born heifers result in these traits being expressed fewer times.

The greatest impact of a lower replacement rate was seen for the economic values for longevity which decreased by 28 % in all breeds. However, an increase in replacement rate of 5 %-points results in a 33 % increase of the economic values. This indicates that the relationship between replacement rate and economic values is not linear. This was investigated further to understand the relationship between replacement rate and longevity. Improvement of longevity in the NTM program is done by changing the replacement rate downwards by one %-unit. In Table 1.7 some key figures are presented for two situations: (1) changing the replacement rate from 27 to 26 % and (2) changing the replacement rate from 37 to 36 %. The economic value of longevity is given as profit per cow per day. This is calculated as the difference in total profit divided by the difference in the number of herd longevity days. The difference in total profit is only approx. 3 % higher in situation (1) using the low replacement rate whereas the difference in longevity days is approx. 90 % higher. The result of the latter is a 46 % lower economic value for longevity in situation (1). However, when showing the economic value as profit per cow per %-unit change in replacement rate the values are almost similar in the two situations.

The reason is that it is relatively more difficult to improve longevity of cows when the replacement rate is already low. In such cases a small group of older cows is the main contributor to the economic value whereas for higher replacement rates the main contribution comes from a large group of younger cows. We could choose to show the economic value per percent change in replacement rate. However, this will create problems in the genetic evaluation of longevity because the unit in the breeding goal for longevity is days.

1.2.3 Participation in health agreement schemes

Since the 2008 NTM calculations health agreement schemes have been implemented in DNK and is running on a trial basis in SWE and FIN. Participation in these schemes enables the herd owner to initiate treatment for certain diseases or perform follow-up treatments after the initial treatment has been performed by a veterinarian. Three main schemes are used:

1. Basis agreement – all treatments are done by the herd veterinarian (in SWE the herd manager can always perform re-treatments).
2. Basis agreement + add-on module 1 – all diagnoses and first treatments are done by the herd veterinarian. The herd manager can perform follow-up treatments for certain diseases and initiate treatments in young stock.
3. Basic agreement + add-on module 2 – the herd manager can initiate treatment of certain diseases for a limited or unlimited time period. Further instructions and authorization also allow the herd manager to initiate treatment of milk fever and/or retained placenta.

For the 2018 NTM calculations, the 2017 DNK participation numbers in the different health agreement options shown above were used, and it was assumed that SWE and FIN in the future will participate at a similar level. It is important to investigate possible impacts on the economic values if, for example, participation in SWE and FIN turns out to be less than expected. The proportion of herds for option 1was assumed to be 10 %. Increasing this proportion will increase treatment costs for certain diseases because more treatments must be performed by a veterinarian and decreasing the proportion will have the opposite effect.

Two scenarios were investigated: (1) no herds participate in option 1 (Basis0%), and (2) 20 % of all herds participate in option 1 (Basis20%). Only results for Basis0% are shown but results for Basis20% were similar but in opposite direction. The effects of changing participation proportion were minor or non-existing for most traits (Tables 1.4-1.6). The greatest effects were seen for diseases where owner treatment is possible, i.e. udder health and feet & legs. However, the effects were still limited to ~5 % change of the economic values.

Table 1.4. Results for sensitivity analyses of conventional biological and management assumptions for Holstein. Actual differences in € are presented. Percentage change is shown in ( ) if larger than 3 %.

TRAIT		**ALTERNATIVE**			
	Unit	Conv. average, €	Sexed semen 62 %	Replacement rate = 27 %	Basis 0%[4]
			MILK PRODUCTION		
Standard milk[1]	Kg	0.191	0.00	0.003	0.00
			BEEF PRODUCTION		
Daily gain	kg/day	0.213	÷5.6	5.2	0.00
EUROP form	score	11.1	÷0.54 (5)	÷0.02	0.00
			CALVING TRAITS		
Survival rate 1st	%-unit	1.61	÷0.01	÷0.24 (15)	0.00
Survival rate later, maternal,	%-unit	3.92	÷0.04	0.16 (4)	0.00
Survival rate later, direct	%-unit	2.55	÷0.14 (6)	-0.02	0.00
Calving ease 1st	point	5.63	0.00	÷0.86 (15)	÷0.01
Calving ease later, maternal	point	26.58	0.87	2.10 (8)	÷0.06
Calving ease later, direct	point	15.67	0.05	0.66 (4)	÷0.03
			FEMALE FERTILITY		
IFL heifers	day	0.80	0.01	÷0.12 (14)	0.00
ICF cows	day	0.54	0.00	÷0.04 (7)	0.01
IFL cows	day	4.24	÷0.01	0.10	0.01
			UDDER HEALTH		
Udder health, all parities	%-unit	4.34	0.00	÷0.01	÷0.20 (5)
			GENERAL HEALTH		
Other metabolic, all parities	%-unit	3.16	0.00	÷0.06	÷0.02
Ketosis sum, all parities	%-unit	1.45	0.00	÷0.03	0.00
Feet & legs sum, all parities	%-unit	1.61	0.00	÷0.02	÷0.08 (5)
Early repro sum, all parities	%-unit	2.10	0.00	÷0.04	÷0.06
Late repro sum, all parities	%-unit	1.81	0.00	÷0.03	÷0.02
			LONGEVITY		
Average culling[3]	day	0.31	0.00	÷0.09 (28)	0.00
			CONFORMATION a.o.		
Frame	point	0.00	0.00	0.00	0.00
Udder	point	29.07	0.00	0.00	0.00
Feet & legs conf.	point	19.38	0.00	0.00	0.00
Milking speed	point	19.38	0.00	0.00	0.00
Temperament	point	9.69	0.00	0.00	0.00
			CLAW HEALTH		
Sole ulcer, all parities	%-unit	0.586	0.00	÷1.26	0.00
Sole hemorrhage, all parities	%-unit	0.096	0.00	÷0.21	0.00
Horn heel erosion, all parities	%-unit	0.148	0.00	÷0.32	0.00
Digital dermatitis, all parities	%-unit	0.148	0.00	÷0.32	0.00
Cork screw claw, all parities	%-unit	0.077	0.00	÷0.17	0.00
Interdigital hyperplasia, all parities	%-unit	0.295	0.00	÷0.64	0.00
White line disease, all parities	%-unit	0.096	0.00	÷0.21	0.00
			YOUNG STOCK SURVIVAL		
Survival heifers 1-30 d	%-unit	3.43	0.01	÷0.21 (6)	0.00
Survival heifers 31-458 d	%-unit	3.68	0.01	÷0.38 (10)	0.00
Survival bulls 1-30 d	%-unit	1.72	÷0.12 (7)	÷0.04	0.00
Survival bulls, 31-184 d	%-unit	2.29	÷0.09 (4)	0.03	0.00

[1]4.20 % fat and 3.40 protein

[2]IFL, time between first and last insemination; ICF, time from calving to 1st insemination

[3]Average economic value of culling in 1st, 2nd and 3rd parity

[4]See explanation in chapter 1.2.3. Participation in health agreement schemes

Table 1.5. Results for sensitivity analyses of conventional biological and management assumptions for RDC. Actual differences in € are presented. Percentage change is shown in ( ) if larger than 3 %.

TRAIT			ALTERNATIVE		
	Unit	Conv. average, €	Sexed semen 62 %	Replacement rate = 27 %	Basis 0%[4]
			MILK PRODUCTION		
Standard milk[1]	kg	0.189	0.00	0.004	0.00
			BEEF PRODUCTION		
Daily gain	kg/day	0.230	-5.3	4.2	0.00
EUROP form	score	11.3	÷-0.48 (4)	÷0.03	0.00
			CALVING TRAITS		
Survival rate 1st	%-unit	1.63	÷0.02	÷0.23 (14)	0.00
Survival rate later, maternal	%-unit	3.92	÷0.02	0.14 (4)	0.00
Survival rate later, direct	%-unit	2.55	÷0.,11 (4)	-0.03 (4)	0.00
Calving ease 1st	point	5.79	0.00	÷0.88 (15)	÷0.01
Calving ease later, maternal	point	25.01	0.50	1.67 (7)	÷0.05
Calving ease later, direct	point	14.97	÷0.09	0.4	÷0.00
			FEMALE FERTILITY		
IFL heifers	day	0.94	0.00	÷-0.14 (15)	0.00
ICF cows	day	0.64	0.00	÷0.02 (4)	0.01
IFL cows	day	3.46	0.00	0.08	0.01
			UDDER HEALTH		
Udder health, all parities	%-unit	4.22	0.00	÷0.01	÷0.19 (5)
			GENERAL HEALTH		
Other metabolic, all parities	%-unit	3.17	0.00	÷0.06	÷0.02
Ketosis, all parities	%-unit	1.49	0.00	÷0.03	0.00
Feet & legs, all parities	%-unit	1.62	0.00	÷0.03	÷0.08 (5)
Early repro, all parities	%-unit	2.09	0.00	÷0.04	÷0.06
Late repro, all parities	%-unit	1.76	0.00	÷0.03	÷0.02
			LONGEVITY		
Average culling[3]	day	0.28	0.00	÷0.08 (28)	0.00
			CONFORMATION a.o.		
Frame	point	0.00	0.00	0.00	0.00
Udder	point	29.07	0.00	0.00	0.00
Feet & legs conf.	point	19.38	0.00	0.00	0.00
Milking speed	point	19.38	0.00	0.00	0.00
Temperament	point	9.69	0.00	0.00	0.00
			CLAW HEALTH		
Sole ulcer, all parities	%-point	0.595	0.00	÷1.24	0.00
Sole hemorrhage, all parities	%-point	0.097	0.00	÷0.20	0.00
Horn heel erosion, all parities	%-point	0.154	0.00	÷0.26	0.00
Digital dermatitis, all parities	%-point	0.154	0.00	÷0.31	0.00
Cork screw claw, all parities	%-point	0.077	0.00	÷0.16	0.00
Interdigital hyperplasia, all parities	%-point	0.296	0.00	÷0.59	0.00
White line disease sum, all parities	%-point	0.096	0.00	÷0.19	0.00
			YOUNG STOCK SURVIVAL		
Survival heifers 1-30 d	%-point	3.30	0.06	÷0.22 (7)	0.00
Survival heifers 31-458 d	%-point	3.66	0.03	÷0.32 (9)	0.00
Survival bulls 1-30 d	%-point	1.92	÷0.10 (5)	÷0.03	0.00
Survival bulls, 31-184 d	%-point	2.09	÷0.10 (5)	÷0.03	0.00

[1]4.20 % fat and 3.40 protein

[2]IFL, time between first and last insemination; ICF, time from calving to 1st insemination

[3]Average economic value of culling in 1st, 2nd and 3rd parity

[4]See explanation in chapter 1.2.3. Participation in health agreement schemes

Table 1.6. Results for sensitivity analyses of conventional biological and management assumptions for JER. Actual differences in € are presented. Percentage change is shown in ( ) if larger than 3 %.

TRAIT			ALTERNATIVE			
	Unit	Conv. average, €	Sexed semen 62 %	Replacement rate = 27 %	Basis 0%[4]	Purebred bulls killed
			MILK PRODUCTION			
Standard milk[1]	kg	0.191	0.00	0.004	0.00	0.00
			BEEF PRODUCTION			
Daily gain	kg/day	0.192	÷2.6	3.4	0.00	÷64.1 (33)
EUROP form	score	6.1	÷0.12	0.01	0.00	÷2.3 (38)
			CALVING TRAITS			
Survival rate 1st	%-unit	0.85	0.00	÷0.14 (16)	0.00	÷0.06 (7)
Survival rate later, maternal	%-unit	3.13	0.04	0.23 (7)	0.00	÷1.09 (35)
Survival rate later, direct	%-unit	1.87	0.00	0.05 (3)	0,00	÷0.62 (33)
Calving ease 1st	point	10.76	0.00	÷1.66 (15)	÷0.05	0.00
Calving ease later, maternal	point	120.95	2.85	14.36 (12)	÷0.57	0.00
Calving ease later, direct	point	64.72	1.16	6.39 (10)	÷0.3	0.00
			FEMALE FERTILITY			
IFL heifers		1.26	0.00	÷0.19 (15)	0.00	0.15 (12)
ICF cows	day	0.18	0.00	÷0.05 (26)	0.01 (5)	0.02 (12)
IFL cows	day	2.56	0.00	0.04	0.01	0.02
			UDDER HEALTH			
Udder health, all parities	%-unit	4.45	0.00	0.01	÷0.29 (7)	0.00
			GENERAL HEALTH			
Other metabolic, all parities	%-unit	3.10	0.00	÷0.06	÷0.01	0.00
Ketosis, all parities	%-unit	1.56	0.00	÷0.04	0.00	0.00
Feet & legs, all parities	%-unit	1.79	0.00	÷0.04	÷0.12 (7)	0.00
Early repro, all parities	%-unit	2.03	0.00	÷0.04	÷0.07 (4)	0.00
Late repro, all parities	%-unit	1.65	0.00	÷0.03	÷0.05	0.00
			LONGEVITY			
Average culling[3]	day	0.36	0.00	-0.10 (28)	0.00	0.03 (7)
			CONFORMATION a.o.			
Frame	point	0.00	0.00	0.00	0.00	0.00
Udder	point	33.02	0.00	0.00	0.00	0.00
Feet & legs conf.	point	22.01	0.00	0.00	0.00	0.00
Milking speed	point	22.01	0.00	0.00	0.00	0.00
Temperament	point	11.01	0.00	0.00	0.00	0.00
			CLAW HEALTH			
Sole ulcer, all parities	%-point	0.795	0.00	÷1.63	0.00	0.00
Sole hemorrhage, all parities	%-point	0.114	0.00	÷0.23	0.00	0.00
Horn heel erosion, all parities	%-point	0.168	0.00	÷0.34	0.00	0.00
Digital dermatitis, all parities	%-point	0.168	0.00	÷0.34	0.00	0.00
Cork screw claw, all parities	%-point	0.091	0.00	÷0.19	0.00	0.00
Interdigital hyperplasia, all parities t	%-point	0.336	0.00	÷0.69	0.00	0.00
White line disease, all parities	%-point	0.114	0.00	÷0.23	0.00	0.00
			YOUNG STOCK SURVIVAL			
Survival heifers 1-30 d	%-point	1.56	0.01	÷0.15 (10)	0.00	0.52 (33)
Survival heifers 31-458 d	%-point	2.05	0.02	÷0.23 (11)	0.00	0.54 (26)
Survival bulls 1-30 d	%-point	0.75	÷0.03 (4	÷0.03 (4)	0.00	÷0.37 (50)
Survival bulls, 31-184 d	%-point	0.73	÷0.03 (5)	÷0.05 (7)	0.00	÷0.43 (58)

[1]4.20 % fat and 3.40 protein

[2]IFL, time between first and last insemination; ICF, time from calving to 1st insemination

[3]Average economic value of culling in 1st, 2nd and 3rd parity

[4]See explanation in chapter 1.2.3. Participation in health agreement schemes

Table 1.7. Some key figures related to calculation of economic value of longevity at different replacement rates. Example based on SWE HOL.

Replacement rate	26	27	Diff.	36	37	Diff.
Longevity days	1,401	1,349	53	1,015	987	28
Prop. in 1st lakt.	0.25	0.26	-0.01	0.34	0.35	-0.01
Prop. in 2nd lakt.	0.22	0.23	-0.01	0.27	0.27	0.00
Prop. in 3rd+ lakt	0.53	0.51	0.002	0.39	0.38	0.01
Total profit, €	177,805	176,657	1,148	166,692	165,577	1,116
Profit cows, €	157,786	156,739	1,047	147,679	146,668	1,011
Profit heifers, €	8,734	8,601	133	7,420	7,285	135
Profit bulls, €	11,284	11,317	-32	11,593	11,623	-30
Profit per cow per day, €			**0.219**			**0.402**
Profit per cow per %[1], €			11.3			11.0

[1]Changing replace rate by one %-unit

1.2.4 Culling of all purebred JER bull calves

It is a well-known challenge in JER herds to raise and sell purebred JER bulls without an economic loss. Instead, most purebred JER bull calves are killed at birth, except in organic herds. In the conventional scenario, it was assumed that purebred JER bulls were all slaughtered. However, it is often not possible to sell the purebred JER calves so we needed to create a scenario to account for this challenge, i.e. setting stillbirth rate for purebred JER bulls to 100 %. This affected traits negatively where genetic improvement results in more bull calves being born (Table 1.6). For the beef production traits, the economic values decreased by 33-38 % because the traits are expressed in fewer animals. The impact of survival rate in 1st parity was limited (7 %) because the proportion of bulls is already low compared to the proportion of heifers. For later parities, the impact is much larger, ~35 %, because the proportion of heifers and bulls are more equal; removing a proportion of the calves means that the trait is expressed fewer times. The effect of improving $IFL_{heifers}$ and ICF in this scenario results in slightly increased values. Improving $IFL_{heifers}$ results in more pregnant heifers; thus, the need for heifers drops. The result of this is that more later parity cows can be inseminated with beef semen which results in more slaughter animals. At the same time fewer purebred JER bulls are born and need to be killed which also increases economic values. Explanation for increased economic values for ICF and longevity is similar. Improvement of these trait both result in the need for fewer heifers and therefore room for more beef animals.

Because all purebred bull calves are killed, improvement of young stock survival for bulls will have no impact on the purebred calves – only 50 % is expressed in beef crosses. Thus, the drop in economic values is substantial, 50-58 %. The effect on young stock survival for heifers is slightly more complicated. Improvement of heifer survival causes the need for replacement heifers to become lower – and fewer cows therefore need to be inseminated with purebred semen. This will also decrease the number of purebred bull calves. In the conventional scenario, the contribution from purebred bull calves is negative when young stock survival is improved. If all purebred bull calves are killed at birth this negative contribution will disappear; thus, the economic value of improving heifer survival will increase (26-33 %) compared to the conventional scenario.

2 Relative weighting and expected genetic response

Based on the results from the sensitivity analyses, relative weights and expected genetic response were calculated for selected scenarios used in the sensitivity analyses. The NTM weights below are shown relative to the yield index. The expected genetic response was again calculated as the correlations between the NTM index and the sub-indices. Genotyped bulls born in either DNK, SWE or FIN (Nordic bulls) in 2015 and 2016 were used or the calculations.

Results are shown for the following scenarios:

- MILKM10: conventional assumptions using a 10 % lower milk price
- FEEDP10: conventional assumptions using a 10 % higher feed costs
- BEEFM10: conventional assumptions using a 10 % lower price for beef
- LABORP10: conventional assumptions using 10 % higher labor costs
- VETCOSTP10: conventional assumptions using 10 % higher veterinary costs
- RPL27: conventional assumption using a replacement rate of 27 %

Table 2.1, 2.3 and 2.5 show the relative weighting for MILKM10 and FEEDP10 for HOL, RDC and JER, respectively, and the proposed conventional NTM weights are shown for comparison. The associated expected genetic responses are showed in Table 2.2, 2.4 and 2.6 for HOL, RDC and JER, respectively. A lower milk price results in a lower economic value per yield index unit. Thus, the relative weighting of most of the remaining sub-indices increase. The effect on the expected economic response is a lower response for yield and a higher response for the remaining trait groups. The economic value of the yield index was also reduced in the FEEDP10 scenario but not as much as in the MILKM10 scenario. Compared to the proposed conventional scenario, relative weights were increased for fertility, general health udder conformation, milking speed and claw health in HOL. In RDC relative weights were increased for fertility, calving, udder health, general health, udder conformation and claw health. For JER the situation was slightly different; here the value of the yield index dropped relatively more compared to HOL and RDC. JER produce more fat which requires relatively more energy; thus, JER is punished relatively more when feed costs increase. Because of this, the relative weights of most sub-indices increased compared to the proposed conventional NTM weights. Only the relative weight of the birth index decreased slightly whereas the weights for claw health and young stock survival were unchanged. The expected genetic response lies between the expected genetic response for the proposed conventional NTM and the MILKM10 NTM for HOL and RDC, whereas the response in JER is closer to the MILKM10 scenario.

Table 2.7, 2.9 and 2.11 show the relative weighting for BEEFM10 and LABORP10 for HOL, RDC and JER, respectively. The expected genetic responses are shown in Table 2.8, 2.10 and 2.12 for HOL, RDC and JER, respectively. When the payment for beef is decreased only traits, where improvement results in more animals, for slaughter are affected negatively. Thus, for HOL relative weights were decreased slightly for growth, fertility, birth, calving and young stock survival. The same was observed in RDC except that changes in economic values of birth and calving were too small to affect the relative NTM weights for these two traits. For JER only relative weights for fertility, calving and young stock survival were affected negatively. For example, the relative weight of growth was not affected in JER because the negative impact on the economic value of JER growth was too small.

Compared to the proposed conventional NTM weights, minor changes were observed when labor costs were increased. Relative weights for fertility, udder health, feet & legs, and udder conformation were increased slightly in HOL. The remaining traits were not affected. The same was observed in RDC, except that the relative weights for udder health and feet & legs were unchanged. Note: economic values of udder health and feet & legs were increased when labor costs were increased but the increase is not big enough to cause changes to the relative NTM weights for these to traits. For JER only the relative weights for udder and milking speed increased slightly. Given the relatively small changes to the relative weighting, only small changes in expected genetic response for the LABORP10 NTM compared to the proposed conventional NTM were observed

Table 2.13, 2.15 and 2.17 show the relative weighting for VETCOSTP10 and RPL27 for HOL, RDC and JER, respectively. The expected genetic responses are shown in Table 2.14, 2.16 and 2.18 for HOL, RDC and JER, respectively. Increasing veterinary costs only increased the relative NTM weights for udder health and general health in HOL. In RDC general health was affected, and in JER only udder health was affected. The impact on the expected genetic response was minor; in HOL the genetic response for yield was reduced slightly whereas the response was increased for udder health, general health and longevity. The genetic response in RDC was limited to a minor increase for fertility and general health. In JER a minor decrease in expected genetic response was observed for fertility, calving and longevity, whereas the response for udder conformation increased slightly.

Reducing the replacement rate to 27 % had a relatively large impact on the expected genetic response – not so much on the relative NTM weights. However, because the herd structure is changed towards more older cows which means a higher annual milk production the economic value of the yield index increases (~2 %). This reduces the weights of most NTM sub-indices in all three breeds. Compared with the proposed conventional NTM, the expected genetic response for yield is increased when replacement rate is lowered, the response for growth is also increased for HOL and RDC. For the remaining sub-indices expected genetic response is mostly decreased (unchanged for a few traits). Especially, the expected genetic response for longevity is affected negatively in all three breeds.

Table 2.1. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM MILKM10 and conv. NTM FEEDP10, respectively for HOL.

Trait	Proposed conv. NTM	Proposed conv. NTM MILKM10	Proposed conv. NTM FEEDP10
Yield index	1.00	1.00	1.00
Beef production	0.07	0.09	0.07
Fertility	0.38	0.45	0.40
Birth index	0.13	0.16	0.13
Calving index	0.13	0.16	0.13
Udder health	0.30	0.33	0.33
General health	0.13	0.15	0.14
Frame	0.00	0.00	0.00
Feet & legs	0.04	0.05	0.04
Udder	0.05	0.06	0.06
Milking speed	0.08	0.10	0.09
Temperament	0.04	0.04	0.04
Longevity	0.07	0.07	0.07
Claw health	0.09	0.11	0.10
Young stock survival	0.11	0.14	0.11

Table 2.2. Correlations between sub-indices and proposed conv. NTM, conv. NTM MILKM10, and conv. NTM FEEDP10, respectively for HOL. Correlations are based on 5,218 genotyped Nordic HOL bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM MILKM10	Proposed conv. NTM FEEDP10
Yield index	0.63	0.55	0.60
Beef production	0.13	0.11	0.11
Fertility	0.44	0.50	0.46
Birth index	0.26	0.29	0.26
Calving index	0.32	0.35	0.33
Udder health	0.34	0.38	0.36
General health	0.34	0.38	0.36
Frame	0.01	-0.02	0.00
Feet & legs	0.17	0.19	0.18
Udder	0.11	0.13	0.13
Milking speed	0.04	0.05	0.04
Temperament	0.09	0.08	0.08
Longevity	0.50	0.53	0.52
Claw health	0.24	0.27	0.25
Young stock survival	0.23	0.26	0.24

Table 2.3. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM MILKM10 and conv. NTM FEEDP10, respectively for RDC.

Trait	Proposed conv. NTM	Proposed conv. NTM MILKM10	Proposed conv. NTM FEEDP10
Yield index	1.00	1.00	1.00
Beef production	0.08	0.10	0.08
Fertility	0.29	0.35	0.31
Birth index	0.08	0.11	0.09
Calving index	0.08	0.10	0.09
Udder health	0.19	0.23	0.21
General health	0.09	0.11	0.10
Frame	0.00	0.00	0.00
Feet & legs	0.05	0.06	0.05
Udder	0.06	0.08	0.07
Milking speed	0.09	0.11	0.09
Temperament	0.03	0.03	0.03
Longevity	0.06	0.06	0.06
Claw health	0.06	0.07	0.06
Young stock survival	0.15	0.19	0.15

Table 2.4. Correlations between sub-indices and proposed conv. NTM, conv. NTM MILKM10, and conv. NTM FEEDP10, respectively for RDC. Correlations are based on 4,368 genotyped Nordic RDC bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM MILKM10	Proposed conv. NTM FEEDP10
Yield index	0.80	0.73	0.78
Beef production	0.05	0.04	0.04
Fertility	0.21	0.27	0.23
Birth index	0.14	0.19	0.15
Calving index	0.16	0.18	0.17
Udder health	0.15	0.20	0.18
General health	0.17	0.19	0.17
Frame	0.02	-0.01	0.01
Feet & legs	0.20	0.23	0.20
Udder	0.04	0.07	0.06
Milking speed	0.18	0.19	0.17
Temperament	0.09	0.07	0.08
Longevity	0.45	0.47	0.46
Claw health	0.14	0.17	0.15
Young stock survival	0.25	0.30	0.26

Table 2.5. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM MILKM10 and conv. NTM FEEDP10, respectively for JER.,

Trait	Proposed conv. NTM	Proposed conv. NTM MILKM10	Proposed conv. NTM FEEDP10
Yield index	1.00	1.00	1.00
Beef production	0.06	0.08	0.07
Fertility	0.25	0.30	0.28
Birth index	0.04	0.05	0.04
Calving index	0.06	0.08	0.06
Udder health	0.33	0.39	0.37
General health	0.11	0.13	0.12
Frame	0.00	0.00	0.00
Feet & legs	0.07	0.08	0.09
Udder	0.13	0.16	0.15
Milking speed	0.08	0.10	0.09
Temperament	0.02	0.03	0.02
Longevity	0.09	0.11	0.13
Claw health	0.04	0.05	0.04
Young stock survival	0.10	0.13	0.10

Table 2.6. Correlations between sub-indices and proposed conv. NTM, conv. NTM MILKM10, and conv. NTM FEEDP10, respectively for JER. Correlations are based on 862 genotyped Nordic JER bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM MILKM10	Proposed conv. NTM FEEDP10
Yield index	0.77	0.70	0.71
Beef production	0.07	0.08	0.08
Fertility	0.25	0.30	0.30
Birth index	0.08	0.08	0.07
Calving index	0.18	0.18	0.17
Udder health	0.38	0.45	0.44
General health	0.27	0.29	0.29
Frame	0.15	0.14	0.14
Feet & legs	0.17	0.19	0.21
Udder	0.15	0.22	0.20
Milking speed	0.07	0.08	0.07
Temperament	-0.01	-0.01	-0.02
Longevity	0.48	0.52	0.53
Claw health[1]	0.09	0.12	0.11
Young stock survival[1]	0.28	0.33	0.29

[1]Based on progeny tested Nordic JER bulls born 2009-2010. N = 97

Table 2.7. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM BEEFM10 and conv. NTM LABORP10, respectively for HOL.

Trait	Proposed conv. NTM	Proposed conv. NTM BEEFM10	Proposed conv. NTM LABORP10
Yield index	1.00	1.00	1.00
Beef production	0.07	0.06	0.07
Fertility	0.38	0.36	0.39
Birth index	0.13	0.11	0.13
Calving index	0.13	0.11	0.13
Udder health	0.30	0.30	0.31
General health	0.13	0.13	0.13
Frame	0.00	0.00	0.00
Feet & legs	0.04	0.04	0.04
Udder	0.05	0.05	0.06
Milking speed	0.08	0.08	0.09
Temperament	0.04	0.04	0.04
Longevity	0.07	0.07	0.07
Claw health	0.09	0.09	0.09
Young stock survival	0.11	0.10	0.11

Table 2.8. Correlations between sub-indices and proposed conv. NTM, conv. NTM BEEFM10, and conv. NTM LABORP10, respectively for HOL. Correlations are based on 5,218 genotyped Nordic HOL bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM BEEFM10	Proposed conv. NTM LABORP10
Yield index	0.63	0.65	0.61
Beef production	0.13	0.11	0.11
Fertility	0.44	0.41	0.45
Birth index	0.26	0.24	0.26
Calving index	0.32	0.30	0.32
Udder health	0.34	0.34	0.35
General health	0.34	0.33	0.35
Frame	0.01	0.02	0.01
Feet & legs	0.17	0.17	0.18
Udder	0.11	0.12	0.13
Milking speed	0.04	0.04	0.05
Temperament	0.09	0.09	0.09
Longevity	0.50	0.50	0.51
Claw health	0.24	0.24	0.24
Young stock survival	0.23	0.22	0.23

Table 2.9. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM BEEFM10 and conv. NTM LABORP10, respectively for RDC.

Trait	Proposed conv. NTM	Proposed conv. NTM BEEFM10	Proposed conv. NTM LABORP10
Yield index	1.00	1.00	1.00
Beef production	0.08	0.07	0.08
Fertility	0.29	0.28	0.30
Birth index	0.08	0.07	0.09
Calving index	0.08	0.07	0.08
Udder health	0.19	0.20	0.20
General health	0.09	0.09	0.09
Frame	0.00	0.00	0.00
Feet & legs	0.05	0.05	0.05
Udder	0.06	0.06	0.07
Milking speed	0.09	0.09	0.09
Temperament	0.03	0.03	0.03
Longevity	0.06	0.06	0.06
Claw health	0.06	0.06	0.06
Young stock survival	0.15	0.14	0.15

Table 2.10. Correlations between sub-indices and proposed conv. NTM, conv. NTM BEEFM10, and conv. NTM LABORP10, respectively for RDC. Correlations are based on 4,368 genotyped Nordic RDC bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM BEEFM10	Proposed conv. NTM LABORP10
Yield index	0.80	0.81	0.79
Beef production	0.05	0.05	0.05
Fertility	0.21	0.19	0.22
Birth index	0.14	0.13	0.15
Calving index	0.16	0.15	0.16
Udder health	0.15	0.16	0.16
General health	0.17	0.15	0.15
Frame	0.02	0.03	0.02
Feet & legs	0.20	0.19	0.20
Udder	0.04	0.05	0.05
Milking speed	0.18	0.18	0.18
Temperament	0.09	0.09	0.08
Longevity	0.45	0.45	0.45
Claw health	0.14	0.14	0.14
Young stock survival	0.25	0.24	0.26

Table 2.11. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM BEEFM10 and conv. NTM LABORP10, respectively for JER.

Trait	Proposed conv. NTM	Proposed conv. NTM BEEFM10	Proposed conv. NTM LABORP10
Yield index	1.00	1.00	1.00
Beef production	0.06	0.06	0.06
Fertility	0.25	0.24	0.25
Birth index	0.04	0.04	0.04
Calving index	0.06	0.05	0.06
Udder health	0.33	0.33	0.33
General health	0.11	0.11	0.11
Frame	0.00	0.00	0.00
Feet & legs	0.07	0.07	0.07
Udder	0.13	0.13	0.14
Milking speed	0.08	0.08	0.09
Temperament	0.02	0.02	0.02
Longevity	0.09	0.09	0.09
Claw health	0.04	0.04	0.04
Young stock survival	0.10	0.08	0.10

Table 2.12. Correlations between sub-indices and proposed conv. NTM, conv. NTM BEEFM10, and conv. NTM LABORP10, respectively for JER. Correlations are based on 862 genotyped Nordic JER bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM BEEFM10	Proposed conv. NTM LABORP10
Yield index	0.77	0.77	0.76
Beef production	0.07	0.08	0.07
Fertility	0.25	0.24	0.25
Birth index	0.08	0.08	0.08
Calving index	0.18	0.18	0.18
Udder health	0.38	0.38	0.39
General health	0.27	0.27	0.27
Frame	0.15	0.15	0.15
Feet & legs	0.17	0.17	0.17
Udder	0.15	0.15	0.16
Milking speed	0.07	0.07	0.08
Temperament	-0.01	0.00	-0.01
Longevity	0.48	0.48	0.49
Claw health[1]	0.09	0.10	0.10
Young stock survival[1]	0.28	0.26	0.28

[1]Based on progeny tested Nordic JER bulls born 2009-2010. N = 97

Table 2.13. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM VETCOSTP10 and conv. NTM RPL27, respectively for HOL.

Trait	Proposed conv. NTM	Proposed conv. NTM VETCOSTP10	Proposed conv. NTM RPL27
Yield index	1.00	1.00	1.00
Beef production	0.07	0.07	0.07
Fertility	0.38	0.38	0.37
Birth index	0.13	0.13	0.12
Calving index	0.13	0.13	0.12
Udder health	0.30	0.31	0.28
General health	0.13	0.14	0.12
Frame	0.00	0.00	0.00
Feet & legs	0.04	0.04	0.04
Udder	0.05	0.05	0.05
Milking speed	0.08	0.08	0.08
Temperament	0.04	0.04	0.03
Longevity	0.07	0.07	0.05
Claw health	0.09	0.09	0.08
Young stock survival	0.11	0.11	0.11

Table 2.14. Correlations between sub-indices and proposed conv. NTM, conv. NTM VETCOSTP10, and conv. NTM RPL27, respectively for HOL. Correlations are based on 5,218 genotyped Nordic HOL bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM VETCOSTP10	Proposed conv. NTM RPL27
Yield index	0.63	0.62	0.65
Beef production	0.13	0.11	0.12
Fertility	0.44	0.44	0.42
Birth index	0.26	0.26	0.25
Calving index	0.32	0.32	0.31
Udder health	0.34	0.35	0.32
General health	0.34	0.35	0.32
Frame	0.01	0.00	0.02
Feet & legs	0.17	0.17	0.17
Udder	0.11	0.12	0.10
Milking speed	0.04	0.04	0.05
Temperament	0.09	0.09	0.08
Longevity	0.50	0.51	0.48
Claw health	0.24	0.24	0.23
Young stock survival	0.23	0.23	0.22

Table 2.15. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM VETCOSTP10 and conv. NTM RPL27, respectively for RDC.

Trait	Proposed conv. NTM	Proposed conv. NTM VETCOSTP10	Proposed conv. NTM RPL27
Yield index	1.00	1.00	1.00
Beef production	0.08	0.08	0.08
Fertility	0.29	0.29	0.28
Birth index	0.08	0.09	0.08
Calving index	0.08	0.08	0.08
Udder health	0.19	0.20	0.18
General health	0.09	0.10	0.09
Frame	0.00	0.00	0.00
Feet & legs	0.05	0.05	0.04
Udder	0.06	0.06	0.06
Milking speed	0.09	0.09	0.08
Temperament	0.03	0.03	0.02
Longevity	0.06	0.06	0.04
Claw health	0.06	0.06	0.05
Young stock survival	0.15	0.15	0.14

Table 2.16. Correlations between sub-indices and proposed conv. NTM, conv. NTM VETCOSTP10, and conv. NTM RPLP10, respectively for RDC. Correlations are based on 4,368 genotyped Nordic RDC bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM VETCOSTP10	Proposed conv. NTM RPL27
Yield index	0.80	0.80	0.83
Beef production	0.05	0.05	0.07
Fertility	0.21	0.21	0.19
Birth index	0.14	0.14	0.13
Calving index	0.16	0.15	0.15
Udder health	0.15	0.16	0.14
General health	0.17	0.16	0.14
Frame	0.02	0.01	0.04
Feet & legs	0.20	0.20	0.18
Udder	0.04	0.04	0.04
Milking speed	0.18	0.18	0.17
Temperament	0.09	0.09	0.08
Longevity	0.45	0.45	0.41
Claw health	0.14	0.14	0.12
Young stock survival	0.25	0.26	0.24

Table 2.17. Weighting of NTM sub-indices relative to the yield index for proposed conv. NTM, conv. NTM VETCOSTP10 and conv. NTM RPL27, respectively for JER.

Trait	Proposed conv. NTM	Proposed conv. NTM VETCOSTP10	Proposed conv. NTM RPL27
Yield index	1.00	1.00	1.00
Beef production	0.06	0.06	0.06
Fertility	0.25	0.25	0.23
Birth index	0.04	0.04	0.04
Calving index	0.06	0.06	0.06
Udder health	0.33	0.34	0.31
General health	0.11	0.11	0.10
Frame	0.00	0.00	0.00
Feet & legs	0.07	0.07	0.06
Udder	0.13	0.13	0.12
Milking speed	0.08	0.08	0.08
Temperament	0.02	0.02	0.02
Longevity	0.09	0.09	0.07
Claw health	0.04	0.04	0.04
Young stock survival	0.10	0.10	0.09

Table 2.18. Correlations between sub-indices and proposed conv. NTM, conv. NTM VETCOSTP10, and conv. NTM RPLP10, respectively for JER. Correlations are based on 862 genotyped Nordic JER bull calves born 2015-2016.

Trait	Proposed conv. NTM	Proposed conv. NTM VETCOSTP10	Proposed conv. NTM RPL27
Yield index	0.77	0.76	0.80
Beef production	0.07	0.07	0.08
Fertility	0.25	0.25	0.22
Birth index	0.08	0.08	0.09
Calving index	0.18	0.18	0.19
Udder health	0.38	0.39	0.35
General health	0.27	0.27	0.25
Frame	0.15	0.15	0.16
Feet & legs	0.17	0.17	0.14
Udder	0.15	0.16	0.12
Milking speed	0.07	0.07	0.08
Temperament	-0.01	-0.01	0.01
Longevity	0.48	0.49	0.46
Claw health[1]	0.09	0.09	0.09
Young stock survival[1]	0.28	0.28	0.26

[1]Based on progeny tested Nordic JER bulls born 2009-2010. N = 97

3 Additional analyses

This section contains additional analyses related to the NTM work. These have been requested by the HOL, RDC or JER breeding associations.

3.1 Doubling economic value of digital dermatitis in HOL

Expected genetic response for conventional NTM where the economic value of digital dermatitis in the claw health index has been doubled. The Holstein associations have requested that expected genetic response are estimated for a scenario where the economic value of digital dermatitis has been doubled. The argument for doubling the value was the high frequency of digital dermatitis but it should be noted that the frequency is taken into account in the EBV for claw health. The analysis is based on conventional assumptions only, and the results are shown in Table 3.1.

Table 3.1. Correlations between sub-indices and proposed conv. NTM, and a scenario where the economic value of digital dermatitis is doubled for HOL. Correlations are based on 5,218 genotyped Nordic HOL bull calves born 2015-2016.

	Proposed conv. NTM	×2 value of digital dermatitis in NTM
Yield index	0.63	0.63
Beef production	0.11	0.11
Fertility	0.44	0.44
Birth index	0.26	0.26
Calving index	0.32	0.32
Udder health	0.34	0.34
General health	0.34	0.34
Frame	0.01	0.01
Feet & legs	0.17	**0.18**
Udder	0.11	0.11
Milking speed	0.04	0.04
Temperament	0.09	0.09
Longevity	0.50	0.50
Claw health	0.24	**0.25**
Young stock survival	0.23	0.23

The relative weight of the claw health index in NTM was increased from 0.09 to 0.10. The effect on the expected genetic response was minor. The response for claw health was increased from 0.23 to 0.24 and the response for feet & legs conformation was increased from 0.17 to 0.18. Every else was unchanged.

3.2 Maintaining current weight for udder health and udder conformation in JER

The Jersey breeding association has requested calculations based on a scenario where expected genetic response is maintained at the current level for udder health and udder conformation – which relative NTM weights should be used for these two traits? Trying to apply relative weights to aim for a specific response is challenging because the correlations between the NTM traits should be accounted for at the same time. Instead we have calculated expected response using the current weights for udder health and udder conformation. For all other traits proposed conventional weights were used.

Results are shown for the current NTM, the proposed conventional NTM and the proposed conventional NTM but using current weights for udder health and udder conformation. It is possible to maintain current response, but not without losing response for other traits, i.e. production traits.

Table 3.2. Expected genetic response for sub-indices in current NTM, the proposed conventional NTM and proposed conventional NTM using current weights for udder health and udder conformation. Correlations are based on 862 genotyped Nordic JER bull calves born 2015-2016.

	Current NTM	Proposed conv. NTM	Added weight on udder health and udder conf.
Yield index	0.58	0.77	0.57
Beef production	-0.02	0.07	0.02
Fertility	0.23	0.25	0.27
Birth index	0.09	0.08	0.06
Calving index	0.19	0.18	0.16
Udder health	**0.59**	**0.38**	**0.60**
General health	0.28	0.27	0.30
Frame	0.17	0.15	0.16
Feet & legs	0.16	0.17	0.20
Udder	**0.42**	**0.15**	**0.42**
Milking speed	0.08	0.07	0.04
Temperament	0.00	-0.01	-0.03
Longevity	0.49	0.48	0.50
Claw health[1]	0.15	0.09	0.14
Young stock survival[1]	0.33	0.28	0.31

[1]Based on progeny tested Nordic JER bulls born 2009-2010. N = 97

3.3 Maintaining current weight for udder conformation and feet & legs in RDC

The RDC breeding associations have requested calculations based on a scenario where expected genetic response is maintained at the current level for udder conformation and feet & legs conformation. As above we have calculated expected response using the current weights for udder conformation (Table 3.3) and feet & legs conformation (Table 3.4). For all other traits proposed conventional weights were used.

Results are shown for the current NTM, the proposed conventional NTM and the proposed conventional NTM but using current weights for either udder conformation or feet & legs conformation. As with JER (see above) it is possible to maintain the current expected genetic response for the conformation traits. The negative impact on the production traits are greatest for udder conformation situation (Table 3.3).

Table 3.3. Expected genetic response for sub-indices in current NTM, the proposed conventional NTM and proposed conventional NTM using current weight for udder conformation. Correlations are based on 4,368 genotyped Nordic RDC bull calves born 2015-2016.

	Current NTM	Proposed conv. NTM	Added weight on udder conformation
Yield index	0.65	0.80	0.72
Beef production	-0.10	0.05	0.03
Fertility	0.16	0.21	0.18
Birth index	0.18	0.14	0.07
Calving index	0.19	0.16	0.17
Udder health	0.35	0.15	0.25
General health	0.17	0.17	0.13
Frame	0.04	0.02	0.12
Feet & legs	0.28	0.20	0.19
Udder	**0.37**	**0.04**	**0.37**
Milking speed	0.14	0.18	0.18
Temperament	0.05	0.09	0.07
Longevity	0.45	0.45	0.42
Claw health	0.16	0.14	0.12
Young stock survival	0.32	0.25	0.22

Table 3.4. Expected genetic response for sub-indices in current NTM, the proposed conventional NTM and proposed conventional NTM using current weight for feet & legs conformation. Correlations are based on 4,368 genotyped Nordic RDC bull calves born 2015-2016.

	Current NTM	Proposed conv. NTM	Added weight on feet & legs conformation
Yield index	0.65	0.80	0.80
Beef production	-0.10	0.05	0.04
Fertility	0.16	0.20	0.21
Birth index	0.18	0.14	0.15
Calving index	0.19	0.15	0.16
Udder health	0.35	0.16	0.15
General health	0.17	0.15	0.15
Frame	0.04	0.02	0.00
Feet & legs	**0.28**	**0.20**	**0.24**
Udder	0.37	0.04	0.04
Milking speed	0.14	0.18	0.18
Temperament	0.05	0.09	0.09
Longevity	0.45	0.45	0.45
Claw health	0.16	0.14	0.15
Young stock survival	0.32	0.25	0.26