2018 Review of Nordic Total Merit Index Appendix: Biological and Economic Assumptions

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Content

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1 Biological assumptions

This document contains information about biological and economic assumptions used for the 2018 NTM review. The document is intended as background material for the January 2018 NAV Workshop because some information is necessary for a fruitful discussion at the meeting. The document is still a draft but the complete information will be included in the final 2018 NTM report.

The phenotypic levels of the different traits groups combined in the NTM index are important to exemplify a future production system, i.e. when NTM 2018 is realized. The levels do not have direct impact on the economic values per trait unit because these are based on marginal changes. Exceptions are categorical traits with more than two outcomes. However, phenotypic levels are important when comparing country differences and differences between different scenarios, e.g. conventional vs. organic production systems, because they affect the overall profit of the model herd. Most phenotypic values shown in this report are based on the newest possible data used for estimation of NAV breeding values. In other cases, qualified guesses on future production circumstances have been made, e.g. use of SS, and will affect the size of the used phenotypic values.

1.1 Milk production traits

The economic values of production traits are calculated as sales price of product (milk or meat) minus costs directly related to making of the product – in this case feed costs. The difference (profit) will subsequently be used to determine the weight of the production traits in NTM.

Phenotypic levels for milk and beef production depend on country and breed. Differences between countries are mainly caused by different management practices. However, differences in breed composition – especially for the red breeds (RDC) – may contribute as well. The assumptions on yield in the NAV countries are shown in Table 1.1. These values together with values for beef production are based on actual national statistics and used for determination of feed costs.

Table 1.1. 305-day yield (kg) in 1st, 2nd and 3rd lactation for RDC, HOL and JER, respectively, in the NAV countries. Based on yield evaluation data, completed lactations in calving year 2016 (2014 for DNK data).

	Milk			Protein			Fat		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
					RDC				
DNK	7,899	9,018	9,457	278	319	329	334	381	400
SWE	7,870	9,209	9,480	282	329	337	345	400	411
FIN	7,926	9,421	9,959	280	332	342	352	411	428
					HOL				
DNK	8,689	10,162	10,582	292	344	354	343	404	422
SWE	8,719	10,544	10,971	298	359	370	355	426	447
FIN	8,661	10,560	11,197	296	359	374	356	426	452
					JER				
DNK	6,064	7,015	7,279	248	291	301	353	409	427

For milk production additional information is needed to calculate 305-day yield for cows culled before 305 days in milk (DIM). In Table 1.2 the average DIM for culled cows and average days dry (all cows) are shown.

Table 1.2. Average days in milk (DIM) for culling and average days dry in 1st, 2nd and 3rd lactation for DNK, SWE and FIN RDC, HOL and JER, respectively. Based on longevity evaluation data for cows calving in 2014.

	DIM			Days dry		
	1st	2nd	3rd	1st	2nd	3rd
			RDC			
DNK	218	238	224	62	64	64
SWE	236	250	233	65	65	65
FIN	212	233	215	65	65	65
			HOL			
DNK	222	245	225	64	69	69
SWE	237	251	229	65	68	68
FIN	213	229	198	66	66	66
			JER			
DNK	215	228	210	58	60	60

1.2 Beef production traits

In DNK approx. 50 % of RDC and HOL bulls are slaughtered as *bull calves* (age at slaughter ≤ 10 months); there is a special pricing for this group of bulls. The remaining bulls in DNK and all bulls in SWE and FIN are slaughtered as *young* bulls (age at slaughter > 10 months). Assumed phenotypic levels for beef production are shown in Table 1.3 and Table 1.4. Live weight was calculated using the following formulas:

```
Live weight = carcass weight*100/dressing percentage
```
3.1

where

```
Dressing percentage = (45+2×carcass weight/100+2/3×EUROP form charac-
ter+
((daily net gain×2000-150)×0.005))/100
```
3.2

Table 1.3. Growth data for bull calves – age at slaughter ≤ 10 months (DNK only). Based on evaluation data collected 12 months prior to June 21st, 2017.

	Age at slaughter, days	Live weight[1], kg	Carcass weight, kg	Daily gain, kg/day	Daily carcass gain, kg/day	Form EUROP	Fatness EUROP	Share of calves
					RDC			
DNK	295	382	201	1.153	0.612	4.06	2.42	56 %
					HOL			
DNK	293	383	204	1.161	0.698	3.64	2.42	48 %
					JER			
DNK	296	306	153	0.943	0.516	3.00	2.17	6 %

[1]Calculated using formula 3.1

Table 1.4. Growth data for young bulls – age at slaughter > 10 months. Based on evaluation data collected 12 months prior to June 21st, 2017.

	Age at slaughter, days	Live weight[1], Kg	Carcass weight, kg	Daily gain, kg/day	Daily carcass gain, kg/day	Form EUROP	Fatness EUROP	Share of calves
					RDC			
DNK	376	439	235	1.056	0.628	4.20	2.61	56 %
SWE	598	596	331	0.931	0.564	5.33	2.39	100 %
FIN	613	612	339	0.930	0.562	4.91	2.40	100 %
					HOL			100 %
DNK	364	425	224	1.050	0.619	3.41	2.41	43 %
SWE	590	596	327	0.938	0.564	4.37	2.21	100 %
FIN	605	616	340	0.942	0.570	4.43	2.22	100 %
					JER			
DNK	422	379	190	0.835	0.453	3.02	2.33	6%

[1]Calculated using formula 3.1

Beef crosses

For simplicity beef crosses were assumed to have slaughter weights and daily gain like purebreds. However, a higher price can be expected because beef crosses have a higher form score. Using data from here: https://www.landbrugsinfo.dk/Kvaeg/Avl/Avlsvaerdital-for-malkekvaeg/Sider/Krydsningsresultater_fodt_og_slagtet.pdf?download=true, added values for form score were assumed as presented in Table 1.5. Added values in SWE and FIN were assumed to be similar to the DNK values. Heifer crosses were handled similar to bull crosses in the NTM program but they have a lower form score. Thus, values were calculated as mean of heifer and bull crosses.

Table 1.5. Average added values for form score for bull and heifer crosses.

	RDC	HOL	JER
Bull calves	+3.00	+3.50	+2.25
Young bulls	+4.00	+4.25	+2.75

1.2.1 Feeding

Determination of feed requirements depends on the used feed evaluation system. Currently, the feed evaluation system used in the NAV countries is called NorFor (Nordic Feed Evaluation System; www.norfor.info). This advanced system replaced a simpler system in 2007. For the 2008 NTM calculations the Danish version of the latter was used for determination of energy and protein requirements (other requirements not considered). It is based on what is referred to as Scandinavian Feed Unit (SFU) as a measure of energy - 1 SFU = 7.89 MJ.

It is no simple task to replace the old SFU system with the NorFor system in the NTM program; however, the 2008 calculation for feed requirements were simple and can still be used for the 2018 calculations. Thus, the NTM working group agreed to re-use the 2008 calculations (formulas). Formulas for calculating energy and protein requirements for all animal groups can be found in Strudsholm et al. (1999) and Strudsholm and Sejersen (2003). An important aspect related to modelling profit of milk production is the *marginal feed utilization* (MFU) defined as energy utilization of the last unit of feed given to a cow. For the 2008 NTM calculations Østergård and Neimann-Sørensen (1989) calculated MFU to be 65 % based on data from 108 Danish dairy herds from 1967 to 1986. This value was retained.

Cows – energy and protein requirements

Energy and protein requirements for cows are divided into requirements for maintenance, milk production, body and fetus growth. The following formulas were used for calculating energy requirements:

$$SFU_{maintenance} = (\text{mature weight} / 200 + 1.5) \times 1.1 \quad (3.3)$$

The last part of formula 3.1 indicates increased (10 %) energy requirement for loose housing with or without pasture time. It was assumed that most cows in the future will be housed in free stall barns or put on pasture in the summer time.

$$SFU_{milk} = 0.4 \text{ SFU per kg ECM} \times \text{kg ECM produced (lactation)} \quad (3.4)$$

$$SFU_{growth} = (\text{mature weight} - \text{weight at } 1^{st} \text{ calving}) \times 4 \text{ SFU per kg gain} \times \text{culling rate} \quad (3.5)$$

$$SFU_{fetus} = \text{mature weight} / 242 \times e^{(-0.14 \times \text{week before calving})} \quad (3.6)$$

Formula 3.6 forms the basis for standard energy requirement per pregnancy, 130 SFU for large breeds and 90 SFU for Jersey. Mature weights for each breed are shown in Table 3.5.

The total SFU per cow (theoretical) was compared to what was used on average in Denmark in 2016 (pers. comm.: Ole Aaes, SEGES) – it was 2.9 % lower. Thus, to reflect reality, the theoretical SFU was then multiplied by 1.029.

The calculation of protein requirements (AAT or amino acids absorbed) was simplified compared to the 2008 NTM calculations. Instead of estimating protein requirement separately for maintenance, milk, growth and fetus, we used a fixed value of 90 g AAT per total SFU. These recommendations are generally accepted mainly because yield increase is observed up to 90 g AAT per SFU but no increase was observed when going above 90 g (Madsen et al., 2003).

Heifers – energy and protein requirements

Heifer growth is determined by age and weight at first calving (Table 1.6). For the 2008 NTM calculation the average age at calving were 26.9, 25.0 and 25.5 months for HOL, RDC, and JER, respectively. In 2016 these had changed to 26.0, 26.8, and 24.5 (mean of DNK, FIN and SWE) for HOL, RDC, and JER, respectively. We used these updated figures for the NTM 2018 calculation. Weight at calving is not readily available from commercial farms. However, we had access to weight data from AMS farms in DNK. From this, average weights (Table 1.6) for 1st parity cows and mature cows (3rd parity) was calculated for HOL, RDC and JER. Data from calving year 2016 and from 0 to 10 DIM was used. Both weight at 1st calving and mature weight have increased since the 2008 NTM calculation, especially for JER. However, because JER and RDC weights were based on relatively few farms confirmation of the attained values was needed. Slaughter data from Danish cows was used for this and weight data from the FUNC project (http://projects.au.dk/func/) were used for this, and a few values were changes slightly. The final values are shown in Table 1.7.

Table 1.6. Average body weight for 1st and 3rd parity (mature) excluding weight of calf. Based on 2016 data from Danish AMS herds and Swedish RDC cows participating in the FUNC project.

Breed		# obs.	# herds	Mean weight, kg[1]
HOL	1st parity	63,377	96	590
	3rd parity	41,771		690
RDC	1st parity	2,743	16	600
	3rd parity	1,597		670
JER	1st parity	5,476	9	400
	3rd parity	3,447		485

[1]rounded to nearest 5 kg

Table 1.7. Applied values for body weight for 1st and 3rd parity (mature) for the 2018 NTM calculations.

Breed		Mean weight, kg
HOL	1st parity	590
	3rd parity	680
RDC	1st parity	565
	3rd parity	655
JER	1st parity	375
	3rd parity	430

Energy requirement up to 100 kg (75 kg for Jersey). Formulas updated:

Large breeds $$\text{SFU per day} = 2.8 - (100 - V_{avg}) \times 0.030 \quad (3.7)$$

Jersey $$\text{SFU per day} = 2.7 - (75 - V_{avg}) \times 0.038 \quad (3.8)$$

where V_{avg} is the average weight in interval from birth to 100 kg (75 kg for Jersey).

Compared to the 2008 NTM figures the new formulas resulted in a difference of -0.09 SFU per day for the large breeds and -0.22 SFU per day for Jersey. Energy requirements for the remaining time to calving depend on daily gain and were calculated using formulas 3.9. Also, it was assumed that all heifers above 100 kg (75 kg for Jersey) were housed in free stalls or put on pasture in the summer time; this increase energy requirements by 5 %. For JER it was assumed that at a given daily gain at a given weight, energy requirements were 25 % larger compared to the large breeds. Finally, a feed utilization of 85 % was assumed (not to be confused with MFU).

Large breeds $$\text{SFU per day} = e^{(\ln(T+1{,}738)/(3{,}079-258 \times \ln(V))) / 0.28)} \times 1.05 \quad (3.9)$$

where T = daily gain, g per day and V = body weight

A heifer’s growth period from weaning to calving was divided into several intervals and growth curves were applied to estimate the number of days in each interval. Finally, average body weight and average daily gain were calculated for each interval and used for calculation of daily energy requirements in each interval.

No AAT standard for heifers exists; usually, standards for digestible crude protein are used. However, for simplicity the AAT standard for cows, 90 gram AAT per SFU, was also applied to the heifers.

Bulls – energy and protein requirements

Energy requirement for bull calves not yet weaned - < 100 kg (75 kg for Jersey) were calculated using formulas 3.7 and 3.8 above. In contrast to heifers, energy requirements for weaned bulls are divided into requirements for growth and requirements for maintenance. Energy requirements were increased by 5 % to account for free housing systems. Also, it was assumed that energy requirements for JER bulls were 20 % higher than for the large breeds at a given daily gain at a given weight. The following formula was used to estimate requirements for maintenance:

$$SFU_{maintenance} \text{ per day} = 0.53 \times (0.9 \times V)^{0.67} / 7.89 \times 1.05 \quad (3.10)$$

Energy requirement for growth was estimated using the following formula:

$$SFU_{growth} \text{ per kg weight gain} = 2.17 \times e^{(0.00256 \times V)} \times 1.05 \quad (3.11)$$

where V is body weight.

Requirements for protein were estimated in same way as for heifers, 90 g AAT per SFU.

Dead calves

Some calves die at a young age from causes other than slaughter. A calf dying at the age of 3 months still must still be fed for the first 3 months. In the 2008 NTM calculation, these costs were only considered for the bulls. For the 2018 NTM calculations feed costs for dead heifers were also accounted for. Using the time intervals from the young stock survival index, 458 days and 184 days old for heifer and bulls, respectively, the average age at death, if death was within these time intervals, was calculated for both groups within breed and country (Table 1.8) The feed requirements were estimated using the formulas described above for heifers and bulls.

Table 1.8. Average age (days) at death for calves dying before day 184 and 458 for bulls and heifers, respectively, within breed and NAV country. Based on evaluation data for young stock survival on calves born in 2015 and assumed similar in both conventional and organic herds.

	Bulls			Heifers		
	DNK	SWE	FIN	DNK	SWE	FIN
RDC	70.5	49.0	56.3	92.1	114.5	87.4
HOL	52.1	41.9	43.5	88.0	112.7	80.4
JER	48.8	-	-	89.9	-	-

1.2.2 Feeding schemes

The way dairy cattle are fed differs between the NAV countries, for example a greater proportion of dairy cows are put on pasture in summer time in FIN compared to DNK. Also, the composition of feed fed indoors differs between the countries. The used feeding scheme affects the costs related to milk and beef production and should be accounted for in the 2018 NTM calculations. Cow feeding experts at SEGES, Växä and FABA were all asked to supply information about average feeding schemes in each NAV country. The applied feeding scheme for each NAV country was further divided into whether it is used in a conventional or an organic production system.

Several feeding schemes can be used in the NTM program – useful for sensitivity analyzes. However, here we only present basic schemes consisting of roughage and concentrates. Roughage is further divided into pasture (fresh grass), grass silage and maize silage. In Table 1.9 the basic feeding schemes used in the 2018 NTM calculation are presented.

Table 1.9. Basic feeding schemes for cows – 2016 figures. Reference: SEGES, Växä, and FABA.

Country	Production system	Proportion of roughage in ration, %	Proportion of roughage type in basic ration: Pasture (fresh grass), %	Grass silage, %	Maize silage, %
DNK	Conventional	60	0	40	60
	Organic	65	20	80	0
SWE	Conventional	60	15	65	20
	Organic	65	20	80	0
FIN	Conventional	55	15	85	0
	Organic	65	20	80	0

1.3 Fertility

The input parameters for the NTM model are insemination rate (IR) and conception rate (CR). The two parameters were estimated based on statistics on length of insemination period (IFL) and number of inseminations (AIS) by calculating IFL and AIS in the NTM model for all possible combinations of CR and IR. The set of CR and IR values where the calculated IFL and AIS values were closest to results seen in practice was selected as input parameters. Actual phenotypic figures on fertility for heifers and cows are shown in Table 1.10 and Table **1.11**, respectively.

Table 1.10. Assumed phenotypic values for fertility parameters for heifers. Based on fertility evaluation data and calving year 2016

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Age at 1st AI, days	487	549	476	473	544	472	436
1st-last AI (IFL), days	23.8	26.9	23.0	24.6	24.0	21.2	27.4
Number of AI (AIS)	1.60	1.68	1.60	1.64	1.55	1.62	1.67
Age at 1st calving, months	25.7	27.3	25.8	25.3	26.9	25.5	24.1

Table 1.11. Assumed phenotypic values for fertility parameters for cows (mean across parity 1-3). Based on fertility evaluation data and calving year 2016.

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Calving-1st AI (ICF), days	74.3	79.6	89.1	76.5	83.3	94.2	71.0
1st-last AI (IFL), days	42.1	46.2	46.6	49.2	52.1	46.7	39.7
Number of AI (AIS)	1.89	1.80	2.01	2.05	1.88	2.01	1.87
Calving interval (CI)	396	406	415	405	415	420	393

Insemination of heifers starts at the age given in Table 1.10, and insemination of cows starts from 71 to 94.2 days after calving depending on breed and country. For both heifers and cows, it was assumed that the insemination period continues until pregnancy or until day 168 (8 insemination periods) after first insemination. Animals which are not pregnant at day 168 were assumed to be slaughtered.

1.3.1 Effect of using SS

The default NTM 2018 scenario includes the use of sexed semen (SS) in combination with unsexed semen (unSS) and beef semen (BS). The proportions of SS used for first inseminations in the NAV countries in

2017 are shown in Table 1.12. It was assumed that when SS was used, it was used for the first two inseminations before switching to unSS or BS.

Table 1.12. Proportions (%) of sexed semen used for first insemination in heifers and cows within breed and country. Based on first inseminations in 2016

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Heifers	30	5	5	30	9	8	42
Cows	4	2	4	3	2	5	20

The values in Table 1.12 do not necessarily reflect future use of SS (when 2018 NTM is realized), i.e. the proportions in SWE and FIN are expected to increase. Following SimHerd (www.simherd.com) simulation results and a thorough discussion in the NTM groups, it was agreed that the following should be implemented for the calculations:

- 40 % of replacement are heifers born from heifers (proportion of SS in the NTM model should be increased until this is achieved)
- Proportion of SS used in cows: fixed at 10 % (20 % for JER)
- Similar for all countries

Some fertility parameters are affected negatively when SS is used compared to unSS because of decreased viability of SS. For the NTM 2018 calculations, it was assumed (based on results from the NAV fertility project 2015-2016) that conception rate, when SS was used, was 90 % of the conception rate when unSS is used for both heifers and cows. No evidence was found that conception rate is affected when BS is used.

The proportions of unSS and BS in relation to SS were calculated using an iterative procedure by adding increasing proportion of unSS. For each iteration round the number of available heifers was calculated and compared with the number of heifers needed to ensure stable herd size. When the difference was positive, i.e. a surplus of heifers was reached, the procedure was stopped and the proportion of BS was calculated as:

`1-proportion of SS-proportion of unSS` (simplified for clarity).

This means that the number of surplus heifers was always minimized in scenarios including SS and BS.

Results from a Danish study (https://www.landbrugsinfo.dk/Kvaeg/Avl/Avlsvaerdital-for-malkekvaeg/Sider/Krydsningsresultater_draegtighed.pdf) indicate that gestation length on average is increased when a beef bull is used compared to a purebred bull. This should be accounted for in the NTM program. Table 1.13 show the assumed values for extended gestation length when a beef sire is used. The reason for the lower values for DNK is because Danish Blues are used extensively in DNK but not in SWE and FIN. Danish Blue has on average gestation length only 1 day longer than purebreds.

Table 1.13. Extended gestation length when beef sire is used compared to when purebred sire is used.

	DNK	SWE	FIN
RDC	+3.45 days	+5.80 days	+5.80 days
HOL	+3.45 days	+5.80 days	+5.80 days
JER	+1.55 days		

1.4 Longevity

The economic value for longevity is calculated by changes in survival rates. In Table 1.14 and Table **1.15** survival rates are shown for conventional and organic production systems, respectively, together with the accompanying replacement rates. Also, cow mortality was included in the calculation to distinguish between dead and slaughtered cows; this has a small effect on the amount of total profit in the model herd. For simplicity only two levels of cow mortalities were used, 1st parity and later parities.

The proportions of cows surviving each lactation are based on data used for genetic evaluation of longevity. However, future proportions of cows in each lactation may also be affected by using SS and BS which tends to decrease the number of available heifers to match the number of heifers needed, i.e. the replacement rate is lowered. This together with increased focus on decreasing cow mortality and increasing longevity could mean that population replacement rate is expected to be lower in the future. Recommendation for a future replacement rate was again based on results from SimHerd simulations and subsequent discussions in the NTM group. It was agreed that we should use an overall **replacement rate of 32 %** for all breeds and countries. Several herds already have replacement rates below 32 % but at population level the rate is higher. However, because of the assumption made about replacement rate level, it will be further investigated during sensitivity analyses.

Table 1.14. Lactation survival rate for conventional productions systems, replacement rate and cow mortality (both conventional and organic). Based on longevity evaluation data and calving year 2014.

	Pct. Survival			Replacement	Pct. Cow mortality	
	1st lact	2nd lact	3rd+ lact	Pct 1st calvings	1st lact	2nd+ lact
				RDC		
DNK	74.4	64.6	51.0	40.5	1.7	4.1
SWE	75.7	67.2	51.7	37.6	2.6	4.1
FIN	79.0	70.6	53.7	35.1	3.3	7.0
				HOL		
DNK	78.6	68.1	51.4	37.1	2.8	4.9
SWE	77.3	67.5	52.8	35.9	4.0	4.9
FIN	81.4	73.0	56.2	32.5	3.7	8.7
				JER		
DNK	78.3	74.8	58.7	33.8	2.7	6.3

Table 1.15. Lactation survival rate for organic productions systems, replacement rate and cow mortality (both conventional and organic). Based on longevity evaluation data and calving year 2014.

	Pct. Survival			Replacement	Pct. Cow mortality	
	1st lact	2nd lact	3rd+ lact	Pct 1st calvings	1st lact	2nd+ lact
				RDC		
DNK	72.5	64.7	60.6	37.3	1.7	4.1
SWE	77.1	70.0	55.4	35.1	2.6	4.1
FIN	81.5	71.3	55.7	33.4	3.3	7.0
				HOL		
DNK	78.5	70.7	56.7	34.5	2.8	4.9
SWE	78.0	72.4	58.0	32.6	4.0	4.9
FIN	84.4	77.7	57.3	30.1	3.7	8.7
				JER		
DNK	81.6	80.1	67.0	27.8	2.7	6.3

1.5 Calving and birth traits

The applied phenotypic levels for stillbirth and calving ease (Table 1.16) are mean values based on farmer registration used for breeding values estimation for calving traits.

Table 1.16. Phenotypic levels for stillbirth and calving ease in 1st and later lactation. Based on evaluation data and calving year 2016.

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Stillborn heifer calves, 1st (%)	3.5	3.0	4.9	5.2	5.3	6.9	4.6
Stillborn bull calves, 1st (%)	5.8	6.0	6.4	9.6	9.8	9.4	4.6
Stillborn heifer calves, later (%)	1.9	2.3	4.0	2.1	2.5	3.0	2.3
Stillborn bull calves, later (%)	3.1	3.9	4.9	4.2	5.1	3.8	2.1
Easy, 1st (%)	84.3	90.8	65.5	74.8	88.9	63.4	95.5
Easy with help, 1st (%)	12.5	6.7	27.2	21.6	8.3	29.3	3.4
Difficult without vet. ass. 1st (%)	2.8	2.2	7.1	3.0	2.5	7.1	0.7
Difficult with vet. ass., 1st (%)	0.40	0.3	0.1	0.5	0.3	0.2	0.3
Easy, later (%)	92.5	95.1	79.7	86.8	95.0	80.4	97.9
Easy with help, later (%)	6.1	3.6	17.7	11.6	3.8	17.3	1.5
Difficult without vet. ass., later (%)	0.9	1.0	2.4	1.1	0.9	2.1	0.4
Difficult with vet. ass., later (%)	0.4	0.3	0.2	0.5	0.4	0.2	0.2

The economic value of stillbirth depends on profit (or costs) from rearing both heifers and bull calves. The difference in profit between heifers and bulls is quite substantial and there are differences in stillbirth rates between the sexes. When SS and BS is used it becomes even more important to take sex effect into account. Therefore, stillbirth rate is included in the calculations for heifers and bulls, separately. Generally, stillbirth rates are of similar magnitude in the NAV countries. However, FIN has a slightly higher stillbirth rate for RDC compared to DNK and SWE.

Calvings are grouped in 4 different groups depending on degree of calving difficulties: 1) easy calving without help; 2) easy calving with help; 3) difficult calving without veterinarian assistance; and 4) difficult calving with veterinary assistance. The last group includes both cesarean and dissection of dead calf. The easiest calvings were seen in JER. For HOL and RDC it seems like FIN has a much lower proportion of easy calvings compared to DNK and SWE.

1.5.1 Effect of using BS

The use of BS is likely to affect calving traits and calf viability because of larger calves which again may affect the economic values of the calving traits. We looked at results on calving ease and stillbirth for beef crosses based on 2016 calving data. For the NTM calculations it was assumed that BS was used for 2nd parity and later only. Size of calf was ignored as larger calves are likely to be expressed as more difficult calvings. Table 1.17 shows mean stillbirth rates for beef cross, heifers and bull calves, respectively, and mean scores of calving ease for purebred and beef crosses, respectively.

Table 1.17. Observed results on stillbirth in beef cross and mean scores for calving ease in pure breed and beef cross (1 = easy calving without help). Based on data from calving year 2016.

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Stillborn heifer calves, later (%)	2.1	1.6	4.1	2.5	1.6	3.2	3.1
Stillborn bull calves, later (%)	2.9	3.7	6.0	6.1	4.4	4.3	5.5
Calving ease, pure breed, mean score	1.09	1.07	1.23	1.15	1.07	1.22	1.03
Calving ease beef cross, mean score	1.16	1.12	1.30	1.28	1.15	1.29	1.19

Stillbirth was not affected negatively in RDC and HOL when a beef sire was used to produce heifer calves. Small negative effects were seen for bull calves for FIN RDC and DNK HOL. In JER stillbirths among heifer crosses was approximately 50 % higher than their purebred counterparts. For JER bull calves the still-birth rate more than doubled when a beef sire was used. Mean score for calving ease was affected negatively for all breeds in all NAV countries; a shift towards more difficult calvings was seen (results not shown) most likely because of large calves.

1.6 Young stock survival

This index consists of four traits: heifer survival 1-30 days after birth (HP1), heifer survival 31-458 days (HP2), bull survival 1-30 days (BP1), and bull survival 31-184 days (BP2). The input parameters for the NTM model include mortality rates (1-survival rate) for both periods for heifers and bulls, respectively. Because differences can be expected between organic and conventional herds mortality rates for calculated for conventional (Table 1.18) and organic (Table 1.19) herds, separately.

Table 1.18. Mean mortality rates for young stock (heifers and bulls) from conventional herds. Based on evaluation data from birth years 2012 to March 2017

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
HP1, %	3.5	2.7	2.1	3.6	2.6	1.8	6.5
HP2, %	4.2	6.3	3.4	4.0	5.2	2.6	7.2
BP1, %	4.1	3.0	3.7	5.3	3.7	3.3	9.8
BP2, %	6.7	4.3	5.0	5.3	3.4	3.3	8.3

In most case mortality rates were slightly higher in the organic herds – only exceptions are for JER HP2, BP1, BP2, and RDC BP2 for FIN. No information on organic bull calves for SWE was available; thus, values from conventional herds were adopted.

Table 1.19. Mean mortality rates for young stock (heifers and bulls) from organic farms. Based on evaluation data from birth years 2012 to March 2017

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
HP1, %	3.68	3.00	2.39	4.54	2.67	1.88	6.86
HP2, %	4.18	5.67	3.88	4.45	4.96	3.05	6.94
BP1, %	4.52	3.00	3.93	5.91	3.70	3.70	8.55
BP2, %	8.49	4.32	4.03	6.04	3.43	4.44	6.36

Mortality of beef crosses may be different from pure breeds. We looked at this and found data to be slightly different. Data from 2000-2016 was used to calculate mean mortality rates for beef crosses (Table 1.20). Unfortunately, only DNK data was available for this; we assumed that mortality rates in SWE and FIN were similar. For RDC beef crosses had higher mortality rates for both heifers and bulls. This was also the case for HOL except for bull calves 1-30 days after birth which was lower in the beef crosses. For JER the beef crosses had lower mortality rates for both heifers and bulls except bull calves 1-30 days after birth.

Table 1.20. Mean mortality rates for young stock sired by beef breeds. Based on data from birth years 2000 to September 2017 – no data available from SWE and FIN.

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
HP1, %	3.60			4.00			5.80
HP2, %	5.00			4.30			5.30
BP1, %	4.60			4.70			10.00
BP2, %	6.90			6.80			6.50

1.7 Disease traits

The assumptions for the phenotypic levels of disease traits are based on registrations used for the routine breeding value estimation and shown for conventional and organic production systems, respectively. The exact specification of each data set from which frequencies are derived are given in the tables for each of 6 categories of diseases/disorders: udder health (Table 1.21-Table 1.22), early reproductive diseases (Table 1.23-Table 1.24), late reproductive diseases (Table 1.25-Table 1.26), metabolic diseases (Table 1.27, Table 1.28, Table 1.29, and Table 1.30), feet and legs diseases not included in claw health (Table 1.31-Table 1.32) and claw health (Table 1.34,

Table **1.35**,

Table 1.36, Table 1.37,Table 1.38, and Table 1.39). Frequencies are country specific and potential differences are caused by different management practices or differences in recording habits. Frequencies are shown as evaluation results, i.e. first treatment within period, and all treatments within category. The latter was edited such that re-treatments were removed; if time between to records was less than 8 days the second treatment was considered a re-treatment. No distinction was made between types of records within category, e.g. the udder health category in DNK consists of 12 possible disease/disorder codes. Before removing re-treatments, all codes were “translated” to the same udder health code.

Table 1.21. Phenotypic levels (%) of recorded udder health treatments for each breed within each NAV country in conventional production systems. Based on udder health evaluation data from calving years 2014-2015.

	Evaluation results				Total cases			
		1st lact -15-50 d	1st lact -51-305 d	2nd lact -15-150 d	3rd lact -15-150 d	1st lact -15 – 305 d	1st lact -51-305 d	2nd lact -15-305 d
					RDC			
DNK	6.02	6.66	12.01	14.50	6.85	8.22	21.41	25.56
SWE	2.70	3.06	6.32	9.20	2.91	3.38	10.82	15.47
FIN	2.92	3.36	7.52	9.87	3.10	3.67	11.41	17.85
					HOL			
DNK	6.74	6.15	12.66	17.02	7.69	7.59	23.73	32.06
SWE	3.41	3.79	8.23	12.37	3.61	4.07	13.82	20.20
FIN	2.90	3.87	8.47	12.51	3.07	4.27	16.00	22.81
					JER			
DNK	9.97	6.46	9.49	11.82	11.29	8.19	14.42	24.08

Table 1.22. Phenotypic levels (%) of recorded udder health treatments for each breed within each NAV country in organic production systems. Based on udder health evaluation data from calving years 2014-2015.

	Evaluation results				Total cases			
	1st lact -15-50 d	1st lact -51-305 d	2nd lact -15-150 d	3rd lact -15-150 d	1st lact -15-305 d	1st lact -51-305 d	2nd lact -15-305 d	3rd lact -15-305 d
					RDC			
DNK	3.44	4.25	7.70	8.69	3.64	5.26	12.11	11.67
SWE	2.44	2.74	5.83	8.67	2.63	2.90	9.84	14.41
FIN	1.87	3.08	7.13	9.27	1.93	3.25	12.20	15.14
					HOL			
DNK	4.77	4.28	9.67	13.33	5.14	4.83	16.22	21.59
SWE	3.07	3.29	7.81	11.21	3.20	3.53	13.09	18.03
FIN	1.37	2.16	5.02	8.76	1.44	2.23	10.81	14.29
					JER			
DNK	8.70	3.89	6.77	9.69	9.02	7.50	11.16	14.96

Table 1.23. Phenotypic levels (%) of early reproductive diseases for each breed within each NAV country in conventional production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact 0-40 d	2nd lact 0-40 d	3rd+ lact 0-40 d	1st lact 0-40 d	2nd lact 0-40 d	3rd+ lact 0-40 d
				RDC		
DNK	5.85	7.94	9.86	6.36	8.75	11.02
SWE	0.94	1.30	1.66	0.97	1.34	1.73
FIN	2.21	2.71	3.66	2.37	2.96	3.99
				HOL		
DNK	10.69	11.15	14.22	11.89	12.48	16.10
SWE	1.26	1.76	2.31	1.29	1.83	2.39
FIN	2.29	2.29	3.04	2.43	2.47	3.33
				JER		
DNK	2.49	3.06	3.44	2.71	3.30	3.76

Table 1.24. Phenotypic levels (%) of early reproductive diseases for each breed within each NAV country in organic production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact 0-40 d	2nd lact 0-40 d	3rd+ lact 0-40 d	1st lact 0-40 d	2nd lact 0-40 d	3rd+ lact 0-40 d
	RDC					
DNK	2.99	3.49	5.10	3.13	3.68	5.10
SWE	0.80	0.82	1.22	0.83	0.83	1.23
FIN	1.30	1.70	1.96	130	1.84	1.96
	HOL					
DNK	4.17	5.94	7.87	4.38	6.14	8.40
SWE	1.22	1.54	1.70	1.24	1.59	1.74
FIN	1.03	0.49	1.39	1.10	0.49	1.39
	JER					
DNK	0.45	2.23	2.61	1.00	2.54	2.86

Table 1.25. Phenotypic levels (%) of late reproductive diseases for each breed within each NAV country in conventional production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact 41-305 d	2nd lact 41-305 d	3rd+ lact 41-305 d	1st lact 41-305 d	2nd lact 41-305 d	3rd+ lact 41-305 d
	RDC					
DNK	1.38	1.94	2.44	1.58	2.28	2.87
SWE	4.54	5.52	6.01	5.11	6.32	6.73
FIN	10.11	11.05	12.42	12.60	13.90	15.88
	HOL					
DNK	1.92	2.97	3.88	2.16	3.43	4.60
SWE	5.55	7.12	7.56	6.49	8.78	9.26
FIN	10.93	12.69	13.39	13.85	16.31	17.55
	JER					
	1.72	2.23	2.64	2.00	2.66	3.17

Records of metabolic diseases are included as a sub-index in the General Health index which is currently under review. This review includes splitting of metabolic diseases into a sub-index containing treatments of ketosis and test-day records of BHB (beta-hydroxy butyrate) and a sub-index containing treatments of metabolic disorders other than ketosis. Ketosis represents between 11 and 55 % of the total number of metabolic disease treatments depending on country and parity.

Table 1.26. Phenotypic levels (%) of late reproductive diseases for each breed within each NAV country in organic production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact 41-305 d	2nd lact 41-305 d	3rd+ lact 41-305 d	1st lact 41-305 d	2nd lact 41-305 d	3rd+ lact 41-305 d
			RDC			
DNK	0.95	0.57	1.70	1.02	0.57	1.96
SWE	4.18	5.36	5.33	4.71	5.98	5.83
FIN	5.77	6.71	8.65	6.48	7.52	11.23
			HOL			
DNK	1.06	1.41	2.14	1.19	1.52	2.42
SWE	4.30	6.58	5.72	5.04	8.08	7.00
FIN	4.41	6.80	6.16	4.77	9.04	7.40
			JER			
	0.91	1.77	2.95	1.88	3.03	3.39

Table 1.27. Phenotypic levels (%) of metabolic diseases excluding ketosis for each breed within each NAV country in conventional production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d	1st lact -15-305 d	2nd lact -15-305 d	3rd + lact -15-305 d
			RDC			
DNK	1.01	2.79	7.25	1.10	2.88	7.60
SWE	1.01	2.19	5.21	1.05	2.28	5.49
FIN	1.37	2.53	5.78	1.44	2.71	6.22
			HOL			
DNK	1.57	3.75	8.94	1.71	3.95	9.43
SWE	1.32	2.97	7.38	1.36	3.13	7.85
FIN	1.57	2.98	7.82	1.66	3.19	8.40
			JER			
DNK	2.38	6.72	15.12	2.60	7.09	16.13

Table 1.28. Phenotypic levels (%) of metabolic diseases excluding ketosis for each breed within each NAV country in organic production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d	1st lact -15-305 d	2nd lact -15-305 d	3rd + lact -15-305 d
			RDC			
DNK	0.54	0.47	1.83	0.68	0.47	2.09
SWE	0.98	1.71	5.38	1.02	1.76	5.70
FIN	0.91	1.25	3.09	0.91	1.33	3.09
			HOL			
DNK	1.37	1.96	6.11	1.47	2.06	6.29
SWE	1.15	2.82	7.74	1.21	2.96	8.21
FIN	0.51	1.65	4.16	0.51	1.75	4.47
			JER			
DNK	2.04	4.10	9.73	2.76	4.21	10.76

Table 1.29. Phenotypic levels (%) of ketosis for each breed within each NAV country in conventional production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d
			RDC			
DNK	1.31	2.07	4.36	1.36	2.19	4.88
SWE	0.38	0.68	1.09	0.40	0.72	1.17
FIN	0.56	0.96	1.21	0.61	1.05	1.32
			HOL			
DNK	2.11	2.75	4.79	2.23	2.90	5.21
SWE	0.28	0.54	0.96	0.28	0.57	1.03
FIN	0.64	1.07	1.94	0.69	1.16	2.13
			JER			
DNK	3.07	1.92	2.69	3.30	2.00	2.79

Table 1.30. Phenotypic levels (%) of ketosis for each breed within each NAV country in organic production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d
			RDC			
DNK	0.14	0.09	0.39	0.14	0.09	0.39
SWE	0.28	0.40	0.78	0.28	0.41	0.83
FIN	0.58	0.59	0.93	0.65	0.59	1.03
			HOL			
DNK	0.33	0.50	0.97	0.33	0.51	1.03
SWE	0.20	0.29	0.53	0.20	0.29	0.55
FIN	0.22	0.78	0.62	0.22	0.78	0.77
			JER			
DNK	0.45	0.93	0.26	0.92	0.99	0.23

Table 1.31. Phenotypic levels (%) of feet and leg diseases for each breed within each NAV country in conventional production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d
			RDC			
DNK	7.18	5.34	6.25	8.81	6.22	7.41
SWE	1.82	1.61	2.37	1.89	1.64	2.39
FIN	1.57	1.15	1.35	1.76	1.27	1.53
			HOL			
DNK	7.85	7.68	8.58	9.52	9.35	10.57
SWE	1.63	1.63	2.68	1.66	1.65	2.73
FIN	1.58	1.35	1.94	1.75	1.52	2.20
			JER			
DNK	7.27	5.29	5.85	8.80	6.23	6.91

Table 1.32. Phenotypic levels (%) of feet and leg diseases for each breed within each NAV country in organic production systems. Based on general health evaluation data and calving years 2014-2015.

	Evaluation data			Total cases		
	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d	1st lact -15-305 d	2nd lact -15-305 d	3rd+ lact -15-305 d
			RDC			
DNK	4.15	3.96	2.88	5.03	4.91	3.01
SWE	1.53	1.28	1.73	1.59	1.34	1.75
FIN	1.69	0.74	0.93	1.81	0.74	1.03
			HOL			
DNK	3.87	3.06	3.29	4.38	3.42	3.52
SWE	1.48	1.19	2.22	1.51	1.19	2.29
FIN	1.47	1.07	1.69	1.69	1.07	1.85
			JER			
DNK	4.99	4.66	3.82	7.99	4.39	4.34

1.7.1 Claw Health

Records of 7 different claw health categories are defined for the genetic evaluation of claw health (Table 1.33). Three categories include two disorders (none/sick) and 4 categories can be scored as either none, mild or severe. For DE, digital mastitis was considered the severe form and interdigital dermatitis the mild form. For DNK, only one category is recorded for DE, i.e no severe cases. In Table 1.34,

Table **1.35**,

Table 1.36,Table **1.37**, andTable **1.39** frequencies of the 7 claw health categories are shown for RDC, HOL and Danish Jersey in 1st to 3rd parity cows calving in 2014-2015 for conventional and organic production systems, respectively.

Table 1.33. Claw health disorders included in the routine genetic evaluation of claw health.

Disorder	Abbreviation	Severity levels
Sole ulcer	SU	0-1-2
Sole hemorrhage	SH	0-1-2
Heel horn erosion	HH	0-1-2
Digital dermatitis (digital dermatitis + interdigital dermatitis)	DE	0-1-2
Skin proliferation (interdigital hyperplasia + verrucose dermatitis)	SP	0-1
White line separation (white line separation + double sole)	WLS	0-1
Cork screw claw	CSC	0-1

Table 1.34. Phenotypic levels (%) of claw health disorders in conventional RDC herds. Based on claw health evaluation data and calving years 2014-2015.

	1st lact.			2nd parity			3rd parity		
	DNK	SWE	FIN	DNK	SWE	FIN	DNK	SWE	FIN
					Mild cases				
SU	3.4	4.3	1.8	3.4	2.4	1.2	2.6	2.4	1.8
SH	14.7	17.9	13.3	11.3	11.7	9.2	7.5	7.8	10.4
HH	7.6	16.1	6.1	6.00	15.6	7.2	5.0	10.8	8.4
DE	28.3	8.6	1.6	24.2	7.7	1.1	15.6	5.9	1.3
CSC	1.2	2.9	8.5	1.6	3.5	9.8	1.0	2.2	10.5
SP	7.1	2.6	1.3	10.7	4.6	2.5	9.2	5.4	2.4
WLS	11.3	3.7	6.7	14.3	4.7	7.8	13.5	4.9	10.9
					Severe cases (for CSC, SP and WLS only one severity class)				
SU	3.2	1.4	0.3	4.5	1.3	0.3	5.0	1.1	0.5
SH	6.5	6.5	1.4	6.5	4.6	0.7	5.5	4.1	0.9
HH	1.8	2.3	0.8	2.5	3.0	1.2	1.8	2.5	1.6
DE	0.0	6.5	1.0	0.0	4.9	1.0	0.0	3.2	1.1

SU: sole ulcer; SH: sole hemorrhage; HH: heel horn erosion; DE: digital dermatitis; CSC: cork screw claw; SP: skin proliferation; WLS: white line separation

Table 1.35. Phenotypic levels (%) of claw health disorders in organic RDC herds. Based on claw health evaluation data and calving years 2014-2015.

	1st lact.			2nd parity			3rd parity		
	DNK	SWE	FIN	DNK	SWE	FIN	DNK	SWE	FIN
					Mild cases				
SU	2.0	3.4	6.0	1.0	1.8	0.0	0.0	1.9	0.0
SH	19.8	13.4	14.7	14.2	8.4	5.9	2.9	6.8	4.6
HH	5.1	9.6	2.6	3.6	10.7	7.6	0.0	7.4	9.1
DE	5.8	5.4	2.6	11.2	4.7	0.0	14.7	3.8	1.1
CSC	0.8	2.6	10.3	0.5	3.7	14.4	5.9	2.5	15.9
SP	2.7	2.1	0.9	6.6	3.2	0.0	8.8	2.1	2.3
WLS	9.3	3.9	8.6	12.2	5.3	7.6	8.8	7.6	11.4
					Severe cases (for CSC, SP and WLS only one severity class)				
SU	1.2	1.2	0.0	0.5	0.7	0.9	5.9	0.4	4.6
SH	3.5	4.6	0.0	1.0	2.3	0.9	2.9	2.3	1.1
HH	1.2	0.8	0.9	2.0	1.1	1.2	0.0	1.1	1.1
DE	0.0	2.5	0.0	0.0	2.4	1.7	0.0	1.0	0.0

SU: sole ulcer; SH: sole hemorrhage; HH: heel horn erosion; DE: digital dermatitis; CSC: cork screw claw; SP: skin proliferation; WLS: white line separation

Table 1.36. Phenotypic levels (%) of claw health disorders in conventional HOL herds. Based on claw health evaluation data and calving years 2014-2015.

	1st lact.			2nd parity			3rd parity		
	DNK	SWE	FIN	DNK	SWE	FIN	DNK	SWE	FIN
					Mild cases				
SU	2.5	3.9	2.7	3.0	3.8	2.8	2.6	2.7	3.9
SH	19.1	20.1	15.9	15.2	14.6	13.2	11.2	9.7	13.5
HH	10.8	15.0	7.3	10.6	14.5	8.7	8.4	9.8	9.2
DE	37.7	9.9	2.9	32.8	10.0	2.0	23.5	6.8	2.0
CSC	1.0	1.8	5.1	1.3	2.3	7.1	1.0	1.3	7.9
SP	6.6	3.5	2.2	9.6	5.8	3.4	9.3	7.7	4.7
WLS	11.9	4.1	10.0	14.2	6.1	11.7	11.9	5.4	15.8
					Severe cases (for CSC, SP and WLS only one severity class)				
SU	2.5	1.8	0.7	3.8	1.9	0.8	3.5	1.7	1.4
SH	8.9	7.8	1.7	8.6	5.5	0.9	6.7	4.7	1.1
HH	1.9	2.3	1.0	3.0	2.5	1.5	2.8	1.7	1.9
DE	0.0	11.7	2.1	0.0	7.8	1.6	0.0	4.8	1.2

SU: sole ulcer; SH: solehemorrhage; HH: heel horn erosion; DE: digital dermatitis; CSC: cork screw claw; SP: skin proliferation; WLS: white line separation

Table 1.37. Phenotypic levels (%) of claw health disorders in organic HOL herds. Based on claw health evaluation data and calving years 2014-2015.

	1st lact.			2nd parity			3rd parity		
	DNK	SWE	FIN	DNK	SWE	FIN	DNK	SWE	FIN
					Mild cases				
SU	2.0	3.4	6.0	1.0	1.82	0.0	0.0	1.9	0.0
SH	19.8	13.4	14.7	14.2	8.4	5.9	2.9	6.8	4.6
HH	5.1	9.6	2.6	3.6	10.7	7.6	0.0	7.4	9.1
DE	5.8	5.4	2.6	11.2	4.7	0.0	14.7	3.8	1.1
CSC	0.3	1.0	7.6	0.2	2.1	9.5	0.4	0.9	14.8
SP	1.9	2.0	0.0	4.0	3.9	4.8	5.0	6.5	3.3
WLS	7.8	4.5	12.6	9.6	6.1	16.2	8.7	6.9	21.3
					Severe cases (for CSC, SP and WLS only one severity class)				
SU	3.0	1.8	0.7	2.5	0.8	1.0	2.6	0.6	1.6
SH	8.0	6.7	2.5	5.5	5.7	0.0	6.1	5.9	0.0
HH	0.6	0.9	0.8	1.1	1.8	0.0	2.5	0.9	1.6
DE	0.0	3.9	0.8	0.0	2.9	0.0	0.0	1.7	1.6

SU: sole ulcer; SH: sole hemorrhage; HH: heel horn erosion; DE: digital dermatitis; CSC: cork screw claw; SP: skin proliferation; WLS: white line separation

Table 1.38. Phenotypic levels (%) of claw health disorders in conventional DNK JER herds. Based on claw health evaluation data and calving years 2014-2015.

	1st lact.	2nd lact.	3rd lact.
		Mild cases	
SU	4.3	4.2	3.2
SH	11.6	9.5	6.4
HH	7.5	7.1	5.2
DE	18.9	14.7	10.0
CSC	1.2	2.3	1.4
SP	1.3	1.9	1.5
WLS	8.0	10.7	8.7
		Severe cases	
SU	3.4	4.7	4.7
SH	2.6	2.8	2.3
HH	0.3	0.7	0.7
DE	0.0	0.0	0.0

SU: sole ulcer; SH: sole hemorrhage; HH: heel horn erosion; DE: digital dermatitis; CSC: cork screw claw; SP: skin proliferation; WLS: white line separation

Table 1.39. Phenotypic levels (%) of claw health disorders in organic DNK JER herds. Based on claw health evaluation data and calving years 2014-2015.

	1st lact.	2nd lact.	3rd lact.
		Mild cases	
SU	1.2	2.0	0.0
SH	24.1	15.0	15.0
HH	9.9	3.8	2.5
DE	6.2	7.8	15.0
CSC	0.2	0.9	2.5
SP	0.2	0.3	0.0
WLS	7.6	14.7	17.5
		Severe cases	
SU	0.7	1.7	5.0
SH	2.1	7.8	12.5
HH	0.2	0.0	0.0
DE	0.0	0.0	0.0

SU: sole ulcer; SH: sole hemorrhage; HH: heel horn erosion; DE: digital dermatitis; CSC: cork screw claw; SP: skin proliferation; WLS: white line separation

2 Economic assumptions

Economic values (income and costs) are treated country-wise; thus, DNK, SWE, FIN are treated as separate scenarios until the economic value per trait unit is estimated. The final economic value to be used in the NTM index will be the mean of the 3 countries. For each country 2 scenarios will be investigated, one based on conventional economic assumptions and one based on organic economic assumptions. The used economic values should reflect future economic levels, e.g. milk price and feed costs. This, however, is very difficult to obtain for some traits/factors, especially if historical levels have been fluctuating. The economic values below represent for the most part 2017 levels. We have used national and international (EU) statistics, statement from experts in each NAV country, Google and whatever source we could get our hands on in order to get as realistic a picture as possible of the economic circumstances in each country. The combined information has been used to make proposed economic values which have subsequently been discussed in the project group.

2.1 Milk and feed pricing

The economic weights of milk, fat and protein depend on the relationship between milk price and feed costs. The milk price in each country is constructed as the sum of the following components: price for protein, price for fat, price for (residual) milk, and additional values, e.g. quality payment, company profit or subsidies. For the 2008 NTM calculations, 2007 prices were used for both milk and feed because of stable relationship between milk price and feed 20 years prior. For the 2018 NTM calculations, a similar approach was not possible because milk price has been fluctuating substantially for the last 6-7 years (Figure 2.1), feed prices less so; thus, the relationship between milk price and feed costs has not been stable. The project group has discussed this challenge intensively. How to find the correct balance between milk price and feed costs? We looked at what experts believe the future milk price to be, what future feed costs would be. Using profit per annual cow as a guide to find a suitable balance between countries and production systems, we settled on the values presented below.

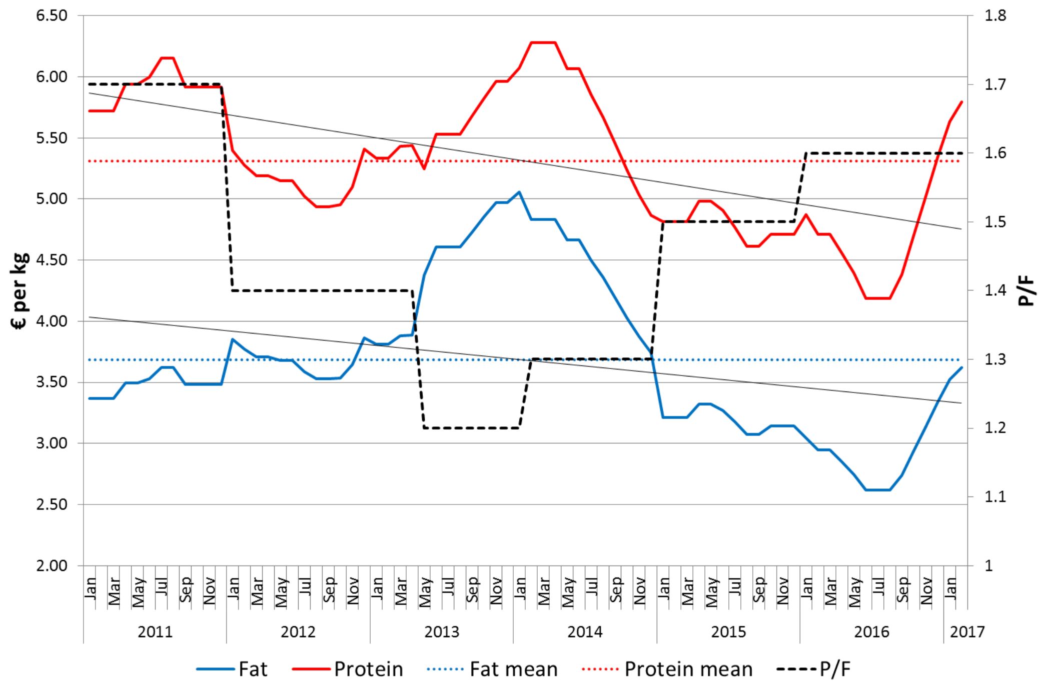

Figure 2.1. Fat and protein prices and fat-protein relationship from 2011 to 2017. DNK milk prices (ARLA). Regression lines for both fat and protein show the overall price trend.

Final assumptions for conventional and organic milk prices in DNK, SWE and FIN are shown in Table 2.1. Assumptions for conventional and organic milk pricing.. Standard milk expresses the price per kg milk with 3.40 % protein and 4.20 %. The standard milk values also contain added values such as quality payment, company profit payout, reginal subsidies etc. In Finland, the added value for organic milk compared to conventional milk is fixed at 0.145 € per kg. This value was transformed and distributed on the price of fat and protein.

Table 2.1. Assumptions for conventional and organic milk pricing.

	Unit	Sweden	Denmark	Finland
			Conventional	
Milk	€/kg	-0.016	-0.016	0
Fat	€/kg	3.83	3.83	2.50
Protein	€/kg	5.51	5.51	6.90
“Standard milk”	€/kg	0.354	0.354	0.388
			Organic	
Milk	€/kg	-0.016	-0.016	0
Fat	€/kg	4.78	4.78	4.05
Protein	€/kg	6.89	6.89	9.26
“Standard milk”	€/kg	0.451	0.451	0.533

Forecasted feed prices for DNK 2018 were used to represent future feed costs in conventional and organic herds are shown in Table 2.2. Assumptions for conventional and organic feed costs.. Values were partly provided by experts at SEGES, Växä and ProAgria but EU statistics (https://ec.europa.eu/agriculture/markets-and-prices/price-monitoring/monthly-prices_en) on e.g. grain prices were also used to determine the final values.

Table 2.2. Assumptions for conventional and organic feed costs.

	Unit	Sweden	Denmark	Finland
			Conventional	
Concentrates	€/kg	0.243	0.243	0.250
Grain	€/kg	0.150	0.165	0.190
Milk powder	€/kg	1.73	1.91	1.91
Calf mixture, starter	€/kg	0.357	0.272	0.340
Calf mixture	€/kg	0.180	0.195	0.220
Silage[1]	€/SFU	0.157	0.147	0.179
			Organic	
Concentrates	€/kg	0.487	0.457	0.520
Grain	€/kg	0.259	0.348	0.360
Calf mixture, starter	€/kg	0.548	0.653	0.590
Calf mixture	€/kg	0.379	0.468	0.448
Silage[1]	€/SFU	0.188	0.178	0.217

[1]Weighted average of grass and maize silage for conventional and grazing and grass silage for organic. Scandinavian feed unit: approx. 7.89 MJ energy per SFU.

2.2 Beef pricing

Beef pricing in the NAV countries follows the EUROP classification scheme for form, fatness and color. Prices are country specific and divided into four categories for the 2018 NTM calculations. Figure 2.2 and Figure **2.3** show the development of beef prices (form class R3) for DNK, SWE and FIN from 2008 to 2017 for bull calves and young bulls, respectively. Large fluctuations in prices were observed for young bulls especially for SWE which is currently at a very high level compared to DNK and FIN. Less fluctuation was seen for bull calves. Mean values for the shown time periods were calculated. For DNK and FIN the mean price was used as input for the NTM program. SWE is currently at a very high value but the SWE price has also been considerably lower than the DNK and FIN prices in the past. The SWE beef producers are mainly producing for the home market and can only meet approximately 50 % of the demand. This indicates that the SWE price may stay at a high level for a while. We took a conservative approach to this and adjusted the SWE mean price upwards with half the difference between the current DNK and SWE prices. Finally, all prices were adjusted to form class O2 level using DNK figures – difference between R3 and O2 is currently -19.33 € per 100 kg carcass.

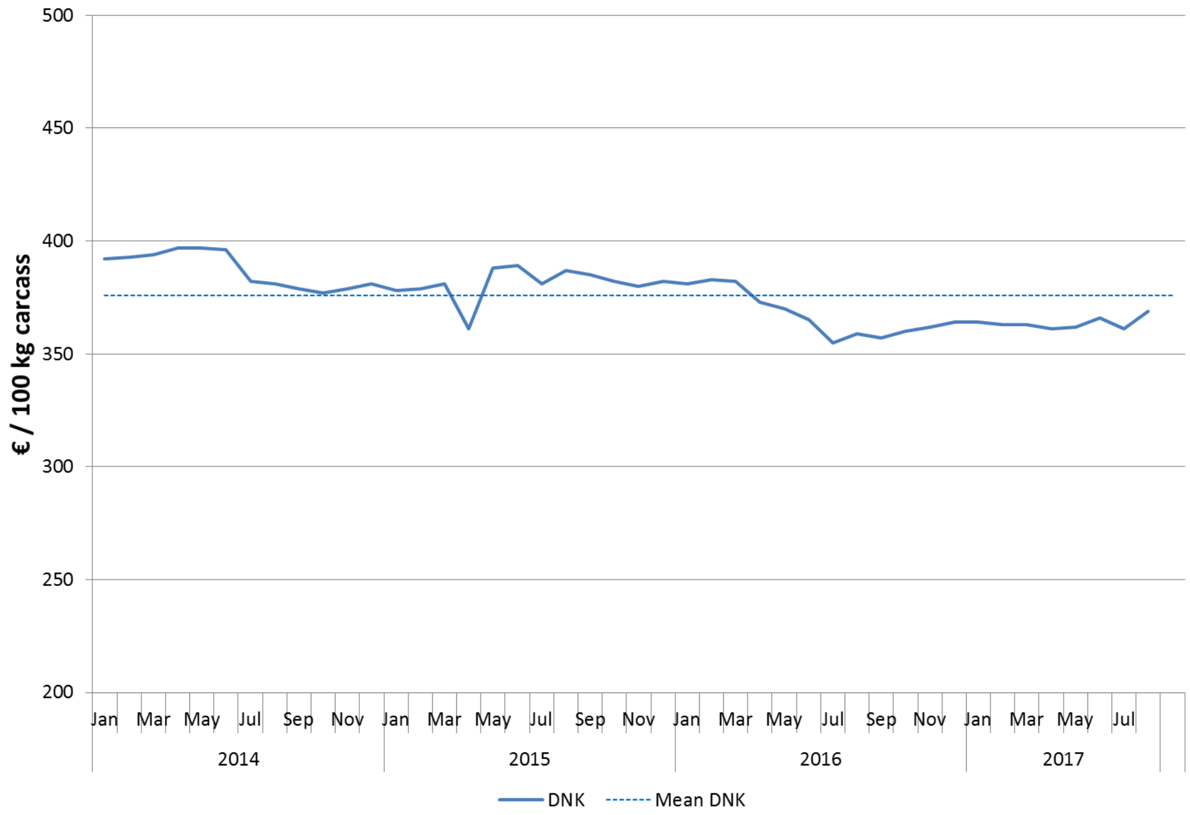

Figure 2.2. Beef price (form class R3) for bull calves (≤ 10 months) for DNK 2014-2017. Dashed line shows mean price across years. Source: https://ec.europa.eu/agriculture/markets-and-prices.

The final standard prices used as input in the NTM program are shown in Table 2.3Table 2.2, form class 5 (O2), fatness class 3, and color class 3. Prices for heifers and cows were calculated in a similar manner (details not shown).

Under organic production circumstances no bulls are slaughtered as bull calves. For the remaining groups, it has been difficult to find useable prices as they vary a lot depending on buyer of the meat, types of contract and quality requirements. Again, we took a rather conservative approach and used the economic values from the conventional scenario + a fixed added value for each group based on values from Friland A/S (Europes larges organic meat company www.friland.dk); thus, added values for organic beef were assumed to be similar in DNK, SWE and FIN. The final values for organic beef production are also shown in Table 2.3.

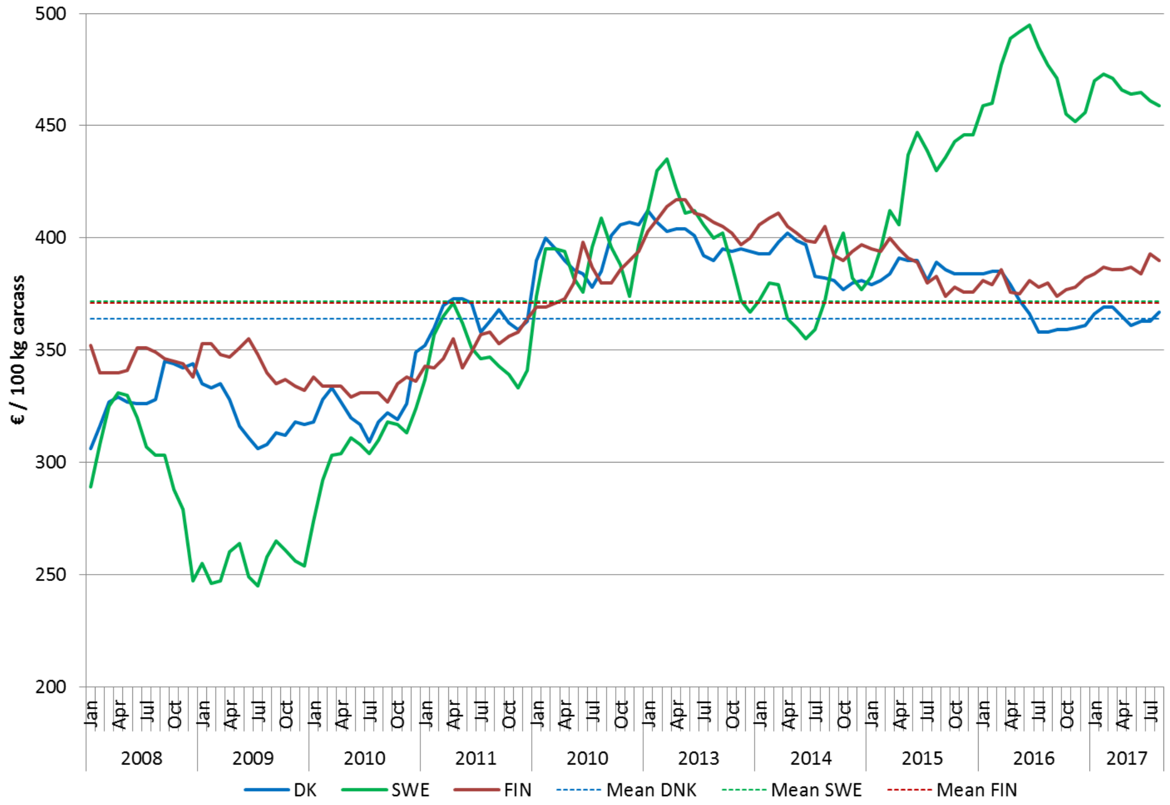

Figure 2.3. Beef prices (form class R3) for young bulls (>10 months) for DNK, SWE and FIN 2008-2017. Dashed line shows mean prices across years. Source: https://ec.europa.eu/agriculture/markets-and-prices.

Table 2.3. Assumptions on beef price, € per kg carcass, for conventional (source: https://ec.europa.eu/agriculture/markets-and-prices) and organic beef for standard classification, form class 5 (O), fatness class 3, and color class 3.

Animal category	Production system	Country		
		SWE	DNK2	FIN
Bull calves	Conventional	-	3.76	-
(≤ 10 months)	Organic	-	-	-
Young bulls	Conventional	3.98	3.45	3.52
(> 10 months)	Organic	4.65	4.12	4.19
Heifers	Conventional	4.20	3.12	3.01
	Organic	5.60	4.52	4.41
Cows	Conventional	3.63	2.77	2.24
	Organic	4.30	3.44	2.91

Live animal prices are used for some calculations in the NTM program. The applied prices for each country are shown in Table 2.4. Higher prices for beef crosses compared to pure breed calves are not accounted for in the NTM program. The reason is that prices for baby calves are internal prices in the NTM program – income for cows and cost for beef; thus, total income and costs are unchanged when prices are changed. Only the price of springing heifers matters because surplus heifers are sold outside the herd.

Table 2.4. Assumptions on breed-specific live animal prices, €. Conventional and organic prices are assumed to be similar.

		SWE	DNK[1]	FIN
Springing heifer	HOL	1,160	1,180	1,290
	RDC	1,041	1,050	1,041
	JER	-	920	-
Baby calves, heifer	HOL	213	220	50
	RDC	213	220	213
	JER	-	107	-
Baby calves, bull	HOL	107	110	125
	RDC	107	110	120
	JER	-	15	-

[1]SEGES price database, May 2017

2.3 Fertility

Cost related to fertility consists of the extra workload related to heat detection and performing AI if done by the herd manager. Costs related to inseminations performed by the AI technician are based on 2016 prices from Viking Genetics (`visiting fee on week days + fee per AI + production costs per dose of semen = €26.60`) – costs in SWE and FIN assumed to be 20 % higher than DNK. Costs related to selection, i.e. choosing a specific bull, is not included because this is a management decision and not common for all herds. The average costs related to an AI depends on the proportion of owner inseminations in each NAV country. Based on actual statistics and assumptions about the future, proportions of owner inseminations in DNK, SWE, and FIN were assumed to be 20, 60, and 30 %, respectively. Work related to one AI for the herd manager was assumed to be `0.25 hours + proportion of owner inseminations × 0.25 hours`. The work load related to heat observation was assumed to be 42 seconds per day a cow is observed (similar in all countries). SS is more expensive to produce than conventional semen resulting in a higher price per dose. This needs to be considered when SS is used in the NTM calculations. These assumptions resulted in the values presented in Table 2.5.

Table 2.5. Assumed costs related to one AI in each NAV country

	SWE	DNK	FIN
Cost per AI, €	17.45	23.08	23.78
Cost per AI (SS), €	28.45	34.08	34.78
Work related to one AI (herd manager), hours	0.40	0.30	0.33

2.4 Longevity

The value of longevity is estimated by changes in culling rates (1-% cows surviving a lactation), for example by decreasing culling rate in 3rd lactation by 10 %. Thus, the economic value of improving longevity by surviving 1 day longer in 3rd lactation is determined by numerous factors namely because changing the distribution of cows among lactation affects many other traits.

2.5 Calving and birth traits

Economic values of calving ease rely on the extra work required for calvings and depend on severity. The assumed work load related to the herd manager is presented in Table 2.6. It was assumed that “easy calving without help” did not require an extra work load. Also, a stillborn calf requires extra work. For FIN it was assumed that 75 % of all stillborn calves are buried which resulted in a much higher work load for stillborn calves in FIN. Also, cost of destruction should be accounted for. For FIN destruction costs was adjusted to account for only 25 % of the stillborn calves being destroyed. It was assumed that destruction cost in SWE was 2× the DNK value.

Table 2.6. Assumptions on extra work for the herd manager related to calvings and handling of stillborn calves.

	SWE	DNK	FIN
Easy calving with help, hours /calving	0.20	0.20	0.20
Difficult calving without vet. ass, hours/calving	1.50	1.50	1.50
Difficult calving with vet. ass., hours/calving	3.35	3.35	3.70
Stillborn calf, hours/calf	0.25	0.25	0.63
Destruction, €/calf	15.80	7.90	17.30

Veterinary costs related to difficult calving are described below. Finally, it was assumed that milk was retained for 1.2 days following a difficult calvings with veterinary assistance.

2.6 Young stock survival

The economic values of keeping young stock alive depends primarily on income and costs related to rearing heifers and bulls – the latter for slaughter – but also the amount of beef crosses produced. Thus, economic values for young stock also depend on the amount of SS and BS used in the calculations

2.7 Disease traits

The costs related to diseases consist of treatment costs (veterinarian fee + medicine and materials), extra work for the dairy manager and amount of retained milk in case of antibiotic treatment. Since the 2008 NTM calculations health agreement schemes have been introduced in Denmark and on a trial basis in Sweden and Finland. In Finland medicine can be bought for re-treatments after prior agreement with the herd veterinarian. In Sweden, standard practice (trials with health agreement schemes excluded) is that the herd veterinarian performs the diagnosis of an infectious disease (e.g. mastitis) and the initial treatment. After that the herd manager can do re-treatments (or follow-up treatments) for the most common diseases in both conventional and organic production systems.

The costs related to a case of disease depend on which health agreement scheme is used. In DNK a health agreement scheme is mandatory when a herd consists of more than 100 cows or 200 young stock but it is also possible to join on a voluntary basis. Three main schemes are used:

1. Basis agreement – all treatments are done by the herd veterinarian
2. Basis agreement + add-on module 1 - all diagnoses and first treatment are done by the herd veterinarian. The herd manager can perform re-treatments for certain diseases and initiate treatments of young stock. This scheme is assumed to be like the prescription scheme in FIN.
3. Basic agreement + add-on module 2 – the dairy manager can initiate treatment of certain diseases for a limited or unlimited time period. Further instructions and authorization also allow the dairy manager to initiate treatment of milk fever and/or retained placenta.

The distribution of the different health agreement schemes in DNK was calculated in the middle of the time period for determination of disease frequencies (December 31st, 2014) using data from the Danish Cattle Database and was 0.10, 0.37 and 0.53 for schemes 1, 2, and 3, respectively. The treatment authorization for milk fever and retained placenta is not herd specific; it was assumed that 50 % of the herds with add-on module 2 had authorization to treat the two diseases based on information from The Danish Ministry of Environment and Food (more than 2,000 authorizations have been given since the introduction in 2014). Organic herds in DNK can only participate in the basic agreement scheme – all treatments done by veterinarian.

Regarding the future when the NTM index is realized, a few assumptions had to be made about participation in the various health agreement schemes. For DNK it was assumed that the present schemes will continue. Thus, the figures above regarding distribution of the different schemes were assumed to be similar in the future. For SWE and FIN it was assumed that health agreement schemes similar to the Danish setup will be implemented in the future with similar distribution except that the basic scheme will not exist under Swedish circumstances. For FIN, it was assumed that 50 % of the Finnish herds take advantage of the possibility of performing re-treatments after prescription unless participation in a health agreement scheme.

Assessment of average treatment costs incl. re-treatments was done by collecting information from each country. In DNK, for example, 3 veterinary practices were asked to separate payment for veterinary work (incl. mileage or time spend) and medicine + materials for a list of common diseases/disorders used for breeding value estimation. For SWE, national guidelines for veterinary pricing was used. And finally for FIN actual invoices send from veterinarians to farmers were used to deduct treatment prices In Table 2.7,Table **2.8**, andTable **2.9** treatment costs, the amount of extra work and amount of retained milk (in days) are shown for organic and conventional production systems in DNK, SWE and FIN. Extra work is required when owner treatment of diseases are employed. This is taken into account in the shown working hours in the beforementioned tables. Similar types of antibiotics were assumed to be used in all 3 countries resulting in similar milk retaining periods (based on DNK information).

For the disease groups used in General Health only the most frequent diseases/disorders were used for estimating a cost for each group - the following assumption were made:

- Metabolic diseases: 50 % replaced abomasum + 50 % milk fewer
- Feet & Legs: 100 % foot root
- Early reproductive diseases: 50 % retained placenta + 50 % metritis
- Late reproductive diseases: 75 % hormonal treatment + 35 % metritis

In general, veterinary treatment costs have increased substantially since 2008 in all countries; however, the employment of health agreement schemes causes large differences between organic and conventional production systems for certain diseases because veterinarian fees can often be discarded. Annual fees for participating in a health agreement schemes are considered part of the fixed costs which are not considered in the NTM calculations.

Table 2.7. Average treatment costs, extra work and the number of days with retained milk for conventional and organic dairy production in DNK for diseases/disorders used in the NTM traits.

Disease/disorder	Vet. fee, €	Medicine, €	Total, €	Extra work, hours	Retained milk, days
			Conventional		
Mastitis	40	47	87	2.00	8.00
Ketosis	72	32	104	1.33	0.00
Metabolic diseases	136	55	191	1.50	3.50
Feet and leg diseases	34	23	56	1.95	3.00
Early reprod. disease	63	25	88	1.60	4.00
Late reprod. disease	65	19	84	0.90	2.00
Difficult calving[1]	188	21	209	3.70	1.20
			Organic		
Mastitis	169	47	216	1.44	14.00
Ketosis	72	32	104	1.33	0.00
Metabolic diseases	151	55	206	1.25	7.00
Feet and leg diseases	115	23	146	1.45	6.00
Early reprod. diseases	121	25	146	1.10	8.00
Late reprod. diseases	99	19	118	0.75	4.00
Difficult calving[1]	209	21	230	3.35	2.40

[1]With vet assistance (20 % cesarian + dissection)

Table 2.8. Average treatment costs, extra work and the number of days with retained milk for conventional and organic dairy production in SWE for diseases/disorders used in the NTM traits.

Disease/disorder	Vet. fee, €	Medicine, €	Total, €	Extra work, hours	Retained milk, days
			Conventional		
Mastitis	40	86	126	2.10	8.00
Ketosis	73	17	89	1.33	0.00
Metabolic diseases	242	44	179	1.55	3.50
Feet and leg diseases	29	30	59	2.00	3.00
Early reprod. disease	114	28	142	1.60	4.00
Late reprod. disease	119	10	129	0.95	2.00
Difficult calving[1]	214	18	232	3.70	1.20
			Organic		
Mastitis	87	86	172	1.90	14.00
Ketosis	73	17	89	1.33	0.00
Metabolic diseases	272	44	208	1.30	7.00
Feet and leg diseases	61	30	92	1.60	6.00
Early reprod. disease	133	28	162	1,50	8.00
Late reprod. disease	119	10	129	0.90	4.00
Difficult calving1	214	18	232	3.70	2.40

[1]With vet assistance (20 % cesarian + dissection)

Table 2.9. Average treatment costs, extra work and the number of days with retained milk for conventional and organic dairy production in FIN for diseases/disorders used in the NTM traits.

Disease/disorder	Vet. fee, €	Medicine, €	Total, €	Extra work, hours	Retained milk, days
			Conventional		
Mastitis	44	100	144	2.50	8.00
Ketosis	78	33	111	1.45	0.00
Metabolic diseases	113	46	165	1.65	3.50
Feet and leg diseases	28	38	66	1.90	3.00
Early reprod. disease	58	21	79	1.80	4.00
Late reprod. disease	65	17	79	1.00	2.00
Difficult calving1	122	43	165	4.05	1.20
			Organic		
Mastitis	210	100	310	2.51	14.00
Ketosis	78	33	111	1.45	0.00
Metabolic diseases	129	46	175	1.65	7.00
Feet and leg diseases	98	38	136	1.87	6.00
Early reprod. disease	120	21	141	1.78	8.00
Late reprod. disease	107	17	124	1.00	4.00
Difficult calving[1]	144	43	187	4.05	2.40

[1]With vet assistance (20 % cesarian + dissection)

2.8 Claw Health

The latest economic values for claw health were calculated in 2011 (Pedersen et al., 2011). Regarding cost related to treatment of each of the 7 claw health disorders, a comprehensive work was done in 2011 investigating costs related to extra work by claw-trimmer (basic costs of claw-trimming not included), extra work by herd manager, possible veterinary treatment costs, and cost related to materials. A few Danish claw trimmers were contacted to verify possible changes to treatment costs. It was found that the economic assumptions used in the 2011 study regarding claw trimmer costs and time spend are still valid. However, total costs related to each disorder have changed because hourly wage has increased and because frequencies of the disorders with 3 categories have changed. The latter makes costs frequency dependent when there is a difference in treatment costs of mild and severe cases, respectively. This is the case for sole ulcer (SU) only; treatment and costs and time spend based on frequencies in calving years 2014-2015 are shown in Table 2.10. For the remaining categories treatment costs and time spend remains as presented in Pedersen et al. (2011). Assumptions for organic and conventional productions systems were similar.

Table 2.10. Average treatment costs across lactations for sole ulcers under SWE, DNK and FIN production circumstances and additional time spend per cases. Based on assumptions in Pedersen et al. (2011).

	Country		
	SWE	DNK	FIN
Treatment, €/case	17.65	28.77	16.28
Herd managers work, minutes	76.00	93.00	73.00
Claw trimmers work, minutes	3.90	3.20	5.00

2.9 Conformation traits, milking speed and temperament

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

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

Therefore, the set up for this trait group is somewhat atypical compared to the other trait 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. The current figures in the NTM program are taken from the Danish 2002 report on economic weights (Pedersen et al., 2003):

- Body: There is no impact on the work load if all traits included in "Body" were linearly scored 1 point away from the optimum.
- Udder: If all traits included in Udder were linearly scored 1 point away from the optimum, the extra work was assumed to be 15 minutes per day per 110 cows.
- Feet&Legs: If all traits included in Feet&Legs were linearly scored 1 point away from the optimum, the extra work was assumed to be 10 minutes per day per 110 cows.

The two farmer-evaluated traits Milking Speed and Temperament are less complicated, because the recorded score can be directly evaluated. If milking speed of all cows is one unit less it is assumed that the extra work would be 10 minutes per day per 110 cows. If the temperament of all cows is 1 unit lower, the extra work was assumed to amount to be 5 minutes per day per 110 cows.

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