NAV Nordisk Avlsværdi Vurdering
Nordic Cattle Genetic Evaluation

2018 Review of Nordic Total Merit Index Results

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Content

Den Europæiske Landbrugsfond for Udvikling af Landdistrikterne:
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1 Introduction

An important step in the design of breeding schemes is the definition of a breeding goal. In the breeding goal, each trait is assigned a weight expressing the direction of genetic improvement for the trait. The economic value of a trait reflects the contribution to genetic improvement of a unit for that trait to the improvement of total improvement. As the breeding values in the Nordic breeding value estimation are expressed as indices, the economic values must be transformed to value per index unit.

The breeding goals in the NAV countries Finland, Sweden and Denmark have for many years included both production and functional traits. In fact, the Nordic countries have been leading in that area with our "Nordic profile" for more than 25 years, (Pedersen et al., 2002; Juga et al., 1999; Philipsson et al., 1975).

During the last decades, the cooperation between the Nordic breeding organisations has steadily become more intensive, with some of the landmarks being the establishment of NAV in 2002, publication of the first common breeding values in 2005, the establishment of the Viking Genetics in January 2008, and the introduction of the common total merit index, NTM, in November 2008. The NTM has remained nearly unchanged since then. Therefore, it seems appropriate to perform a revision of the biological and economic assumptions for the NTM. When we in the remainder of this report refer to the 2008 (or original) scenario, this also includes the later additions of the claw health and young stock survival indices. In preparation for the review, breed and AI organizations have supplied input and discussed future production circumstances for dairy production in the NAV countries. This was discussed at the January 2017 NAV Workshop. Following the discussions at the workshop it became clear that the following items should be considered in the NTM revision.

- The use of sexed semen (SS) and increased amount of beef crosses: It could have effect on value of calving traits, fertility traits and growth traits. Besides, there might be an interrelationship with longevity traits.
- Increased production in organic herds: In organic herds, some production costs are higher but also the product prices are higher. In this project, the economic aspects of organic farming are considered but also biological aspects are considered where values differ from a conventional production system.
- Feed efficiency is very important in a dairy enterprise. It relates to weight of the cow and level of production but also to feed utilization. The latter is difficult to handle in breeding because it is expensive to measure on an individual basis. Nevertheless, the economic value can be estimated. Most of this work will be done in the REFFICO project (Robust and effective dairy cows), but indications might be obtained for value of cow weight and marginal feed utilization for production.
- The value of increased frequency of polled cows should also be considered.

From the items above three main scenarios were designed:

Classic: Similar to the 2008 setup but with updated economic and biological assumptions based on conventional production circumstances. This scenario is only included to assess the effect of changed economic and biological assumptions for comparison with the 2008 results and does not include the use of SS and beef semen (BS).

Conventional (default): Economic and biological assumptions are similar to assumptions in the classic scenario. However, the use of SS and BS was included in this scenario. The amount of SS was based on the assumption that 40 % of replacement heifers are born from heifers in the future. Also, replacement rate was reduced to 32 % because it is expected to decrease in the future. These assumptions were identical for all NAV countries. Also, assumptions about future health agreement schemes, i.e. owner treatment of certain diseases, were made. Currently, health agreement schemes are on trial in SWE and FIN similar to the current DNK health agreement schemes. We assumed that when the 2018 NTM is realized these will be fully implemented on a level similar to the DNK level. This is described in more detail in the appendix: Biological and Economic Assumptions.

Organic: Similar to the default scenario with respect to the use of SS and BS and level of replacements rate. However, economic assumptions for organic productions circumstances were used and biological assumptions were adjusted for traits where a clear difference was seen between conventional and organic herds. It was assumed that health agreement schemes are not introduced in organic productions system. However, organic farmers in SWE are allowed to administer follow-up treatments.

It was decided to use the same economic model as in 2008. Therefore, the work has focused on:

- Assessment and analyses of the economic conditions for milk production in Sweden, Finland and Denmark from a perspective of dairy cattle breeding.
- Estimate and analyze economic values of the traits of interest for the Nordic Holstein breeds (HOL), the Nordic Red Dairy Cattle (RDC) and for the Jersey (JER) breed.
- Develop the economic model to enable handling of SS and BS.

Results (economic value per trait unit) are summarized as averages of Denmark, Sweden and Finland for each trait for each of the three scenarios and compared with the 2008 results. For the conventional and organic scenario, the results are also presented for each individual country.

Feed efficiency is not included in the current NTM model but will be handled in a separate section. Likewise, the introduction of polledness in a herd will also be discussed in a separate section.

The result of this work is intended to serve as basis for a final evaluation of economic weights to be used in a revised NTM. Also, this final evaluation might include breed policies as well as ethical and consumer aspects.

Sensitivity analyses is an important part of the NTM work; for example, what happens if the milk price change (up or down) in the future. This work has not yet been completed but will be included in the final 2018 NTM report prepared after discussions at the January 2018 NAV Workshop and before the May 2018 NAV Workshop.

Descriptions of biological and economic assumptions are not included in this report but documented separately in an appendix that comes with this report: Biological and Economic Assumptions.

2 Results – economic values for traits and sub-traits

In Table 2.1, 2.2, and 2.3 average economic values (simple means of DNK, SWE and FIN) are presented for HOL, RDC, and JER, respectively, for the Classic, Conventional and Organic scenarios. Also, economic values calculated in 2008 are added for comparison. In Table 2.4 and 2.5 country-specific values are presented for HOL and RDC, respectively. As JER results are based on only DNK conditions, these are already shown in Table 2.3. In Tables 2.6 and 2.7 country-specific values are presented for the organic scenario for HOL and RDC, respectively.

2.1 Explaining differences

There can be many reasons why results are different from the 2008 results. The most obvious reasons are updated economic values, but also biological factors have an effect if they change the structure of the model herd, for example lower culling rates will affect replacement rates and therefore the distribution of parities which in turn will have an effect on a wide range of traits. The use of SS and BS have a similar effect, affecting the distribution of born heifers, bulls, and beef calves. Below we have made short explanations for each trait group. The classic scenario will not be discussed here. The conventional (default) scenario will be compared with the original 2008 results and the organic scenario will be compared with the conventional scenario.

Yield: Both the assumed price of milk and feed has increased – mostly the milk price. For establishment of the economic value of improving yield it is important to mention that only the marginal feed costs matter. In the NTM model this is only determined by the price of concentrates which has increased since 2008. Thus, profit per kg milk has increased resulting in a higher economic value per kg standard milk. Also, P:F (protein fat relationship) has decreased from 1.70 to 1.44 in DNK and SWE resulting in a higher value for fat. For FIN the P:F is unchanged. Overall, the relative increase is largest for fat. The profit per kg milk is generally lower in the organic scenario because feed is costlier relative to milk price; thus, a lower economic value for standard milk in the organic scenario. The high organic feed price in Finland has a large effect on the average economic values for fat and protein. Because of the “low” fat value it is not profitable to improve fat in FIN whereas the opposite is the case for protein; thus, the economic value of fat is lower in the organic scenario and higher for protein.

Beef production: Overall, the mean economic values of the beef production traits have increased considerably. There are 3 main reason for this: (1) The design of the conventional and organic scenarios with the use of SS and BS and a much lower replacement compared to the original scenario results in a higher number of animals for slaughter and fewer heifers that starts on AI (Table 2, SWE used as example because this country has the largest impact on the beef trait values). (2) it has become more profitable to produce beef (largest effect on the economic values), especially in SWE, and (3) the inclusion of beef crosses results in a higher slaughter price, i.e. beef crosses grow faster and gets more form points. The country-wise differences are quite large for the beef production traits. This is mainly because of a different production system in SWE and FIN - animals are much older at slaughter - compared to DNK, resulting in a higher form value and total slaughter price. The economic values in the organic scenario are much lower mainly because the higher slaughter price cannot compensate the increased feed costs. In practice, few animals are slaughtered as organic. Also, the organic beef market is highly specialized making it challenging to settle on a fixed slaughter price for organic beef.

Especially for JER the increase in the beef production traits are large. Of course, the higher slaughter price compared to 2008 has a positive effect but also the calculation of required feed has been changed slightly for JER resulting in a slightly lower feed requirement compared to 2008.

Table 2.1. Comparison between statistics from the original and conventional scenario showing numbers of animals in each category and profit per slaughter animal using SWE HOL as an example.

Scenario	Calvings per year, N	Heifers started on AI, N	Slaughter animals, N	Profit per slaughter animal, €
Original (2008)	118.4	52.3	49.3	254
Classic (2008)	111.7	49.9	48.5	534
Default (2018)	111.7	35.7	62.3	563

Calving traits: The economic value of survival rate has decreased in 1st parity and increased in later parities when comparing classic with original. The reason is the lower replacement rate which results in fewer 1st calvings and more later parity calvings. The value for 1st parity decrease slightly when SS and BS is introduced leading to a changed ratio of born heifer and bull calves. The stillbirth rate is higher for bull calves compared to heifer calves. With more heifer calves being born from heifers because of SS the value of lower stillbirth rate decreases. The value increases in later parities mainly because of a higher number of beef crosses despite a higher survival rate of the beef crosses compared to purebreds. The reason behind the increased values is the increase number of slaughtered beef crosses at a higher slaughter price compared to purebred bulls when survival rate is improved. The economic values for survival rate are lower in the organic scenario because feed costs are much higher compared to the conventional scenario which reduces the economic benefit of improving survival rate.

Calving ease is one of the traits that depends heavily on the basic parameters. CE is recorded in 4 categories and especially the categories “difficult” and difficult with vet. assistance affect the economic value. If the distribution of these categories changes, the value will change, e.g. if there are no longer any cases of difficult with vet assistance then the value of improving CE becomes smaller. This is the case compared to 2008 because the frequency of difficult calvings has decreased. This explains the lower value of CE in 1st parity. Also, the number of first calvings has become lower because of a lower replacement rate.

For later parities, the economic value of CE is only slightly higher in the classic scenario compared to original. The number of difficult calvings has decreased slightly but on the other hand the veterinary costs related to difficult calvings have increased and the number of later calvings has increased due to the lower replacement rate.

When beef crosses are introduced (conventional scenario), the value of CE in later lactations increases considerably because now many of the calves born at later calvings are crosses which on average induce more calving difficulties compared to purebred calves. Especially for JER crosses there are more difficult calvings – 0.2 % of calvings require vet assistance whereas the value is 1.0 % for JER beef crosses. That gives considerable increase in value of CE at later calvings for JER because improvement of calving ease save expensive vet costs (vet costs for calving assistance is €232 in DNK). The economic values for CE in the organic scenario are nearly the same as in the conventional scenario; there is a slight increase because of increased veterinary costs.

For calving traits, economic values for direct and maternal calving traits in 1st parity are similar because we assume that beef crosses are born by cows only. However, for later parities a lower economic value is seen for the direct effect. That is because we evaluate only improvement of the purebred genes – and the crosses carry only 50 % purebred dairy genes.

Female fertility: The method for calculating the economic value of fertility has been changed compared to 2008 model. In general, the difference between the original 2008 results and results from the classic scenario is small. The largest change is observed for JER where the value of IFL for heifers has increased.

IFL for heifers: Improvement of IFL for heifers will make more heifers pregnant within the time limit set in the model and save AI costs, and age at 1st calving will be lower. In the classic scenario, all heifers including surplus heifers are inseminated whereas only the heifers needed for replacement are inseminated in the conventional scenario. Because of the lower number of animals expressing this trait the economic value becomes lower in the conventional scenario.

IFL for cows: Improving IFL will make calving interval shorter. That will increase the number of calvings per year and save costs for AI. The increased number of calves will produce more surplus heifers which are not profitable and more bull calves in the classic scenario. In the conventional scenario, it will make room for more beef crosses. Aside from saving AI costs, milk production will also be reduced a little because of shorter lactations.

ICF for cows: Improving ICF will make calving interval shorter. That will increase the number of calvings per year. In the classic scenario, the increased number of calves will produce more surplus heifers and more bull calves, In the conventional scenario, it will make more room for beef crosses in the conventional and organic scenario. The yearly milk production will be reduced slightly. The economic value for ICF in the organic scenario are lower than the conventional values because profit from production of beef crosses is lower in the organic scenario. For example, the value becomes negative for organic JER. This has to be investigated further when performing the sensitivity analyses.

Udder health: The veterinary costs for treating udder diseases have increased considerably in all three NAV countries. However, participation in health agreement schemes, which enables owner treatments, causes economic values to decrease in the conventional scenario compared with original. In the organic scenario, legislation regarding owner treatments are very different – in most cases, except follow-up treatments in SWE, treatments must be performed by the herd veterinarian. This causes a large increase in the economic values for udder health in the organic scenario compared to conventional.

General health: The situation for traits included in the general health index is quite like the udder health case. In general, treatment costs have increased considerably. For diseases, where owner treatment is allowed, the economic value of the disease group decreases compared with the original economic values. The opposite is seen, for diseases that must be treated by a vet, which is the case for most diseases. In the organic scenario, the economic values are generally higher than in the conventional scenario, mostly because farmers can perform follow-up treatments in the conventional scenario for diseases initially treated by a vet. The most noticeable difference from the original results is the separation of ketosis and other metabolic diseases. Thus, the 2018 results are not comparable with the original results for metabolic diseases.

Longevity: Improving longevity implies that each year fewer replacement heifers are needed. In the original and classic scenario, this means that surplus heifers are sold. The profit from selling surplus heifers has decreased considerably in the classic scenario which is reflected in the economic values. I the conventional scenario, the need for fewer replacement increases the room to produce beef crosses. If it is more profitable to produce beef crosses than surplus heifers the economic values for longevity will increase. This is the case especially in SWE and FIN but not so much in DNK. On average, this results in a small increase in the economic value in the conventional scenario compared with the classic scenario. The average economic value of longevity in the organic scenario is lower than the conventional results mainly because it is costlier to raise beef crosses in this production system resulting in less profit compared with the conventional scenario.

It is well known that the breeding value for longevity is heavily influenced by fertility, udder health, general health, claw health and to a certain degree by conformation of udder and feet & legs. Due to model limitations, the effect of reduced culling on the economic value of these traits is not included. Therefore, variation explained by other NTM traits is transferred from longevity to other traits in the NTM index. The transfer is bases on analyses of the relationship between longevity and the other traits in NTM. The values expressing how large part of the variance of longevity to be explained by other traits and their relative importance is shown in Table 2.8. How the distribution is done is illustrated for HOL. The average value of longevity for conventional HOL was 0.31 €/day of which 67 % should be transferred to other traits, i.e. 0.21 € should be transferred and 0.10 € is the remaining economic value of longevity. The distribution of the 0.21 is given below:

- 24 % of 0.21 = 0.05 should be added to the total economic value for fertility
- 33 % of 0.21 = 0.07 should be added to the total economic value for udder health
- 16 % of 0.21 = 0.03 should be added to the total economic value for general health
- 9 % of 0.21 = 0.02 should be added to the total economic value for feet & legs
- 18 % of 0.21 = 0.04 should be added to the total economic value for claw health

Conformation traits: The calculation of economic values for the conformation traits is only based on the amount of saved work when conformation is improved. Wages in all three countries have increased compared with the original scenario causing the economic values to increase.

Claw health: The method for calculating economic values for the claw health trait has not been changed for the 2018 calculations. Because the average wage has increased this causes the economic values to increase slightly. This also explain country differences together with a different composition of claw disorders with three categories (e.g. sole ulcer) where the proportion of severe cases is lower in SWE and FIN compared with DNK.

Young stock survival: The value of heifer survival has decreased in the classic scenario compared with the original results because profit from producing surplus heifers was higher in 2008. For bull calves the situation is the opposite; the profit from beef production is higher and therefore the value of bull calf survival is higher in the classic scenario, mostly in FIN and especially in SWE.

In the conventional scenario, the number of heifer calves has decreased because of lower replacement rate and the use of SS, and the number of bull calves has increased. However, most of the bull calves are beef crosses (heifer crosses also included here), and genetic improvement of survival only has 50 % impact on crosses. For heifer calves the values increase because survival of one heifer will make room for an extra beef cross calf. For the organic scenario, the value of survival of bull calves decreases further because profit from organic beef production is lower than conventional.

Table 2.2. Average economic values for HOL across DNK, SWE, and FIN for the three scenarios. Original 2008 values added for comparison. Values presented as Euros (€) per trait unit.

		Scenario			
Trait	Unit	Original 2008-2012	Classic	Conventional	Organic
		MILK PRODUCTION			
Milk	kg	-0.030	-0.049	-0.049	-0.087
Fat	kg	1.28	1.65	1.65	0.95
Protein	kg	4.60	5.02	5.02	5.57
Standard milk[1]	kg	0.181	0.191	0.191	0.143
		BEEF PRODUCTION			
Net daily gain	kg/day	0.171	0.219	0.213	0.077
EUROP form score	score	13.3	14.2	23.8	26.0
		CALVING TRAITS			
Survival rate, 1st parity	%-unit	1.92	1.64	1.61	1.40
Survival rate, later parities maternal	%-unit	3.10	3.64	3.92	3.05
Survival rate, later parities direct	%-unit	3.10	3.64	2.55	2.01
Calving ease, 1st parity	points	10.99	5.63	5.63	5.85
Calving ease, later parities maternal	points	14.86	15.03	26.58	28.00
Calving ease, later parities direct	points	14.86	15.03	15.67	16.58
		FEMALE FERTILITY[2]			
IFL, heifers	day	1.07	0.99	0.80	0.63
ICF, cows	day	0.55	0.48	0.54	0.16
IFL, cows	day	3.95	4.18	4.24	3.87
		UDDER HEALTH			
Udder health, 1st parity, 1st period	%-unit	1.50	0.86	0.86	1.56
Udder health, 1st parity, 2nd period	%-unit	1.55	0.91	0.91	1.67
Udder health, 2nd parity	%-unit	1.13	1.28	1.28	2.39
Udder health, 3rd parity	%-unit	1.44	2.20	2.20	4.12
		GENERAL HEALTH			
Other metabolic, all parities	%-unit	1.88[3]	3.16	3.16	4.06
Ketosis, all parities	%-unit	-	1.45	1.45	1.43
Feet & legs disorders, all parities	%-unit	1.75	1.61	1.61	2.78
Early repro disorders, all parities	%-unit	2.00	2.10	2.10	3.25
Late repro disorders, all parities	%-unit	1.05	1.81	1.81	2.50
		LONGEVITY			
Average culling[4]	day	0.53	0.30	0.31	0.29
		CONFORMATION A.O.			
Body	point	0.00	0.00	0.00	0.00
Udder	point	25.55	29.07	29.07	29.07
Feet & legs	point	17.03	19.38	19.38	19.38
Milking speed	point	17.03	19.38	19.38	19.38
Temperament	point	8.52	9.69	9.69	9.69
		CLAW HEALTH			
Sole ulcer, all parities	%-unit	0.494	0.586	0.586	0.586
Sole hemorrhage, all parities	%-unit	0.087	0.096	0.096	0.096
Heel horn erosion, all parities	%-unit	0.140	0.148	0.148	0.148
Digital dermatitis, all parities	%-unit	0.140	0.148	0.148	0.148
Cork screw claw, all parities	%-unit	0.088	0.077	0.077	0.077
Interdigital hyperplasia, all parities	%-unit	0.265	0.295	0.295	0.295
White line disease, all parities	%-unit	0.087	0.096	0.096	0.095
		YOUNG STOCK SURVIVAL			
Survival heifers, 1-30 days	%-unit	3.58	2.87	3.43	3.14
Survival, heifers, 31-458 days	%-unit	4.29	3.68	3.68	3.67
Survival, bulls, 1-30 days	%-unit	1.78	2.51	1.72	1.24
Survival, bulls, 31-184 days	%-unit	2.79	2.65	2.29	1.75

[1]4.20 % fat and 3.40 % protein

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

[3]In 2008 metabolic diseases was the sum of ketosis and other metabolic diseases

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

Table 2.3. Average economic values for RDC across DNK, SWE, and FIN for the three scenarios. Original 2008 values added for comparison. Values presented as Euros (€) per trait unit.

		Scenario			
Trait	Unit	Original 2008-2012	Classic	Conventional	Organic
MILK PRODUCTION					
Milk	kg	-0.029	-0.048	-0.048	-0.086
Fat	kg	1.33	1.64	1.64	0.94
Protein	kg	4.82	4.95	4.95	5.50
Standard milk[1]	kg	0.190	0.189	0.189	0.141
BEEF PRODUCTION					
Net daily gain	g/day	0.187	0.251	0.230	0.092
EUROP form score	score	12.9	14.6	24.4	27.7
CALVING TRAITS					
Survival rate, 1st parity	%-unit	1.85	1.59	1.63	1.45
Survival rate, later parities maternal	%-unit	3.11	3.59	3.92	3.21
Survival rate, later parities direct	%-unit	3.11	3.59	2.55	2.09
Calving ease, 1st parity	points	11.39	5.79	5.79	6.00
Calving ease, later parities maternal	points	15.69	16.88	25.01	26.36
Calving ease, later parities direct	points	15.69	15.69	14.97	15.79
FEMALE FERTILITY[2]					
IFL, heifers	day	0.94	1.03	0.94	0.77
ICF, cows	day	0.48	0.52	0.64	0.31
IFL, cows	day	2.91	3.34	3.46	3.13
UDDER HEALTH					
Udder health, 1st parity, 1st period	%-unit	1.46	0.85	0.85	1.53
Udder health, 1st parity, 2nd period	%-unit	1.50	0.89	0.90	1.61
Udder health, 2nd parity	%-unit	1.05	1.22	1.22	2.23
Udder health, 3rd parity	%-unit	1.49	2.15	2.15	3.95
GENERAL HEALTH					
Other metabolic, all parities	%-unit	1.87[3]	3.17	3.17	4.10
Ketosis, all parities	%-unit	-	1.49	1.49	1.43
Feet & leg disorders, all parities	%-unit	1.70	1.62	1.62	2.82
Early repro disorders, all parities	%-unit	1.93	2.09	2.09	3.17
Late repro disorders, all parities	%-unit	1.04	1.76	1.76	2.40
LONGEVITY					
Average culling[4]	day	0.39	0.25	0.28	0.26
CONFORMATION A.O.					
Body	point	0.00	0.00	0.00	0.00
Udder	point	25.55	29.07	29.07	29.07
Feet & legs	point	17.03	19.38	19.38	19.38
Milking speed	point	17.03	19.38	19.38	19.38
Temperament	point	8.52	9.69	9.69	9.69
CLAW HEALTH					
Sole ulcer, all parities	%-unit	0.493	0.595	0.595	0.595
Sole hemorrhage, all parities	%-unit	0.086	0.097	0.097	0.097
Heel horn erosion, all parities	%-unit	0.139	0.154	0.154	0.154
Digital dermatitis, all parities	%-unit	0.139	0.154	0.154	0.154
Cork screw claw, all parities	%-unit	0.087	0.077	0.077	0.077
Interdigital hyperplasia, all parities	%-unit	0.261	0.296	0.296	0.296
White line disease, all parities	%-unit	0.086	0.096	0.096	0.096
YOUNG STOCK SURVIVAL					
Survival heifers, 1-30 days	%-unit	3.40	2.52	3.30	3.19
Survival, heifers, 31-458 days	%-unit	4.06	3.26	3.66	3.77
Survival, bulls, 1-30 days	%-unit	1.89	2.70	1.92	1.44
Survival, bulls, 31-184 days	%-unit	2.96	2.92	2.09	1.76

[1]4.20 % fat and 3.40 % protein

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

[3]In 2008 metabolic diseases was the sum of ketosis and other metabolic diseases

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

Table 2.4. Average economic values for JER across DNK, SWE, and FIN for the three scenarios. Original 2008 values added for comparison. Values presented as Euros (€) per trait unit.

		Scenario			
Trait	Unit	Original 2008-2012	Classic	Conventional	Organic
		MILK PRODUCTION			
Milk	kg	-0.046	-0.051	-0.051	-0.084
Fat	kg	1.55	2.12	2.12	1.48
Protein	kg	4.15	4.52	4.52	4.89
Standard milk[1]	kg	0.160	0.191	0.191	0.145
		BEEF PRODUCTION			
Net daily gain	g/day	0.019	0.216	0.192	0.007
EUROP form score	score	8.5	7.8	13.8	14.7
		CALVING TRAITS			
Survival rate, 1st parity	%-unit	0.65	0.86	0.85	0.25
Survival rate, later parities maternal	%-unit	1.20	2.07	3.13	0.55
Survival rate, later parities direct	%-unit	1.20	2.07	1.87	0.35
Calving ease, 1st parity	points	15.74	10.76	10.76	11.57
Calving ease, later parities maternal	points	33.73	26.36	120.95	130.13
Calving ease, later parities direct	points	33.73	33.73	64.72	69.69
		FEMALE FERTILITY[2]			
IFL, heifers	day	1.13	1.72	1.26	1.01
ICF, cows	day	0.19	0.21	0.18	-0.38
IFL, cows	day	2.60	2.59	2.56	2.00
		UDDER HEALTH			
Udder health, 1st parity, 1st period	%-unit	1.35	0.78	0.79	1.41
Udder health, 1st parity, 2nd period	%-unit	1.35	0.88	0.86	1.56
Udder health, 2nd parity	%-unit	1.01	1.25	1.13	2.28
Udder health, 3rd parity	%-unit	1.75	2.37	2.08	4.33
		GENERAL HEALTH			
Other metabolic, all parities	%-unit	1.70[3]	3.10	3.10	4.18
Ketosis, all parities	%-unit	-	1.56	1.56	1.89
Feet & leg disorders, all parities	%-unit	1.69	1.79	1.79	3.40
Early repro disorders, all parities	%-unit	1.91	2.03	2.03	4.39
Late repro disorders, all parities	%-unit	0.94	1.65	1.65	3.23
		LONGEVITY			
Average culling[4]	day	0.41	0.37	0.36	0.31
		CONFORMATION A.O.			
Body	point	0.00	0.00	0.00	0.00
Udder	point	25.55	33.02	33.02	33.02
Feet & legs	point	17.03	22.01	22.01	22.01
Milking speed	point	17.03	22.01	22.01	22.01
Temperament	point	8.52	11.01	11.01	11.01
		CLAW HEALTH			
Sole ulcer, all parities	%-unit	0.664	0.795	0.795	0.795
Sole hemorrhage, all parities	%-unit	0.090	0.114	0.114	0.114
Heel horn erosion, all parities	%-unit	0.145	0.168	0.168	0.168
Digital dermatitis, all parities	%-unit	0.145	0.168	0.168	0.168
Cork screw claw, all parities	%-unit	0.128	0.091	0.091	0.091
Interdigital hyperplasia, all parities	%-unit	0.241	0.336	0.336	0.336
White line disease, all parities	%-unit	0.090	0.114	0.114	0.114
		YOUNG STOCK SURVIVAL			
Survival heifers, 1-30 days	%-unit	1.92	1.96	1.56	0.66
Survival, heifers, 31-458 days	%-unit	2.38	2.70	2.05	1.36
Survival, bulls, 1-30 days	%-unit	0.19	1.27	0.75	0.08
Survival, bulls, 31-184 days	%-unit	0.73	1.42	0.73	0.24

[1]4.20 % fat and 3.40 % protein

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

[3]In 2008 metabolic diseases was the sum of ketosis and other metabolic diseases

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

Table 2.5. Economic values (€) for HOL (mean of DNK, SWE and FIN) and within country values for conventional scenario.

Trait	Unit	€ per unit, mean	Denmark	Sweden	Finland
		MILK PRODUCTION			
Milk	gg	**-0.049**	-0.053	-0.055	-0.039
Fat	kg	**1.65**	2.14	2.26	0.55
Protein	kg	**5.02**	4.58	4.84	5.64
Standard milk[1]	kg	**0.191**	0.193	0.205	0.176
		BEEF PRODUCTION			
Net daily gain	g/day	**0.213**	0.200	0297	0.141
EUROP form score	score	**23.8**	9.5	29.6	32.4
		CALVING TRAITS			
Survival rate, 1st parity	%-unit	**1.61**	0.86	2.18	1.81
Survival rate, later parities maternal	%-unit	**3.92**	3.27	4.42	4.07
Survival rate, later parities direct	%-unit	**2.55**	2.00	3.04	2.60
Calving ease, 1st parity	points	**5.63**	6.64	6.32	3.94
Calving ease, later parities maternal	points	**26.58**	30.27	34.64	14.82
Calving ease, later parities direct	points	**15.67**	17.81	20.57	8.63
		FEMALE FERTILITY[2]			
IFL, heifers	day	**0.80**	0.67	0.84	0.90
ICF, cows	day	**0.54**	0.10	0.90	0.62
IFL, cows	day	**4.24**	4.08	4.96	3.70
		UDDER HEALTH			
Udder health, 1st parity, 1st period	%-unit	**0.86**	0.81	0.86	0.91
Udder health, 1st parity, 2nd period	%-unit	**0.91**	0.89	0.88	0.97
Udder health, 2nd parity	%-unit	**1.28**	1.21	1.22	1.41
Udder health, 3rd parity	%-unit	**2.20**	2.19	2.03	2.37
		GENERAL HEALTH			
Other metabolic, all parities	%-unit	**3.16**	3.04	3.88	2.58
Ketosis, all parities	%-unit	**1.45**	1.55	1.25	1.57
Feet & leg disorders, all parities	%-unit	**1.61**	1.77	1.45	1.63
Early repro disorders, all parities	%-unit	**2.10**	2.09	2.38	1.82
Late repro disorders, all parities	%-unit	**1.81**	1.60	2.15	1.68
		LONGEVITY			
Average culling[3]	day	**0.31**	**0.24**	0.30	0.41
		CONFORMATION A.O.			
Body	points	**0.0**	0.0	0.0	0.0
Udder	points	**29.07**	33.02	28.03	26.16
Feet & legs	points	**19.38**	22.01	18.69	17.44
Milking speed	points	**19.38**	22.01	18.69	17.44
Temperament	points	**9.69**	11.01	9.34	8.72
		CLAW HEALTH			
Sole ulcer, all parities	%-unit	**0.586**	0.771	0.514	0.472
Sole hemorrhage, all parities	%-unit	**0.096**	0.111	0.091	0.086
Heel horn erosion, all parities	%-unit	**0.148**	0.163	0.142	0.137
Digital dermatitis, all parities	%-unit	**0.148**	0.163	0.142	0.137
Cork screw claw, all parities	%-unit	**0.077**	0.089	0.073	0.069
Interdigital hyperplasia, all parities	%-unit	**0.295**	0.326	0.284	0.275
White line disease, all parities	%-unit	**0.096**	0.111	0.091	0.086
		YOUNG STOCK SURVIVAL			
Survival heifers, 1-30 days	%-unit	**3.43**	1.38	4.79	4.12
Survival, heifers, 31-458 days	%-unit	**3.68**	2.01	4.82	4.22
Survival, bulls, 1-30 days	%-unit	**1.72**	1.19	2.28	1.68
Survival, bulls, 31-184 days	%-unit	**2.29**	1.55	3.09	2.23

[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 2.6. Economic values (€) for RDC (mean of DNK, SWE and FIN) and within country values for conventional scenario.

Trait	Unit	€ per unit, mean	Denmark	Sweden	Finland
MILK PRODUCTION					
Milk	Kg	**-0.048**	-0.052	-0.054	-0.038
Fat	Kg	**1.64**	2.11	2.24	0.56
Protein	kg	**4.95**	4.50	4.75	5.61
Standard milk[1]	Kg	**0.189**	0.190	0.201	0.176
BEEF PRODUCTION					
Net daily gain	kg/day	**0.230**	0.204	0.332	0.155
EUROP form score	score	**24.4**	9.6	32.8	30.8
CALVING TRAITS					
Survival rate, 1st parity	%-unit	**1.63**	0.87	2.16	1.84
Survival rate, later parities maternal	%-unit	**3.92**	2.55	4.93	4.28
Survival rate, later parities direct	%-unit	**2.55**	1.62	3.29	2.72
Calving ease, 1st parity	points	**5.79**	6.64	6.77	3.96
Calving ease, later parities maternal	points	**25.01**	29.58	33.42	12.02
Calving ease, later parities direct	points	**14.97**	17.86	19.80	7.25
FEMALE FERTILITY[2]					
IFL, heifers	day	**0.94**	0.65	1.06	1.11
ICF, cows	day	**0.64**	0.24	1.05	0.64
IFL, cows	day	**3.46**	2.87	3.76	3.73
UDDER HEALTH					
Udder health, 1st parity, 1st period	%-unit	**0.85**	0.79	0.86	0.92
Udder health, 1st parity, 2nd period	%-unit	**0.90**	0.86	0.88	0.95
Udder health, 2nd parity	%-unit	**1.22**	1.13	1.23	1.29
Udder health, 3rd parity	%-unit	**2.15**	2.08	2.08	2.29
GENERAL HEALTH					
Other metabolic, all parities	%-unit	**3.17**	3.04	3.90	2.57
Ketosis, all parities	%-unit	**1.49**	1.59	1.29	1.59
Feet & leg disorders, all parities	%-unit	**1.62**	1.80	1.45	1.61
Early repro disorders, all parities	%-unit	**2.09**	2.06	2.39	1.81
Late repro disorders, all parities	%-unit	**1.76**	1.62	2.02	1.64
LONGEVITY					
Average culling[3]	day	**0.28**	0.22	0.27	0.36
CONFORMATION A.O.					
Body	points	**0.0**	0.0	0.0	0.0
Udder	points	**29.07**	33.02	28.03	26.16
Feet & legs	points	**19.38**	22.01	18.69	17.44
Milking speed	points	**19.38**	22.01	18.69	17.44
Temperement	points	**9.69**	11.01	9.34	8.72
CLAW HEALTH					
Sole ulcer, all parities	%-unit	**0.595**	0.785	0.523	0.476
Sole hemorrhage, all parities	%-unit	**0.097**	0.113	0.096	0.087
Heel horn erosion, all parities	%-unit	**0.154**	0.178	0.144	0.139
Digital dermatitis, all parities	%-unit	**0.154**	0.178	0.144	0.139
Cork screw claw, all parities	%-unit	**0.077**	0.089	0.074	0.069
Interdigital hyperplasia, all parities	%-unit	**0.296**	0.323	0.289	0.277
White line disease, all parities	%-unit	**0.096**	0.109	0.093	0.087
YOUNG STOCK SURVIVAL					
Survival heifers, 1-30 days	%-unit	**3.30**	1.31	4.75	3.83
Survival, heifers, 31-458 days	%-unit	**3.66**	1.90	4.98	4.10
Survival, bulls, 1-30 days	%-unit	**1.92**	1.40	2.72	1.63
Survival, bulls, 31-184 days	%-unit	**2.09**	1.50	2.96	1.83

[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 2.7. Economic values (€) for HOL (mean of DNK, SWE and FIN) and within country values for organic scenario.

Trait	Unit	€ per unit, mean	Denmark	Sweden	Finland
MILK PRODUCTION					
Milk	kg	**-0.087**	-0.085	-0.094	-0.081
Fat	kg	**0.95**	1.50	1.35	-0.01
Protein	kg	**5.57**	4.97	5.09	6.65
Standard milk[1]	kg	**0.143**	0.147	0.136	0.145
BEEF PRODUCTION					
Net daily gain	g/day	**0.077**	0.090	0.226	-0.085
EUROP form score	score	**26.0**	16.3	29.7	32.1
CALVING TRAITS					
Survival rate, 1st parity	%-unit	**1.40**	0.76	2.15	1.27
Survival rate, later parities maternal	%-unit	**3.05**	2.17	4.33	2.65
Survival rate, later parities direct	%-unit	**2.01**	1.34	2.98	1.71
Calving ease, 1st parity	points	**5.85**	7.02	6.44	4.08
Calving ease, later parities maternal	points	**28.00**	32.16	35.94	15.91
Calving ease, later parities direct	points	**16.58**	19.11	21.33	9.28
FEMALE FERTILITY[2]					
IFL, heifers	day	**0.63**	0.53	0.69	0.67
ICF, cows	day	**0.16**	-0.21	0.60	0.11
IFL, cows	day	**3.87**	3.77	4.66	3.18
UDDER HEALTH					
Udder health, 1st parity, 1st period	%-unit	**1.56**	1.51	1.35	1.82
Udder health, 1st parity, 2nd period	%-unit	**1.67**	1.67	1.39	1.94
Udder health, 2nd parity	%-unit	**2.39**	2.33	1.97	2.85
Udder health, 3rd parity	%-unit	**4.12**	4.22	3.32	4.82
GENERAL HEALTH					
Other metabolic, all parities	%-unit	**4.06**	3.80	4.87	3.50
Ketosis, all parities	%-unit	**1.43**	1.49	1.21	1.59
Feet & leg disorders, all parities	%-unit	**2.78**	2.96	2.29	3.10
Early repro disorders, all parities	%-unit	**3.25**	3.29	3.25	3.21
Late repro disorders, all parities	%-unit	**2.50**	2.32	2.58	2.59
LONGEVITY					
Average culling[3]	day	**0.29**	0.21	0.23	0.42
CONFORMATION A.O.					
Body	points	**0.0**	0.0	0.0	0.0
Udder	points	**29.07**	33.02	28.03	26.16
Feet & legs	points	**19.38**	22.01	18.69	17.44
Milking speed	points	**19.38**	22.01	18.69	17.44
Temperament	points	**9.69**	11.01	9.34	8.72
CLAW HEALTH					
Sole ulcer, all parities	point	**0.586**	0.771	0.514	0.472
Sole hemorrhage, all parities	point	**0.096**	0.111	0.091	0.086
Heel horn erosion, all parities	point	**0.148**	0.163	0.142	0.137
Digital dermatitis, all parities	point	**0.148**	0.163	0.142	0.137
Cork screw claw, all parities	point	**0.077**	0.089	0.073	0.069
Interdigital hyperplasia, all parities	point	**0.295**	0.326	0.284	0.275
White line disease, all parities	point	**0.096**	0.111	0.091	0.086
YOUNG STOCK SURVIVAL					
Survival heifers, 1-30 days	%-unit	**3.14**	1.75	4.71	2.97
Survival, heifers, 31-458 days	%-unit	**3.67**	2.58	5.08	3.34
Survival, bulls, 1-30 days	%-unit	**1.24**	0.54	2.20	0.97
Survival, bulls, 31-184 days	%-unit	**1.75**	0.89	3.09	1.26

[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 2.8. Economic values (€) for RDC (mean of DNK, SWE and FIN) and within country values for organic scenario (organic production system).

Trait	Unit	€ per unit, mean	Denmark	Sweden	Finland
		MILK PRODUCTION			
Milk	Kg	**-0.086**	-0.084	-0.093	-0.080
Fat	Kg	**0.94**	1.49	1.35	-0.02
Protein	kg	**5.50**	4.90	5.00	6.59
Standard milk[1]	Kg	**0.141**	0.145	0.134	0.143
		BEEF PRODUCTION			
Net daily gain	kg/day	**0.092**	0.080	0.263	-0.066
EUROP form score	score	**27.7**	19.5	33.0	30.6
		CALVING TRAITS			
Survival rate, 1st parity	%-unit	**1.45**	0.86	2.14	1.34
Survival rate, later parities maternal	%-unit	**3.21**	1.95	4.84	2.84
Survival rate, later parities direct	%-unit	**2.09**	1.23	3.21	1.83
Calving ease, 1st parity	points	**6.00**	6.99	6.91	4.10
Calving ease, later parities maternal	points	**26.36**	31.67	34.84	12.55
Calving ease, later parities direct	points	**15.74**	19.19	20.53	7.64
		FEMALE FERTILITY[2]			
IFL, heifers	day	**0.77**	0.58	0.83	0.88
ICF, cows	day	**0.31**	0.03	0.80	0.11
IFL, cows	day	**3.13**	2.67	3.51	3.20
		UDDER HEALTH			
Udder health, 1st parity, 1st period	%-unit	**1.53**	1.45	1.37	1.75
Udder health, 1st parity, 2nd period	%-unit	**1.61**	1.62	1.40	1.82
Udder health, 2nd parity	%-unit	**2.23**	2.15	2.02	2.52
Udder health, 3rd parity	%-unit	**3.95**	3.96	3.42	4.48
		GENERAL HEALTH			
Other metabolic, all parities	%-unit	**4.10**	4.13	4.83	3.34
Ketosis, all parities	%-unit	**1.43**	1.47	1.26	1.58
Feet & leg disorders, all parities	%-unit	**2.82**	3.20	2.28	3.00
Early repro disorders, all parities	%-unit	**3.17**	3.18	3.20	3.14
Late repro disorders, all parities	%-unit	**2.40**	2.28	2.35	2.56
		LONGEVITY			
Average culling[3]	day	**0.26**	0.21	0.21	0.36
		CONFORMATION A.O.			
Body	points	**0.0**	0.0	0.0	0.0
Udder	points	**29.07**	33.02	28.03	26.16
Feet & legs	points	**19.38**	22.01	18.69	17.44
Milking speed	points	**19.38**	22.01	18.69	17.44
Temperement	points	**9.69**	11.01	9.34	8.72
		CLAW HEALTH			
Sole ulcer, all parities	%-unit	**0.595**	0.785	0.523	0.476
Sole hemorrhage, all parities	%-unit	**0.097**	0.113	0.093	0.087
Heel horn erosion, all parities	%-unit	**0.154**	0.178	0.144	0.139
Digital dermatitis, all parities	%-unit	**0.154**	0.178	0.144	0.139
Cork screw claw, all parities	%-unit	**0.077**	0.089	0.074	0.069
Interdigital hyperplasia, all parities	%-unit	**0.296**	0.323	0.289	0.277
White line disease, all parities	%-unit	**0.096**	0.109	0.093	0.087
		YOUNG STOCK SURVIVAL			
Survival heifers, 1-30 days	%-unit	**3.19**	1.92	4.83	2.83
Survival, heifers, 31-458 days	%-unit	**3.77**	2.77	5.26	3.28
Survival, bulls, 1-30 days	%-unit	**1.44**	0.68	2.63	1.00
Survival, bulls, 31-184 days	%-unit	**1.76**	0.85	2.97	1.46

[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 2.9. The amount of longevity explained by other traits and their relative importance.

	HOL	RDC	JER
% of longevity value to be transferred to other indices	67 %	65 %	65 %
Most important traits and their relative importance			
Fertility	0.24	0.32	0.36
Udder health	0.33	0.33	0.23
General health	0.16	0.06	0.08
Feet & legs	0.09	0.18	0.25
Udder	-	-	0.09
Claw health	0.18	0.11	-

3 Economic value of saved feed costs

In the past decades, researchers have tried to gain knowledge for estimation of breeding values for feed efficiency in dairy cattle. However, nobody has currently implemented feed efficiency based on data from commercial farms into the breeding goal, because suitable quantities of reliable feed intake data do not exist. Feed efficiency is highly interesting in many livestock species, including dairy cattle - 87-89 % of the variable farm costs are related to feed. From the 2017 NAV Workshop, it was concluded that feed efficiency should be looked at in conjunction with update of NTM. In a master thesis by Rasmus Stephansen in 2018 (within the REFFICO project), the economic value of feed efficiency was estimated. Further details can be found here: "link will be added to the final version of the NTM report".

3.1 Possible breeding goal traits

Implementation of feed efficiency using an index for dry matter intake into a breeding goal has been proposed (Veerkamp et al.,2014; de Jong, 2016). A drawback of this implementation method is: (1) increased mobilization in early lactation; (2) difficulty of handling double counting for feed costs in the breeding goal; and (3) identify energy efficient animals. Another method for including feed efficiency into the breeding goal is based on residual feed intake (RFI), defined as the difference between observed feed intake and predicted feed intake based on energy sink traits (i.e. milk production, body weight and body weight change). The advantage of using RFI in the breeding goal is the independence of energy sink traits and because the most efficient animals can easily be identified once breeding values for RFI have been estimated.

The objective of this project was to derive economic values for. The results were be based on simulated data utilizing NAV economic assumptions similar to the NAV NTM 2018 assumptions. Different definitions of RFI were investigated and advantages and idsadvantages of the methods were discussed and used as a starting point for discussions at the January 2018 NAV Workshop.

3.2 Methods

Simherd was used for the calculations, and RFI was derived during simulations as:

$$RFI \quad = DMI_{actual} - DMI_{predicted}$$

where DMI_{actual} is the actual dry matter intake and $DMI_{predicted}$ is the predicted DMI. Since feed intake observations are not available from commercial dairy farms, Simherd predicts DMI_{actual} from energy requirements of the cow such as energy required for milk production, maintenance etc. Variation was added to DMI_{actual} in SimHerd to simulate variance of RFI.

The simulations were based on the ideas by Li et al. (2017): (1) treating RFI as the same trait throughout lactation, and (2) treating RFI as two different traits throughout lactation with a threshold, the first trait from 0-84 days after calving and the second from 84 days after calving to the end of lactation. Scenarios combined the number of RFI traits and different levels of feed utilizations to investigate sensitivity of economic values for RFI.

3.3 Results

The mean economic value of RFI across scenarios was €0.171 per SFU which is close to the average price per SFU calculated in the NTM model. No effect was found of varying the level of feed utilization (82 to 101 %), and the number of RFI periods within lactation. There was an effect using either one or two RFI traits on profit per annual cow because of differences in feed costs. Li et al (2017) only report results for first parity Holstein cows. Thus, the assumptions used for this study may not be valid for later parities.

3.4 Discussion

The adopted methods for this study were based on phenotypic regression coefficients from Li et al. (2017) for estimating predicted DMI; thus, RFI will not be genetically uncorrelated with the energy sink traits, a drawback in breeding goal setting. Kennedy et al. (1993) proposed a theory for genetic RFI which avoids genetic correlations between RFI and the energy sink traits; thus, double counting for feed costs in the breeding goal can be avoided. Currently, regression coefficients for genetic RFI under Danish circumstances are non-existent, due to lack of reliable feed intake data needed for the estimation.

In a RFI model, metabolic live weight is typically included to account for energy towards maintenance. This may favor heavier cows if the genetic correlation structure is not considered. From a biological point of view, it is important to include live weight as an energy sink trait. From an economic point of view, it is, however, better to avoid live weight in estimation of phenotypic RFI, as the costs of energy for a larger body is waste of energy.

Furthermore, separation of mobilization in different tissues (protein and fat) is currently not available. RFI models typically accounts only for overall changes in body weight. The energy density of mobilized tissue and total tissue weight differ a lot between body fat and body protein. Furthermore, body fat is mobilized until approximately 70 days after calving, whereas body protein is mobilized 0-28 days after calving. It is important to distinguish between mobilization of these two important body tissues in order to avoid RFI being mathematically equal to an energy balance model. These registrations will not be available in the near future.

More research on feed efficiency is required before we can implement a feed efficiency trait into NTM; however, we now have a method to derive the economic value for RFI in relation to setting an index value for RFI in NTM. Discussion points needs to be investigated and suitable quantities of feed intake data are required before reliable breeding values for feed efficiency can be estimated and feed efficiency can be implemented into NTM. Furthermore, it is recommended to evaluate how energy towards maintenance should be handled in NTM, both with and without a trait for saved feed costs.

4 Introducing polledness into the herd

A future scenario could be that dairy cattle will no longer have horns because all animals will be either hetero- or homozygous carriers of the gene variation responsible for polledness in cattle. Compared to a herd with 100 % horned cattle, time and money can be saved because the work related to dehorning the calves ceases to exist. From our point of view the introduction of polledness into the NTM calculations does not affect economic values of any current NTM traits. Instead, polledness should be treated as a simple new trait.

Costs related to dehorning calves in the NAV countries are assumed to be:

- Veterinary costs – local anesthesia and sedatives (mandatory)
- Dehorning costs – gas/electricity.
- Extra work for the farm manager (catching calves for vet + performing dehorning procedure assuming calves are not moved from pen).

Veterinary costs were established by investigating actual invoices send from veterinarians to farm owners (DNK only). No vet fee is included because procedures related to dehorning are usually accomplished when the veterinarian is visiting the herd anyway. We took a conservative approach and set the veterinary costs to €2.00 per calf (actual figures are less). Similar, the dehorning procedure itself was set to €1.00 per calf. Finally, extra work including catching calf, holding calf for veterinarian to perform injections, performing dehorning procedure, and getting equipment ready was assumed to be around 6 minutes per calf – again a conservative approach was taken and the extra work was increased to 10 minutes (or 0.2 hours) per calf. These assumptions were assumed to apply to SWE and FIN also.

It was assumed that only heifer calves (excl. heifer beef crosses) were dehorned in DNK whereas all calves were dehorned in SWE and FIN. Calves dying before day 31 after birth were not dehorned. The results were based on the conventional NTM 2018 scenario including use of both SS and BS for minimization of surplus heifers.

4.1 Results

As mentioned the results are based on the NTM 2018 default scenario which is based on a model herd of 110 cows. The numbers of calves surviving the first 30 days after birth are shown in Table 4.1.

Table 4.1. Number of calves surviving day 30 after birth for each breed and country combination

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Heifers	37.3	38.4	36.9	37.2	37.7	36.5	38.8
Bulls incl. beef crosses	72.3	68.1	68.0	68.2	65.6	67.5	66.6
Total	109.6	106.4	104.9	105.4	103.3	104.0	105.4

In Table 4.2 saved costs per calf or per annual cow are shown. Costs related to dehorning calves range from €2.73 to €7.30 per annual cow. As expected the costs are much lower in DNK where only purebred heifer calves are dehorned compared to SWE and FIN. Difference between breeds in DNK can be explained by the number of needed heifers for replacement – lowest for JER and highest for RDC. In SWE and FIN all calves are dehorned. The higher costs for SWE can be explained by a slightly higher (~7 %) hourly wage compared to FIN.

Table 4.2. Costs saved from dehorning in a herd with 100 % polled animals compared to a herd with 0% polled animals.

	RDC			HOL			JER
	DNK	SWE	FIN	DNK	SWE	FIN	DNK
Per calf, €	2.75	7.30	6.16	2.85	7.30	6.16	2.97
Per annual cow, €	2.73	7.06	5.87	2.73	6.86	5.82	2.85

Compared to a recent American study our results seem a bit too low. Thompson et al. (2017) found that a semen dose from a homo- or heterozygous bull could cost between €5.08 and €10.17 more than semen from a bull producing horned progeny. However, they included additional cost for using semen from polled bulls and accounted for whether a home- or heterozygous bull was used.

Neither our study nor the American study considers the effect of introducing 100 % polledness from a genetic perspective. Polled bulls are likely to be from closely related families. This may decrease genetic variation and increase inbreeding in the population. Also, polled bulls may be genetically inferior to horned bulls. Thus, using polled bulls only, will limit the genetic gain at population level. We do not have estimates on the economic consequences at the genetic level but they should not be underestimated.

Finally, legislation and consumer attitude towards dehorning of cattle from an animal welfare point of view is not considered either. The economic value of this is difficult to deduct but if dehorning of cattle, for example, became illegal to perform, it may force the dairy cattle industry to focus even more on introducing polled genetics into the dairy population.

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