STØTTET AF
Mælkeafgiftsfonden

Note on decreased replacement rate and on increased use of Y-sorted beef semen in dairy herds

Effect on economic values

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In latest revision of the economic values in dairy breeding (described in "Review of Nordic Total Merit Index, Full Report, November 2018") it was assumed that the beef semen was used for crossing in dairy herds as far as possible. However, the use of Y-sorted beef semen was not considered.

Since 2018, the use of Y-sorted beef semen has become quite common. Therefor it has been decided to analyse if the increased use of Y-sorted semen have effect on the economic values and subsequently economic weights of NTM described in "Review of Nordic Total Merit Index, Full Report, November 2018".

With the increased use of X-sorted dairy semen and of beef semen in dairy herds the heifer replacement rates have decreased. The lower heifer replacement rate is expected to improve the total farm profitability with effects not only on animal biology but also the way of conducting routine dairy farm operation. Therefor it has been decided to analyse the effect of decreased heifer replacement rate on the values described in "Review of Nordic Total Merit Index, Full Report, November 2018".

In this note, first the scenarios to identify the effect of Y sorted beef semen is evaluated, second effect of reducing the heifer replacement, and finally the combined effects of Y sorted beef semen and reduced heifer replacement rates are investigated and reported.

Use of Y-sorted beef semen

Expected effect of Y-sorted beef semen on dairy herds

- In the dairy version of the bio economic model the improvement in the purebred genes are being evaluation and not the beef genes
- In general, the use of Y-sorted beef semen does not change the frequency of dairy and beef genes - but the genes are distributed differently on crossbred male and female calves. Therefor we do not expect changes for traits that are expressed only in dairy cows. However, if improvement of a trait changes the distribution of purebred and crossbred genes it might have some impact.
- In the dairy version the value is expressed per annual cow and not per crossbred calf as in the NBDI-version of the model

For this report, the TMI-model has been modified such that we can chose to vary the use of Y-sorted beef semen: Three alternatives have been compared:

- No Y-sorted beef semen (distribution of born beef crosses: females:males is 50:50)
- 50% of beef semen is Y-sorted (distribution of born beef crosses: females:males is 25:75)
- 100% of beef semen is Y-sorted (distribution of born beef crosses: females:males is 0:100)

In table 1-3 the results are shown for the traits where we observe some effect of using Y-sorted beef semen and table 4-6 the percentwise differences are shown.

Use of Y-sorted beef semen have **no** effect on value of traits that are only expressed by cows. The traits are:

- Yield
- Mastitis
- Other disease
- Claw health
- Conformation
- Calving ease at 1st calving. In this version of the model, it is assumed that beef semen is not used on heifers.

Use of Y-sorted beef semen have **small** effect on values of:

- Stillbirth at 1st calving
- Fertility traits
- Longevity/culling rates

That is because improvement of these traits has some effect on the distribution of purebred and crossbred calves born in the herd (see details later – table 7).

Use of Y-sorted beef semen have effect on value of:

- Growth: The effect is slightly negative because fewer animals reach age of slaughter, due to higher mortality of male crosses compared to female crosses.
- Form score: The effect is slightly negative in SWE and FIN - more negative in DNK. In DNK form score is not very important for calves slaughtered at a young age (under concept "Danish Calf"). When the share of male calves increases, more DNK calves are slaughtered under "Danish Calf" concept where form score is not important
  In the current version of the model heifer crosses are never slaughtered as "Danish Calf" (But analyses for the NBDI-project have shown that a large share of heifer crosses are also slaughtered under "Danish Calf" concept). In the future this assumption should be updated.
- Stillbirth at later calving: Positive effect of a live born calve as a maternal trait, because all the dams of the calves are purebred. The effect for direct stillbirth is smaller because many calves are crossbred and carry only 50% purebred genes.
- Calving ease at later calvings: There is a very large positive effect of easier calvings as a maternal trait, because all the dams of the calves are purebred. The effect for the direct trait is smaller because many calves are crossbred and carry only 50% purebred genes.
- Young Stock Survival (YSS):
  - YSS heifers 2-30 days: Much smaller value because fewer heifers with purebred genes are represented.
  - YSS heifers 31-458 days: Much smaller value because fewer heifers with purebred genes are represented.
  - YSS bulls 2-30 days: Much larger value because more males with purebred genes are represented.
  - YSS bulls 31-458 days: Much larger value because more males with purebred genes are represented.

Table 1. Value in euro per unit for traits where use of Y-sorted beef semen has effect, HOL results

		No Y-sorted			50% Y-sorted			100% Y-sorted		
Trait	**Unit**	**DNK**	**SWE**	**FIN**	**DNK**	**SWE**	**FIN**	**DNK**	**SWE**	**FIN**
Net daily gain	**g/day**	235.9	293.3	135.8	232.8	290.4	134.6	229.7	287.5	133.4
EUROP form score	**Score**	5.9	13.8	14.8	5.3	13.7	14.7	4.7	13.6	14.6
%stillborn, 1st, mat.	**%**	1.25	2.22	1.92	1.22	2.18	1.89	1.18	2.14	1.86
%stillborn, later, mat.	**%**	4.07	4.55	4.43	4.68	5.19	4.63	5.28	5.83	4.83
%stillborn, 1st, dir.	**%**	1.27	2.23	1.93	1.23	2.18	1.90	1.19	2.14	1.87
%stillborn, later, dir.	**%**	2.51	3.10	2.80	2.81	3.41	2.89	3.10	3.72	2.99
easy calving, 1st,mat.	**Point**	6.64	6.32	3.94	6.64	6.32	3.94	6.64	6.32	3.94
easy, later, mat.	**Point**	13.24	19.62	7.25	17.23	26.25	9.67	21.22	32.88	12.09
easy calving, 1st, dir.	**Point**	6.64	6.32	3.94	6.64	6.32	3.94	6.64	6.32	3.94
easy, later, dir.	**Point**	9.26	13.02	4.83	11.26	16.34	6.05	13.26	19.67	7.26
IFL, heifers	**Day**	0.86	0.91	0.94	0.84	0.89	0.93	0.82	0.87	0.92
ICF, cows	**Day**	0.31	0.94	0.67	0.29	0.92	0.66	0.27	0.89	0.65
IFL, cows	**Day**	4.29	5.00	3.75	4.27	4.98	3.74	4.25	4.95	3.73
Culled, 1st	**Day**	0.25	0.26	0.37	0.24	0.26	0.37	0.24	0.25	0.37
Culled, 2nd	**Day**	0.29	0.32	0.44	0.29	0.32	0.43	0.29	0.31	0.43
Culled, 3rd	**Day**	0.30	0.33	0.44	0.29	0.32	0.44	0.29	0.32	0.44
Surv. heif. 2-30 days	**%**	2.63	5.02	4.38	2.20	4.16	3.48	1.78	3.30	2.58
Surv. heif. 31-200 days	**%**	3.23	5.03	4.47	2.78	4.50	3.76	2.34	3.97	3.06
Surv. bulls 2-30 days	**%**	1.20	2.32	1.74	1.45	2.90	2.26	1.70	3.49	2.78
Surv. bulls 31-200 days	**%**	1.58	3.16	2.28	1.99	4.14	3.06	2.39	5.11	3.84

Table 2. Value in euro per unit for traits where use of Y-sorted beef semen has effect, RDC results

		No Y-sorted			50% Y-sorted			100% Y-sorted		
Trait	**Unit**	**DNK**	**SWE**	**FIN**	**DNK**	**SWE**	**FIN**	**DNK**	**SWE**	**FIN**
Net daily gain	**g/day**	251.10	327.76	149.81	249.02	325.03	148.40	246.95	322.29	146.99
EUROP form score	**Score**	6.33	15.05	14.08	5.52	14.93	13.97	4.71	14.81	13.86
%stillborn, 1st, mat.	**%**	1.38	2.31	1.97	1.34	2.27	1.94	1.30	2.23	1.90
%stillborn, later, mat.	**%**	3.52	5.21	4.72	3.65	5.85	5.00	3.78	6.49	5.28
%stillborn, 1st, dir.	**%**	1.38	2.31	1.97	1.34	2.27	1.94	1.30	2.23	1.90
%stillborn, later, dir.	**%**	2.22	3.47	2.99	2.27	3.78	3.12	2.33	4.09	3.25
easy calving, 1st,mat.	**Point**	6.64	6.77	3.96	6.64	6.77	3.96	6.64	6.77	3.96
easy, later, mat.	**Point**	17.82	18.32	6.73	23.69	24.41	8.86	29.55	30.50	10.99
easy calving, 1st, dir.	**Point**	6.64	6.77	3.96	6.64	6.77	3.96	6.64	6.77	3.96
easy, later, dir.	**Point**	11.97	12.25	4.61	14.91	15.31	5.67	17.86	18.36	6.74
IFL, heifers	**Day**	0.89	1.09	1.15	0.87	1.06	1.13	0.85	1.04	1.12
ICF, cows	**Day**	0.50	1.10	0.70	0.48	1.08	0.69	0.46	1.06	0.67
IFL, cows	**Day**	3.14	3.82	3.80	3.12	3.80	3.78	3.10	3.78	3.77
Culled, 1st	**Day**	0.24	0.25	0.33	0.24	0.25	0.33	0.23	0.24	0.33
Culled, 2nd	**Day**	0.27	0.29	0.37	0.27	0.28	0.37	0.27	0.28	0.37
Culled, 3rd	**Day**	0.29	0.30	0.39	0.29	0.30	0.39	0.28	0.30	0.39
Surv. heif. 2-30 days	**%**	2.77	5.13	4.06	2.32	4.33	3.33	1.87	3.53	2.59
Surv. heif. 31-200 days	**%**	3.47	5.23	4.37	2.91	4.69	3.70	2.35	4.14	3.04
Surv. bulls 2-30 days	**%**	1.41	2.76	1.68	1.77	3.54	2.15	2.14	4.32	2.62
Surv. bulls 31-200 days	**%**	1.52	3.02	1.86	1.90	3.89	2.40	2.27	4.76	2.95

Table 3. Value in euro per unit for traits where use of Y-sorted beef semen has effect, DNK JER results

Trait	Unit	No Y-sorted	50% Y-sorted	100% Y-sorted
Net daily gain	**g/day**	193.01	190.35	187.69
EUROP form score	**Score**	6.27	6.12	5.98
%stillborn, 1st, mat.	**%**	0.97	0.94	0.91
%stillborn, later, mat.	**%**	3.53	3.87	4.21
%stillborn, 1st, dir.	**%**	0.97	0.94	0.91
%stillborn, later, dir.	**%**	2.11	2.27	2.43
easy calving, 1st,mat.	**Point**	10.76	10.76	10.76
easy, later, mat.	**Point**	43.99	61.96	79.93
easy calving, 1st, dir.	**Point**	10.76	10.76	10.76
easy, later, dir.	**Point**	26.09	35.11	44.13
IFL, heifers	**Day**	1.31	1.30	1.28
ICF, cows	**Day**	0.22	0.21	0.20
IFL, cows	**Day**	2.61	2.59	2.58
Culled, 1st	**Day**	0.33	0.33	0.32
Culled, 2nd	**Day**	0.38	0.38	0.38
Culled, 3rd	**Day**	0.39	0.39	0.39
Surv. heif. 2-30 days	**%**	1.78	1.55	1.31
Surv. heif. 31-200 days	**%**	2.28	2.06	1.84
Surv. bulls 2-30 days	**%**	0.76	0.96	1.15
Surv. bulls 31-200 days	**%**	0.76	0.92	1.08

Table 4. Relative effect on economic value by changing share of Y-sorted beef semen (based on results in table 1)

		Difference 50% Y-sorted - NO Y-sorted			Difference 100% Y-sorted - NO Y-sorted		
Trait	**Unit**	**DNK**	**SWE**	**FIN**	**DNK**	**SWE**	**FIN**
Net daily gain	**g/day**	-1.3%	-1.0%	-0.9%	-2.6%	-2.0%	-1.8%
EUROP form score	**Score**	-10.2%	-0.9%	-0.7%	-20.3%	-1.8%	-1.3%
%stillborn, 1st, mat.	**%**	-3.0%	-1.9%	-1.4%	-6.0%	-3.8%	-2.8%
%stillborn, later, mat.	**%**	14.8%	14.1%	4.5%	29.6%	28.2%	9.0%
%stillborn, 1st, dir.	**%**	-3.2%	-2.0%	-1.6%	-6.4%	-4.0%	-3.1%
%stillborn, later, dir.	**%**	11.7%	10.0%	3.3%	23.4%	20.0%	6.6%
easy calving, 1st,mat.	**Point**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
easy, later, mat.	**Point**	30.1%	33.8%	33.4%	60.3%	67.6%	66.9%
easy calving, 1st, dir.	**Point**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
easy, later, dir.	**Point**	21.6%	25.6%	25.1%	43.2%	51.1%	50.3%
Surv. heif. 2-30 days	**%**	-16.3%	-17.2%	-20.5%	-32.5%	-34.4%	-41.1%
Surv. heif. 31-200 days	**%**	-13.8%	-10.5%	-15.8%	-27.7%	-21.1%	-31.5%
Surv. bulls 2-30 days	**%**	21.0%	25.3%	30.0%	42.0%	50.5%	60.0%
Surv. bulls 31-200 days	**%**	25.7%	30.9%	34.3%	51.5%	61.8%	68.6%

Table 5. Relative effect on economic value by changing share of Y-sorted beef semen in RDC (based on results in table 2)

		Difference 50% Y-sorted - NO Y-sorted			Difference 100% Y-sorted - NO Y-sorted		
Trait	**Unit**	**DNK**	**SWE**	**FIN**	**DNK**	**SWE**	**FIN**
Net daily gain	**g/day**	-0.8%	-0.8%	-0.9%	-1.7%	-1.7%	-1.9%
EUROP form score	**Score**	-12.7%	-0.8%	-0.8%	-25.5%	-1.5%	-1.5%
%stillborn, 1st, mat.	**%**	-3.1%	-1.7%	-1.7%	-6.1%	-3.5%	-3.5%
%stillborn, later, mat.	**%**	3.7%	12.3%	6.0%	7.4%	24.7%	11.9%
%stillborn, 1st, dir.	**%**	-3.1%	-1.7%	-1.7%	-6.1%	-3.5%	-3.5%
%stillborn, later, dir.	**%**	2.5%	8.9%	4.4%	5.0%	17.9%	8.8%
easy calving, 1st,mat.	**Point**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
easy, later, mat.	**Point**	32.9%	33.3%	31.6%	65.9%	66.5%	63.3%
easy calving, 1st, dir.	**Point**	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
easy, later, dir.	**Point**	24.6%	25.0%	23.2%	49.2%	49.9%	46.3%
Surv. heif. 2-30 days	**%**	-16.2%	-15.6%	-18.1%	-32.5%	-31.2%	-36.2%
Surv. heif. 31-200 days	**%**	-16.1%	-10.4%	-15.2%	-32.3%	-20.7%	-30.4%
Surv. bulls 2-30 days	**%**	25.9%	28.3%	28.1%	51.9%	56.6%	56.2%
Surv. bulls 31-200 days	**%**	24.5%	28.9%	29.1%	49.0%	57.7%	58.3%

Table 6. Relative effect on economic value by changing share of Y-sorted beef semen in JER (based on results in table 3)

Trait	Unit	Difference 50% Y-sorted - NO Y-sorted	Difference 100% Y-sorted - NO Y-sorted
Net daily gain	**g/day**	-1.4%	-2.8%
EUROP form score	**Score**	-2.3%	-4.6%
%stillborn, 1st, mat.	**%**	-3.3%	-6.6%
%stillborn, later, mat.	**%**	9.6%	19.1%
%stillborn, 1st, dir.	**%**	-3.3%	-6.6%
%stillborn, later, dir.	**%**	7.6%	15.2%
easy calving, 1st,mat.	**Point**	0.0%	0.0%
easy, later, mat.	**Point**	40.8%	81.7%
easy calving, 1st, dir.	**Point**	0.0%	0.0%
easy, later, dir.	**Point**	34.6%	69.1%
Surv. heif. 2-30 days	**%**	-13.1%	-26.3%
Surv. heif. 31-200 days	**%**	-9.7%	-19.5%
Surv. bulls 2-30 days	**%**	25.4%	50.9%
Surv. bulls 31-200 days	**%**	21.5%	43.0%

Economic value of Stillbirth at 1st calving

Beef semen is not used for heifers (model assumption) – Then no crosses are born at 1st calving – Therefor our first thought is that use of Y-sorted beef semen have no impact on value of improving stillbirth at 1st calving. **But it turned out that the value was slightly decreased when the share of Y-sorted semen increased.**

Explanation:

- Most heifer calves for replacement are born at 1st calving due to the use of X-sorted dairy semen.
- When stillbirth at 1st calving is improved more heifer calves are born **– but the model adapt to this situation by increasing the use beef semen** – such that the number of replacement heifers are kept constant. The use of purebred semen is decreased, and the use of beef semen is increased.
- When the use of Y-sorted semen is increased, more male beef crosses are born (and fewer female beef crosses). But due to larger stillbirth rate and higher young stock mortality among male calves (compared to female calves) fewer crosses will finish the growth period compared to the situation where no Y-sorted beef semen is used.

  The table 7 below show an example. The differences are small but there is a difference and this difference give a slightly smaller value of SB1 when the use Y-sorted semen is increased.
  - When stillbirth rate is improved the number of purebred calves decrease because the model adjusts the number of purebred inseminations such that the number of replacement heifers are kept constant.
  - The number of born beef crosses are increased correspondingly such that the total number of born calves are constant.
  - Increased use of Y-sorted beef semen will increase the number of male calves

- The loss of male calves due to stillbirth and young stock mortality is higher than for females.

Table 7. Example with SWE HOL: Number of calves born in a herd of 100 annual cows – and final number for replacement or slaughtered calves

	No Y-sorted beef		100% Y-sorted beef	
	Basic	-10% Stillbirth at 1st calving	Basic	-10% Stillbirth at 1st calving
Born: Pure female calves	36.733	36.603	36.733	36.603
Born: Pure male calves	17.788	17.658	17.788	17.658
Born: Beef female crosses	23.531	23.661	0.000	0.000
Born: Beef male crosses	23.531	23.661	47.061	47.321
Final: Replacement heifers	**31.963**	**31.963**	**31.963**	**31.963**
Final: Pure male calves	15.366	15.321	15.366	15.321
Final: Beef female crosses	21.272	21.390	0.000	0.000
Final: Beef male crosses	19.980	20.091	39.960	40.181

Economic value of fertility traits
When the use of Y-sorted semen is increased the value of fertility traits have turned out to be slightly decreased.

The reason is that improved fertility will increase the number of calvings per year, but the need for replacement heifers remains unchanged. **The model adapts to the changes by increasing the use of beef semen.**

- The extra calves born per year due to improved fertility will all be beef crosses.
- When the use of Y-sorted beef semen is increased more of beef crosses will be males.
- Males have a larger stillbirth rate and a higher young stock mortality than females.
- Therefor slightly fewer crossbred animals will be ready for slaughter (compared to the situation without use of Y-sorted semen).
- That decreased the value of fertility slightly.

Economic value of culling
When the use of Y-sorted semen is increased the value of culling traits have turned out to be slightly decreased.

If the culling rates are decreased the distribution of purebred and crossbred is changed. The effect is the same as we observed for fertility trait and for stillbirth at 1st calving.

Economic value of young stock survival

When the use of Y-sorted semen is increased the value of young stock survival (YSS) is changed.

- The value of improving purebred female genes for YSS are decreased considerably because the share of purebred female genes is decreased (even though the crossbred calves carry only 50% purebred genes).
- The value of improving purebred male genes for YSS are increased considerably because the share of purebred male genes is increased (even though the crossbred calves carry only 50% purebred genes).

Summary on use of Y-sorted semen

The results for "no Y-sorted" beef semen is similar to the results obtained in 2018. There are some deviations due to minor corrections of errors. The update of assumptions for calving ease of cross-bred calves gave some changes in the value of calving ease.

The use of Y-sorted semen changes the value of:

- Value of stillbirth at later calvings is increased – most for the maternal trait and less for direct stillbirth
- Value of calving ease at later calvings is increased – most for the maternal trait and less for direct calving ease
- Young stock survival (YSS)
    - Value of YSS for heifer calves is decreased
    - Value of YSS for bull calves is increased

Traits that are also affected to a minor degree is:

- EUROP form score
- Daily gain
- Stillbirth at 1st calving
- Fertility
- Longevity (culling rate per parity)

Decreased heifer replacement rate

During the latest years we have seen a decreased replacement rate due to better health of cows and use of X-sorted dairy semen. In the 2018 analyses of values for NTM the assumption was that the replacement rate was 32%. However, the replacement rate is still decreasing. Therefor we have analysed the effect of decreased replacement rate from 32% to 20% on the values of the traits included in the NTM.

Table 8 shows some key figures from all the alternatives analysed. However, in the subsequent tables only results for replacement rate 32% (current), 27% and 20% is shown.

Table 8. Key figures related to calculation of economic value of longevity at different replacement rates. Example based on DNK HOL. This table is almost the same as Table 5.2 in 2018 report.

	Replacement rate								
	32	31	30	27	26	25	23	21	20
Longevity days	1141,4	1178,1	1217,6	1349,5	1405,8	1462,3	1585,5	1742,2	1825,5
prop. In 1st lact	0,30	0,30	0,29	0,26	0,25	0,25	0,23	0,21	0,20
prop. In 2nd Lact	0,25	0,25	0,24	0,23	0,22	0,21	0,20	0,19	0,18
Prop. In 3rd Lact	0,44	0,46	0,47	0,51	0,53	0,54	0,57	0,60	0,62
Total profit	166.263	167.176	168.098	170.808	171.816	172.751	174.572	176.527	177.433
Pct culled 1st lact	17,6%	17,0%	16,3%	14,5%	13,9%	13,2%	12,1%	10,9%	10,3%
Pct culled 2nd lact	25,9%	25,0%	24,1%	21,4%	20,4%	19,5%	17,8%	16,0%	15,2%
Pct culled 3rd+ lact	42,5%	41,0%	39,5%	35,1%	33,5%	32,0%	29,2%	26,3%	25,0%

As the replacement rate decreases the number of days for longevity increases which means the animals need to live longer and the herd will require to be older. This can be seen as the proportion of animals in the 3rd lactation increases as replacement rate decreases. This also poses challenges for farmers and animals to see if they can manage to have longer longevity and older cows.

The economic values and the percentage difference of the traits between 32%, 27%, and 20% replacement rates for HOL, RDC, and JER are shown in table 9-14:

- The results in tables 9-11 deal with production, fertility and survival traits.
- The results in tables 12-14 show the values of disease traits.

The most interesting is the development over lactations. The development for milk production traits is shown in table 15 and the relationship between parities is nearly the same for all traits. The results clearly indicate that with decreasing replacement rate the value of 1st lactation rate decreases whereas value of later lactation (3rd +) increases. In the current calculation of sub-indexes, the weights for 1st, 2nd and later lactations is 0.35:0.25:0.40 in general for all traits that are calculated per lactation/parity. With lower replacement rate this relationship must be revised - and for replacement rate of 20% the relation is closer to 0.20:0.20:0.60.

Table 9. Average HOL results for different assumption on replacement rate

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Milk 1st,	-0.016	-0.014	-0.011	-13.2%	-33.6%
Milk 2nd	-0.013	-0.011	-0.009	-9.1%	-26.0%
Milk 3rd+	**-0.020**	**-0.024**	**-0.030**	**19.7%**	**51.6%**
Protein 1st	1.736	1.507	1.153	-13.2%	-33.6%
Protein 2nd	1.313	1.199	0.980	-8.7%	-25.4%
Protein 3rd+	**1.973**	**2.401**	**3.098**	**21.7%**	**57.0%**
Fat 1st	0.567	0.492	0.376	-13.2%	-33.6%
Fat 2nd	0.433	0.395	0.323	-8.8%	-25.5%
Fat 3rd+	**0.651**	**0.787**	**1.008**	**20.9%**	**54.8%**
Standard milk	0.191	0.195	0.199	1.7%	4.1%
Net daily gain	209.1	213.9	220.8	2.3%	5.6%
EUROP form score	11.1	11.1	11.1	-0.2%	-0.4%
Surv. at birth, 1st	1.67	1.41	1.04	-15.3%	-37.6%
Surv. at birth, later	2.62	2.55	2.57	-2.8%	-1.9%
Easy calvings, 1st	5.63	4.76	3.51	-15.5%	-37.6%
Easy calvings, later	**15.67**	**16.34**	**17.28**	**4.2%**	**10.3%**
IFL days, heifers	0.84	0.71	0.52	-14.7%	-38.1%
ICF days, cows	0.57	0.53	0.47	-6.4%	-17.3%
IFL days, cows	**4.28**	**4.38**	**4.52**	**2.3%**	**5.6%**
Surv. heifers 1-30 d.	3.62	3.38	3.08	-6.6%	-14.8%
Surv. heifers 31-200 d	3.86	3.46	2.99	-10.2%	-22.6%
Surv. bulls 1-30 d.	1.75	1.72	1.67	-1.8%	-4.4%
Surv. bulls 31-200 d.	2.34	2.37	2.42	1.4%	3.3%

Table 10. Average RDC results for different assumption on replacement rate

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Milk 1st,	-0.016	-0.014	-0.010	-13.1%	-33.4%
Milk 2nd	-0.012	-0.011	-0.009	-9.2%	-26.3%
Milk 3rd+	**-0.020**	**-0.024**	**-0.031**	**20.1%**	**52.9%**
Protein 1st	1.68	1.46	1.12	-13.2%	-33.6%
Protein 2nd	1.27	1.16	0.94	-8.9%	-25.9%
Protein 3rd+	**2.00**	**2.44**	**3.15**	**21.9%**	**57.7%**
Fat 1st	0.55	0.48	0.37	-13.2%	-33.6%
Fat 2nd	0.42	0.39	0.31	-8.9%	-25.8%
Fat 3rd+	**0.66**	**0.81**	**1.04**	**21.5%**	**56.5%**
Standard milk	0.19	0.19	0.20	2.1%	5.4%
Net daily gain	226.88	230.78	236.33	1.7%	4.2%
EUROP form score	11.29	11.26	11.22	-0.3%	-0.7%
Surv. at birth, 1st	1.73	1.43	1.02	-16.9%	-40.7%
Surv. at birth, later	2.65	2.57	2.53	-3.0%	-4.4%
Easy calvings, 1st	5.79	4.90	3.62	-15.5%	-37.6%
Easy calvings, later	**14.97**	**15.38**	**15.96**	**2.7%**	**6.6%**
IFL days, heifers	0.96	0.81	0.60	-16.3%	-37.4%
ICF days, cows	0.68	0.66	0.61	-3.2%	-10.0%
IFL days, cows	**3.50**	**3.58**	**3.69**	**2.4%**	**5.3%**
Surv. heifers 1-30 d.	3.52	3.30	2.83	-6.4%	-19.5%
Surv. heifers 31-200 d	3.85	3.50	2.95	-9.1%	-23.4%
Surv. bulls 1-30 d.	1.95	1.93	1.90	-1.1%	-2.8%
Surv. bulls 31-200 d.	2.13	2.11	2.08	-1.0%	-2.4%

Table 11. Average JER results for different assumption on replacement rate

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Milk 1st,	-0.016	-0.014	-0.011	-12.9%	-33.1%
Milk 2nd	-0.013	-0.012	-0.010	-9.0%	-25.9%
Milk 3rd+	**-0.022**	**-0.026**	**-0.033**	**19.8%**	**52.0%**
Protein 1st	1.49	1.29	0.99	-13.1%	-33.5%
Protein 2nd	1.15	1.05	0.86	-8.9%	-25.8%
Protein 3rd+	**1.87**	**2.27**	**2.91**	**21.1%**	**55.5%**
Fat 1st	0.69	0.60	0.46	-13.1%	-33.4%
Fat 2nd	0.54	0.49	0.40	-8.9%	-25.8%
Fat 3rd+	**0.88**	**1.06**	**1.36**	**20.9%**	**54.7%**
Standard milk	0.19	0.19	0.20	2.2%	5.4%
Net daily gain	188.98	192.04	196.40	1.6%	3.9%
EUROP form score	6.14	6.15	6.17	0.2%	0.5%
Surv. at birth, 1st	0.92	0.78	0.57	-15.4%	-37.7%
Surv. at birth, later	**1.97**	**2.03**	**2.12**	**3.0%**	**7.7%**
Easy calvings, 1st	10.76	9.10	6.72	-15.5%	-37.6%
Easy calvings, later	**64.73**	**71.16**	**80.33**	**9.9%**	**24.1%**
IFL days, heifers	1.29	1.09	0.80	-15.5%	-37.5%
ICF days, cows	0.20	0.16	0.07	-21.7%	-63.8%
IFL days, cows	2.58	2.62	2.66	1.6%	3.1%
Surv. heifers 1-30 d.	1.67	1.51	1.28	-9.5%	-23.2%
Surv. heifers 31-200 d	2.17	1.92	1.58	-11.2%	-27.3%
Surv. bulls 1-30 d.	0.76	0.73	0.69	-4.1%	-9.8%
Surv. bulls 31-200 d.	0.76	0.70	0.63	-7.0%	-17.0%

Table 12. Average HOL results for disease traits for different assumptions on replacement rate

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Mastitis, -50d. 1st	0.86	0.73	0.54	-15.5%	-37.7%
Mastitis, +50d, 1st	0.92	0.77	0.57	-15.5%	-37.7%
Mastitis, 2nd	1.28	1.12	0.87	-12.2%	-31.9%
Mastitis, 3rd	**2.20**	**2.48**	**2.92**	**13.1%**	**33.1%**
Metabolic, 1st	0.96	0.81	0.60	-15.5%	-37.6%
Metabolic, 2nd	0.81	0.71	0.55	-12.2%	-31.9%
Metabolic, 3rd	**1.40**	**1.59**	**1.87**	**13.2%**	**33.3%**
Leg&Feet, 1st	0.46	0.39	0.29	-14.5%	-35.8%
Leg&Feet, 2nd	0.42	0.37	0.28	-12.2%	-31.9%
Leg&Feet, 3rd	**0.73**	**0.83**	**0.98**	**13.1%**	**33.1%**
E Repro, 1st	0.62	0.52	0.38	-15.5%	-37.6%
E Repro, 2nd	0.54	0.47	0.37	-12.2%	-31.9%
E Repro, 3rd	**0.94**	**1.07**	**1.25**	**13.1%**	**33.2%**
L Repro, 1st	0.53	0.45	0.33	-15.5%	-37.6%
L Repro, 2nd	0.46	0.41	0.32	-12.2%	-31.9%
L Repro, 3rd	**0.81**	**0.92**	**1.08**	**13.2%**	**33.2%**
Ketosis, 1st	0.44	0.37	0.28	-15.5%	-37.7%
Ketosis, 2nd	0.37	0.32	0.25	-12.2%	-31.9%
Ketosis, 3rd	**0.64**	**0.73**	**0.86**	**13.1%**	**33.0%**
Sole Ulcer, 1st	18.12	15.31	11.31	-15.5%	-37.6%
Sole Ulcer, 2nd	14.84	13.03	10.10	-12.2%	-31.9%
Sole Ulcer, 3rd	**25.60**	**28.95**	**34.05**	**13.1%**	**33.0%**
Sole Hemorhage, 1st	2.96	2.50	1.85	-15.5%	-37.6%
Sole Hemorhage, 2nd	2.45	2.15	1.66	-12.2%	-31.9%
Sole Hemorhage, 3rd	**4.17**	**4.72**	**5.55**	**13.1%**	**33.1%**
Horn Heel Erosion, 1st	4.58	3.87	2.85	-15.5%	-37.6%
Horn Heel Erosion, 2nd	3.74	3.28	2.54	-12.2%	-31.9%
Horn Heel Erosion, 3rd	**6.44**	**7.28**	**8.56**	**13.1%**	**33.1%**
Digital Dermatitis, 1st	4.57	3.86	2.85	-15.5%	-37.6%
Digital Dermatitis, 2nd	3.74	3.28	2.55	-12.2%	-31.9%
Digital Dermatitis, 3rd	**6.43**	**7.27**	**8.56**	**13.1%**	**33.1%**
Interdigital Hyperplasia, 1st	9.14	7.72	5.70	-15.5%	-37.6%
Interdigital Hyperplasia, 2nd	7.48	6.56	5.09	-12.2%	-31.9%
Interdigital Hyperplasia, 3rd	**12.86**	**14.55**	**17.12**	**13.1%**	**33.1%**
White Line disease, 1st	2.97	2.51	1.85	-15.5%	-37.6%
White Line disease, 2nd	2.43	2.13	1.66	-12.2%	-31.9%
White Line disease, 3rd	**4.19**	**4.74**	**5.57**	**13.1%**	**33.1%**
Cork Screw claws, 1st	2.38	2.01	1.48	-15.5%	-37.6%
Cork Screw claws, 2nd	1.94	1.71	1.32	-12.2%	-31.9%
Cork Screw claws, 3rd	**3.35**	**3.79**	**4.46**	**13.1%**	**33.1%**

Table 13. Average RDC results for disease traits for different assumptions on replacement rate

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Mastitis, -50d. 1st	0.85	0.72	0.53	-15.5%	-37.6%
Mastitis, +50d, 1st	0.89	0.76	0.56	-15.5%	-37.6%
Mastitis, 2nd	1.22	1.07	0.83	-12.3%	-32.0%
Mastitis, 3rd	**2.15**	**2.43**	**2.85**	**12.8%**	**32.4%**
Metabolic, 1st	0.95	0.81	0.59	-15.5%	-37.6%
Metabolic, 2nd	0.80	0.70	0.54	-12.3%	-32.0%
Metabolic, 3rd	**1.42**	**1.60**	**1.88**	**12.9%**	**32.5%**
Leg&Feet, 1st	0.48	0.41	0.30	-15.5%	-37.6%
Leg&Feet, 2nd	0.41	0.36	0.28	-12.3%	-32.1%
Leg&Feet, 3rd	**0.73**	**0.82**	**0.96**	**12.8%**	**32.3%**
E Repro, 1st	0.61	0.52	0.38	-15.5%	-37.6%
E Repro, 2nd	0.53	0.47	0.36	-12.3%	-32.0%
E Repro, 3rd	**0.95**	**1.07**	**1.25**	**12.9%**	**32.5%**
L Repro, 1st	0.52	0.44	0.32	-15.5%	-37.6%
L Repro, 2nd	0.45	0.39	0.30	-12.3%	-32.0%
L Repro, 3rd	**0.79**	**0.89**	**1.04**	**12.9%**	**32.5%**
Ketosis, 1st	0.45	0.38	0.28	-15.5%	-37.6%
Ketosis, 2nd	0.37	0.33	0.25	-12.3%	-32.1%
Ketosis, 3rd	**0.67**	**0.76**	**0.89**	**12.8%**	**32.3%**
Sole Ulcer, 1st	18.13	15.32	11.31	-15.5%	-37.6%
Sole Ulcer, 2nd	14.92	13.08	10.14	-12.3%	-32.1%
Sole Ulcer, 3rd	**26.44**	**29.82**	**34.97**	**12.8%**	**32.3%**
Sole Hemorhage, 1st	2.97	2.51	1.85	-15.5%	-37.6%
Sole Hemorhage, 2nd	2.44	2.14	1.66	-12.3%	-32.0%
Sole Hemorhage, 3rd	**4.32**	**4.87**	**5.71**	**12.8%**	**32.3%**
Horn Heel Erosion, 1st	4.57	3.86	2.85	-15.5%	-37.6%
Horn Heel Erosion, 2nd	3.76	3.30	2.55	-12.3%	-32.0%
Horn Heel Erosion, 3rd	**7.04**	**7.94**	**9.31**	**12.8%**	**32.3%**
Digital Dermatitis, 1st	4.57	3.86	2.85	-15.5%	-37.6%
Digital Dermatitis, 2nd	3.76	3.30	2.55	-12.3%	-32.0%
Digital Dermatitis, 3rd	**6.64**	**7.49**	**8.78**	**12.8%**	**32.4%**
Interdigital Hyperplasia, 1st	9.14	7.72	5.70	-15.5%	-37.6%
Interdigital Hyperplasia, 2nd	7.21	6.32	4.90	-12.3%	-32.0%
Interdigital Hyperplasia, 3rd	**13.27**	**14.97**	**17.57**	**12.8%**	**32.4%**
White Line disease, 1st	2.97	2.51	1.85	-15.5%	-37.6%
White Line disease, 2nd	2.30	2.02	1.57	-12.3%	-32.0%
White Line disease, 3rd	**4.32**	**4.87**	**5.72**	**12.8%**	**32.3%**
Cork Screw claws, 1st	2.38	2.01	1.48	-15.5%	-37.6%
Cork Screw claws, 2nd	1.90	1.67	1.29	-12.3%	-32.0%
Cork Screw claws, 3rd	**3.46**	**3.90**	**4.57**	**12.8%**	**32.3%**

Table 14. Average JER results for disease traits for different assumptions on replacement rate

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Mastitis, -50d. 1st	0.78	0.66	0.49	-15.5%	-37.6%
Mastitis, +50d, 1st	0.88	0.74	0.55	-15.5%	-37.6%
Mastitis, 2nd	1.25	1.09	0.84	-12.4%	-32.3%
Mastitis, 3rd	**2.37**	**2.66**	**3.10**	**12.3%**	**31.0%**
Metabolic, 1st	0.92	0.78	0.57	-15.5%	-37.6%
Metabolic, 2nd	0.76	0.66	0.51	-12.5%	-32.4%
Metabolic, 3rd	**1.42**	**1.60**	**1.86**	**12.3%**	**30.9%**
Leg&Feet, 1st	0.53	0.44	0.33	-15.5%	-37.6%
Leg&Feet, 2nd	0.44	0.39	0.30	-12.5%	-32.3%
Leg&Feet, 3rd	**0.82**	**0.93**	**1.08**	**12.3%**	**30.9%**
E Repro, 1st	0.58	0.49	0.36	-15.5%	-37.6%
E Repro, 2nd	0.50	0.44	0.34	-12.5%	-32.3%
E Repro, 3rd	**0.95**	**1.06**	**1.24**	**12.3%**	**30.9%**
L Repro, 1st	0.47	0.40	0.29	-15.5%	-37.6%
L Repro, 2nd	0.41	0.36	0.28	-12.5%	-32.4%
L Repro, 3rd	**0.77**	**0.87**	**1.01**	**12.3%**	**30.9%**
Ketosis, 1st	0.47	0.40	0.30	-15.5%	-37.6%
Ketosis, 2nd	0.38	0.33	0.26	-12.5%	-32.4%
Ketosis, 3rd	**0.71**	**0.79**	**0.92**	**12.2%**	**30.9%**
Sole Ulcer, 1st	23.57	19.92	14.70	-15.5%	-37.6%
Sole Ulcer, 2nd	19.56	17.12	13.22	-12.5%	-32.4%
Sole Ulcer, 3rd	**36.35**	**40.80**	**47.56**	**12.2%**	**30.9%**
Sole Hemorhage, 1st	3.38	2.85	2.11	-15.5%	-37.6%
Sole Hemorhage, 2nd	2.81	2.46	1.90	-12.5%	-32.4%
Sole Hemorhage, 3rd	**5.22**	**5.86**	**6.83**	**12.2%**	**30.9%**
Horn Heel Erosion, 1st	4.98	4.21	3.11	-15.5%	-37.6%
Horn Heel Erosion, 2nd	4.14	3.62	2.80	-12.5%	-32.4%
Horn Heel Erosion, 3rd	**7.69**	**8.63**	**10.06**	**12.2%**	**30.9%**
Digital Dermatitis, 1st	4.98	4.21	3.11	-15.5%	-37.6%
Digital Dermatitis, 2nd	4.14	3.62	2.80	-12.5%	-32.4%
Digital Dermatitis, 3rd	**7.69**	**8.63**	**10.06**	**12.2%**	**30.9%**
Interdigital Hyperplasia, 1st	9.95	8.41	6.21	-15.5%	-37.6%
Interdigital Hyperplasia, 2nd	8.28	7.24	5.60	-12.5%	-32.4%
Interdigital Hyperplasia, 3rd	**15.38**	**17.26**	**20.12**	**12.2%**	**30.9%**
White Line disease, 1st	3.38	2.85	2.11	-15.5%	-37.6%
White Line disease, 2nd	2.79	2.45	1.89	-12.5%	-32.4%
White Line disease, 3rd	**5.22**	**5.86**	**6.83**	**12.2%**	**30.9%**
Cork Screw claws, 1st	2.70	2.28	1.69	-15.5%	-37.6%
Cork Screw claws, 2nd	2.25	1.97	1.52	-12.5%	-32.4%
Cork Screw claws, 3rd	**4.17**	**4.69**	**5.46**	**12.2%**	**30.9%**

Table 15. Relative values of 1st, 2nd and later lactations for milk production traits for different assumptions on replacement rate.

	Replacement rate = 32			Replacement rate = 27			Replacement rate = 20		
	HOL	**RDC**	**JER**	**HOL**	**RDC**	**JER**	**HOL**	**RDC**	**JER**
Milk 1st,	33.1%	32.7%	31.9%	28.4%	28.0%	27.2%	21.3%	20.9%	20.3%
Milk 2nd	25.8%	25.6%	25.3%	23.2%	22.9%	22.6%	18.5%	18.1%	17.8%
Milk 3rd+	41.0%	41.6%	42.8%	48.4%	49.2%	50.2%	60.2%	61.0%	61.9%
Protein 1st	34.6%	34.0%	33.0%	29.5%	28.9%	28.0%	22.0%	21.4%	20.8%
Protein 2nd	26.1%	25.7%	25.6%	23.5%	22.9%	22.8%	18.7%	18.1%	18.0%
Protein 3rd+	39.3%	40.4%	41.5%	47.0%	48.2%	49.2%	59.2%	60.5%	61.2%
Fat 1st	34.3%	33.6%	32.9%	29.4%	28.6%	28.0%	22.1%	21.3%	20.8%
Fat 2nd	26.2%	25.8%	25.6%	23.6%	23.1%	22.8%	18.9%	18.2%	18.0%
Fat 3rd+	39.4%	40.6%	41.6%	47.0%	48.3%	49.2%	59.0%	60.5%	61.2%

Replacement rate and increased use of Y-sorted beef semen

Corresponding to the results in table 9, 10 and 11, the tables 16, 17 and 18 show the results for the alternatives with use of 100% Y-sorted semen. Only results for growth, survival at birth, calving ease and young stock survival is shown, because it is the value of these traits that change with increased use of Y-sorted semen.

However, the interaction with the change of replacement rate is only significant for (shown in table 19):

- Stillbirth at later calvings
- Calving ease at later calvings
- Young stock survival

Table 16. Average HOL results for different assumption on replacement rate when 100% of beef semen is Y-sorted

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Net daily gain	216.83	222.65	230.94	2.7%	6.5%
EUROP form score	10.94	10.90	10.84	-0.4%	-0.9%
Surv. at birth, 1st	1.73	1.46	1.08	-15.3%	-37.6%
Surv. at birth, later	5.31	5.62	6.11	5.7%	15.0%
Easy calvings, 1st	5.63	4.76	3.51	-15.5%	-37.6%
Easy calvings, later	22.06	23.61	25.81	7.0%	17.0%
IFL days, heifers	0.87	0.74	0.54	-15.1%	-37.8%
ICF days, cows	0.60	0.57	0.51	-5.5%	-15.5%
IFL days, cows	4.31	4.41	4.56	2.4%	5.8%
Surv. heifers 1-30 d.	2.55	2.15	1.59	-15.7%	-37.8%
Surv. heifers 31-200 d	3.12	2.62	1.94	-16.2%	-37.9%
Surv. bulls 1-30 d.	2.65	2.74	2.87	3.4%	8.1%
Surv. bulls 31-200 d.	3.78	4.01	4.33	5.9%	14.4%

Table 17. Average RDC results for different assumption on replacement rate when 100% of beef semen is Y-sorted

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Net daily gain	238.74	244.01	251.54	2.2%	5.4%
EUROP form score	11.13	11.08	11.00	-0.5%	-1.2%
Surv. at birth, 1st	1.81	1.53	1.10	-15.6%	-39.4%
Surv. at birth, later	5.18	5.43	5.85	4.8%	12.9%
Easy calvings, 1st	5.79	4.90	3.62	-15.5%	-37.6%
Easy calvings, later	23.68	25.20	27.37	6.4%	15.6%
IFL days, heifers	1.00	0.84	0.63	-16.7%	-37.4%
ICF days, cows	0.73	0.72	0.67	-2.3%	-8.2%
IFL days, cows	3.55	3.64	3.74	2.5%	5.5%
Surv. heifers 1-30 d.	2.66	2.29	1.61	-13.9%	-39.7%
Surv. heifers 31-200 d	3.18	2.71	1.96	-14.6%	-38.3%
Surv. bulls 1-30 d.	3.03	3.15	3.31	3.9%	9.4%
Surv. bulls 31-200 d.	3.32	3.46	3.65	4.0%	9.7%

Table 18. DNK JER results for different assumption on replacement rate when 100% of beef semen is Y-sorted

	Replacement rate				
	32	**27**	**20**	**%Dif. 27-32**	**%Dif. 20-32**
Net daily gain	187.69	190.57	194.66	1.5%	3.7%
EUROP form score	5.98	5.97	5.95	-0.2%	-0.4%
Surv. at birth, 1st	0.91	0.77	0.57	-15.3%	-37.7%
Surv. at birth, later	4.21	4.59	5.14	9.0%	22.1%
Easy calvings, 1st	10.76	9.10	6.72	-15.5%	-37.6%
Easy calvings, later	78.25	86.61	98.53	10.7%	25.9%
IFL days, heifers	1.28	1.08	0.80	-15.5%	-37.5%
ICF days, cows	0.20	0.15	0.07	-22.2%	-65.2%
IFL days, cows	2.58	2.62	2.66	1.6%	3.1%
Surv. heifers 1-30 d.	1.31	1.11	0.82	-15.5%	-37.8%
Surv. heifers 31-200 d	1.84	1.55	1.14	-15.4%	-37.7%
Surv. bulls 1-30 d.	1.15	1.18	1.21	2.1%	5.2%
Surv. bulls 31-200 d.	1.08	1.08	1.07	-0.6%	-1.5%

Table 19. Interaction for the effect of increased used of Y-sorted beef semen and decreased replacement rate. Percent difference between replacement rate 20% and replacement rate 32%

	HOL		RDC		JER	
	No Y-sorted	100% Y-sorted	No Y-sorted	100% Y-sorted	No Y-sorted	100% Y-sorted
%stillborn, 1st	-37.6%	-37.6%	-40.7%	-39.4%	-37.7%	-37.7%
%stillborn, later	-1.9%	15.0%	-4.4%	12.9%	7.7%	22.1%
easy calvings, 1st	-37.6%	-37.6%	-37.6%	-37.6%	-37.6%	-37.6%
easy, later	10.3%	17.0%	6.6%	15.6%	24.1%	25.9%
Survival, heifers 1-30 days	-14.8%	-37.8%	-19.5%	-39.7%	-23.2%	-37.8%
Survival, heifers 31-200 days	-22.6%	-37.9%	-23.4%	-38.3%	-27.3%	-37.7%
Survival, bull calves 1-30 days	-4.4%	8.1%	-2.8%	9.4%	-9.8%	5.2%
Survival, bull calves 31-200 days	3.3%	14.4%	-2.4%	9.7%	-17.0%	-1.5%

Relative weighting and expected genetic response using proposed relative NTM weights

Based on the results from various NTM scenarios, relative weights and expected genetic response were calculated. The NTM weights below are shown relative to the yield index. The expected genetic response was calculated as the correlations between the NTM index and the sub-indices. Genotyped bulls born in either DNK, SWE or FIN (Nordic bulls) in 2021 and 2022 were used for the calculations.

In table 20-22 the weights for various NTM alternatives are shown. The tables also include the current weights that are modified by some breed political decisions. The weights from the 2018 report are also included. They differ slightly from the “32% RPL, 0% Y” scenario due to some corrections of the model and because the longevity values are not redistributed to other traits.

Table 20. The relative weights used for analyses of NTM of HOL.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Yield	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Growth	0.08	0.07	0.09	0.08	0.09	0.08	0.09	0.08
Fertility	0.36	0.38	0.26	0.26	0.26	0.25	0.25	0.25
Birth, direct	0.14	0.13	0.09	0.10	0.08	0.09	0.07	0.08
Calving, maternal	0.14	0.13	0.15	0.17	0.14	0.15	0.12	0.14
Udder health	0.30	0.30	0.26	0.26	0.25	0.25	0.23	0.23
General health	0.14	0.13	0.05	0.05	0.05	0.05	0.05	0.05
Frame	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feet & legs conformation	0.05	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Udder conformation	0.18	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Milkability	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Temperament	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
Longevity	0.06	0.07	0.22	0.21	0.15	0.15	0.08	0.08
Claw health	0.10	0.09	0.04	0.04	0.04	0.04	0.04	0.04
Young stock survival	0.13	0.11	0.14	0.17	0.13	0.15	0.12	0.14
Feed	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 21. The relative weights used for analyses of NTM of RDC

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Yield	1.02	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Growth	0.10	0.08	0.11	0.10	0.08	0.08	0.07	0.07
Fertility	0.36	0.29	0.19	0.19	0.26	0.26	0.25	0.25
Birth, direct	0.11	0.08	0.08	0.08	0.08	0.08	0.07	0.07
Calving, maternal	0.10	0.08	0.10	0.11	0.08	0.08	0.08	0.08
Udder health	0.26	0.19	0.16	0.16	0.15	0.15	0.14	0.14
General health	0.11	0.09	0.09	0.09	0.08	0.08	0.08	0.08
Frame	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feet & legs conformation	0.06	0.05	0.03	0.03	0.03	0.03	0.03	0.03
Udder conformation	0.26	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Milkability	0.11	0.09	0.09	0.09	0.08	0.08	0.08	0.08
Temperament	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
Longevity	0.06	0.06	0.18	0.18	0.12	0.12	0.07	0.06
Claw health	0.07	0.06	0.03	0.03	0.05	0.05	0.04	0.04
Young stock survival	0.19	0.15	0.18	0.19	0.14	0.14	0.14	0.14
Feed	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 22. The relative weights used for analysis of NTM of JER

Trait	Current NTM	2018 report	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Yield	0.83	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Growth	0.00	0.06	0.03	0.03	0.06	0.06	0.06	0.06
Fertility	0.26	0.25	0.16	0.16	0.18	0.18	0.18	0.18
Birth, direct	0.04	0.04	0.05	0.05	0.04	0.04	0.04	0.04
Calving, maternal	0.07	0.06	0.07	0.08	0.06	0.06	0.06	0.06
Udder health	0.44	0.33	0.29	0.29	0.28	0.28	0.26	0.26
General health	0.14	0.11	0.04	0.04	0.09	0.09	0.09	0.09
Frame	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Feet & legs conformation	0.07	0.07	0.03	0.03	0.03	0.03	0.03	0.03
Udder conformation	0.15	0.13	0.11	0.11	0.11	0.11	0.11	0.11
Milkability	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Temperament	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Longevity	0.09	0.09	0.28	0.27	0.19	0.19	0.10	0.10
Claw health	0.04	0.04	0.03	0.03	0.04	0.04	0.03	0.03
Young stock survival	0.00	0.10	0.01	0.01	0.09	0.09	0.09	0.09
Feed	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 23 Correlations between NTM's calculated with the weights in table 20. The correlations are based on the spring 2023 evaluation and data from 6177 genotyped Nordic HOL bull calves born in 2021 and 2022.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Current NTM		0.98	0.97	0.97	0.97	0.97	0.95	0.96
2018 NTM			0.99	0.99	0.99	0.99	0.98	0.98
32% RPL 0% Y				0.999	0.997	0.997	0.99	0.99
32%RPL 100% Y					0.996	0.997	0.99	0.99
27% RPL 0% Y						0.999	0.997	0.997
27%RPL 100% Y							0.997	0.997
20% RPL 0% Y								0.999

The difference between no and 100% Y sorted beef semen scenarios are negligible in genetic response to selection. Mainly Growth decreases by 1 percentage point and birth, direct and calving maternal increase by 1 percentage point by moving from no Y to 100% Y sorted semen. By moving from 32% to 20% heifer replacement rate, the genetic response on Yield increases slightly and the rest of the subindexes decreases.

Table 24. Correlations between sub-indices and NTM's calculated with the weights in table 20. The correlations are based on the Spring 2023 evaluation and data for 6177 genotyped Nordic HOL bull calves born in 2021 and 2022.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Yield	0.77	0.84	0.87	0.86	0.89	0.89	0.91	0.91
Growth	0.11	0.13	0.15	0.14	0.15	0.14	0.15	0.14
Fertility	0.24	0.18	0.09	0.09	0.07	0.07	0.04	0.04
Birth, direct	0.18	0.14	0.11	0.12	0.09	0.10	0.07	0.08
Calving, maternal	0.19	0.18	0.17	0.18	0.15	0.16	0.13	0.15
Udder health	0.26	0.20	0.18	0.18	0.16	0.16	0.12	0.12
General health	0.27	0.23	0.16	0.16	0.15	0.14	0.12	0.12
Frame	-0.04	0.03	0.05	0.05	0.07	0.07	0.09	0.08
Feet & legs conformation	0.10	0.07	0.06	0.06	0.05	0.06	0.05	0.05
Udder conformation	0.17	0.04	0.04	0.04	0.03	0.02	0.01	0.01
Milkability	0.06	0.05	0.06	0.06	0.07	0.07	0.08	0.08
Temperament	0.10	0.10	0.11	0.12	0.11	0.11	0.11	0.11
Longevity	0.32	0.26	0.29	0.28	0.24	0.24	0.18	0.18
Claw health	0.15	0.11	0.06	0.06	0.04	0.05	0.03	0.03
Young stock survival	0.12	0.09	0.10	0.12	0.09	0.10	0.08	0.09
Feed	0.07	0.01	- 0.004	0.002	-0.014	-0.011	-0.027	-0.024

Table 25. Correlations between NTM's calculated with the weights in table 21. The correlations are based on the spring 2023 evaluation and data from 5246 genotyped Nordic RDC bull calves born in 2021 and 2022.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Current NTM		0.96	0.95	0.95	0.96	0.96	0.95	0.95
2018 report NTM			0.99	0.99	0.996	0.996	0.995	0.994
32% RPL 0% Y				0.999	0.995	0.995	0.993	0.993
32%RPL 100% Y					0.995	0.995	0.993	0.993
27% RPL 0% Y						1.00	0.997	0.996
27%RPL 100% Y							0.997	0.996
20% RPL 0% Y								0.999

Table 26. Correlations between sub-indices and NTM's calculated with the weights in table 21. The correlations are based on the Spring 2023 evaluation and data for 5246 genotyped Nordic RDC bull calves born in 2021 and 2022.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Yield	0.73	0.86	0.87	0.87	0.87	0.87	0.89	0.89
Growth	0.02	0.08	0.11	0.10	0.09	0.09	0.09	0.09
Fertility	0.24	0.14	0.08	0.08	0.12	0.12	0.10	0.09
Birth, direct	0.13	0.07	0.07	0.07	0.07	0.07	0.05	0.05
Calving, maternal	0.25	0.24	0.24	0.24	0.23	0.23	0.23	0.23
Udder health	0.31	0.20	0.17	0.18	0.17	0.17	0.15	0.14
General health	0.26	0.20	0.18	0.18	0.18	0.18	0.17	0.17
Frame	-0.02	0.11	0.13	0.13	0.12	0.12	0.14	0.14
Feet & legs conformation	0.21	0.12	0.08	0.09	0.09	0.09	0.08	0.08
Udder conformation	0.33	0.18	0.17	0.17	0.17	0.17	0.16	0.16
Milkability	0.15	0.16	0.18	0.18	0.16	0.16	0.16	0.17
Temperament	0.12	0.15	0.16	0.16	0.15	0.15	0.16	0.16
Longevity	0.48	0.41	0.45	0.45	0.43	0.43	0.39	0.38
Claw health	0.16	0.09	0.04	0.04	0.07	0.07	0.05	0.05
Young stock survival	0.18	0.12	0.12	0.12	0.11	0.11	0.10	0.10
Feed	0.06	-0.07	-0.09	-0.09	-0.08	-0.08	-0.10	-0.10

Table 27. Correlations between NTM's calculated with the weights in table 22. The correlations are based on the spring 2023 evaluation and data from 797 genotyped Nordic JER bull calves born in 2021 and 2022.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Current NTM		0.95	0.93	0.93	0.94	0.94	0.92	0.92
2018 report NTM			0.99	0.99	0.99	0.99	0.99	0.99
32% RPL 0% Y				0.999	0.997	0.997	0.993	0.993
32%RPL 100% Y					0.997	0.997	0.993	0.993
27% RPL 0% Y						1.00	0.997	0.997
27%RPL 100% Y							0.997	0.997
20% RPL 0% Y								1.00

Table 28. Correlations between sub-indices and NTM's calculated with the weights in table 22. The correlations are based on the Spring 2023 evaluation and data for 797 genotyped Nordic JER bull calves born in 2021 and 2022.

Trait	Current NTM	2018 re-port	32% RPL 0% Y	32% RPL 100% Y	27% RPL 0% Y	27% RPL 100% Y	20% RPL 0% Y	20% RPL 100% Y
Yield	0.70	0.86	0.88	0.88	0.89	0.89	0.90	0.90
Growth	0.12	0.16	0.13	0.13	0.16	0.16	0.16	0.16
Fertility	0.22	0.14	0.08	0.08	0.09	0.09	0.08	0.08
Birth, direct	0.09	0.07	0.08	0.09	0.08	0.08	0.08	0.08
Calving, maternal	0.29	0.25	0.24	0.25	0.24	0.24	0.24	0.24
Udder health	0.45	0.28	0.25	0.25	0.24	0.24	0.21	0.21
General health	0.37	0.27	0.20	0.20	0.24	0.24	0.22	0.22
Frame	-0.03	0.14	0.15	0.15	0.15	0.15	0.16	0.16
Feet & legs conformation	0.12	0.04	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03
Udder conformation	0.16	0.07	0.03	0.03	0.03	0.03	0.01	0.01
Milkability	0.10	0.13	0.14	0.14	0.14	0.14	0.15	0.15
Temperament	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Longevity	0.44	0.34	0.38	0.38	0.35	0.35	0.30	0.30
Claw health	0.03	-0.05	-0.08	-0.08	-0.07	-0.07	-0.08	-0.08
Young stock survival	NA	NA	NA	NA	NA	NA	NA	NA
Feed	0.09	-0.13	-0.13	-0.13	-0.13	-0.13	-0.15	-0.15

NA breeding values for Young stock survival are available

Summary – conclusions

Increased use of Y-sorted beef semen will increase the value of:

- Maternal stillbirth and calving ease at later calvings
- Young stock survival of bull calves (and decrease value of value survival of heifer calves)
- There will be minor effect on growth traits, survival at 1st calving and fertility traits

Decreased replacement rate will change the balance between parities for all traits where we calculated breeding values per parity. The current weight on parities (1st : 2nd : later) will change from 0.35:0.25:0.40 toward 0.20:0.20:0.60.

The combination of increased use of Y-sorted beef semen and decreased replacement rate will additionally have effect on:

- Maternal stillbirth and calving ease at later calvings
- Young Stock Survival