INTERBULL breeding values calculated April 2022

This newsletter is primarily written for VikingGenetics staff and breeding advisors in Denmark, Sweden, and Finland, but can also be of interest for dairy farmers.

Table of content

International breeding values for the traits and breeds shown in table 1 have been published 5th April 2022

Current evaluation	
Daughter proven bulls: Yield Conformation Somatic cell count and udder health Longevity Calving – maternal and direct Female fertility Milking speed and temperament NTM for Nordic and foreign bulls	Young genomic tested bulls - HOL: Yield Conformation Somatic cell count and udder health Longevity Calving – maternal and direct Female fertility Milking speed and temperament

Table 1. Traits and breeds for which international breeding values are published.

Trait:	**International breeding values for the breeds:**
Yield	Red breeds, Holstein and Jersey
Conformation	Red breeds, Holstein and Jersey
Udder health	Red breeds, Holstein and Jersey
Longevity	Red breeds, Holstein and Jersey
Calving – maternal and direct	Red breeds and Holstein
Female fertility	Red breeds, Holstein and Jersey
Milking speed	Red breeds, Holstein and Jersey
Temperament	Red breeds and Holstein

You can find Interbull breeding values for all bulls with international breeding values on www.nordicebv.info

On the page you can search within breed or country. You can also search with the herdbook number or the name of the bull. Click on the herdbook number of the bull and view a graphical representation of the bulls breeding values.

You can sort the bulls by different breeding values by clicking on the top line of the table.

Bulls from Denmark, Finland and Sweden are in the following grouped under DNK/FIN/SWE

Daughter proven bulls

In the tables below, only sires that have breeding values based on daughter information is shown

Yield

In tables 2-4 is a comparison of the genetic level of yield for bulls from different countries. The analysis includes bulls born in 2015 or later, that have more than 60 daughters in the genetic evaluation.

Table 2. Genetic level for yield traits, Red breeds. Bulls born in 2015 or later.

Country	No. of bulls	Milkindex	Fatindex	Proteinindex	Y-index	Y-index STD
Australia	8	88,3	83,9	79,1	79,6	14,2
Canada	25	95,4	94,1	91,4	91,9	7,1
Germany	7	100,4	105,4	101,3	103,9	5,8
DNK/FIN/SWE	156	100,0	103,1	103,1	103,9	7,7
UK	5	75,6	79,4	68,6	73,0	6,4
Norway	87	96,7	96,5	96,1	96,2	9,5
New Zealand	16	90,3	94,3	87,8	90,8	9,1

Table 3. Genetic level for yield traits, Holstein. Bulls born in 2015 or later.

Country	No. of bulls	Milkindex	Fatindex	Proteinindex	Y-index	Y-index STD
Australia	61	96,6	101,0	96,4	98,9	8,8
Belgium	16	106,9	106,9	105,9	106,3	6,4
Canada	390	111,0	110,6	108,6	109,1	10,1
Switzerland	76	99,5	100,7	99,1	99,8	8,0
Czech Republic	31	110,8	110,6	107,6	108,5	7,6
Germany	611	110,8	107,8	109,4	108,2	9,4
DNK/FIN/SWE	225	102,8	104,9	106,0	106,2	9,5
Spain	61	110,7	104,1	103,1	101,8	9,1
Estonia	5	93,0	95,4	91,6	93,4	9,6
France	273	105,6	102,9	105,4	104,0	8,3
UK	63	105,2	109,8	104,7	107,4	8,5
Ireland	56	73,7	88,7	81,6	87,5	9,5
Israel	104	101,9	104,1	101,4	102,8	6,9
Italy	248	107,5	105,3	105,5	104,9	8,2
Japan	28	109,0	109,4	106,5	107,5	7,3
Luxembourg	10	113,5	110,5	110,6	109,9	5,2
Netherlands	482	106,4	107,1	106,7	107,0	9,3
New Zealand	655	77,2	92,7	87,5	92,9	6,1
Poland	92	103,5	103,0	101,1	101,5	8,6
Slovenia	28	98,2	91,4	91,1	89,5	6,0
USA	2271	110,6	112,3	109,0	110,4	9,1

Table 4. Genetic level for yield traits, Jersey. Bulls born in 2015 or later.

Country	No. of bulls	Milkindex	Fatindex	Proteinindex	Y-index	Y-index STD
Australia	22	104,5	94,4	99,3	94,5	7,1
Canada	19	111,1	97,3	103,5	97,2	13,0
DNK/FIN/SWE	76	104,0	106,3	107,6	107,8	8,4
New Zealand	298	99,4	93,6	99,2	95,6	7,2
USA	359	117,2	100,8	111,3	102,7	10,3

International comparison for yield among most important populations shows that:

- Red breeds: DNK/FIN/SWE have higher genetic level than Norway and Canada
- Holstein: DNK/FIN/SWE, Canada, Germany, USA, and Netherlands have similar genetic level
- Jersey: Denmark has higher genetic level than USA. New Zealand has considerably lower genetic level

Conformation

The international genetic evaluation is done for 16 linear traits for Holstein, Red breeds and Jersey. In addition, frame, body condition score and locomotion are included in this trait group.

Breeding values for frame

EBV for frame is calculated from the 6 linear traits that are part of the international genetic evaluation. The composite NAV breeding value for frame also includes topline. There is no international genetic evaluation of topline.

We calculate international breeding value for frame based on a regression of NAV breeding values for the 6 linear international traits on NAV EBV for frame for Danish, Swedish and Finnish bulls born in 2004-05. The estimated regression coefficients are used to calculate international breeding value for frame for foreign bulls. This method is used to ensure the same relative weight between traits in NAV and international composite traits.

Breeding values for feet and legs

EBV for feet and legs is calculated from the 3 linear traits that are part of the international genetic evaluation. The composite NAV breeding values for feet and legs also include hock quality and bone quality. There is no international genetic evaluation for these two traits.

We calculate international breeding value for feet and legs based on a regression of NAV breeding values for the 3 linear international traits on NAV EBV for feet and legs for Danish, Swedish and Finnish bulls born in 2004-05. The estimated regression coefficients are used to calculate international breeding value for feet and legs for foreign bulls.

Breeding values for udder

The international genetic evaluation for udder includes 7 traits. The Nordic genetic evaluation for udder also includes teat thickness and udder balance. There is no international evaluation for these two traits.

We calculate international breeding value for udder based on a regression of NAV breeding values for the 7 linear international traits on NAV EBV for udder for Danish, Swedish and Finnish bulls born in 2004-05. The estimated regression coefficients are used to calculate international breeding value for udder for foreign bulls.

Genetic level of composite conformation traits

In tables 5-7 is a comparison of genetic level of composite conformation traits for bulls from different countries. The calculation includes bulls that have at least 25 daughters in genetic evaluation.

Table 5. Genetic level for conformation traits, Red breeds. Bulls born in 2015 or later.

Country	No. of bulls	Frame		Feet&legs		Udder	
		Average	STD	Average	STD	Average	STD
Canada	49	102,3	8,8	102,9	4,1	102,8	8,6
Germany	18	107,6	7,8	105,8	4,1	102,8	10
DNK/FIN/SWE	238	99,1	11,3	100,6	5,2	100,8	8,5
UK	10	107,1	8,2			105,7	4,2
Norway	93	103,3	12,1	98,3	5,6	85,0	8,7
USA	6	109,3	5,4	104,3	2,9	113,3	5,5

Table 6. Genetic level of conformation traits, Holstein. Bulls born in 2015 or later.

Country	No	Frame		Feet&legs		Udder	
		Average	STD	Average	STD	Average	STD
Australia	20	113,3	7,7	97,6	4,4	102,6	11,9
Belgium	16	110,8	14,1	104,4	7,4	104,3	9,1
Canada	312	117,9	10,8	98,9	6,5	113,8	9,4
Switzerland	86	113,5	8,2	99,2	5,4	109,3	9,2
Czech Republic	33	114,3	10,5	98,3	5,3	101,8	10,7
Germany	595	110,4	9,4	101,2	6,2	107,2	8,5
DNK/FIN/SWE	209	101,7	11,3	100,6	6,3	104,4	8,8
Spain	59	119,0	8,1	101,3	5,7	107,0	7,4
Estonia	7	106,4	7,0	96,0	4,6	92,0	14,6
France	238	117,6	9,5	102,4	5,7	109,2	8,4
UK	46	109,6	9,8	100,2	4,7	107,0	7,3
Ireland	28	90,0	10,9	96,0	4,0	75,2	12,2
Italy	243	113,1	9,5	100,2	5,8	107,0	8,3
Japan	261	114,7	9,5	99,9	5,6	104,2	8,3
Korea	7	111,6	6,2	99,4	4,5	99,0	5,2
Luxembourg	9	111,2	9,3	104,7	4,2	106,4	5,4
Netherlands	378	110,7	9,9	104,0	6,8	104,3	9,0
New Zealand	651	83,8	8,8				
Poland	77	111,9	7,4	100,0	4,5	96,6	7,1
Slovenia	25	104,8	10,8	99,1	5,9	95,5	7,0
USA	1290	111,4	10,7	98,4	5,7	108,6	8,9

Table 7. Genetic level of conformation traits, Jersey. Bulls born in 2015 or later.

Country	No	Frame		Feet&legs		Udder	
		Average	STD	Average	STD	Average	STD
Australia	11	106,7	5,9	98,6	7,6	90,5	5,8
Canada	22	111,9	9,3	104,5	7,2	99,3	9,4
DNK/FIN/SWE	70	101,7	8,2	100,5	6,9	102,0	9,3
USA	301	113,2	8,8	102,8	6,8	99,1	8,7

International comparison for conformation traits among most important populations show that:

- Red breeds: Canada have generally higher genetic level for udder than DNK/FIN/SWE. Compared to Norway, DNK/FIN/SWE have similar genetic level for feet&legs and higher level for udder

- Holstein: DNK/FIN/SWE has same genetic level for frame than most other populations. North America, Spain, France and Italy have the highest genetic level for frame. Populations with grass based dairy farming like Ireland and New Zealand has lower genetic level for frame. For feet&legs there are only small differences between populations. DNK/FIN/SWE has a below average genetic level for udder. North America and France has the highest genetic level for udder.

- Jersey: Denmark has lower genetic level for frame than USA, but same level for udders

Somatic cell count and udder health

Interbull does two international genetic evaluations – one for somatic cell count and one for udder health. In the first one only somatic cell count is included for all countries. NAV sends breeding values for somatic cell count to Interbull, so Nordic bulls get official breeding values for somatic cell count in countries where this trait is official. In the second evaluation breeding values based on mastitis diagnoses are included. NAV's official breeding value for udder health is used. For countries that do not record mastitis diagnoses, somatic cell count is included in this evaluation.

Index for udder health is published in the Nordic countries when reliability is 40% or higher. In tables 8-10 is a comparison of genetic level of udder health for bulls from different countries.

Table 8. Genetic level for udder health, Red breeds. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	11	98,8	6,7
Canada	11	95,2	7,4
DNK/FIN/SWE	188	99,5	8,4
Norway	89	99,6	9,7
New Zealand	32	94,5	7,0

Table 9. Genetic level for udder health, Holstein. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	77	94,6	7,8
Belgium	10	94,6	10,6
Canada	184	98,6	8,9
Switzerland	20	96,7	7,7
Czech Republic	33	95,4	8,5
Germany	411	98,9	7,4
DNK/FIN/SWE	206	103,0	7,8
Spain	67	96,8	8,0
France	249	99,5	7,8
UK	41	96,5	7,5
Ireland	56	93,3	9,4
Israel	108	100,4	8,8
Italy	224	96,7	8,7
Japan	223	91,1	8,2
Korea	18	94,6	4,6
Luxembourg	10	102,8	7,3
Netherlands	255	99,6	8,1
New Zealand	664	92,8	7,0
Poland	104	97,7	9,2
Slovenia	29	94,5	7,6
USA	1174	97,4	8,8

Table 10. Genetic level for udder health, Jersey. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	32	92,4	6,6
Canada	8	85,7	17,3
DNK/FIN/SWE	75	101,2	8,8
New Zealand	322	95,5	6,8
USA	169	87,9	7,9

International comparison for udder health among most important populations show that:

- Red breeds: DNK/FIN/SWE has higher genetic level than Norway
- Holstein: DNK/FIN/SWE have similar or higher genetic level than other major European populations, USA and Canada
- Jersey: Denmark is substantially better than USA

Longevity

In tables 11-13 is a comparison of genetic level of longevity for bulls from different countries. Bulls are included if they have at least 40 daughters in the genetic evaluation.

Table 11. Genetic level for longevity, Red breeds. Bulls born in 2014 or later.

Country	No. of bulls	Average	STD
Australia	7	87,2	12,0
Canada	39	92,9	8,4
Germany	15	95,1	7,2
DNK/FIN/SWE	168	101,9	7,4
UK	8	82,6	4,4
Norge	125	91,6	7,8
New Zealand	5	80,2	6,1

Table 12. Genetic level for longevity, Holstein. Bulls born in 2014 or later.

Country	No. of bulls	Average	STD
Australia	69	90,0	7,6
Belgium	27	99,5	6,8
Canada	513	101,5	8,4
Switzerland	114	92,3	7,8
Czech Republic	42	104,3	7,1
Germany	917	103,2	8,4
DNK/FIN/SWE	293	102,9	7,7
Spain	89	98,3	6,6
France	325	96,3	8,0
UK	79	101,8	8,1
Ireland	109	88,7	4,7
Israel	149	92,7	6,4
Italy	284	100,4	6,5
Luxembourg	10	107,0	9,2
Netherlands	695	102,4	8,7
New Zealand	432	85,8	4,7
Poland	116	98,3	8,1
Slovenia	40	93,9	7,7
USA	2684	104,4	8,7

Table 13. Genetic level for longevity, Jersey. Bulls born in 2014 or later.

Country	No. of bulls	Average	STD
Australia	21	92,4	6,5
Canada	20	91,3	8,0
DNK/FIN/SWE	53	100,3	7,6
New Zealand	121	92,0	4,2
USA	440	97,2	7,3

International comparison for longevity among most important populations shows that:

- Red breeds: DNK/FIN/SWE has higher level than the other populations

- Holstein: DNK/FIN/SWE are among the countries with the highest genetic level
- Jersey: Denmark has higher genetic level than other populations

Calving – maternal and direct

For Red breeds Canada, Denmark, Finland, Norway, Sweden and the United States send data to this evaluation. It has not been possible to obtain enough high correlations between countries for still birth, so the international evaluation only includes calving ease (maternal and direct) for Red breeds.

In the Holstein group there are international breeding values for both still birth (maternal and direct) and calving ease (maternal and direct), but only for first lactation. In the Nordic countries also, information from later lactations and from birth weight is included in calving, maternal and calving, direct.

We have calculated international indices for calving, maternal and calving, direct by performing a regression between NAV breeding values for still birth and calving ease and NAV breeding value for calving for Nordic bulls born in 2001-2006. The calculated regression coefficients are used to calculate a calving index for foreign bulls - same method is used for calving, maternal and calving, direct.

In Tables 14 and 15 the average genetic level for Red breed and Holstein bulls is shown for different countries. Only bulls born in 2015 or later are included. Bulls need to have breeding values for yield to be included.

Table 14. Genetic level for calving, maternal and calving, direct, Red breeds. Bulls born in 2015 or later.

Country	Calving, direct			Calving, maternal		
	No. of bulls	Average	STD	No. of bulls	Average	STD
Canada	33	95,6	6,5	18	95,4	7,2
DNK/FIN/SWE	158	101,4	6,4	148	100,4	6,4
Norway	88	99,9	7,2	88	92,0	7,3

Table 15. Genetic level for calving, maternal and calving, direct, Holstein. Bulls born in 2015 or later.

Country	Calving, direct			Calving, maternal		
	No. of bulls	Average	STD	No. of bulls	Average	STD
Australia	78	96,2	5,3	1	101,0	
Austria	5	93,6	6,1	3	102,0	14,9
Belgium	17	99,2	5,3	15	102,4	8,8
Canada	413	97,0	5,9	317	103,0	6,1
Switzerland	96	96,6	5,1	70	98,0	9,5
Germany	664	97,3	6,3	579	99,8	8,0
DNK/FIN/SWE	226	100,7	7,0	225	102,5	7,2
Spain	70	95,2	4,7	28	100,8	4,5
France	49	96,8	8,0	32	102,9	9,9
UK	61	98,8	5,1	19	100,2	6,0
Israel	43	97,8	5,4	115	92,6	6,4
Italy	240	95,7	6,1	120	100,9	5,7
Luxembourg	13	96,7	5,0	9	102,7	4,8
Netherlands	466	97,9	6,7	387	99,3	9,1
New Zealand	669	100,5	4,7	0		
USA	2418	98,9	5,8	1682	102,8	5,9

International comparison for calving traits among most important populations shows that:

- Red breeds: DNK/FIN/SWE and Norway have similar genetic level for calving, direct. For calving, maternal DNK/FIN/SWE has a higher level than Norway
- Holstein: DNK/FIN/SWE are among the best populations for both calving, direct and calving, maternal.

Female fertility

NAV calculates breeding values for female fertility based on linear regression between NAV breeding values for female fertility and NAV breeding values for the sub-indices in female fertility. Basis for the regressions are Nordic bulls born in 2001-2005 – see more information below. The estimated regression coefficients are used to calculate international breeding value for female fertility for foreign bulls.

In practice 3 regressions are calculated with different explaining variables (Jersey only 2 and 3):

1: Female fertility = Ability to conceive (R^2, HOL = 0,05) (R^2, Red breeds = 0,35)
2: Female fertility = Days open (R^2, HOL = 0,87) (R^2, Red breeds = 0,85) (R^2, Jer = 0,87)
3: Female fertility = Ability to return to recycle after calving + ability to conceive + Days open (R^2, HOL = 0,96) (R^2, Red breeds = 0,94), (R^2, Jer = 0,94).

R^2 (degree of explanation) indicates the proportion of the variance of the index for female fertility, that the traits in the regression can explain. Since the regression is used on foreign bulls, and the genetic correlations between international and NAV traits are not 1, the observed degree of explanation will be lower.

For each foreign bull we use the regression with the greatest explanatory power given the international sub-indices that are available. The degree of explanation therefore depends largely of the traits being available from the different countries.

Table 16. Genetic level for female fertility, Red breeds. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	5	87,8	19,0
Canada	25	96,9	10,6
Germany	7	85,1	9,4
DNK/FIN/SWE	151	99,8	9,4
UK	5	96,6	7,2
Norway	57	115,3	8,3
New Zealand	15	98,5	6,3

Table 17. Genetic level for female fertility, Holstein. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	55	91,7	8,7
Belgium	16	98,2	5,9
Canada	378	95,9	8,8
Switzerland	68	95,2	2,6
Czech Republic	26	96,2	3,0
Germany	530	94,1	8,5
DNK/FIN/SWE	225	102,1	11,2
Spain	19	92,7	8,0
France	232	96,5	8,2
UK	50	100,0	6,9
Ireland	56	107,5	3,1
Israel	99	96,5	2,5
Italy	232	95,0	7,1
Japan	28	92,6	5,3
Luxembourg	9	99,9	5,3
Netherlands	418	94,7	8,1
New Zealand	450	99,0	5,3
Poland	53	91,5	6,3
USA	2174	96,8	8,7

Table 18. Genetic level for female fertility, Jersey. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	34	91,2	8,2
Canada	21	86,2	12,6
DNK/FIN/SWE	126	100,1	12,2
New Zealand	330	95,9	7,9
USA	478	84,0	10,8

International comparison for female fertility among most important populations shows that:

- Red breeds: DNK/FIN/SWE has a lower level than Norway
- Holstein: DNK/FIN/SWE have a high genetic level. However, Ireland have the highest level
- Jersey: Genetic level is higher in Denmark than the other major countries

Milking speed and temperament

In Tables 19-21, the genetic level for bulls from different countries, born in 2015 or later are shown for Holstein, Red breeds and Jersey.

Table 19. Genetic level for milking speed and temperament, Red breeds. Bulls born in 2015 or later.

Country	Milking speed			Temperament		
	No. of bulls	Average	STD	No. of bulls	Average	STD
Australia	5	101,3	4,1	5	106,1	6,7
Canada	32	92,6	15,6	31	95,9	15,8
Germany	6	104,9	4,7	7	101,9	4,5
DNK/FIN/SWE	169	99,2	8,3	148	100,0	11,1
Norway	79	95,6	4,5	76	99,8	7,1
New Zealand	11	98,1	6,5	11	99,0	6,0

Table 20. Genetic level for milking speed and temperament, Holstein. Bulls born in 2015 or later.

Country	Milking speed			Temperament		
	No. of bulls	Average	STD	No. of bulls	Average	STD
Australia	51	100,9	4,9	51	101,6	5,5
Austria	5	97,8	10,4			
Belgium	13	95,7	13,2	15	102,6	13,5
Canada	254	98,5	11,0	252	105,4	10,3
Switzerland	89	95,7	9,3	89	99,8	9,5
Germany	471	98,5	9,7	408	102,2	13,8
DNK/FIN/SWE	222	100,0	7,9	181	102,5	16,0
France	211	97,0	9,1	209	103,8	9,5
UK	50	100,4	9,8	49	105,4	6,9
Italy	173	100,4	5,0	173	103,7	8,4
Luxembourg	8	93,1	6,7			
Netherlands	300	95,8	12,7	284	102,9	11,8
New Zealand	657	103,0	2,9	657	96,5	2,4
Slovenia	31	97,5	6,3			
USA	559	101,0	11,7	537	105,4	10,8

Table 21. Genetic level for milking speed, Jersey. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australien	20	98,1	10,2
Canada	15	94,5	7,9
DNK/FIN/SWE	68	100,7	10,8
New Zealand	278	98,5	6,2
USA	27	98,2	9,8

International comparison for milking speed and temperament among most important countries show that:

- Red breeds: DNK/FIN/SWE has a higher genetic level for milking speed and temperament than Norway and Canada
- Holstein: DNK/FIN/SWE has similar level as other populations for milking speed and temperament.
- Jersey: Denmark has similar genetic level as New Zealand and higher than USA

NTM for Nordic and foreign bulls

NTM index is calculated for all bulls (Nordic and others) that have official breeding values (NAV breeding values or international EBVs) for yield, udder health and conformation.

Interbull NTM is calculated by weighing the Interbull / NAV breeding values for yield, female fertility, calving (maternal and direct), udder health, longevity, feet&legs, udder, milking speed and temperament. The same economic weight factors are used as for NAV breeding values.

Rules for calculation of NTM based partly or entirely on international breeding values are stated below in order of priority.

1. **Bull has NAV breeding value for a trait**

If the bull has NAV breeding value for a specific trait, this is used in the calculation of NTM - no matter if the bull also has international breeding value for that trait.

2. **Bull has no NAV breeding value, but has an international breeding value for a trait**

If the bull does not have NAV breeding value for the trait, the international breeding value is used, provided that Interbull calculates international breeding values for that trait and the bull comes from a country which provides data for that trait.

3. **Bull has no NAV or no international breeding value for a trait**

For traits where no Interbull EBV is available or the bull has no Interbull EBV, and at the same time it is not tested in the Nordic countries, a pedigree index is used. Pedigree index is calculated as ½ (EBV_{sire} -100) +1/4 ($EBV_{maternal\ grand\ sire}$-100) +100. The contributions from the sire and maternal grand sire can be based on either NAV breeding values or international breeding values. If EBV_{sire} or $EBV_{maternal\ grand\ sire}$ are unofficial the pedigree index is set to 100.

Publication rules for NTM

All foreign and Nordic bulls that have Interbull breeding values for yield, udder health and udder get a public Interbull NTM. This NTM is calculated with a lower reliability than an NTM for Nordic proven bulls, where information for all traits is always available.

Genetic level for Interbull NTM

In tables 22-24 genetic level for Interbull NTM for Jersey, Red breeds and Holstein are shown. Bulls included are born in 2015 or later.

Table 22. Genetic level for NTM, Red breeds. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Canada	17	-15,7	7,8
DNK/FIN/SWE	156	6,4	9,3
Norway	67	-4,7	9,3

Table 23. Genetic level for NTM, Holstein. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Australia	21	-5,8	11,9
Belgium	13	3,8	7,6
Canada	204	6,3	11,4
Switzerland	55	-5,0	8,6
Czech Republic	31	5,6	7,9
Germany	435	5,8	8,6
DNK/FIN/SWE	219	10,5	7,9
Spain	58	-2,1	10,5
France	236	2,7	7,7
UK	45	5,2	6,8
Ireland	29	-13,7	8,5
Italy	225	1,3	8,3
Japan	28	2,3	7,5
Luxembourg	9	11,0	4,5
Netherlands	314	5,5	9,4
Poland	87	-3,6	9,0
Slovenia	27	-16,0	6,5
USA	1066	9,1	9,0

Table 24. Genetic level for NTM, Jersey. Bulls born in 2015 or later.

Country	No. of bulls	Average	STD
Canada	6	-10,5	3,8
DNK/FIN/SWE	75	8,5	7,5
USA	107	-7,1	7,8

International comparison of NTM among most important populations shows that:

- Red breeds: DNK/FIN/SWE is better than Canada and Norway
- Holstein: DNK/FIN/SWE and USA have the highest level
- Jersey: Denmark's average NTM is more than 15 index points better than USA

Changes since last run

In the evaluation in April 2022 the following changes are done compared to August 2021 evaluation. Only changes in major countries:

Yield

- NOR (RDC) New models with: Regression on level of Heterozygosity; Fixed effect of milking-system within lactation; Fourth and fifth lactation included from 2009, New definition of genetic groups. Genetic parameters were re-estimated. Some daughters lost due to new criterion of phenotype being outside +- 4 std within lactation and calving year. The rolling definition of hys is causing the daughters to distribute somewhat differently over hys-classes at

each evaluation. Therefore, some bulls occasionally may lose EDC although the number of daughters stay the same.
- ITA (HOL) Base change plus 1-year cutoff data
- DEU (ALL) Base change
- NZL (ALL) Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change. Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes.
- CAN (ALL) Base change
- USA (ALL) Drops in information due to pedigree corrections and herd-year minimum edits. In this run a larger number of drops will be seen in yield traits, as the inclusion of Milk-only records in the evaluation is impacting herd-year editing.
- FRA (ALL) Base change

Fertility
- DFS (ALL) Records for each cow are checked with calving informations, and if they do not match, the fertility record is deleted, this causes drops in EDC
- ITA (HOL) Base change plus 1-year cutoff data.
- DEU (ALL) Herd-years with uninformative NonReturn56, i.e., 100% NR56 ae excluded. Some traits are verified with the subsequent calving, e.g., interval first to last insemination, insemination dates must match with calving dates and result in reasonable gestation length. Thus, there are always some bulls having number of herds/daughters/EDC decreased, being not publishable anymore or in case number of herds drop below 10 herds, bulls are even not sent anymore. Base change
- NZL (ALL) Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change, Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes. The AB Companies have a Short Gestation Length scheme in NZL where they have been selecting bulls who will have shorter gestation. It was decided to remove the daughters of these bulls from the Fertility extract so that the fact the bulls had short gestation did not over inflate the Fertility BV incorrectly. This change affects the reliability of some bulls.
- NLD (ALL) HCO: Heritability discovered too high and corrected
- CAN (ALL) Base change
- USA (ALL) Excluded fertility information from herds not correctly reporting ET, causing drops in information. Pedigree corrections and herd-year minimum edits causing drops in information
- FRA (ALL) Base change

Calving
- ITA (HOL) Base change, 1 year cutoff of data
- DEU (ALL) Decrease in infromation due to pedigree and phenotype corrections, Base change
- CAN (HOL) Base change
- USA (ALL) Pedigree corrections and herd-year minimum edits causing drops in information
- FRA (ALL) Quite a lot of publication rules changed in relation with setting up of the single step EBV

Conformation
- NOR (RDC) Introduction of genetic groups for all traits except for ang, bde, cwi and rwi. OCS: new model and data extraction pipeline for this trait: -Repeatability model, with lactations later than first included from 2015. Technicians now score whole herds, rather than randomly chosen 1st lactation daughters in a progeny testing scheme. -New parameters and multitrait constellation. -New fixed effects and definition of genetic groups. ocs changed definition in 2014 and is now run multitrait with the old trait, together with helper traits for the old trait. The ordinary data extraction pipeline is somewhat stricter, causing many bulls to lose from 1 to 12 daughters, depending on size of the progeny group. This

also caused 5 bulls to become unofficial as they now got less than 50 daughters. Ftl got its heritability updated and was included in the new models and data extraction pipeline. This means having stricter tests than before.
- ITA (HOL) Base change plus 1-year cutoff data.
- DEU (ALL) Base change
- USA (HOL) Decrease in information due to parentage verification
- NZL (ALL) Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change, Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes.
- CAN (ALL) Base change
- USA (JER) Updated SD used in the multi-trait evaluation of type traits
- FRA (ALL) Base change

Udder health
- NOR (RDC) New models with: Regression on level of Heterozygosity; Fixed effect of milking-system within lactation; Fourth and fifth lactation included from 2009, New definition of genetic groups. Genetic parameters were re-estimated. Some daughters lost due to new criterion of phenotype being outside +- 4 std within lactation and calving year. The rolling definition of hys is causing the daughters to distribute somewhat differently over hys-classes at each evaluation. Therefore, some bulls occasionally may lose EDC although the number of daughters stay the same
- ITA (HOL) Base change plus 1-year cutoff data.
- DEU (ALL) Decrease in infromation due to pedigree and phenotype corrections, Base change
- NZL (ALL) Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change. Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes.
- CAN (ALL) Base change
- USA (ALL) Pedigree corrections and herd-year minimum edits causing drops in information
- FRA (ALL) Base change, quite a lot of publication rules changed in relation with setting up of the single step EBV affecting HOL, SIM and MON breeds

Longevity
- ITA (HOL) Base change plus 1-year cutoff data.
- DEU (ALL) Base change
- NZL (ALL) Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change. Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes.
- CAN (ALL) Base change
- USA (ALL) Pedigree corrections and herd-year minimum edits causing drops in information
- FRA (ALL) Base change

Milking speed and temperament
- NOR (RDC) Heritability of milkability now reported as narrow sense.
- ITA (HOL) Corrected a bug in herds calculation
- DEU (ALL) Base change
- NZL (ALL) Daughter counts: New Zealand has continuous DNA parentage testing so daughters will always change. Herd Count: Affected by continuous DNA parentage testing. EDCs: Affected by continuous DNA parentage testing. Reliability changes.
- CAN (ALL) Base change

Genomic tested young Holstein bulls

In the tables below, only Holstein sires that have breeding values based on genomic information and no daughters is shown

Averages are only shown for countries with more than 20 bulls.

Yield

In tables 25 is a comparison of the genetic level of yield for bulls from different countries.

Table 25. Genetic level for yield traits, Holstein. Bulls born in 2019 or later.

Country	No. of bulls	Milkindex	Fatindex	Proteinindex	Y-index	Y-index STD
Australia	13	110,8	111,9	110,6	111,0	9,9
Belgium	11	107,6	118,3	114,6	117,6	8,0
Brasil	8	122,5	112,5	115,3	112,8	5,8
Canada	325	112,7	125,8	116,4	120,9	9,3
Switzerland	18	103,8	106,1	104,4	105,2	11,4
Czech Republic	21	116,3	115,6	116,3	116,0	5,6
Germany	390	117,9	117,8	120,2	119,8	6,4
DNK/FIN/SWE	103	102,2	120,2	115,0	119,6	5,6
Spain	72	114,0	112,0	112,8	112,3	7,2
France	320	110,9	112,8	115,0	114,9	6,0
UK	39	110,1	127,0	116,0	121,6	7,0
Hungary	29	112,6	109,2	108,7	108,1	7,2
Italy	82	114,0	113,9	117,0	116,4	6,5
Netherlands	184	109,3	116,2	115,4	117,0	7,8
Poland	57	109,9	112,1	112,7	113,0	6,0
USA	1120	114,6	126,1	118,3	122,1	6,6

International comparison for yield shows that DNK/FIN/SWE, has a little lower genetic level than other major countries

Conformation

The international genetic evaluation is done for 16 linear traits for Holstein. In addition, frame condition score and locomotion are included in this trait group.

Calculation of frame, feet&legs and udder follows same principles as for daughter proven bulls.

In tables 26 is a comparison of genetic level of composite conformation traits for bulls from different countries.

Table 26. Genetic level of conformation traits, Holstein. Bulls born in 2019 or later.

		Frame		Feet&legs		Udder	
Country	No	Average	STD	Average	STD	Average	STD
Australia	13	118,1	12,7	99,5	3,3	114,3	7,1
Belgium	11	106,4	6,1	106,3	4,9	106,8	6,4
Brasil	8	112,1	5,2	95,1	1,2	107,4	6,5
Canada	325	115,2	10,9	99,2	4,6	110,3	9,0
Switzerland	18	117,0	9,5	100,3	5,3	121,8	7,1
Czech Republic	21	113,2	8,4	101,3	5,3	106,3	7,0
Germany	390	108,9	8,7	103,1	4,5	110,8	7,2
DNK/FIN/SWE	103	103,8	10,0	102,6	5,2	108,7	6,9
Spain	72	113,7	10,9	104,9	4,9	115,0	9,0
France	320	117,5	8,3	104,5	4,1	116,9	7,7
UK	39	107,0	8,5	99,8	3,9	106,6	7,5
Hungary	29	114,8	8,3	98,6	4,4	106,1	6,5
Italy	82	112,6	7,8	99,5	4,2	111,8	7,3
Netherlands	184	109,5	7,5	107,9	5,7	106,2	7,8
Poland	57	114,1	8,4	102,5	3,6	108,3	8,6
USA	1120	109,0	9,5	98,0	4,2	105,9	8,2

International comparison for conformation traits among most important populations shows that DNK/FIN/SWE has lower genetic level for frame than most other populations. For feet&legs and udder there are only small differences between populations.

Somatic cell count and udder health

In tables 27 is a comparison of genetic level of udder health for bulls from different countries.

Table 27. Genetic level for udder health, Holstein. Bulls born in 2019 or later.

Country	No. of bulls	Average	STD
Australia	13	99,3	5,2
Belgium	7	100,9	9,6
Brasil	8	97,3	2,9
Canada	255	98,8	4,8
Switzerland	11	100,0	6,3
Czech Republic	7	101,5	8,8
Germany	299	101,3	5,7
DNK/FIN/SWE	78	105,9	5,4
Spain	54	104,9	8,0
France	251	108,1	6,4
UK	31	99,9	4,3
Hungary	12	96,4	5,7
Italy	66	102,6	6,9
Netherlands	142	102,5	6,7
Poland	40	104,8	7,5
USA	745	98,3	4,9

International comparison for udder health among most important populations show that DNK/FIN/SWE and France have higher genetic level than other major European and North American populations

Longevity

In tables 28 is a comparison of genetic level of longevity for bulls from different countries.

Table 28. Genetic level for longevity, Holstein. Bulls born in 2019 or later.

Country	No. of bulls	Average	STD
Australia	13	104,2	5,6
Belgium	11	110,0	8,1
Brasil	8	108,3	4,8
Canada	325	110,0	5,8
Switzerland	18	107,2	7,7
Czech Republic	12	109,1	4,9
Germany	390	113,9	6,2
DNK/FIN/SWE	103	112,4	6,2
Spain	72	110,2	8,2
France	320	110,0	5,8
UK	39	111,0	4,1
Hungary	29	100,8	7,1
Italy	82	110,1	5,7
Netherlands	184	110,6	7,3
Poland	57	107,4	6,6
USA	1120	111,3	4,8

International comparison for longevity among most important populations shows that DNK/FIN/SWE has the highest level closely followed by Germany

Calving – maternal and direct

In Tables 29 the average genetic level for bulls is shown for different countries.

Table 29. Genetic level for calving, maternal and calving, direct, Holstein. Bulls born in 2019 or later.

Country	Calving, direct			Calving, maternal		
	No. of bulls	Average	STD	No. of bulls	Average	STD
Australia	13	98,6	6,3	13,0	102,3	4,8
Belgium	11	102,1	3,4	11,0	105,2	4,7
Brasil	8	100,9	4,0	8,0	102,6	4,0
Canada	325	100,8	4,8	325,0	105,7	4,6
Switzerland	18	99,3	4,8	18,0	102,5	5,0
Czech Republic	12	100,7	4,7	12,0	104,0	3,9
Germany	389	100,3	4,8	390,0	102,9	5,4
DNK/FIN/SWE	103	102,0	5,4	103,0	103,7	5,1
Spain	72	98,3	4,8	65,0	101,6	4,5
France	319	97,4	4,9	319,0	103,3	5,0
UK	39	103,8	4,3	39,0	104,4	3,9
Hungary	29	97,2	3,2	29,0	101,3	2,6
Italy	82	99,4	4,8	82,0	104,0	4,5
Netherlands	183	102,0	4,6	184,0	102,2	6,0
Poland	57	97,0	4,2	57,0	101,2	4,7
USA	1112	101,8	4,0	1120,0	106,1	4,3

International comparison for calving (direct and maternal) shows that DNK/FIN/SWE, has nearly similar level as other major countries

Female fertility

In Tables 30 the average genetic level for bulls is shown for different countries.

Table 30. Genetic level for female fertility, Holstein. Bulls born in 2019 or later.

Country	No. of bulls	Average	STD
Australia	13	98,9	7,4
Belgium	11	95,1	5,8
Brasil	8	101,9	5,1
Canada	325	98,9	6,6
Switzerland	18	101,4	9,9
Czech Republic	12	97,1	5,6
Germany	390	101,4	6,9
DNK/FIN/SWE	103	106,4	6,7
Spain	72	100,4	7,7
France	319	100,8	5,9
UK	39	101,5	5,0
Italy	82	101,9	6,6
Netherlands	184	99,4	7,2
Poland	57	100,6	7,9
USA	1120	100,7	5,9
USA	1368	101,3	5,9

International comparison for female fertility among most important populations shows that DNK/FIN/SWE is in the top.

Milking speed and temperament

In Tables 31, the genetic level for bulls from different countries.

Table 31. Genetic level for milking speed and temperament, Holstein. Bulls born in 2019 or later.

Country	Milking speed			Temperament		
	No. of bulls	Average	STD	No. of bulls	Average	STD
Australia	13	97,9	2,2	12	104,2	2,7
Belgium	11	97,4	2,5	11	103,7	7,4
Brasil	8	102,1	0,4			
Canada	324	101,5	4,8	291	106,1	4,5
Switzerland	18	100,7	3,0			
Czech Republic	12	100,7	8,4			
Germany	375	99,1	5,2	368	105,1	8,6
DNK/FIN/SWE	103	102,0	1,9	100	104,8	4,8
Spain	72	96,5	3,6	64	105,1	5,0
France	315	95,7	2,1	312	106,5	4,9
UK	39	103,2	5,8	39	105,8	6,2
Italy	81	96,1	8,1	76	105,2	5,9
Netherlands	183	98,2	5,4	182	104,2	9,6
Poland	54	94,3	22,5	35	105,5	5,6
USA	1111	102,4	3,4	1097	106,0	5,0

For milking speed DNK/FIN/SWE are superior. For temperament there are only small differences between populations.

Changes since last routine run
In the routine evaluation in August 2021 the following changes are done compared to April 2021 routine evaluation:

Yield:
- CAN (HOL) Base change.
- DEU (HOL) Base change.
- FRA (HOL) Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database). Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.
- ITA (HOL) Base change. Cut off one year. Excluded bulls which are not publishable and do not belong to ITA. In pedigree loading excluded North America Partners bulls <2 years old.

Fertility:
- CAN (HOL) Base change.
- DEU (HOL) Base change.
- FRA (HOL) Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database). Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.

- ITA (HOL) Base change. Cut off one year. Excluded bulls which are not publishable in releasible list and do not belong to ITA. In pedigree loading excluded North America Partners bulls <2 years old.

Calving:
- CAN (HOL) Base change.
- DEU (HOL) Base change.
- ITA (HOL) Base change. Cut off one year. Excluded bulls which are not publishable and do not belong to ITA. In pedigree loading excluded North America Partners bulls <2 years old.

Conformation:
- CAN (HOL) Base change.
- DEU (HOL) Base change.
- FRA (HOL)Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database). Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.
- ITA (HOL)Base change. Cut off one year. Excluded bulls which are not publishable and do not belong to ITA. In pedigree loading excluded North America Partners bulls <2 years old. For "ous" submitted gebv in line with changes in mace. Two new traits have been included: rear teat placement and teat length. Consequently, all weights have been changed and heritability changed as well.

Udder health:
- CAN (HOL) Base change.
- DEU (HOL) Base change.
- FRA (HOL) Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database). Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.
- ITA (HOL) Base change. Cut off one year. Excluded bulls which are not publishable and do not belong to ITA. In pedigree loading excluded North America Partners bulls <2 years old.

Longevity:
- CAN (HOL) Base change.
- DEU (HOL) Base change.
- FRA (HOL) Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database). Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.
- ITA (HOL) Base change. Cut off one year. Excluded bulls which are not publishable and do not belong to ITA. In pedigree loading excluded North America Partners bulls <2 years old.

Milking speed and temperament:

- CAN (HOL) Base change.
- DEU (HOL) Base change.
- FRA (HOL)Base change. Corrections in pedigree, as a consequence changes were observed in number of daughters and number of herds (bulls are not directly concerned). The several decreases in reliability are due to either a change in the information used to calculate EBVs of their parents (french EBV or MACE) or parents GEBVs or decrease in the reliability of their polygenic information (correction of database). Bulls' change of status due to new publication rules at the national level following the introduction of Single Step.
- ITA (HOL)Base change. Cut off one year. Excluded bulls which are not publishable and do not belong to ITA.In pedigree loading excluded North America Partners bulls <2 years old. msp: applied correction on herd calculation in line with MACE.

Dates of publication of Interbull breeding values in 2022:

Month	Date
April	5
August	9
December	6

The indices can be found at the national databases in Denmark, Sweden, and Finland 2-3 days after they have been published by Interbull.

Regards
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