News - NAV routine evaluation
May 7, 2019

Dairy cattle
The latest NAV routine evaluation for yield, fertility, conformation, udder health, general health, calving traits, milkability, temperament, growth, longevity, young stock survival, claw health and NTM took place as scheduled. NAV carried out three evaluations per trait group:

Holstein evaluation, including data from: Danish Holstein, Swedish Holstein, Finnish Holstein, Finnish Ayrshire and Finn Cattle.

Red Dairy Cattle evaluation, including data from: Danish Red, Swedish Red, Finnish Ayrshire, Finnish Holstein and Finn Cattle.

Jersey evaluation, including data from: Danish Jersey, Swedish Jersey and Finnish Jersey.

Extraction dates
Dates for extraction of data from national databases are given in Table 1.

Table 1. Dates for extraction of data from the national databases

Trait	Denmark	Finland	Sweden
Yield	25.03.2019	17.03.2019	15.03.2019
Type, milkability and temperament	25.03.2019	17.03.2019	15.03.2019
Fertility	25.03.2019	17.03.2019	16.03.2019
Udder health and other disease	25.03.2019	17.03.2019	16.03.2019
Calving	25.03.2019	17.03.2019	16.03.2019
Longevity	25.03.2019	17.03.2019	16.03.2019
Growth	25.03.2019	17.03.2019	21.03.2019
Claw health	25.03.2019	17.03.2019	16.03.2019
Youngstock survival	25.03.2019	17.03.2019	16.03.2019

Data used in genomic prediction
Genotypes were extracted from the joint Nordic SNP data base 4th April 2019. INTERBULL information from April 2019 was included in the genomic prediction.

News in relation to NAV genetic evaluation
Genomic prediction
No changes

Traditional evaluation
Improvements General Health evaluation
The main improvements in the General Health (GH) evaluation include changes in data and handling of data, model changes and updated lactation and economic weights for the GH index. Details on each of these changes are given below as well as the effects on the breeding values for sires and cows.

1. Data

New data. The GH evaluation has been upgraded to include β-hydroxybutyrate (BHB) and Acetone from Finland as indicator traits in the GH evaluation. Danish BHB and Acetone information was al-

ready included in GH evaluation upgrade in November 2017. Sweden started collecting BHB and Acetone on a regular basis from the beginning of 2019. Data for BHB and Acetone from Swedish herds will be incorporated into the GH evaluation when the amount of data is sufficiently large (2-3 years of data).

Table 2. Availability of BHB and acetone data by country and breed

	Holstein	**RDC**	**Jersey**
Denmark	2013-	2013-	2013-
Sweden	(Not yet included in the evaluation) Regularly recorded from 2019 -		
Finland	2015-	2015-	2015-

The addition of BHB and acetone from Finland has some impact on EBVs for mainly HOL and RDC bulls with daughters in Finland now having daughters with BHB and Acetone information. The largest effect is seen for the EBV and reliability estimates of BHB, Acetone, Ketosis and other metabolic disorders for individual Finnish cows with new phenotypes included.

Data editing. The heterogeneous variance adjustment (HV) for veterinary treatments has been updated to take into account differences in disease treatment frequency across years and countries. This procedure required an update of the genetic parameters. The largest impact of the new HV adjustment is on those traits that have the largest frequency differences across countries and years. In the case of HOL and RDC the largest effect is on EBVs for Early and Late Reproductive disorders (ERP and LRP) for bulls and cows.
To handle differences in phenotypic standard deviation of BHB and acetone records between Finland and Denmark and across years of sampling the variation in phenotypic records were adjusted according to country, calving year and breed. The impact of HV adjustment for acetone and BHB has a marginal effect on the EBVs for bulls and cows.

2. Genetic model and genetic parameters

Genetic model. The main changes in the genetic model for GH traits are the inclusion of phantom parent groups (PHG) for all breeds and the exclusion of breed proportions and heterosis from the HOL evaluation. The genetic model with PHG has increased EBVs for older animals (born before 2000) affecting the raking of the top 100 bulls for HOL and RDC. Other than that the PHG has shown very little effect in the most recent year classes for bulls and cows.
A further change in the genetic model, which has a very limited impact on bulls EBVs, is the omission of Clinical Mastitis from lactation 1 (CM1) as a correlated trait in the evaluation of the general health traits. The genetic correlations between CM1 and the general health traits have been re-estimated and were found to be positive but lower than assumed so far.

Genetic parameters. As a consequence of the new HV adjustment for the veterinary treatment traits (VT traits) the genetic parameters have been (re-)estimated for HOL, RDC and JER (Table 3) and genetic correlations between traits have been kept the same as for the February 2019 routine evaluation, except for those correlations in the HOL and RDC evaluation that there were not affected by the inclusion of BHB and acetone in phase 1 and therefore have been updated in this new evaluation.

Table 3. Genetic correlations and heritabilities (on the diagonal) in first lactation for Early Reproductive Disorders (ERP), Late Reproductive Disorders (LRP), Other Metabolic Disorders (OMB), Ketosis (KET), Feet&Legs (FLP), β-hydroxybutyrate (BHB) and Acetone (ACE) for HOL, RDC and JER.

Traits	**ERP**	**LRP**	**OMB**	**KET**	**FLP**	**BHB**	**ACE**
HOL							
Early Reproductive Disorders	0.034						
Late Reproductive Disorders	0.40	0.004					
Other Metabolic Disorders	0.40	0.29	0.006				
Ketosis	0.29	0.21	0.74	0.010			
Feet&Leg Problems	0.35	0.36	0.38	0.19	0.013		
β-hydroxybutyrate	0.05	-0.02	0.48	0.65	0.01	0.149	
Acetone	0.03	0.03	0.65	0.76	0.04	0.89	0.053
RDC							
Early Reproductive Disorders	0.007						
Late Reproductive Disorders	0.24	0.008					
Other Metabolic Disorders	0.30	0.09	0.003				
Ketosis	0.26	-0.08	0.64	0.010			
Feet&Leg Problems	0.00	-0.01	0.39	-0.06	0.005		
β-hydroxybutyrate	0.04	-0.02	0.46	0.63	0.01	0.149	
Acetone	0.04	-0.09	0.62	0.74	0.10	0.89	0.053
JER							
Early Reproductive Disorders	0.009						
Late Reproductive Disorders	0.32	0.004					
Other Metabolic Disorders	0.47	-0.05	0.004				
Ketosis	0.39	0.10	0.55	0.013			
Feet&Leg Problems	0.28	0.04	0.22	0.34	0.013		
β-hydroxybutyrate	0.04	0.00	0.33	0.60	0.08	0.052	
Acetone	0.05	-0.04	0.40	0.72	0.04	0.92	0.017

3. Changes in economic weights

The revision of the Nordic Total Merit Index (NTM) in 2018 considered a new set of biological and economic assumptions, leading to a change in lactation and economics weights of all traits in the breeding goal including the General Health index. Updated lactation weights for the sub-index traits change from 0.5, 0.3 and 0.2 to 0.3, 0.25 and 0.45 for lactation 1, lactation 2 and lactation 3 respectively. The new economic weights used to calculate the GH index changed as shown in table 4 below.

Table 4. Old and new economic weights to calculate General Health index

Old GH evaluation February 2018	
All breeds	GH = 2.00*ERP + 1.05*LRP + 1.88*(2*OMB + KET)/3 + 1.75*FLP
New GH evaluation May 2019	
HOL	GH = 2.04*ERP + 1.78*LRP + 3.12* OMB + 1.45* KET + 1.57*FLP
RDC	GH = 2.04*ERP + 1.73*LRP + 3.12* OMB + 1.49* KET + 1.58*FLP
JER	GH = 2.04*ERP + 1.63*LRP + 3.05* OMB + 1.56* KET + 1.75*FLP

4. Summary of changes and effects on breeding values

The upgrade of the GH evaluation has considered new data editing procedures, new genetic parameters, and changes in the model used for the evaluation. All together, these changes have significant impact on bull and cows EBVs. A summary of the changes is in Table 5 and tables showing the effects on sire EBVs are in Tables 6, 7, 8 and 9.

Table 5. Summary of the major differences between May 2019 evaluation and old GH evaluation (February 2019)

Old evaluation	May 2019 Evaluation	Comments	Effect
No use of BHB and acetone data **from Finnish herds** as indicator traits in the GH evaluation	Use of Finnish BHB and Acetone data as indicator traits in the GH evaluation	BHB and Acetone data is up to now only available from Denmark and Finland (Sweden will join in a later phase) There are genetic correlations between BHB and acetone with all traits in GH evaluation. However the highest correlations are between Ketosis with BHB and Acetone	Effects mainly on bulls with Finnish daughters having BHB/Acetone information and Finnish cows with own information. Increases the EBV reliability especially for Ketosis
Clinical Mastitis from lactation 1 as a correlated trait for the veterinary treatment traits	Clinical Mastitis from lactation 1 is removed from the GH evaluation.	Lower than expected re-estimated genetic correlations between CM1 and the other traits in the GH evaluation	In HOL and RDC minor effect. Largest effect on LRP for the JER
Heterogeneous variance adjustment for the veterinary treatment traits due to breed, year of calving and country.	Heterogeneous variance adjustment taking into account differences in genetic parameters due to disease treatment frequency differences across years and countries	Genetic parameters updated. Genetic correlations that were not updated in phase 1 because there were not affected by the inclusion of BHB and ace (i.e. ERP, LRP and FLP) were updated in this new evaluation	Effects bulls and cows EBVs for all traits in all breeds. The magnitude of the change depends on the disease treatment frequency differences between countries and the changes in heritabilities.
No heterogeneous variance adjustment for BHB and Acetone	Heterogeneous variance adjustment by country, calving year and breed		Minor effect. Mainly in the standard deviation of EBVs for Finnish cows and bulls for BHB and Acetone
Breed proportions for HOL	Breed proportions have been removed and phantom parent groups are included		Effects mostly GH EBVs for older bulls and cows in HOL and RDC evaluations
Includes Heterosis for HOL	Remove Heterosis		Minor effect. Some impact on cows and bulls EBV born in the early 90s.
Lactation weights and economic weights derived from NTM 2008	Lactation weights and economic weights derived from NTM 2018		Effect on the EBV for all breeds and sex. Largest effect on the GH index for the JER evaluation

The upgrade of the GH evaluation introduced changes, for bulls and cows, for all breeds, traits and countries. Within-country correlations between EBVs for the old and new evaluation for bulls having reliability >0.35 are shown in table 5 for the GH index and sub-indexes for HOL, RDC and JER. As expected, including BHB and Acetone data from Finland had an effect on the bulls EBVs mainly having Finnish daughters. The traits mostly effected are those highly correlated with BHB and Acetone, such is the case for KET and OMB. The effect of extra BHB and Acetone data from Finland can also be seen in the proportion of bulls changing more than 3 EBV units for KET and OMB, which is larger for Finland and Sweden compared to the other sub-index traits.
Other changes that have affected the correlations between bull EBVs from the old and the new evaluation are the update of HV adjustment and consequently the genetic parameters, but also the new economic weights to calculate the GH index. Altogether, the impact of these changes on bulls EBV correlations are shown in table 6.

Table 6. Within country correlations between EBVs from the new (May 2019) evaluation and the old (February 2019) evaluation for the GH index and included traits for AI bulls with a reliability for the GH index above 0.35 born after 2009 (for JER born after 2003 to increase the sample size)

Birth country of the bull	**Denmark**			**Finland**		**Sweden**	
Breed	**HOL**	**RDC**	**JER**	**HOL**	**RDC**	**HOL**	**RDC**
General health index	0.97	0.95	0.94	0.96	0.94	0.95	0.93
Early Reproductive Disorders	0.97	0.95	0.98	0.97	0.96	0.97	0.94
Late Reproductive Disorders	0.95	0.93	0.96	0.97	0.96	0.93	0.94
Ketosis	0.98	0.95	0.98	0.92	0.93	0.94	0.95
Other Metabolic Disorders	0.96	0.96	0.99	0.94	0.91	0.96	0.96
Feet&Leg Problems	0.96	0.94	0.99	0.96	0.93	0.94	0.93

The frequency of EBV changes for Finnish and to a minor extent Swedish RDC and HOL is largest for those traits (KET and OMB) where the input data (BHB and Acetone from Finland) have been modified (Tables 7, 8 and 9).

Table 7. Frequency (%) of changes in EBVs between the new evaluation and the old evaluation for HOL bulls born after year 2009 (and with reliability for GH index over 0.35) split into bulls that change zero EBV units, from 1 or 3 units and more than 3 (>3) EBV units.

Birth country of the bull	**Denmark**			**Finland**			**Sweden**		
Change in EBV index units	**0**	**1-3**	**>3**	**0**	**1-3**	**>3**	**0**	**1-3**	**>3**
General health index	40	47	13	40	45	15	33	41	25
Early Reproductive Disorders	39	45	15	48	44	9	37	49	14
Late Reproductive Disorders	33	45	21	42	44	13	30	42	28
Ketosis	43	45	13	25	42	33	24	40	36
Other Metabolic Disorders	33	47	20	29	45	26	25	43	33
Feet&Leg Problems	44	42	14	45	45	10	35	48	17

The changes in GEBVs for General health follow the changes observed in EBVs meaning that correlations between the GEBVs from the new and the old model are on same level as observed for EBVs for all breeds (Table 6).

Table 8. Frequency (%) of changes in EBVs between the new evaluation and the old evaluation for RDC bulls born after year 2009 (and with reliability for GH index over 0.35) split into bulls that change zero EBV units, from 1 or 3 units and more than 3 (>3) EBV units.

Birth country of the bull	**Denmark**			**Finland**			**Sweden**		
Change in EBV index units	**0**	**1-3**	**>3**	**0**	**1-3**	**>3**	**0**	**1-3**	**>3**
General health index	28	45	27	33	42	25	36	42	22
Early Reproductive Disorders	34	43	23	41	40	19	37	45	17
Late Reproductive Disorders	21	43	35	34	44	22	33	40	27
Ketosis	38	46	16	29	42	28	47	37	16
Other Metabolic Disorders	31	44	25	23	42	35	27	42	31
Feet&Leg Problems	26	45	29	30	44	27	30	33	37

Table 9. Frequency (%) of changes in EBVs between the new evaluation and the old evaluation for JER bulls born after year 2003 (and with reliability for GH index over 0.35) split into bulls that change zero EBV units, from 1 or 3 units and more than 3 (>3) EBV units.

Birth country of the bull	**Denmark**		
Change in EBV index units	**0**	**1-3**	**>3**
General health index	50	42	8
Early Reproductive Disorders	28	43	30
Late Reproductive Disorders	39	47	13
Ketosis	57	39	4
Other Metabolic Disorders	49	43	8
Feet&Leg Problems	26	42	32

Table 10. EBV correlations between GH index and the five sub-index traits for sires born after 2009 (and with a reliability of the GH index over 0.35) from old (February 2019) and the new (May 2019) GH evaluation, respectively

Breed	**HOL**		**RDC**		**JER**	
Evaluation	**Old**	**New**	**Old**	**New**	**Old**	**New**
ERP[a]	0.84	0.77	0.81	0.73	0.87	0.71
LRP[b]	0.64	0.51	0.52	0.56	0.44	0.47
OMB[c]	0.71	0.83	0.71	0.81	0.68	0.88
KET[d]	0.58	0.65	0.42	0.53	0.66	0.76
FLP[e]	0.59	0.56	0.26	0.30	0.63	0.63

[a]Early Reproductive Disorders (ERP), [b]Late Reproductive Disorders (LRP), [c]Other Metabolic Disorders (OMB), [d]Ketosis (KET), [e]Feet&Legs (FLP).

Following the expectations, EBV reliabilities in the new evaluation for Finnish cows with added BHB and acetone observations were higher for the GH index for RDC. The same pattern was found for most of the VT traits, but especially for KET and OMB when comparing the same group of cows without BHB and acetone observations in old evaluation (Table 11).

Table 11. Approximate reliabilities for seven sub-traits and the GH index, for RDC Finnish cows without BHB and Acetone observations (in the old evaluation) and with BHB and Acetone observations (in the new evaluation) but without own progeny

Finnish RDC cows	**Old (February 2019) – NO BHB and Acetone obs.**	**New (May 2019) – YES BHB and Acetone obs.**
General health index	0.29	0.30
Early Reproductive Disorders	0.28	0.29
Late Reproductive Disorders	0.28	0.28
Ketosis	0.28	0.32
Other Metabolic Disorders	0.27	0.31
Feet&Leg Problems	0.27	0.26

In general, reliability estimates of the five GH traits follow the changes in data editing (heterogeneous variance), heritability and the extra information from BHB and Acetone.

Table 12. Approximate reliabilities for seven sub-traits and the GH index, for cows with observations but without own progeny, separate for cows with or without BHB and Acetone (Ace) observations. (N = number of cows in that group)

Breed	**BHB&Ace observations**	**ERP[a]**	**LRP[b]**	**OMB[c]**	**KET[d]**	**FLP[e]**	**GH[f]**	**BHB[g]**	**ACE[h]**	**N**
HOL	**Yes**	0.31	0.27	0.34	0.35	0.28	0.32	0.43	0.40	576,124
	No	0.29	0.26	0.28	0.27	0.26	0.29	0.25	0.26	1,972,074
RDC	**Yes**	0.29	0.27	0.32	0.34	0.26	0.30	0.40	0.37	98,774
	No	0.28	0.27	0.28	0.30	0.26	0.29	0.27	0.28	1,462,266
JER	**Yes**	0.27	0.25	0.28	0.30	0.27	0.29	0.35	0.32	89,326
	No	0.26	0.24	0.25	0.25	0.25	0.26	0.21	0.22	190,240

[a]Early Reproductive Disorders (ERP), [b]Late Reproductive Disorders (LRP), [c]Other Metabolic Disorders (OMB), [d]Ketosis (KET), [e]Feet&Legs (FLP), General Health index, [g]β-hydroxybutyrate (BHB) and [h]Acetone (ACE).

Genetic base

EBVs for bulls and females are expressed on the same cow base. This genetic evaluation included cows born from 07.05.2014 to 07.05.2016 in the genetic base (average 100).

Publication of NTM for Nordic and foreign bulls

NTM is published if the bull has official EBVs (NAV (G)EBV or international EBV) for Yield, Mastitis and Type. By official means for NAV EBVs that the NAV thresholds are met, and for international EBVs (IB EBVs) that Interbull EBVs for the single bull exist. For traits without a NAV (G)EBV or an IB (G)EBV a NAV pedigree index is calculated.

For bulls with a Nordic herd book number the pedigree index follows the principles described in the October 2008 routine information. For foreign bulls without a Nordic herd book number the pedigree index is calculated in as ½(EBVsire-100) +1/4(EBVmgs-100) +100. If EBVsire or EBVmgs is not official NAV EBVs then 100 is used.

Publication of EBVs/GEBVs

Official EBVs/GEBVs for bulls used for AI in Denmark, Finland or Sweden are published at the NAV Bull Search.

Official NAV GEBVs for foreign AI bulls not used for AI in Denmark, Finland and Sweden are published at NAV homepage. The excel sheets also include GEBVs for bulls used for AI in Denmark, Finland and Sweden. The excel sheets include AI bulls that are 10 months to 5 years old at the date of publication, and is mainly useful for foreign AI-companies.

Interbull EBVs/GEBVs are published at the NAV Interbull Search.

Genetic evaluation of beef bulls used in dairy herds

The latest NAV routine evaluation for AI beef bulls based on their crossbred offspring from dairy cows for calving and carcass traits took place as scheduled. Breeding values for AI beef bulls will be estimated four times per year, in connection to the NAV routine genetic evaluation for dairy breeds (table 13), and EBVs are published at https://www.nordicebv.info/beef-cattle/beef-x-dairy-publication/

NAV – frequency and timing of routine runs

NAV has 4 large evaluations per year, which include updated phenotypic and genomic data, and additional eight small runs including updated genotypes. In Table 13 the NAV and INTERBULL release dates for 2019 are shown. The beef evaluation based on beefxdairy crossbreeds will take place along with the large NAV runs 4 times a year.

Table 13. NAV and INTERBULL release dates in 2019. EBVs released at NAV dates in bold will be delivered to international genetic evaluation.

Month	NAV Small run[1)]	NAV Large runs[2)3)]	INTERBULL
January 2019	3		
February 2019		5	
March 2019	5		
April 2019	2		2
May 2019		7	
June 2019	4		
July 2019	2		
August 2019		13	13
September 2019	3		
October 2019	1		
November 2019		5	
December 2019	3		3

[1)] Genotypes updated; [2)] Genotypes and phenotypes updated; 3) Beef evaluation

You can get more information about the joint Nordic evaluation:
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