Status and plans - genomic prediction and traditional evaluation

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Nordisk Avlsværdi Vurdering •

Outline

1. Overview – implemented 2015 (Gert)
2. Genotype statistics (Ulrik)
3. GEBV analyses (Ulrik)
4. Weekly genomic prediction (Gert)
5. Future development (Gert)
   - Genomic prediction
   - Traditional evaluation

Implemented in nov 2014/15

Trait/index	Date	Comment
Improved type evaluation	Nov 2014	Updated genetic parameters and model. AM ML
EBV for Young stock survival	Nov 2014	Traditional model
GEBV Holstein	Nov 2014/Feb 2015	Revised blending method, Animal Model pedigree in genomic prediction, and cows in reference populations applied for Holstein

Implemented in 2015

Trait/index	Date	Comment
Fertility version I	May 15	AM ML fertility, model improvements
GEBV	Aug 15	Publication of GEBV for linear traits for females and calculation of composite traits from linear traits
GEBV to EBV	Aug 15	Improve the transition from genomic breeding values to daughter based breeding values for bulls
Fimpute in RDC	Sep 15	Fimpute instead of Beagle for imputation of RDC (requirement for weekly evaluation)
SNP BLUP	Sep 15	SNP BLUP instead of GBLUP for genomic prediction (requirement for weekly evaluation)

Implemented in 2015

Trait/index	Date	Comment
New NAV homepage	Sep 15	New NAV home page
Claw health updates	Nov 15	Updated genetic parameters. Cow EBVs from the Animal Model instead of pedigree index
Reliabilities GEBVs	Nov 15	Official GEBV reliabilities
Jersey changes in weights for udder conformation	Nov 15	Changed weight on linear traits
Weekly genomic prediction	Dec 15	Focus on candidate bull calves

GEBV reliabilities, average young bulls born 2014

Traits	Holstein	RDC	Jersey
Yield	74	67	67
Growth	60	49	28
Fertility	65	47	42
Birth	70	57	44
Calving	64	43	65
Udder health	68	57	56
Other disease	45	38	26
Claw health	43	33	-
Longevity	61	38	37
Frame	73	58	63
Feet & Legs	68	54	53
Udder	73	55	60
Milking speed	69	66	60
Temperament	62	53	27

Reference population
January 2016

	Reference population	
	Bulls	Cows
Holstein	31,800[a)]	14,900
RDC	7,600[b)]	19,600
Jersey	2,500[c)]	13,500

a) Includes proven bulls from NLD, FRA, DEU, ESP, POL
b) Includes proven bulls from NOR
c) Includes proven bulls from USA

Tested females per country and birth year

Year	Holstein			RDC			Jersey		
	DNK	FIN	SWE	DNK	FIN	SWE	DNK	FIN	SWE
2009	871	138	138	96	295	108	151	1	5
2010	1,104	353	150	506	1,848	1,257	2,176	1	43
2011	1,637	1,137	358	897	3,605	1,783	4,038	6	89
2012	2,408	1,799	570	1,304	3,731	1,930	4,442	16	111
2013	3,746	2,575	1,602	1,630	3,427	2,226	3,194	12	84
2014	3,985	2,693	2,154	1,762	3,475	2,651	3,668	26	82
2015	3,080	1,820	1,360	1,408	2,697	2,140	2,546	20	53
Total	18,408	10,643	6,564	7,738	19,394	12,201	20,506	82	480
	HOL total : 35,615 Last year: 13,978			RDC total : 39,333 13,645			Jersey total : 21,068 6,910		

Level of genomic tested Holstein

November 2015

	Bulls with HB		Bulls with out HB		Females	
Born	Number	NTM	Number	NTM	Number	NTM
2009	296	5.8	844	1.4	1,147	0.4
2010	248	9.2	903	2.7	1,607	3.9
2011	200	15.3	1,532	7.2	3,132	5.8
2012	222	19.7	1,958	10.8	4,777	8.1
2013	186	23.7	2,210	13.9	7,923	10.7
2014	133	30.7	3,033	18.3	8,832	14.8
2015	32	35.1	2,073	23.0	6,260	18.3

Level of genomic tested RDC

November 2015

	Bulls with HB		Bulls without HB		Females	
Born	Number	NTM	Number	NTM	Number	NTM
2009	247	1.4	344	-0.8	499	2.1
2010	256	6.4	738	2.5	3,611	0.9
2011	294	9.3	1,518	6.2	6,284	3.0
2012	267	14.2	2,071	8.2	6,965	8.2
2013	249	16.7	2,103	10.2	7,281	8.5
2014	148	23.4	2,177	14.2	7,884	12.0
2015	48	29.0	1,746	19.2	6,240	15.9

Level of genomic tested Jersey

November 2015

	Bulls with HB		Bulls without HB		Females	
Born	Number	NTM	Number	NTM	Number	NTM
2010	72	5.7	179	0.7	2,896	1.1
2011	73	8.1	325	2.8	4,806	2.2
2012	58	10.0	369	5.3	4,713	3.0
2013	67	12.1	386	7.3	3,291	5.6
2014	67	16.1	412	9.4	3,776	7.6
2015	7	21.7	400	14.5	2,619	10.5

Changes in information in NTM over time
- 3 different reasons

1. Base change - similar for all categories of animals
2. Own performance (progeny test)
3. Animals without own performance
   - Differences in new pedigree information. Not the same among year groups.

Animals without own performance
Changes in NTM in 2015 compared to 2014

	HOL		RDC		JER	
Born	HB	noHB	HB	noHB	HB	noHB
2010		-2.5		-3.1		-2.3
2011	-3.2	-2.4	-4.2	-3.4	-2.4	-2.4
2012	-3.5	-2.2	-4.4	-3.7	-2.9	-2.5
2013	-5.0	-4.3	-5.4	-4.3	-3.8	-2.9
2014		-3.7		-4.5		-3.4

GEBV's from November 2015

Size of year groups almost identical

Sub conclusion

- **Number of tested animals are still increasing**
- **Selection differencies are still increasing between selected and not selected bulls:**
  - **HOL : 11 NTM**
  - **RDC: 9 NTM**
  - **JER: 7 NTM**
- **Changes in pedigree information affect year groups differently**

Does genomic prediction work?

- **Insemination bulls: Young bulls better than proven bulls:**
  - **Very good for pre-selection of young bulls**
  - **Young bulls - much higher level than before**
- **Sires of sons: Are young bulls better that proven bulls ?**
  - **Do average young bulls get expected EBVs when proven?**
  - **Are young bull sires as good as proven bull sires?**

Changes in genomic prediction May 2013 to Nov 2015

- **All breeds:**
  - **New blending procedure**
  - **Including females in reference population**
    - **Biggest effects for RDC and JER**
  - **US JER in reference population**
  - **New standardisation procedure**
    - **Effect on HOL level (minus 2-3 NTM for the best)**
    - **Effect on level and standard deviation for RDC and JER**

Do average young bulls get expected EBVs when proven?

- Comparison of official indices in May 2013 and November 2015
  - Group1:
    - Born in 2007 and 2008
    - Progeny test in both 2013 and 2015
  - Group2:
    - Born in 2009 and 2010
    - No progeny test in 2013 but a progeny test in 2015

Do average young bulls get expected EBVs when proven?

	No.	NTM, 2013	NTM, 2015	Difference	Corr.
HOL					
Group1	495	6,2	-0,9	-7,1	0,93
Group2	350	16,6	8,5	-8,1	0,60
RDC					
Group1	337	4,6	-1,9	-6,5	0,86
Group2	191	7,2	4,2	-3,0	0,55
JER					
Group1	97	7,5	-0,9	-8,4	0,85
Group2	67	6,8	5,1	-1,7	0,51




Self-study Holstein

	Group 1			Group 2		
	2013	**2015**	**Corr.**	**2013**	**2015**	**Corr**
Yield	105.4	101.5	0.95	109.6	104.9	0.67
Growth	99.2	98.3	0.99	100.5	99.0	0.81
Fertility	100.1	97.0	0.84	104.8	102.8	0.70
Birth	100.3	98.2	0.99	103.6	101.6	0.95
Calving	100.8	100.2	0.96	103.2	102.7	0.67
Udder health	100.9	98.7	0.89	104.9	102.8	0.62
Other diseases	100.4	97.8	0.84	106.1	102.4	0.61
Frame	99.1	102.8	0.52	98.8	101.1	0.51
Feet&Legs	101.8	99.8	0.93	103.7	100.8	0.63
Udder	104.3	101.4	0.95	109.0	104.6	0.74
Milking speed	100.1	99.6	0.97	101.9	99.9	0.71
Temperament	101.5	100.5	0.89	102.6	100.9	0.55
Longevity	103.2	97.9	0.67	111.7	105.3	0.68
Claw health	99.2	98.7	0.83	103.0	103.2	0.59
NTM	6.2	-0.9	0.93	16.6	8.5	0.60

Self-study RDC

	Group 1			Group 2		
	2013	2015	Corr	2013	2015	Corr
Yield	103.9	100.5	0.92	103.2	103.0	0.59
Growth	102.2	103.4	0.99	100.8	100.4	0.77
Fertility	99.7	98.0	0.81	102,1	97,7	0.60
Birth	99.5	99.0	0.99	101,2	101.0	0.98
Calving	100.0	98.0	0.93	102.2	102.0	0.53
Udder health	100.4	98.8	0.82	101.6	101.4	0.57
Other diseases	100.1	100.9	0.67	103.0	103.0	0.63
Frame	100.1	98.4	0.95	101.2	99.1	0.60
Feet&Legs	99.7	97.0	0.93	101.6	99.0	0.60
Udder	102.6	98.5	0.90	104.4	102.2	0.66
Milking speed	101.2	98.9	0.96	102.5	99.7	0.75
Temperament	101.0	99.7	0.93	102.5	101.3	0.64
Longevity	100.2	96.2	0.59	106.4	101.1	0.63
Claw health	100.2	99.5	0.70	101.0	101.0	0.53
NTM	4.6	-1.9	0.86	7.2	4.2	0.55

Self-study - Jersey

	Group 1			Group 2		
	2013	2015	Corr	2013	2015	Corr
Yield	107.5	101.4	0.93	103.6	102,0	0.48
Fertility	102.2	97.2	0.90	104,5	101,3	0.62
Birth	97.8	97.1	0.96	99,9	99,6	0.89
Calving	100.3	99.0	0.91	103,5	103,0	0.51
Udder health	101.3	97.6	0.83	103,2	103,1	0.42
Other diseases	102.6	98.8	0.54	104,2	99,8	0.51
Frame	97.9	97.9	0.95	99,7	99.9	0.57
Feet&Legs	100.9	101.0	0.92	101.6	101,6	0.70
Udder	99.5	99.0	0.82	101,4	103,4	0.51
Milking speed	101.1	103.1	0.97	102.0	103,2	0.55
Temperament	99.9	99.5	0.83	101,1	100,3	0.34
Longevity	100.9	97.9	0.65	104,0	101.8	0.66
NTM	7.5	-0.9	0.85	6,8	5,1	0.51

Sub conclusion

- Average genetic level higher for group 2 than group 1 as expected
  - Biggest difference for HOL because of strongest pre selection in 2009 and 2010
- Changes for group 2 less than expected for RDC and JER
  - But big changes in genomic prediction between 2013 and 2015

Are young bull sires as good as proven bull sires?

- What happens to the best young bulls?
  - Genomic test in May 2013
  - Progeny test in November 2015

    At least 500 daughters with production information

Are young bull sires as good as proven bull sires?

NTM Level Nov. 2015	HOL	RDC	JER
<=10	17	18	8
11-12	7	4	2
13-14	5	1	1
15-16	11	3	
17-18	8	3	1
19-20	6		2
21-22	4	2	
23-24	1		
25-26			
27-28			
>=29			

Are young bull sires as good as proven bull sires?

	Bulls	NTM May 2013	NTM Nov. 2015	Diff. NTM	Genetic progress
HOL	374	14.2	6.8	-7.4	7
RDC	211	6.4	2.9	-3.5	6
JER	60	5.5	3.7	-1.8	6

LESS than 500 milking daughters Nov. 2015

Are young bull sires as good as proven bull sires?

	Bulls	NTM May 2013	NTM Nov. 2015	Diff. NTM	Genetic progress
HOL	59	24.5	13.2	-11.3	7
RDC	31	15.1	8.9	-6.2	6
JER	14	11.8	8.4	-3.4	6

MORE than 500 milking daughters in Nov. 2015

Are young bull sires as good as proven bull sires?

- Best genomic tested bulls drop more than expected

Does this mean that top genomic bulls should not be used as bull sires?

Are young bull sires as good as proven bull sires?

- Genomic tested bulls born in 2014/2015 of a VG bull :
  - Group 1: Sire had progeny test in May 2013
  - Group 2: Sire was genomic tested in May 2013 and progeny tested in Nov. 2015.
  - Tested bulls not within these groups were deleted

Are young bull sires as good as proven bull sires?

- **Average official bull sire means for NTM were calculated for both May 2013 and Nov. 2015**
- **Number of genomic tested sons was taking into account**

Average NTM for bull sires according to group for bulls born 2014 and 2015

	No offspring	2013	2015
HOL			
Group1	87	29.7	17.5
Group2	455	29.0	16.1
RDC			
Group1	411	22.5	11.0
Group2	51	17.1	12.9
JER			
Group1	256	20.9	10.9
Group2	154	10.6	16.8




Sub conclusion

- Genomic tested bull sires are as good as proven sires
  - Even if HOL bulls have been overestimated
  - Important to use many bull sires (also VG plan from 2015)
- Remember big changes in genomic prediction between May 2013 and Nov. 2015

Changes in genomic prediction May 2013 to Nov. 2015

- **All breeds:**
  - **New blending procedure**
  - **Including females in reference population**
    - **Biggest effects for RDC and JER**
  - **US JER in reference population**
  - **New standardisation procedure**
    - **Effect on HOL level (minus 2-3 NTM for the best)**
    - **Effect on level and standard deviation for RDC and JER**
- **But we continue to focus on why the best genomic tested bulls drop more**

More frequent genomic prediction – a request from farmers

Aim GEBV for bull calves available as early as possible

1. Efficient registration of animal and collection of DNA (farmer and VG)
2. More frequent and faster genotyping (GenoSkan)
3. More frequent genomic prediction (NAV)

We had room for improvement in all 3 steps!

Weekly genomic prediction
Started December 2015

- Unofficial Genomic EBVs (GEBVs) for male candidates on a weekly basis - delivered to Viking Genetics (VG) for selection decisions.
- Unofficial GEBVs are scaled DGVs and very highly correlated to the official GEBVs

Weekly GEBV
Pedigree considerations

Imputation use pedigree information

- Bull calves with correct pedigree – weekly GEBV very close to official
- Bull calves with unknown pedigree – weekly GEBV fairly close to official with full pedigree
- Bull calves with incorrect pedigree – weekly GEBV not reliable

How long time does it take before a bull calf get an unofficial GEBV?

	Until dec 2015	Weekly 2016	Saved days
Frequency effect on age	15 days	4 days	11
Collecting of DNA and sending to lab	25 days	20 days	**5**
Genotyping at lab	23 days	13 days (+7)	10 (3)
Genomic prediction	18 days	5 days	13
Total	**81 days**	**42 (+7)**	**34 (27)**

How long time does it take before a heifer or a cow get official GEBV?

	Until dec 2015	Monthly 2016	Saving
Frequency effect on age	15 days	15 days	0
Collecting of DNA and sending to lab	25 days	20 days	**5**
Genotyping at lab	23 days	13 days (+7)	10 (7)
Genomic prediction	18 days	18 days (more checking)	0
Total	**81 days**	**66 days (+7)**	**15 days**

GEBV Young stock survival

- **Holstein and RDC validation reliability +10% over PA (same as for other diseases)**
- **Jersey no effect very few ref. Bulls**
- **GEBVs will be published February 2016**

Cows in reference more traits all breeds – work will start primo 2016

- Fertility
- Claw health
- Calving traits (require change from SM to AM - ongoing)
- Young stock survival – unsure if it will work
- Other diseases (require change SM to AM)

Implementation during 2016 for the first traits

Checking of GEBV results

- RDC and Jersey nice results
- In general Holstein works fine, but some high GEBV bulls drop more than expected when they get milking daughters
- Main difference between RDC/Jersey and Holstein
  - Number of foreign reference bulls

Comparing GEBV and EBV

- GEBV is predicted based on information from 3 lactations
- First daughter based EBVs information mainly from early first lactation.
- Reliability is below 100% for both GEBV and EBV

Holstein - analyses GEBVs

- Effect of EG bulls in reference (production +5%, functional traits +10%)
- Possible relation between Mendelian sampling as candidate (PA-GEBV) and later change GEBV-EBV (no effect)
- Analyses will continue to check if we can improve the predictions further

Further improvement - GEBVs

- Better use of information current model
  - Include more information from pedigree in the GEBVs
  - Use of extra SNPs added on LD
- One step (Luke)
  - Simultaneously use of phenotypes and genotypes in evaluation
- Handling more informative SNPs (AU)
  - Give additional weight to SNPs carrying more information

Traditional genetic evaluation

- EBVs from traditional genetic evaluation based on pedigree and phenotypes only is the basis for genomic prediction and it is still important to:
  - Improve models
  - Include new phenotypes

Fertility – model version I

- Upgraded old evaluation to animal model
  - Updated genetic parameters
  - Updated model: lactations 1-3 separate traits
  - Harmonised fixed effects across countries
  - Correlations of 0.95-0.97 between old and new evaluation for progeny tested bulls

Routine evaluation May 2015

Fertility – model version II

- Conception rate – new traits (repeated NRR)
  - Harmonisation within EuroGenomics
- Effect of sexed semen
- Variance component estimation
- Include effect of production?

Aim: IB test run in Sep 2016 and implementation November 2016

Animal Model calving traits

- Main aim – make it possible to include females in reference population
  - Change from Sire Model to Animal Model
  - Take care of a change in Swedish scale for calving difficulties changed from 2 to 4 classes

Aim: IB test run in Sep 2016 and implementation November 2016

Linear udder traits and overall udder index

- Use udder coordinates as correlated information for:
  - Udder depth
  - Udder balance
  - Teat placement front
  - Teat placement back

Aim. Interbull test run Sep 2016, Routine evaluation November 2016

Other disease upgrade - 2016

- Review the current model and data
- Include BHB (Beta Hydroxy Butyrate) or/and acetone as information about ketose
  - Recorded along with milk recording in DNK
  - h^2 =0.09
  - Genetic correlation BHB-ketose 0.70
- Possibility to apply Animal Model
- Handling of heterogeneous variance

Norwegian Jersey and Holstein

- Include Norwegian data in phenotypic evaluation for all traits for Jersey and Holstein
  - Development will start during 2016

NTM

- Economic basis for current NTM developed in 2007/2008
- NTM introduced in 2008
  - Claw health and Young stock survival has been added
  - A few modifications have been introduced over years

NTM

- NAV board plan to start a project in 2017 to upgrade NTM
  - Updated economic assumption
  - Improved methods for calculation of economic values

Summary - implementation plan 2016

Trait/index	Date	Comment
GEBV young stock survival	Feb 2016	Available for the workshop
GEBV fat% and protein%	Feb 2016	Export wish
Young stock survival in NTM	2016	Based on recommendations form workshop
GEBV	2016	Cows in reference populations for more traits – other improvements
Fertility	Nov 2016	Version II – IB sept 16
Udder conformation	Nov 2016	Udder coordinates included – IB sep 16
AM calving traits	Nov 2016	Animal model to be able to include females in ref - IB sep 16
Yield	Nov 2016	Handling AMS/CMS+outlier – IB sep 16