Genetic Evaluation for Maintenance – Towards Genomic Breeding Values for Saved Feed in Nordic Dairy Cattle

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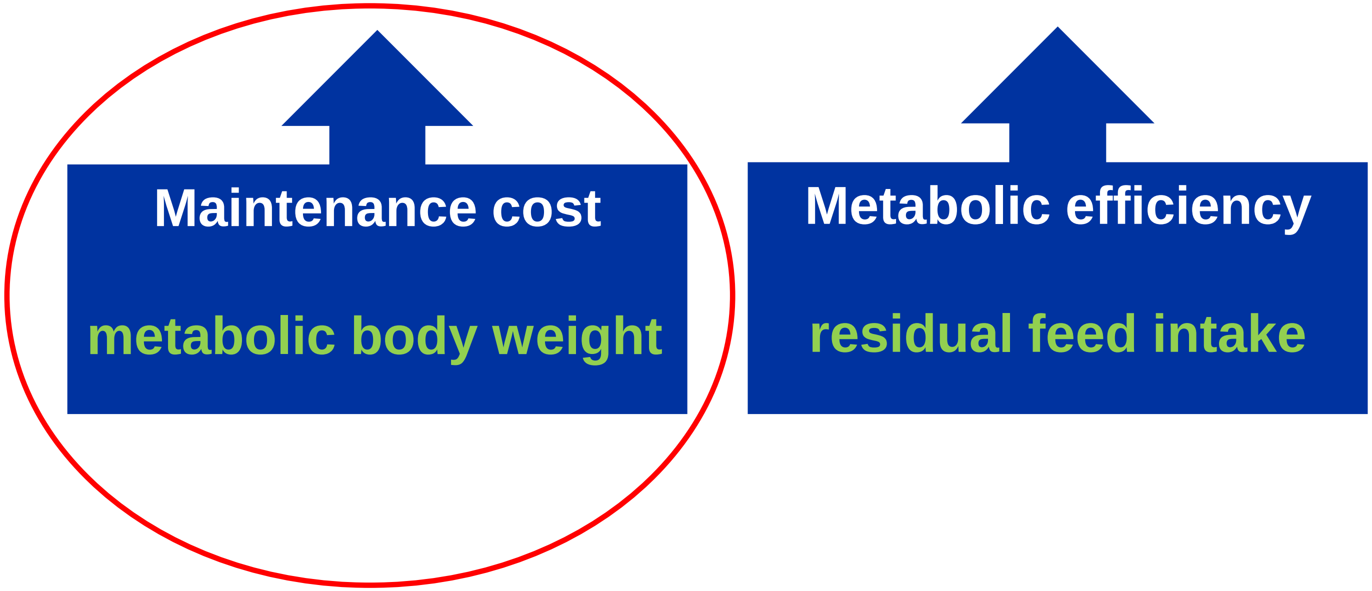
AIM

- Genomic breeding values for Saved Feed
- For all dairy breeds in the NAV countries (Denmark, Finland, Sweden)

Saved Feed Index

Two components:

$$\textbf{Saved Feed} = \mathbf{v_1} \times \mathbf{GEBV_{Maintenance}} + \mathbf{v_2} \times \mathbf{GEBV_{Metabolic}}$$



Maintenance cost

metabolic body weight

Metabolic efficiency

residual feed intake

Included in the launching phase
of the Saved Feed Index

Why maintenance

- ~1/3 of feed intake is needed for cows' maintenance
- → for a cow of 600 kg: ~ 6 kg dry matter intake / day
- Relationship between maintenance and metabolic body weight (MBW)

  energy requirement for maintenance = 0.515 [MJ ME / kg$^{0.75}$] x MBW

  where MBW [kg$^{0.75}$] = (body weight)$^{0.75}$
- 2 genetic SD improvement in MBW

  → Saved Feed ~ 220 kg dry matter / cow / year (~ 3% feed)

Available data

Cows with observations

BW measurements by tape (heart girth)	>800 000 cows
BW measurements by scale	>90 000 cows
Conformation measurements	>2 900 000 cows

Observations by trait and breed

Trait	Holstein	Nordic Red	Jersey
MBW 1	269 746	521 289	4 113
MBW 2	157 556	323 195	2 157
MBW 3	67 701	106 134	1 215
Stature	1 829 079	841 718	256 962
Chest width	1 823 373	798 341	261 614
Body depth	1 823 374	798 351	261 613

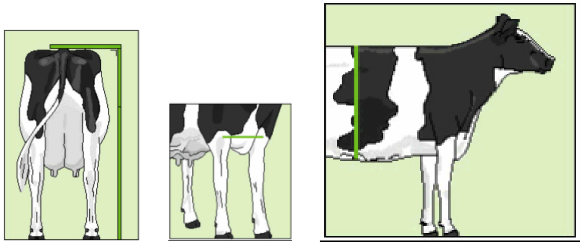
Available data

Phenotypic means of metabolic body weight by lactation and breed

Trait	Holstein	Nordic Red	Jersey
MBW 1	112.9 (545kg BW)	107.8 (513kg BW)	86.2 (380kg BW)
MBW 2	122.4 (608kg BW)	115.2 (560kg BW)	96.8 (444kg BW)
MBW 3	127.2 (629kg BW)	119.2 (587kg BW)	101.1 (471kg BW)

Model design

- Multiple-trait model
- Metabolic body weight (MBW)
  - 1st , 2nd and 3rd lactation considered as different traits
  - Lactation averages of MBW are modelled
  - Weights for MBW observations
    - single tape measurements have lower measurement errors than single scale measurements
    - cows can have over 400 scale measurements per lactation
- Correlated traits
  - Stature
  - Chest width
  - Body depth



THE GLOBAL STANDARD FOR LIVESTOCK DATA

- For each breed an own evaluation

Variance components for Holstein & Nordic Red

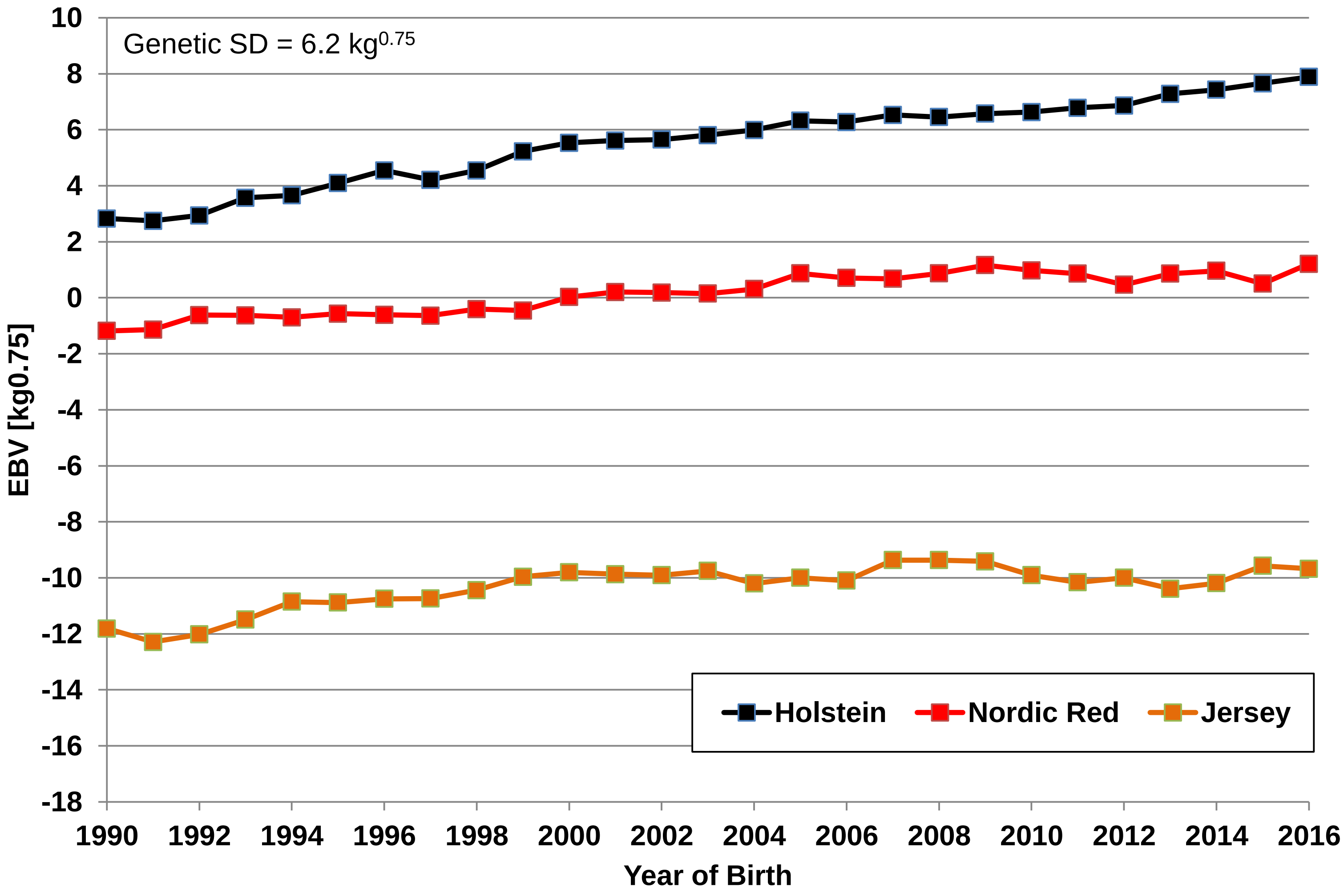
Heritabilities (on diagonal) and genetic correlations

	MBW1	MBW2	MBW3	Stature	Chest width	Body depth
MBW 1	**0.46**	0.98	0.96	0.65	0.58	0.51
MBW 2		**0.51**	0.99	0.68	0.55	0.49
MBW 3			**0.56**	0.68	0.53	0.48
Stature				**0.60**	0.17	0.21
Chest width					**0.18**	0.55
Body depth						**0.26**

Model effects for metabolic body weight traits

- Fixed effects
  - MBW curve ($c_1 \times DIM + c_2 \times DIM^2 + c_3 \times e^{-0.1DIM}$) nested within breed, country and time periods
  - linear regression on calving age nested within breed
  - year x season
  - herd x 5-year time periods
- Random effects
  - herd x year
  - additive genetic
  - Residual
- Accuracy of MBW observations is accounted for by weights

Genetic trends in cows for combined EBV $(0.30\text{ebv}_{\text{MBW1}}+0.25\text{ebv}_{\text{MBW2}}+0.45\text{ebv}_{\text{MBW3}})$



Correlation of MBW index with other index traits

- MBW index $= 100 - \frac{(0.30 \times ebv_{MBW1} + 0.25 \times ebv_{MBW2} + 0.45 \times ebv_{MBW3}) - ebv_{base}}{0.1 \times SD(ebv_{base})}$
- AI bulls born 2005 to 2010
- r^2 for $EBV_{MBW} > 0.8$

Traits	Holstein (N=729)	Nordic Red (N=568)
Frame	-0.78	-0.72
Beef production	-0.12	-0.29
Milk production	-0.01	0.05
Mastitis	0.06	0.06
Female fertility	0.06	0.03
Claw health	0.14	0.18
Calving traits	0.10	0.35
Longevity	0.18	0.20
Nordic Total Merit (NTM)	0.04	0.11

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Genomic prediction

- SNPBLUP

  $\mathbf{y} = \mathbf{1}\mu + \mathbf{Wa} + \mathbf{Zg} + \mathbf{e}$

  where

  y … de-regressed proofs for combined EBV ($0.30\text{ebv}_{MBW1}+0.25\text{ebv}_{MBW2}+0.45\text{ebv}_{MBW3}$)

  a … random polygenic effects (proportion: 10%)

  g … random SNP marker effects

- Reference population
  - All bulls with EBV reliability >0.5
  - All cows with observations

	Holstein	Nordic Red	Jersey
Bulls	7 268	5 487	1 556
Cows	39 630	38 737	18 799
Total	**46 898**	**44 224**	**20 355**

Validation of genomic prediction

- Forward prediction
  - DGV from SNPBLUP prediction, where data from most recent four years of bulls (+progenies) were excluded
  - $DRP = b_0 + b_1 * DGV + e$

    where
    - DRP … de-regressed proofs for candidates
    - DGV … genomic breeding values from reduced data
  - $R^2_{validation} = \frac{corr(DRP,DGV)^2}{r^2_{DRP}}$

Validation statistics

	N	b_1	$R^2_{validation}$
Holstein	584	0.87	0.59
Nordic Red	519	0.95	0.74
Jersey	188	0.91	0.65

Next steps

- Saved Feed Index introduction in August 2019
- Aim to include Saved Feed Index into Nordic Total Merit in 2020
- Upgrading Saved Feed Index (metabolic efficiency) in 2020

Thank you!

VIKINGGENETICS

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