Faculty of Agriculture and Nutritional Science

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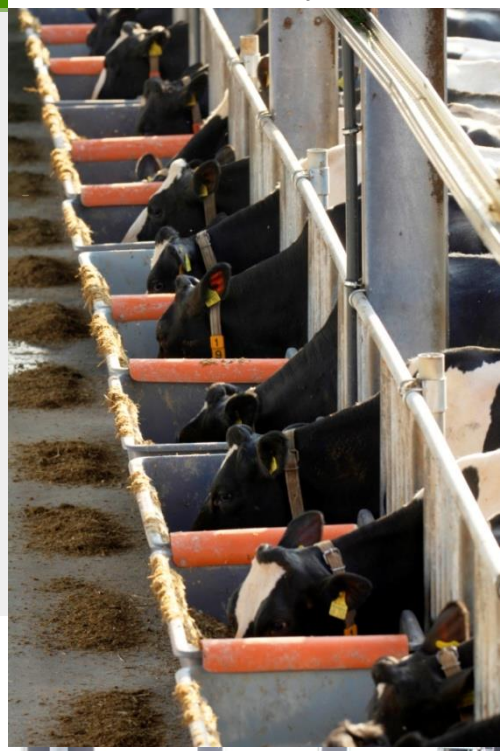
Institute of Animal Breeding and Husbandry

Investigations on the relationship of dry matter intake and energy balance to health in German dairy cattle using conventional and genomic breeding values



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Introduction & Objective

- **The application of genomic selection has enabled selection for** difficult-to-measure traits, like **dry matter intake (DMI) or energy balance (EB)**.
- To improve health traits, a **less pronounced energy deficit p.p.** is considered a key challenge. On the other hand, **feed efficiency** is gaining economic importance possibly leading to **conflicts in the design of breeding goals**.
- Although several **significant phenotypic associations between health and EB traits** were reported (*Collard et al., 2000*), **little is known about their *genetic* relationship**.
- **The impact of selection for improved feed efficiency should be carefully considered to avoid potential negative consequences**, especially if DMI can be considered in the breeding goal, but genomic evaluation for health traits is not (yet) possible.

→The relationship of DMI and EB to health in German dairy cattle was examined using both, conventional and genomic breeding values.

Material & Methods

- Conventional and genomic breeding values were estimated using **distinct datasets**.
- **Analyses based on conventional breeding values** were performed using only data from the pre-genomic era

  → EBVs for EB & health traits from Buttchereit et al. (2010)

  Karkendamm research farm (bull dam test station) ★

- For the **analyses based on genomic breeding values**, data basis was more comprehensive and up-to-date

  → gEBVs for DMI and EB from „optiKuh“

  8 German research farms keeping HF cows ☆

  → gEBVs for health traits from vit, Verden

  >1,200 German farms participating in „KuhVision“

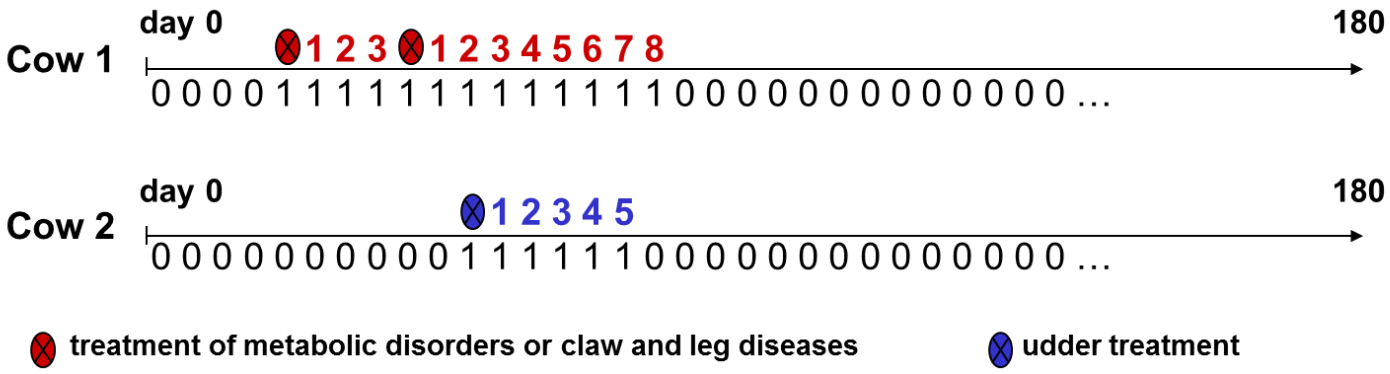
- The relationship of DMI and EB to health was examined using only **EBVs from cows of the Karkendamm herd**.

Material & Methods

Analyses based on conventional breeding values

Data recording and breeding value estimation for health

- Data from the dairy research farm **Karkendamm**
- **1,589 Holstein Friesian primiparous cows**
- Recording period: **Jan. 2000 to Feb. 2010**, **days in milk 0 to 180**
- Health data recorded by veterinarians or farm staff
- 3 categories: **Claw and leg health**, **udder health** and **metabolic health**
- Data coding: Each day was allocated a code: “1” if the cow showed a disease, “0” if the cow was healthy



- Breeding values were estimated using a **threshold model** (Buttchereit et al., 2010).

Material & Methods

Analyses based on conventional breeding values

Data recording and breeding value estimation for EB

- Data from the dairy research farm **Karkendamm**
- **526 Holstein Friesian primiparous cows**
- Recording period:
  March 2006 to Apr. 2009,
  days in milk 11 to 180
- **Daily EB** was calculated as the **difference between energy intake and estimated energy requirements for milk output and maintenance**.
- Karkendamm cows returned to a positive EB at day 42 in milk.
- Breeding values were estimated using a **random regression model**
  (Buttchereit et al., 2010). .

➢ **526 HF cows with both, conventional daily EBVs for EB *and* conventional EBVs for health traits**

Material & Methods

Analyses based on genomic breeding values

Data recording and genomic breeding value estimation for DMI /EB

- Data from **8 dairy research farms** (incl. Karkendamm)
- **1,341 / 1,322 Holstein Friesian cows with DMI / EB records**
- Recording period:
  Dec. 2014 to March 2017,
  days in milk 1 to 350
- **EB** was calculated as the **difference between energy intake and estimated energy requirements for milk output, maintenance, growth** (only for primiparous cows, not for cows in lact. 2-11), **and gestation**.
- OptiKuh HF cows returned to a positive EB at day 75 in milk.
- **1,163 cows with both phenotypes *and* 50K genotypes**
- Genomic breeding values were estimated applying a **random regression model** (Harder et al., accepted) and using the **Single Step method.**

➢ **336 Karkendamm cows with daily gEBVs for DMI and EB from "optiKuh"**

Material & Methods

Analyses based on genomic breeding values

Data recording and official genomic breeding value estimation for direct health traits by vit (Verden)

- Data from **> 1,200 farms** contributing to „KuhVision“ (incl. Karkendamm)
- **676,508 cows** and 1,490,285 lactations
- Health data recorded by veterinarians, farmers and claw trimmers
- 13 health traits belonging to 4 complexes: **Udder health**, **claw health**, **reproduction** and **metabolic stability**
- No. of disease events within lactation was evaluated for all traits
- An animal without any recorded information for a trait was defined as healthy for this trait, provided that it was present in herd at least 75% of the trait specific time span without having a diagnosis.
- For ‘udder health’, ‘reproduction’ and ‘metabolic stability‘ breeding values were estimated within the respective trait complex using a **multi trait animal model including repeated measures.** For claw health traits a **single trait model (incl. repeated measures)** was used (vit, 2019).

➢ **269 Karkendamm cows with both, gEBVs for DMI/EB and gEBVs for direct health traits**

Results & Discussion

Analyses based on conventional breeding values

Average relative breeding values for health traits plotted against breeding value classes for EB (n=526 HF cows)*

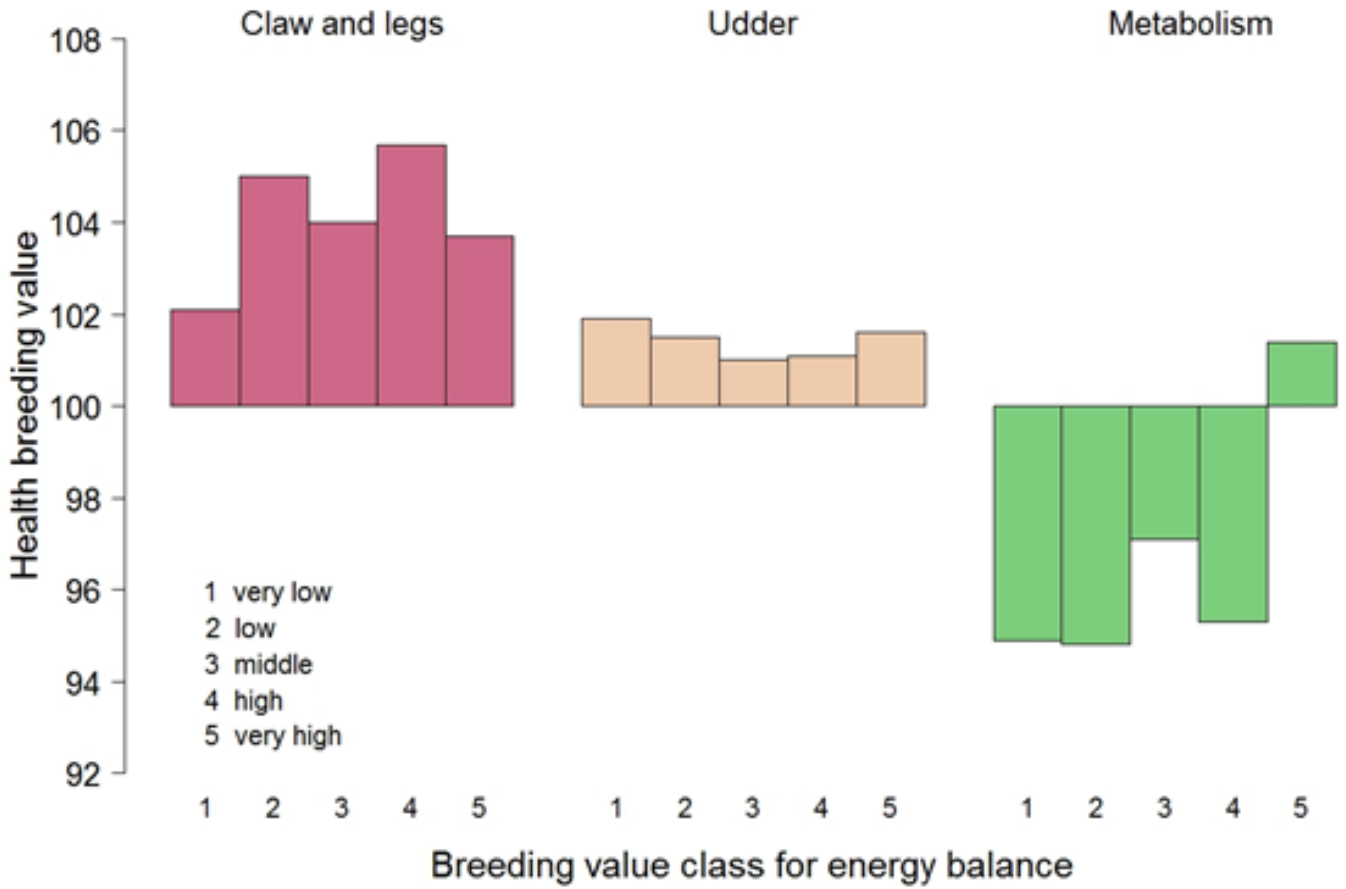


Fig. adapted from Fig. 2 in Buttchereit et al. (2010)

*Cows exhibited a negative EB during the first 42 days in milk; thus, daily relative breeding values for EB from day 11-42 were averaged and used for grouping.

Results & Discussion

Analyses based on genomic breeding values

Pearson correlations between official genomic enhanced breeding values (gEBV) estimated by vit and genomic breeding values for DMI and EB from „optiKuh“ (n=269 HF cows)

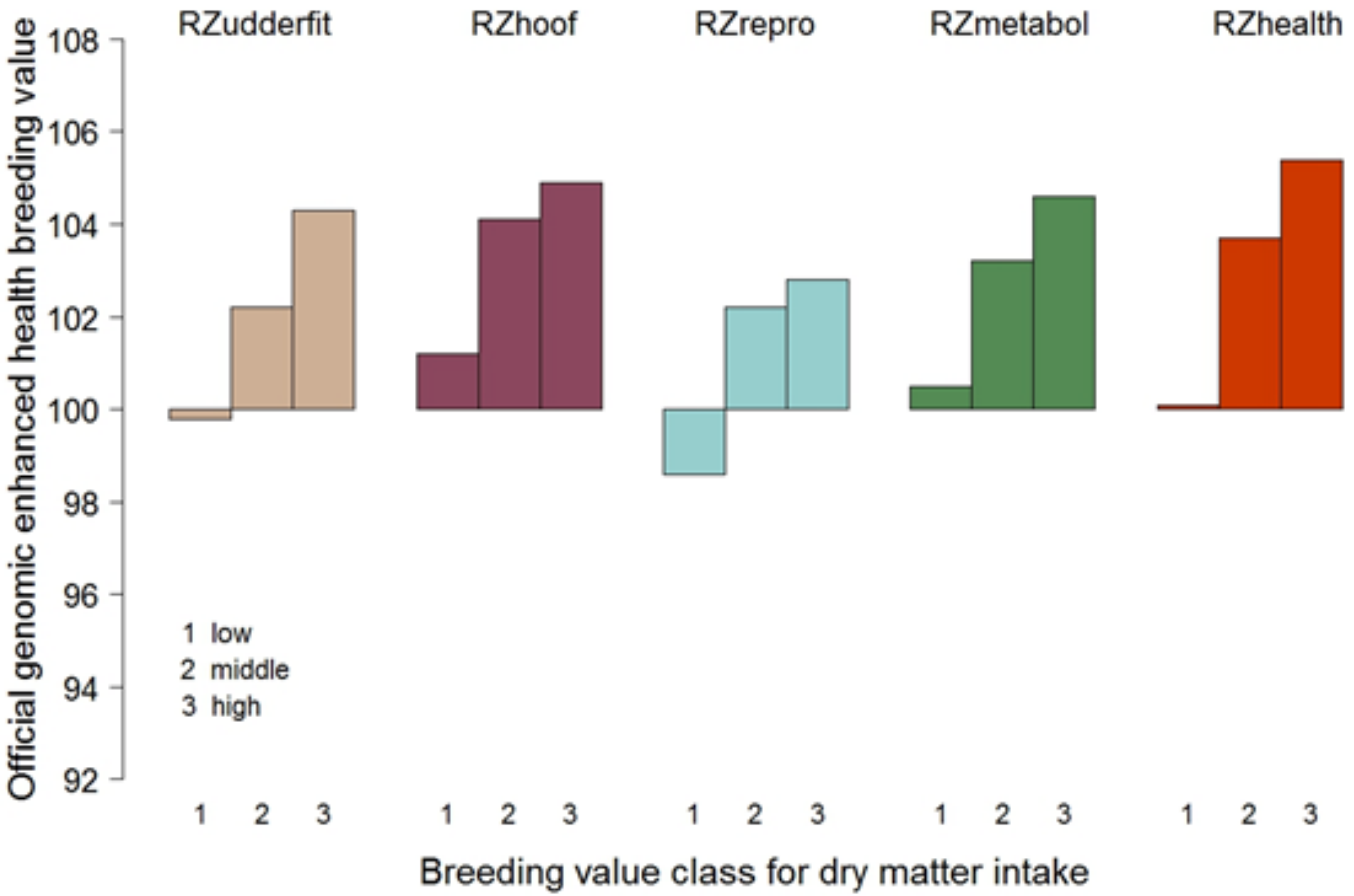
	Average lactation day 1 to 350 genomic breeding value for …		Average lactation day 1 to 75 genomic breeding value for …	
Official gEBV for …	DMI	EB	DMI	EB
mastitis resistance	0.13	0.26	0.22	0.32
claw health	0.26	0.30	0.30	0.32
resistance to reproductive disorders	0.12	0.18	0.27	0.32
resistance to metabolic disorders	0.27	0.20	0.35	0.27
total health	0.23	0.32	0.34	0.41
production	0.54	0.10	0.50	n.s.
longevity	0.23	0.29	0.33	0.41
reproduction	n.s.	n.s.	n.s.	0.14
conformation	0.16	0.15	0.15	0.16
total merit index	0.57	0.24	0.56	0.24

n.s. = not significant ($p \geq 0.05$)

Results & Discussion

Analyses based on genomic breeding values

Official gEBVs for health traits plotted against breeding value classes for DMI (n=269 HF cows)*

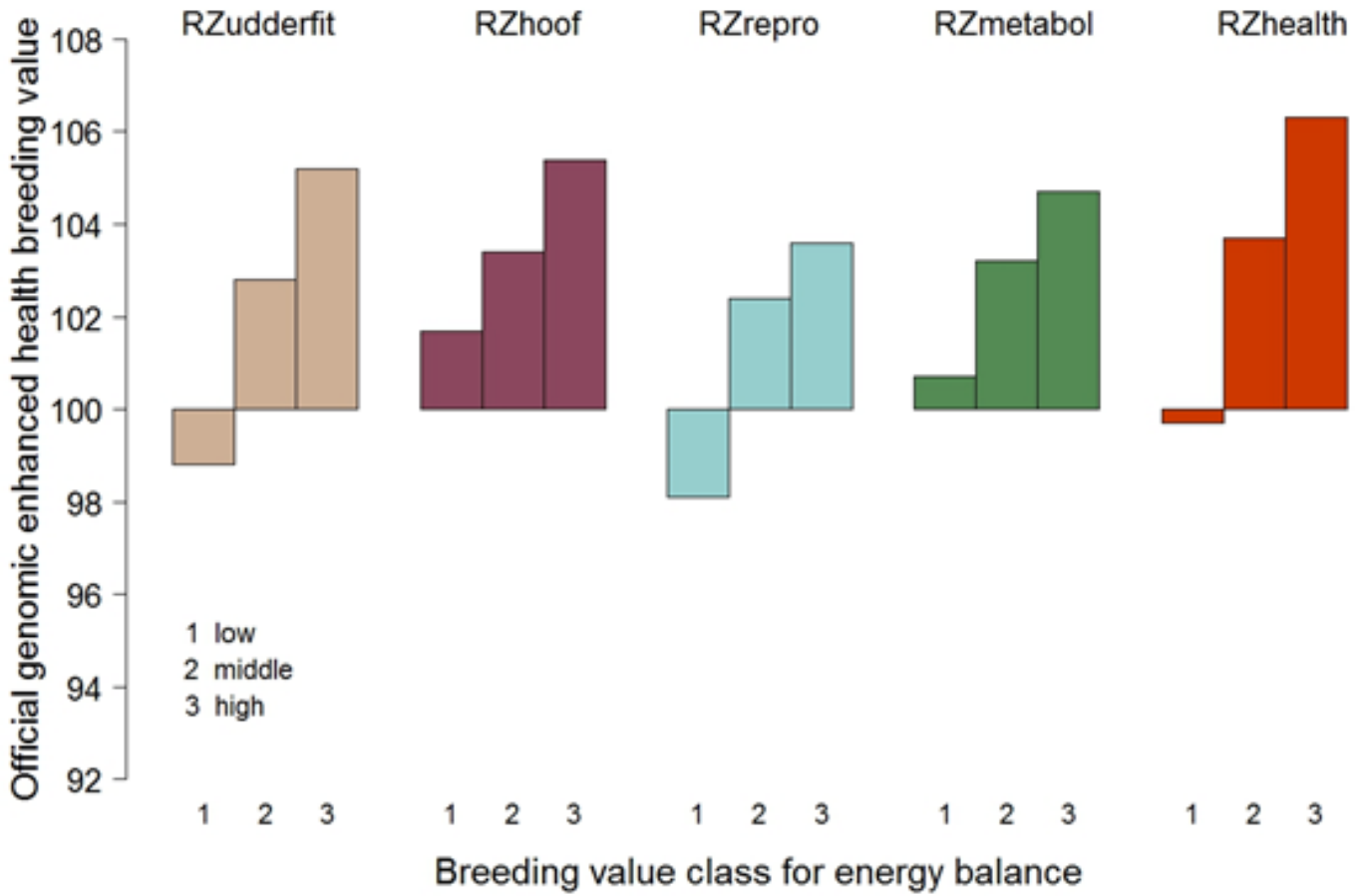


*Cows exhibited a negative EB during the first 75 days in milk; thus, daily relative breeding values for DMI from day 1-75 were averaged and used for grouping

Results & Discussion

Analyses based on genomic breeding values

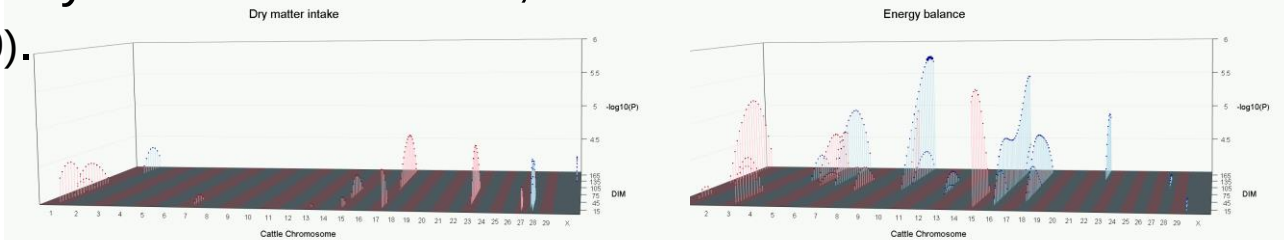
Official gEBVs for health traits plotted against breeding value classes for EB (n=269 HF cows)*



*Cows exhibited a negative EB during the first 75 days in milk; thus, daily relative breeding values for EB from day 1-75 were averaged and used for grouping

Conclusions

- **With regard to health traits, selecting for higher DMI or a less severe energy deficit in early lactation** would be **beneficial**.
- **This complicates the current efforts to improve feed efficiency,** .
- However, it seems possible to reduce the energy deficit in early lactation *and* subsequently improve feed efficiency, i.e. to optimize the lactation trajectory of DMI in a way that satisfies both, welfare and economic issues (Krattenmacher et al., 2019).



- **International collaboration** (e.g. within the framework of the global Dry Matter Initiative II) **should be strengthened**
  i. to further enhance our **knowledge on the genetic associations between DMI, EB, and health traits** and
  ii. to enable the **design of *balanced* breeding goals aiming to avoid unwanted correlated responses**.

Thanks for your attention!

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