The importance of claw health traits and implications for future genetic evaluation in German Holstein dairy cattle

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Overview

❖ introduction / background:
   role of claw health in dairy cattle

❖ recording and use of claw health data in German Holsteins

❖ applications for supporting the improvement of claw health

   ❖ routines

   ❖ fields of R&D activities

   ❖ perspectives

Background (I)

- importance of health of feet and legs in dairy cattle
  - <u>lameness</u> as animal welfare indicator

EFSA advises on welfare of dairy cows

EFSA's Panel on Animal Health and Welfare (AHAW) has published five scientific opinions and a scientific report on the overall effects of the most relevant farming systems on the welfare of dairy cows and related diseases. The Panel concluded that long term genetic selection for higher milk yield and the nature of the farming systems used – i.e. housing and equipment, as well as management and handling practices – are major factors affecting the health and welfare of dairy cows. Lameness and mastitis are the most significant indicators of poor dairy cow welfare, as well as reproductive, metabolic and behavioural disorders. The Panel proposed a series of recommendations which could be taken into account by risk managers in view of further improving welfare in the areas of housing, feeding and the genetic selection of dairy cows.

...

The Panel also concluded that farms with a high prevalence of lameness in dairy cows (e.g. above 10%) do not have an adequate prevention programme and should improve housing conditions, genetic selection and management practices. Moreover, farmers who are well trained in recognising signs of disease at an early stage and in knowing when to seek veterinary advice can contribute to reducing the prevalence of lameness.

Source: https://www.efsa.europa.eu/en/press/news/090709-0

Background (II)

TAKE HOME:
➢ lameness as important, but (too) late and unspecific sign
➢ recognition (and documentation!) of
  <u>causes of lameness</u> as key for targeted improvement

- importance of health of feet and legs in dairy cattle
  - <u>lameness</u> as animal welfare indicator

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Background (III)

- importance of health of feet and legs in dairy cattle
  - lameness as animal welfare indicator
  - <u>claw conditions</u> as primary reason for impaired locomotory health
  - considerable economic impact of suboptimal claw health management
    (Cha et al. 2010, Charfeddine & Pérez-Cabal 2017)
  - huge variation between farms (e.g. Cramer et al. 2008, Foditsch et al. 2016)
  - relevant and usable genetic background of claw conditions
    (e.g. König & Swalve 2006, Malchiodi et al. 2015)

> **claw health as essential part in initiatives (projects, programs)
> for monitoring and improving health of dairy cows worldwide**

> **BUT:** ❖ especially challenging
> (logistics, sources, structure, quality, etc. of claw data)
> ❖ often not fully integrated (different data flow and data processing)
> implying risk of loosing potentially valuable information

Recording & use of health data (I)

- comprehensive and integrative approach
  - veterinary diagnoses, observations of farmers,
    regular screening results, records from routine hoof trimming
  - support of management ($\rightarrow$ health reports)
    and breeding ($\rightarrow$ genetic evaluation)

Data logistics (claw health):
- standard interfaces for feet and legs data
  - providing flexibility regarding recording
    (e.g. paper-to-PC, mobile)
  - allowing direct electronic data transfer
    - on individual farms
    - to the central health data base
- > since 2011 routine transfer of feet and legs data
  (claw health data) into the central health data base

Feet and legs documentation on paper

Claw trimmers' software → Herd management software

Central health data base
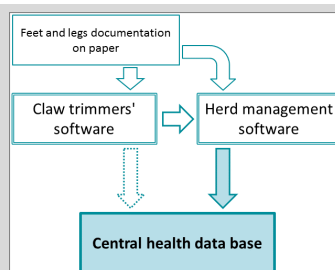
Recording & use of health data (II)

- comprehensive and integrative approach
  - veterinary diagnoses, observations of farmers,
    regular screening results, records from routine hoof trimming
  - support of management ($\rightarrow$ health reports)
    and breeding ($\rightarrow$ genetic evaluation)
- key factors of success
  - strong regional partners
    (data quality management, visible benefit)
  - interdisciplinary exchange and collaboration
  - powerful tool set for short- and long-term improvements

> ➤ drivers of the development: practice-oriented initiatives
>   of the dairy sector with strong engagement of breeding organizations

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Claw health traits in health monitoring

- target (optimum) for claw data:
  - complete information on all clinical cases
  - reliable and regular records of claw health status for all cows
  - direct electronic documentation (mobile systems)
- present situation:
  - heterogeneity of completeness, detailedness, etc.
    of claw data across herds
  - different levels of integration of trimming data
  - ensured standardized recording across documentation systems

> ➤ **complex structure of claw data (cases, controls)
>   to be used for genetic and future genomic evaluations $\rightarrow$ impact?!**

> ➤ **correlation study using results of independent genetic evaluations**

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Standardized recording of claw data (I)

- comprehensive national key for health data recording
  - corresponding to the international reference, i.e. ICAR central health key (ICAR 2013)
  - claw health as integral part

- national key for claw data recording
  - widely accepted und used for trimming documentation
  - update according to the new ICAR standard for claw data recording (ICAR 2015)

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Basis of the study

❖ **project GKUH***plus*
  ▪ German Innovations Partnership
  ▪ national framework for implementing an integrated system for health monitoring in German Holstein dairy cattle
  ▪ joint genetic evaluation (prototype) for health traits in German Holsteins

❖ **program proFit***plus*
  ▪ breeding organizations RBB and RA
  ▪ data collection in contract herds as basis of targeted strengthening of their breeding programs
  ▪ independent genetic evaluations for additional functional traits

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Genetic evaluations for claw health (I)

■ integrated use of treatment and trimming data of German Holsteins

■ health data collected in commercial dairy farms
  ▪ in all farms documentation of clinical cases (animal, affected limb/claw)
    GKUH*plus* 2009-2016, proFit*plus* 2007-2016
  ▪ complete trimming records (electronic recording and data transfer) in a subset of farms since 2011

Genetic evaluations for claw health (II)

- integrated use of treatment and trimming data of German Holsteins

- health data collected in commercial dairy farms

- trait definition
  - number of claw health events per lactation
  - minimum requirements for controls
    - days at risk in the herd without claw disease record * or
    - informative trimming records and no claw disease record **

Characteristics of the genetic evaluation system	GKUH*plus*	proFit^plus
No. of parity records (no. of animals)	188,195 (96,421)	410,665 (180,927)
No. of Holstein AI bulls with daughters (average no. of daughters)	4,655 (18.0)	4,641 (35.8)

Table 1: Outline of the genetic evaluations for claw health traits in German Holstein dairy cattle

* 75 percent of reference period (full lactation DIM -10 to 305, i.e. 236 days)
** more than one documented trimming with at least 30 days between first and last trimming and last trimming at DIM 150 or later

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Genetic evaluations for claw health (III)

- quantitatively most important claw disorders
  → N=6 individual claw health traits:
  - interdigital hyperplasia (IH)
  - laminitis (LA)
  - white line disease (WL)
  - claw ulcers (UL)
  - digital phlegmon (PH)
  - digital dermatitis (DD)

- genetic analyses
  - estimation of variance components / REML (VCE6)
  - prediction of breeding values / BLUP (PEST)
  - univariate linear repeatability animal model accounting for herd-year-season and parity
    $y_{ijkl} = \mu + HYS_i + Par_j + a_k + pe_k + e_{ijkl}$

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Genetic parameters for claw health traits

Trait	GKUH*plus*			proFit[plus]		
	h²	Index weight	Index h²	h²	Index weight	Index h²
Interdigital hyperplasia (IH)	**0.15**	10 %		**0.13**	10 %	
Laminitis (LA)	**0.06**	15 %		**0.03**	15 %	
White line disease (WL)	**0.09**	15 %	**0.08**	**0.08**	15 %	**0.09**
Claw ulcers (UL)	**0.08**	15 %		**0.12**	15 %	
Digital phlegmon (PH)	**0.07**	15 %		**0.10**	15 %	
Digital dermatitis (DD)	**0.06**	30 %		**0.10**	30 %	

Table 2: Genetic parameters (heritabilities, h²; SE$_{h²}$ < 0.01) of claw health traits in the genetic evaluations, with additional information on composition and heritability of the respective claw health index (genetic parameters used in the genetic evaluations 10/2016 [2016Q3])
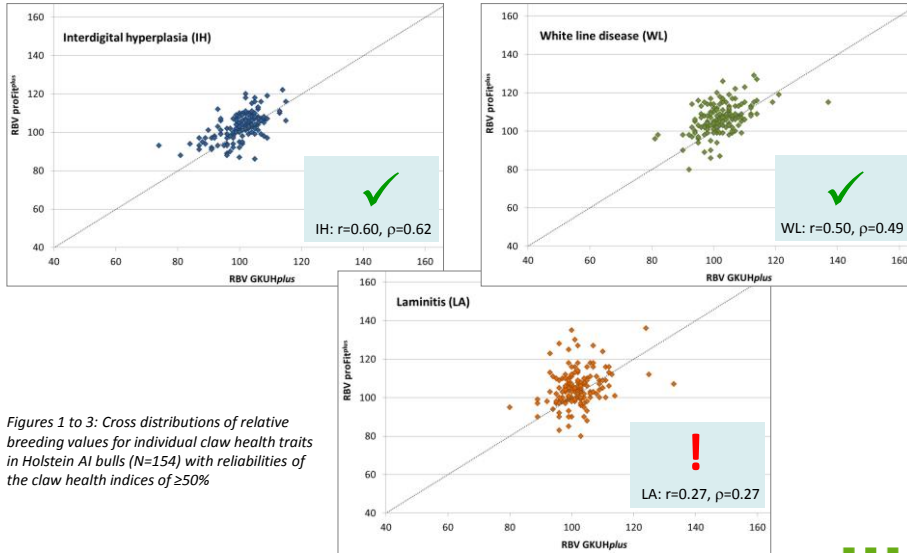
TAKE HOME:
➢ suitability of integrated claw health data for genetic analyses
➢ significant influence of genetics on claw health
   implying opportunities for targeted breeding measures
➢ consistent pattern of genetic parameters across genetic evaluation systems

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Correlations between breeding values

■ approx. 4,600 Holstein AI bulls with daughters in each of the genetic evaluations (GE) for claw health → 40% overlap
  ▪ N=1,869 bulls with daughters in GKUH*plus* GE <u>and</u> proFit[plus] GE; B0)

■ few bulls with higher reliabilities of breeding values in both GE
  ▪ N=154 bulls with ≥50% reliability of the claw health indices (B50)
  ▪ N=64 bulls with ≥70% reliability of the claw health indices (B70)

➢ cross distributions of corresponding EBV
➢ Pearson correlation coefficients (r) and Spearman rank correlations (ρ)

Correlations between breeding values: Individual claw health traits (I)

Interdigital hyperplasia (IH) — IH: r=0.60, ρ=0.62

White line disease (WL) — WL: r=0.50, ρ=0.49
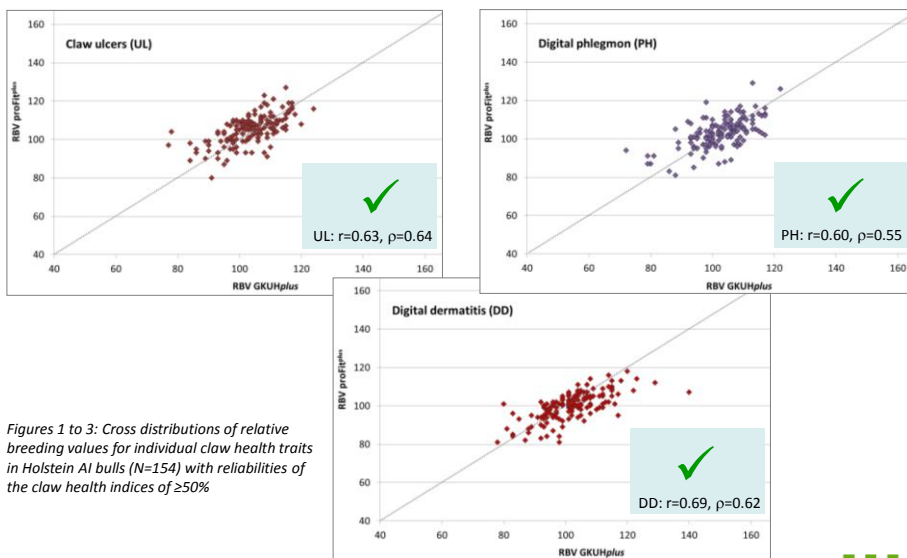
Laminitis (LA) — LA: r=0.27, ρ=0.27

Figures 1 to 3: Cross distributions of relative breeding values for individual claw health traits in Holstein AI bulls (N=154) with reliabilities of the claw health indices of ≥50%

Claw health traits in German Holsteins (STOCK et al.), EHRC Conference 2017, 18 September 2017, Budapest, Hungary   16

Correlations between breeding values: Individual claw health traits (II)

Claw ulcers (UL) — UL: r=0.63, ρ=0.64

Digital phlegmon (PH) — PH: r=0.60, ρ=0.55

Digital dermatitis (DD) — DD: r=0.69, ρ=0.62

Figures 1 to 3: Cross distributions of relative breeding values for individual claw health traits in Holstein AI bulls (N=154) with reliabilities of the claw health indices of ≥50%

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Summary & conclusions

- feasibility of integrated use of claw data for genetic evaluation for claw health traits in Holstein dairy cattle

- consistent patterns of genetic parameters for claw health traits across rather heterogeneous genetic evaluation systems

- correlations between breeding values for claw health traits
  - **overall very favorable**
    (expected impact of low heritabilities and reliabilities)
  - pinpointing fields of further work:
    - standardized recording and trait definition → LA
    - completeness of documentation (cases and controls) → IH, DD
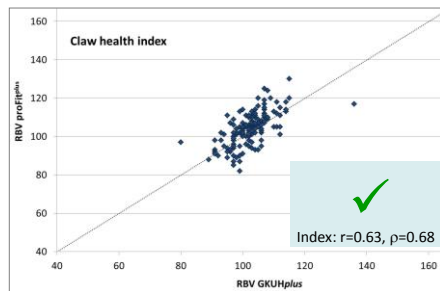
Claw health index

Index: r=0.63, ρ=0.68

Prospects - for claw health & beyond

- promising results of genetic analyses within and across initiatives promoting health monitoring in dairy cattle projects

- very good basis and starting point for **continued work on strengthening breeding applications for direct health traits**
  → new R&D project KuhVision (female reference population) and future genomic applications

  KUHVISION

- crucial awareness of remaining challenges related to phenotyping
  - harmonization and standardization of data recording
  - logistics and data quality management → collaboration!
  - definition of traits, ...

ICAR CLAW HEALTH ATLAS

IT-Solutions for Animal Production

Thank you!

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