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IT-Solutions for
Animal Production

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Genetic evaluation for claw health traits as part of the integrated system for health monitoring in German Holstein dairy cattle

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Background

- importance of health of feet and legs in dairy cattle
  - lameness as animal welfare indicator
  - claw conditions as primary reason for impaired locomotory health
  - huge variation between farms (e.g. Cramer et al. 2008, Foditsch et al. 2016)
  - considerable economic impact of suboptimal claw health management (Cha et al. 2010, Charfeddine & Pérez-Cabal 2017)
- 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

- project GKUH*plus* as national framework
  for the development of an integrated system for health monitoring
  in German Holstein dairy cattle
  - veterinary diagnoses, observations of farmers,
    regular screening results,
    records from routine hoof trimming
  - support of management (→ health reports)
    and breeding (→ genetic evaluation)
  - joint genetic evaluation (prototype) for German Holsteins
- 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

The project is supported by funds of the German Government's Special Purpose Fund held at Landwirtschaftliche Rentenbank.

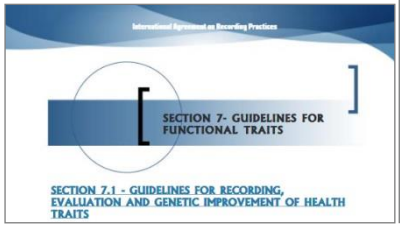
Claw health traits in health monitoring

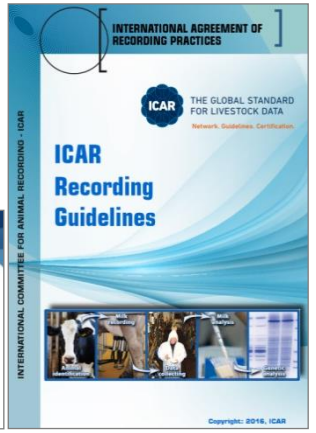
- target (optimum) for claw data:
  - complete information on all clinical cases
  - reliable and regular records of claw health status for all cows
  - direct electronic documentation (mobile systems)
- present situation:
  - heterogeneity of completeness, detailedness, etc. of claw data across herds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

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)

http://www.icar.org/index.php/publications-technical-materials/technical-series-and-proceedings/atlas-claw-health-and-translations/

Standardized recording of claw data (II)

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Genetic evaluation for claw health (I)

- integrated use of treatment and trimming data
- health data collected in commercial dairy farms in 2009-2016
  → approx. 250,000 lactations of 134,917 German Holstein dairy cows
  - documentation of clinical cases (animal, affected limb/claw) in all farms
  - complete trimming records (direct electronic transfer)
    for approx. 30% of lactations
- trait definition
  - number of claw health events per lactation
  - minimum requirements for controls
    - days at risk in the herd without claw disease record
      (75 percent of reference period, i.e. 236 days) or
    - informative trimming records and no claw disease record
      (more than one documented trimming with at least 30 days
      between first and last trimming and last trimming at DIM 150 or later)

Genetic evaluation for claw health (II)

- 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 genetic parameters / REML (VCE6)
  - prediction of breeding values / BLUP (PEST)
  - univariate linear repeatability animal model:
    $y_{ijkl} = \mu + HYS_i + Par_j + a_k + pe_k + e_{ijkl}$

Genetic parameters

Trait	N lactations	LI	h^2	Index weight	Index h^2
Interdigital hyperplasia, IH	240,312	5.0 %	**0.11**	10 %	**0.08**
Laminitis, LA	242,160	8.7 %	**0.06**	15 %	
White line disease, WL	241,257	7.6 %	**0.06**	15 %	
Claw ulcers, UL	203,344	14.5 %	**0.09**	15 %	
Digital phlegmon, PH	199,342	12.8 %	**0.07**	15 %	
Digital dermatitis, DD	217,817	20.2 %	**0.07**	30 %	

$SE_{h^2} < 0.01$

Table: Claw health traits in the genetic evaluation with frequencies (lactation incidences, LI) and heritabilities (h^2), with additional information on the composition and heritability of the claw health index

(GKUHplus GE1701; data 01/2009 to 12/2016 from 30 Jan 2017)

- **SUITABILITY OF INTEGRATED CLAW HEALTH DATA FOR GENETIC ANALYSES**
- **SIGNIFICANT INFLUENCE OF GENETICS ON CLAW HEALTH**

IMPLYING OPPORTUNITIES FOR TARGETED BREEDING MEASURES

Breeding values for claw health (I)

- in total, N=5,955 Holstein AI bulls with on average 19 daughters (range 1 to 2,052)

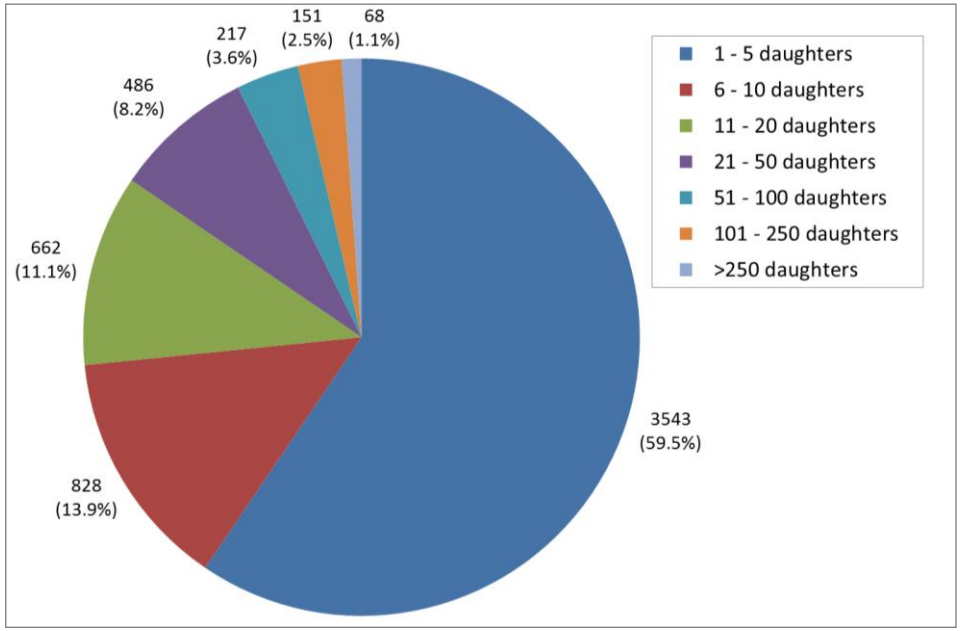

Figure: Distribution of Holstein AI bulls by their numbers of daughters in the genetic evaluation for claw health (GKUHplus GE1701; data 01/2009 to 12/2016 from 30 Jan 2017)

- minimum reliability of 50% (claw health index): N=436 Holstein AI bulls

Breeding values for claw health (II)

- individual patterns of genetic dispositions for claw health traits

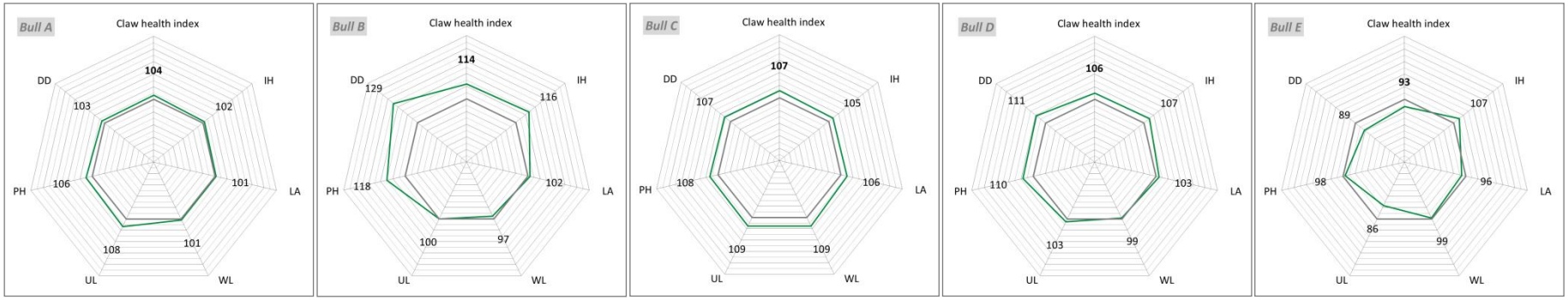

Figure: Distribution of relative breeding values (RBV) for claw health traits in 5 Holstein AI bulls with >1000 daughters
(GKUHplus GE1701; data 01/2009 to 12/2016 from 30 Jan 2017)

- significant phenotypic differentiation between progeny groups of bulls by RBV classes

➢ **BREEDING VALUES FOR INDIVIDUAL CLAW HEALTH TRAITS AND CLAW HEALTH INDEX AS VALUABLE TOOLS FOR REDUCING FREQUENCIES OF CLAW DISORDERS**

Correlations of breeding values (I)

Trait	RZG	RZM	RZS	RZR	RZN	RZE	RZ Spr	RZ KWi	RZ HBs	RZ HBw	RZ Bew	RZ Fun
Claw health index	0.36	0.21	0.17	0.17	0.38	0.03	0.07	0.04	0.08	-0.16	0.36	0.27
Interdigital hyperplasia, IH	0.20	0.07	0.11	0.05	0.26	0.11	0.09	0.06	0.16	-0.11	0.31	0.27
Laminitis, LA	0.29	0.20	0.11	0.10	0.27	-0.01	0.05	0.02	0.01	-0.07	0.22	0.16
White line disease, WL	0.37	0.18	0.19	0.23	0.40	0.13	0.13	-0.03	-0.02	-0.03	0.22	0.17
Claw ulcers, UL	0.42	0.23	0.23	0.20	0.43	0.10	0.06	0.06	0.07	-0.17	0.34	0.26
Digital phlegmon, PH	0.19	0.02	0.16	0.08	0.32	0.02	0.12	-0.06	0.06	-0.12	0.27	0.21
Digital dermatitis, DD	0.24	0.18	0.08	0.11	0.21	-0.07	0.00	0.05	0.09	-0.16	0.29	0.21

RZG = total merit index, RZM = production, RZS = somatic cell score, RZR = fertility, RZN = longevity, RZE = conformation; Spr = Sprunggelenk / hock quality, KWi = Klauenwinkel / foot angle, HBs = Hinterbeinstellung / rear leg set rear view, HBw = Hinterbeinwinkelung / rear leg set side view, Bew = Bewegung / locomotion, Fun = Fundament / feet

Table: Correlations (Pearson correlation coefficients) between breeding values for claw health and results of routine genetic evaluation for dairy cattle (GE1704) in N=436 Holstein AI bulls with at least 50% reliability of the claw health index (GKUHplus GE1701: data 01/2009 to 12/2016 from 30 Jan 2017)

➢ **CLAW HEALTH TRAITS AS IMPORTANT COMPONENT OF SUSTAINABLE BREEDING PROGRAMS FOR DAIRY CATTLE**

Correlations of breeding values (II)

Trait	RZG	RZM	RZS	RZR	RZN	RZE	RZ Spr	RZ KWi	RZ HBs	RZ HBw	RZ Bew	RZ Fun
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RZG = total merit index, RZM = production, RZS = somatic cell score, RZR = fertility, RZN = longevity, RZE = conformation; Spr = Sprunggelenk / hock quality, KWi = Klauenwinkel / foot angle, HBs = Hinterbeinstellung / rear leg set rear view, HBw = Hinterbeinwinkelung / rear leg set side view, Bew = Bewegung / locomotion, Fun = Fundament / feet

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➢ **CLAW HEALTH TRAITS AS IMPORTANT COMPONENT OF SUSTAINABLE BREEDING PROGRAMS FOR DAIRY CATTLE**

Conclusions & prospects

- feasibility of integrated use of claw data for genetic evaluation for claw health traits in Holstein dairy cattle
- promising results of the GKUHplus project indicating the potential of the new R&D project KuhVision (female reference population) and future genomic applications

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

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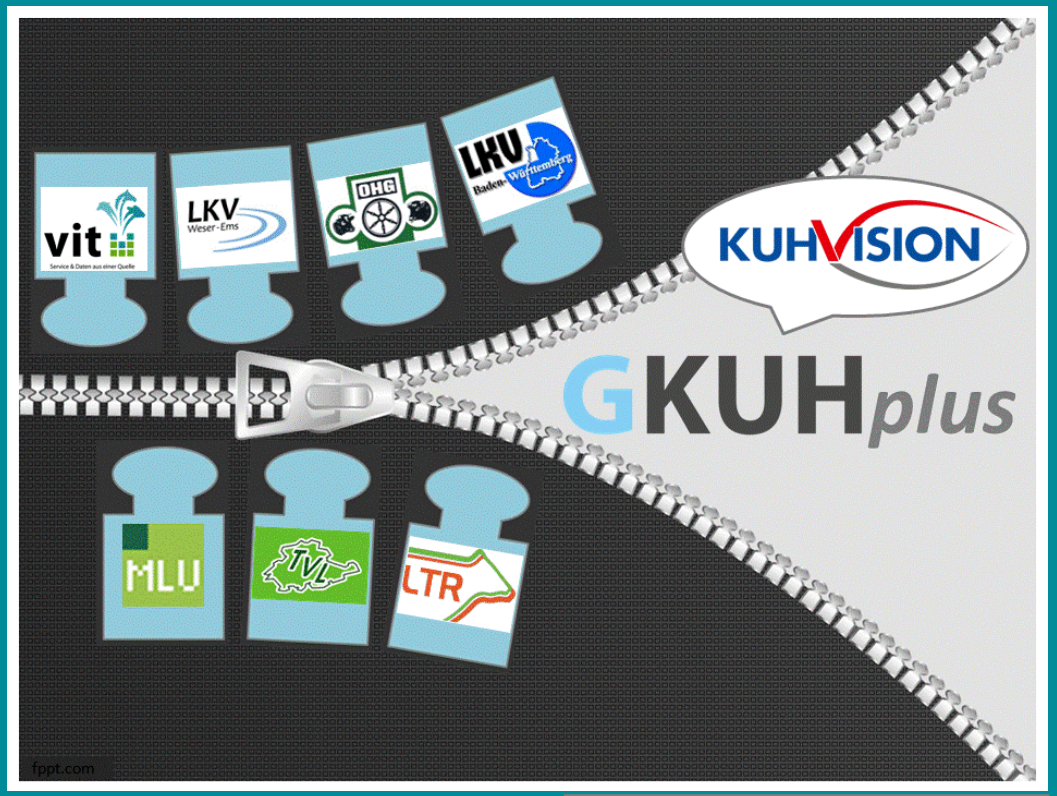
Thank you!



ICAR THE GLOBAL STANDARD FOR LIVESTOCK DATA
Functional Traits Working Group

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