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Use of hoof digital images in estimation of genetic parameters connected with health

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Hoof disorders – what is it all about?

- 3rd most often reason of culling
- 90% lameneess
- Decrease of milk production 350 – 570 kg/ lactation
- Prolonged Days open, higher insemination index, decreased longevity
- Locomotion score >2 = 8.4x higher culling rate

Genetic parameters – what is it all about?

- heritability
- correlations

- selection index
  - resistant – better adapted to the environment
  - economically important

Economic values of claw disease

of claw diseases in Slovak Pinzgau herds (Riecka et al., 2008). Effect of claw disease on the loss of revenue due to discarding of milk during cow illness (only for cases treated with antibiotics) as well as additional costs for drugs, veterinary service, and labor for herdsmen's or trimmers' time were considered when calculating the marginal economic value for the trait. To avoid double counting of effects, the effect of claw disease on other traits included simultaneously in the evaluation (milk yield, reproductive traits, cow survival) was not considered when calculating financial losses from claw disease. The amount of discarded milk ($Disc_{milk}$) in kilograms per cow per year was calculated as

values for residual feed intake (**RFI**) can be found in Hietala et al. (2014). Residual feed intake was defined as the difference between the actual daily DMI and the predicted daily DMI of an animal. Based on the definition of RFI (Williams et al., 2011), the average RFI of each animal group of interest (cows, breeding heifers, fattened animals) was assumed to be zero, which means the actual daily DMI was equal to the predicted daily DMI in the base calculation. Therefore, the procedure for the estimation of economic values of traits described before cannot be applied for RFI. To calculate the economic value for RFI, the trait mean for the appropriate animal group was changed by ±0.05 kg of DM/d

Table 4. Detailed parameters for calculating economic values of claw disease and clinical mastitis incidence

Variable (unit)	Value
Parameters for claw disease	
Costs for drugs or treatment (€/case)	
With antibiotics	10.05
Without antibiotics	4.05
Time of veterinarian service (h/case)	0.50
Charge for veterinary service (€/h)	9.21
Number of cases per cow-year at risk (minimum/maximum)[1]	0.20/0.40
Percentage of cases treated with antibiotics (minimum/maximum)[1]	10/20
Variation in daily claw disease incidence with antibiotic treatment[2] (minimum/maximum)[1]	0.00/0.02
Parameters for clinical mastitis	
Costs for drugs (€/case)	27.82
Time of veterinarian service (h/case)	0.50
Charge for veterinary service (€/h)	9.21
Number of cases per cow-year at risk (minimum/maximum)[1]	0.20/0.30
Price of drugs for dry-cow treatment (€/dose)	1.22
Percentage of cows receiving dry-cow antibiotics	97
Variation in daily mastitis incidence[3] (minimum/maximum)[1]	0.000/0.025

Parameters for claw disease

Costs for drugs or treatment (€/case)

With antibiotics 10.05

Without antibiotics 4.05

Time of veterinarian service (h/case) 0.50

Charge for veterinary service (€/h) 9.21

Number of cases per cow-year at risk (min./max.) 0.20/0.40

Percentage of cases treated with antibiotics (min./max.) 10/20

Variation in daily claw disease incidence with antibiotic treatment (min./max.) 0.00/0.02

Marginal economic values (in € per unit of trait and per cow and year) and relative economic values (%) for traits in dairy system

Claw disease incidence (cases) -26.73€ / 0.2%

Economic values for health and feed efficiency traits of dual-purpose cattle in marginal areas

Z. Krupová – E. Krupa – M. Michaličková – M. Wolfová – R. Kasarda J. Dairy Sci. 99:644–656

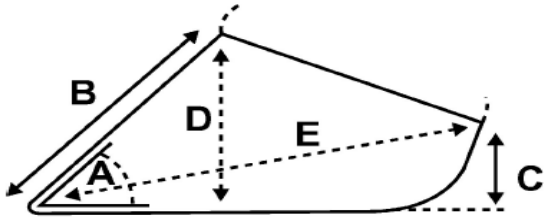
Objectives

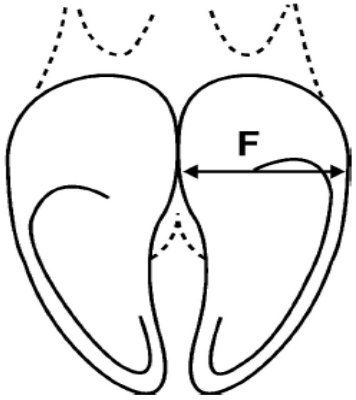
- estimate the heritability
- estimate genetic correlations

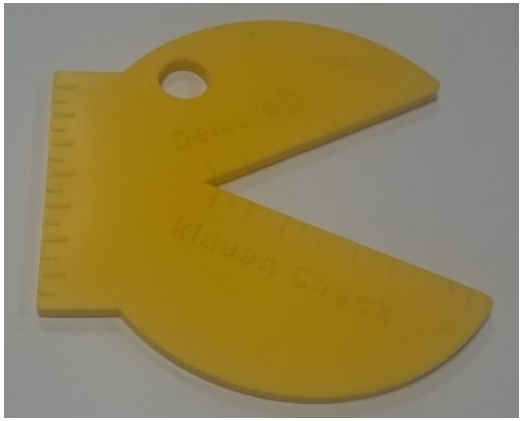
- traits associated with dairy cattle health:
  - hoof parameters
  - hoof disorders
  - metabolic status

Material&Methods

- Vermuth&Greenough (1995)
- Swalve, Alkohed&Pijl (2008)







n = 299
Average milk production 38.44 ± 9.45kg
Average Fat: 3.79 ± 0.81%
Average Protein: 3.06 ± 0.28%
DIM 47.98 ± 26.59 d.
average F/P ratio 1.24 ± 0.26

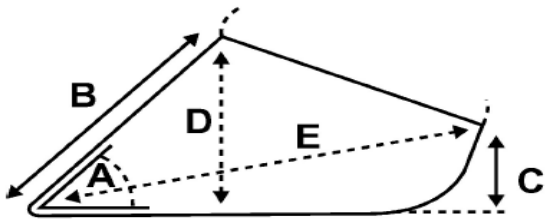
Hoof Trimming : data collection

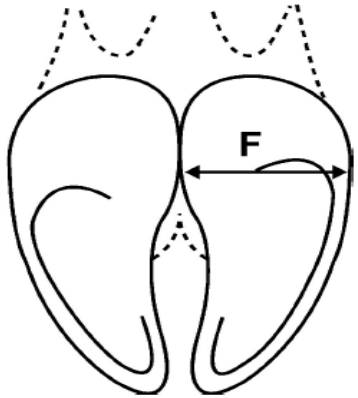
- 2 holstein herds (382 records/ 299 cows)
  - 2015-2017

- digital image
  - right hind claw
  - outer lateral claw

Basic claw measures

- A – claw angle
- B – toe depth
- C – heel depth
- D – claw height
- E – diagonal
- F – claw width





Vermuth&Greenough (1995)

New claw measures

- Total claw area
- Functional claw area

- PC based measurement
  - NIS software (Nikon)

Vlček, M.&Kasarda, R.: Optimisation of claw traits evaluation in accordance to claw and metabolic disorder of dairy cows, *68th EAAP Annual Meeting*, Tallinn, Estonia, 2017

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Hoof disorders

Interdigital Dermatitis and Heel Erosion	**0 – 1**	**83%**
Digital Dermatitis	**0 – 1**	**17%**
Sole Ulcer	**0 – 1**	**16%**

Statistical model

- heritability and genetic correlation estimated based on the Bayesian approach adopted in R package **MCMCglmm**
- **quality control of data:** in total 382 functional trimming records from 299 Holstein cows, before running of animal model any records with missing phenotypes were filtered out (-30 records)

Statistical model - heritability

- Single trait model: diseases – binary (0,1)
  - sire
  - herd-year-season
  - season of hoof trimming
  - hoof trimmer
  - days in milk

Statistical model – heritability, correlations

- Multi trait model: (measures, F/P ratio, TA, FA)
  - sire
  - herd-year-season
  - method of claw parameters measurement
  - season of hoof trimming
  - hoof trimmer

Claw measures results

Variable	N_obs	Mean	Std Dev	Minimum	Maximum	Lower 95% CL for Mean	Upper 95% CL for Mean
A	352	51.33256	5.574256	33.41	69.7	50.74822	51.91689
B	352	9.328068	2.205391	5.83	17.73	9.096882	9.559255
C	352	4.569915	1.315501	2.3	8.81	4.432014	4.707816
D	352	8.121335	2.198517	5.34	15.4	7.890869	8.351801
E	352	15.06614	3.791992	9.62	26.54	14.66863	15.46364
TA	352	55.80259	26.34794	29.15	155.37	53.04059	58.56458
FA	352	32.60926	16.87173	10.18	95.67	30.84063	34.37789

A – claw angle, B – toe depth, C – heel depth, D – claw height, E – diagonal, F – claw width,
TA – total area, FA – functional area

Claw&metabolic disorders results

Single Trait*	h^2
A	0.624
B	0.624
C	0.626
D	0.626
E	0.623
F	0.619
TA	0.620
FA	0.621
F/P ratio	0.522
IDHE	0.014
DD	0.035
SU	0.039

Multi Trait	h^2
A	0.516
B	0.612
C	0.473
D	0.415
E	0.555
F	0.529
TA	0.575
FA	0.523
F/P ratio	0.562

A – claw angle, B – toe depth, C – heel depth, D – claw height, E – diagonal, F – claw width,
TA – total area, FA – functional area,
IDHE – interdigital dermatitis and heel erosion, DD – Digital Dermatitis, SU – sule ulcer

Correlations

Trait	TA	FA
A	0.222	-0.837
B	0.982	0.937
C	0.991	0.995
D	0.997	0.993
E	0.544	0.864
F	0.984	1
F/P ratio	0.242	0.402

A – claw angle, B – toe depth, C – heel depth, D – claw height, E – diagonal, F – claw width,
TA – total area, FA – functional area, F/P ratio – fat to protein

Pearson Correlation Coefficients	
	F/P Ratio
IDHE	-0.0177
DD	0.105
SU	-0.014

IDHE – interdigital dermatitis and heel erosion,
DD – Digital Dermatitis, SU – sule ulcer

Conclusions

- provide base for the future selection and automation of claw data evaluation by use of machine learning
- construction of new selection indices with use of new generation indicators possible for the further use in selection of metabolically resistant animals

Conclusions

- F/P ratio is inherited
- heritability of F/P ratio is highly considerable
- correlated response to the claw traits (but not with disorders)

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  - animal recording data
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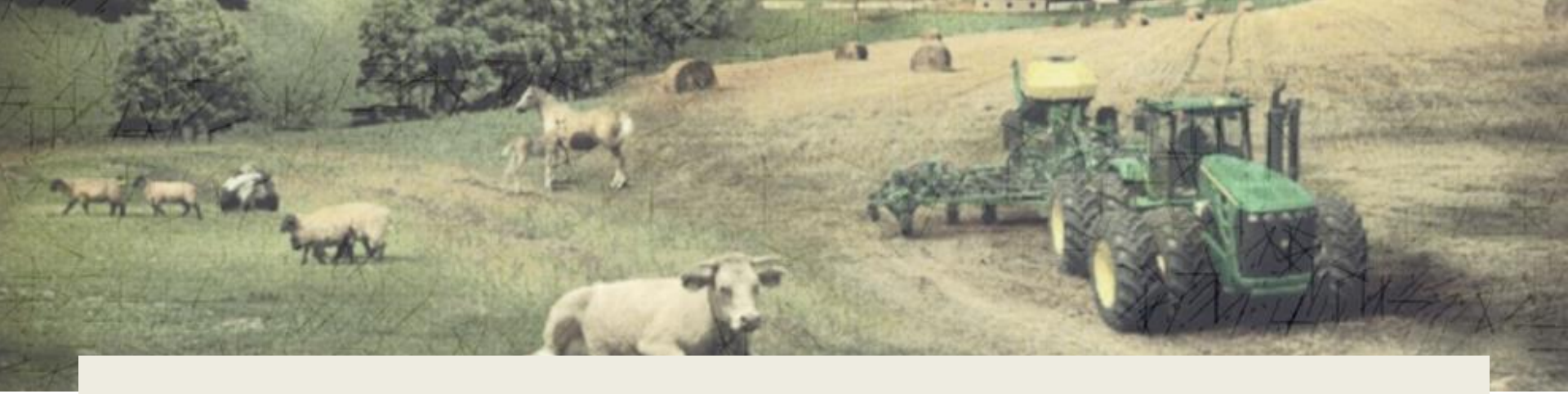
  - APVV 14-0054, APVV 17-0060
- Scientific Agency of Slovak Republic
  - VEGA 1/0742/17
- COST DairyCare FA1308



Thank You for your attention!

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