MARTIN-LUTHER-UNIVERSITY HALLE-WITTENBERG
Institute of Agricultural and Nutritional Sciences, Group Animal Breeding

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FUGATO

Precise phenotyping of 2,000 first lactation Holstein cows for claw disorders in a designed experiment

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Introduction

Feet and leg problems…

- Economically important

- Reduced lifespan
- Impaired well-being
- Inferior productivity

➔ Main problem is laminitis

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Designed experiment: Collection of 2,000 phenotypes FUGATO-Plus GENE-FL - Project

➔384 SNPs from 143 candidate genes – custom-made SNP-chip
➔ to be done

Criteria for participating herds:

Large herd size

Standard slatted flooring

First lactation cows only

Lactation stage varying between 50 and 150 days in milk

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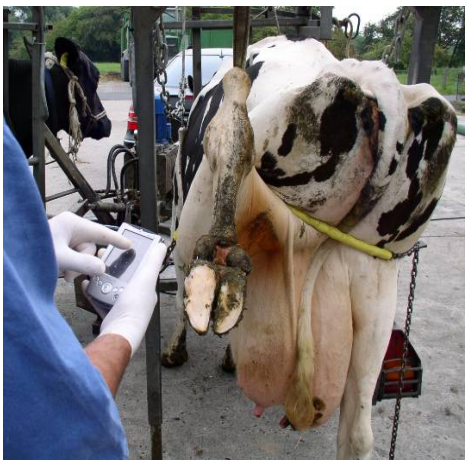
Designed experiment: Collection of 2,000 phenotyps



- Diagnoses of the claw disorders at the time of trimming by a professional hoof trimmer
- Collection of horn clips (lateral claw of the hind leg)
- Recording of backfat thickness, body condition score, weight, height at sacrum
- Taking of blood samples for genotyping

Material

- 1,962 Holstein cows in the 1st lactation
  → 274 sires
  → 7 herds
- Milk records
- Classification of conformation
- Insemination records

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Descriptive statistics for weight, height, backfat thickness and body condition score

traits	$\bar{x}$	s	Min	Max
Weight (kg)	530.2	55.7	370	737
Height (cm)	145.3	3.8	133	158
BFT (mm)	25.6	9.9	8	52
BCS (0.25)	2.7	0.6	1.25	4.75

Results

Incidence rates for the five most relevant diseases

Name of disease	Incidence rate
Laminitis	57.3
Dermatitis digitalis	17.0
White line disease	12.6
Sole ulcer	7.1
Dermatitis interdigitalis	6.9

$n_{heifers}$=1.962

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Threshold model

$$PR(y_{ijklmn}=1)=\theta\,(\mu + date_i + DIM_j + weight_k + height_l + BCS_m + BFT_n)$$

where

PR	= Probability of occurrence of treatment of claw disorder
Y_{ijklmn}	= binary trait (1= positive; 0= negative)
Θ	= link function
μ	= overall mean
$date_i$	= fixed effect of herd-visit group date (i=1,…,24)
DIM_j	= fixed effect of milk day (j=1,…,5: with classes of 50 days)
$weight_k$	= fixed effect of $weight_k$ (k=1,…,4)
$height_l$	= fixed effect of height (l=1,…,4)
BCS_m	= fixed effect of body condition score (m=1,…,3)
BFT_n	= fixed effect of backfat thickness (n=1,…,4)

Test of fixed effects by threshold model

Effect / Claw disorder	Herd-visit date	dim	weight	height	BCS	BFT
lam	***	***	*	n.s.	n.s.	n.s.
dd	***	n.s.	n.s.	n.s.	*	n.s.
did	***	n.s.	n.s.	n.s.	n.s.	n.s.
wld	***	n.s.	*	**	n.s.	n.s.
su	***	n.s.	*	n.s.	**	n.s.

p= ≤ 0,001***, p= ≤ 0,01**, p= ≤ 0,05*

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Least Squares means of incidences for laminitis (in %) stratified by stage of lactation

days in milk	laminitis***
< 50	49.01 (3.14)
50-99	**72.27** (2.10)
100-149	60.38 (3.35)
150-199	51.35 (3.91)
>200	56.50 (4.63)

(standard error in parenthesis)

Least Squares means of incidences (in %) for laminitis and white line disease stratified by weight

weight	laminitis*	wld*
< 500 kg	51.50 2.83	6.77 1.17
500-549 kg	56.78 2.27	10.40 1.33
550-599 kg	60.31 2.70	11.56 1.77
> 600 kg	**63.93** 4.05	**14.10** 2.94

(standard error in parenthesis)

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Least Squares means of incidences for dermatitis digitalis and sole ulcer (in %) stratified by body condition score

BCS	dd*	su**
< 2.5	**21.22** 1.97	**7.87** 1.9
2.5-3.5	13.62 1.23	4.85 1.1
>3.5	15.29 2.76	2.37 0.9

(standard error in parenthesis)

Threshold model for genetic evaluations

$$PR(y_{ijk}=1)=\theta\,(\mu + date_i + DIM_j + sire_k)$$

where

PR	= Probability of occurrence of treatment of claw disorder
Y_{ijkl}	= binary trait (1= positive; 0= negative)
Θ	= link function
μ	= overall mean
$date_i$	= fixed effect of herd-visit group date (i=1,…,24)
DIM_j	= fixed effect of milk day (j=1,…,5: with classes of 50 days)
$sire_k$	= random effect of sire

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Estimates of heritabilities for claw disorders

Name of disease	Logit link		Probit link	
	h^2	s.e.	h^2	s.e
Laminitis	0.22	0.10	0.28	0.12
Dermatitis digitalis	0.23	0.12	0.25	0.14
Dermatitis interdigitalis	0.23	0.19	0.22	0.19
White line disease	0.38	0.15	0.35	0.15
Sole ulcer	0.00	0.00	0.02	0.16

Conclusions

- Consistent recording of hoof health status by one person is very useful for genetic evaluations
- Incidence rate of laminitis is high
- Estimates of heritabilities are in a moderate range (except sole ulcer)
- Improvements by genetic selection are possible
- Material seems useful for SNP analysis

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Thank you for your attention !

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(***Gene****tic Causes of a Pre-disposition for Diseases of the* ***F****eet and* ***L****eg System in Cattle, Swine, Horse and Sheep)*