Auxiliary traits for lameness in Austrian Fleckvieh cows

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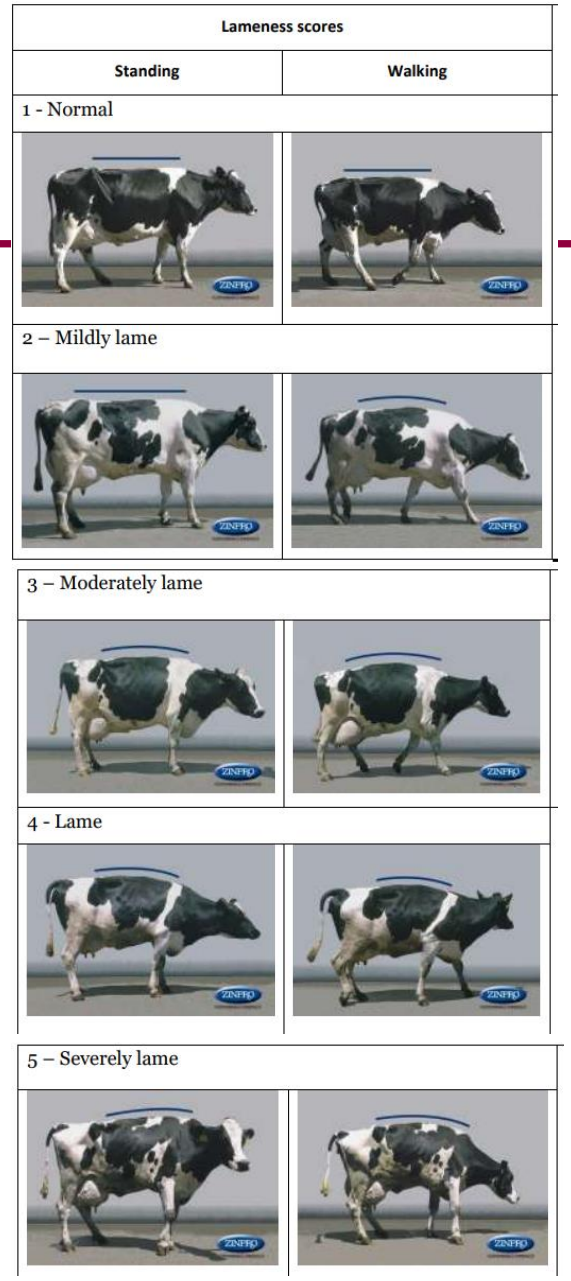
Background

- **Direct traits for genetic improvements are claw disorders – routine recording set up in Austria**
- **To increase reliability of genetic evaluation – auxiliary traits of interest**
- **Lameness is an important health and welfare issue that causes considerable economic losses**
- **Lameness** is not routinely recorded in Austria:
  - **Hind feet position** (Bulgarelli-Jiménez et al. 1996) - could be more easy recorded in the milking parlour at milk recording
  - **Sensor data** - frequently used for heat detection and health monitoring (metabolic and infectious diseases)

Lameness scoring

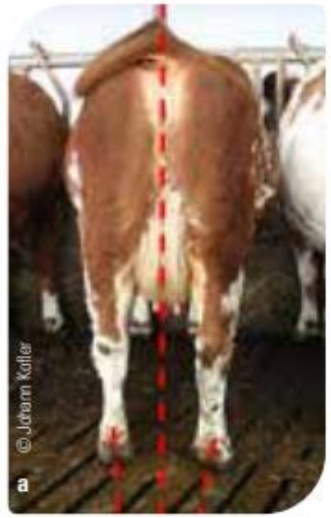
- **Lameness most often caused by claw and/or leg disorders** reflecting the attempt of the animal to reduce the amount of weight bearing on the affected limb(s)
- **Locomotion scoring (LCS)**: **five-point scale system** (1 is «normal» and 5 is «severely lame») of the presence of behaviors such as an arched back when standing and walking (Sprecher et al., 1997) (see ICAR Guidelines)
- **Genetic correlations between lameness and claw health between 0.60 and 0.95** (Heringstad and Egger-Danner et al., 2018; Ring et al., 2018).



ICAR-Guideline - Ref.: Sprecher et al. 1997 / Source of the pictures: Zinpro First Step®: Dairy Lameness Assessment and Prevention Program

Hind feet position (Bulgarelli-Jiménez et al. 1996)

- The hind feet position score is evaluated by **visual scoring** of the **position of both the hind-digits** (angle formed by the line of interdigital space of each claw-pair) **to the mid-line of the cow´s body** (the line along the vertebral column).
- Scoring is done by a visual assessment from the back while the cows stand still.
- Physiologically the angle formed by the interdigital line and the body-midline ranges:
  - **Score 1**: angle between 0° - <17°
  - **Score 2:** angle of 17° - 24°
  - **Score 3:** angle of >24°



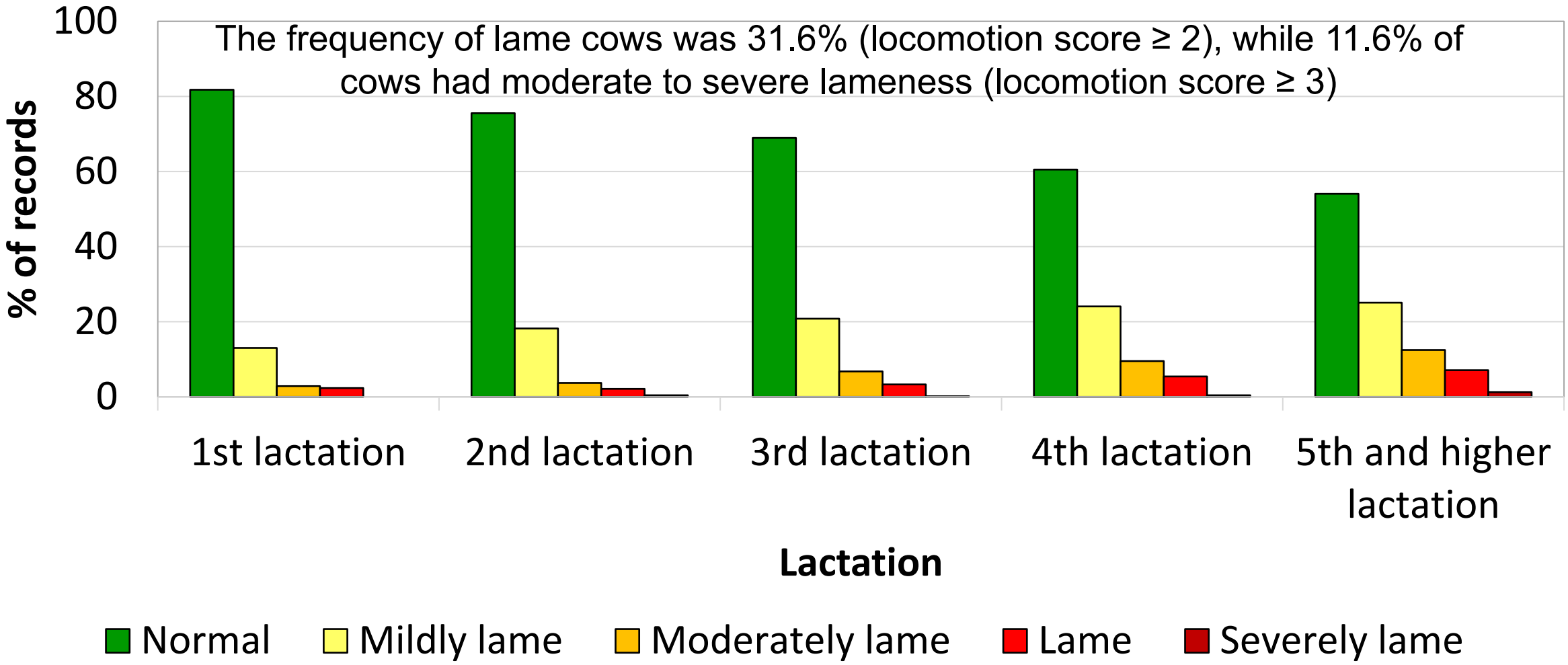
Hind feet position (Bulgarelli-Jiménez et al. 1996)

- Assist decision regarding the **optimal time for functional hoof trimming**
- A few months **after hoof trimming** the **outer hind claw is commonly distinctly higher than the inner claw**, resulting in claw overload and stimulation of horn growth (Van der Tol et al., 2004; Sadiq et al., 2020; Fischer et al., 2021)
- **Increased pressure on sole horn,** and therefore **increasing the risk for sole hemorrhages, double soles, sole ulcers and white line lesions** (Machado et al., 2010; Griffiths et al., 2020)
- Presence of **painful stages of digital dermatitis, interdigital dermatitis and of severe forms of heel horn erosion** may result in an increase of the bulbs of the heel preferably on the outer hind claw, causing the heel height to increase over time, and pushing the hock inward and the claws outward (Holzhauer et al., 2005)

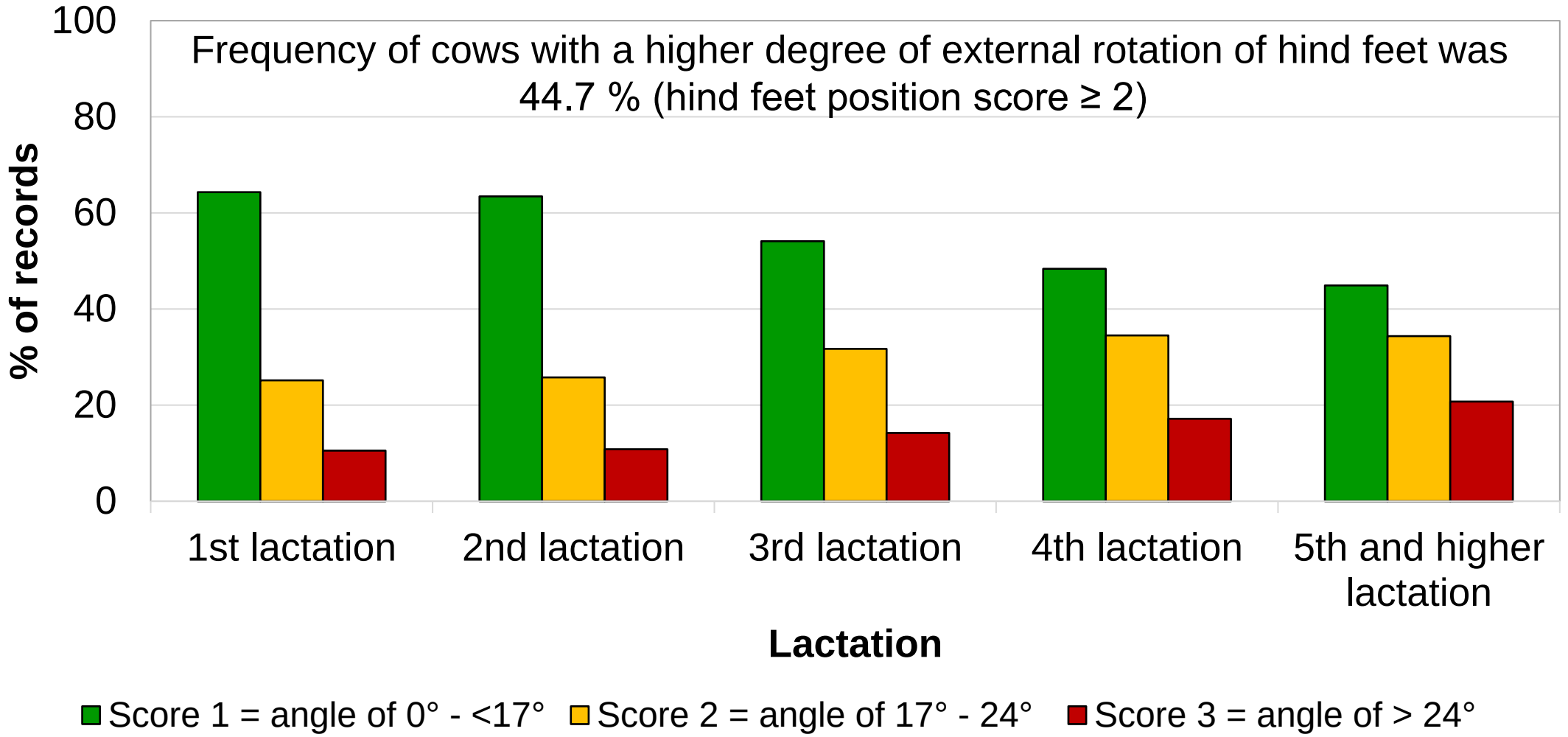
Material and Methods

- **Data collection** was carried out by the regional milk recording organizations on **selected farms with a milking parlour** during routine milk performance testing
- **Assessors were trained** for recording LCS (1-5) and hind feet position score (1-3)
- In total, **3,478 records** from **1,064 Fleckvieh cows** from **35 farms** were available from **September 1, 2021 to March 5, 2022**
- Data were analyzed with a **bivariate linear animal model** using the average information-restricted maximum likelihood (AI-REML) procedure in the DMU package (Madsen and Jensen, 2008)
  - **Fixed effects** of **herd, lactation** (1-5+) and **lactation stage** (1 ≤ 90 DIM, 2 = 91-180 DIM, 3 = 181-270 DIM, 4 > 270 DIM); **random permanent environmental effects**; **random animal additive genetic effects**

Descriptive statistics – Lameness



Descriptive statistics – Hind feet position



Results – Genetic analyses

Heritabilities (on the diagonal), genetic correlation (above the diagonal), phenotypic correlation (below the diagonal)

	Hind feet position	Lameness
Hind feet position	**0.071 (0.036)**	0.80 (0.27)
Lameness	0.38	**0.096 (0.039)**

Use of sensor data to improve detection of lameness Lemmens et al., 2023

animals

MDPI

Article

The Combined Use of Automated Milking System and Sensor Data to Improve Detection of Mild Lameness in Dairy Cattle

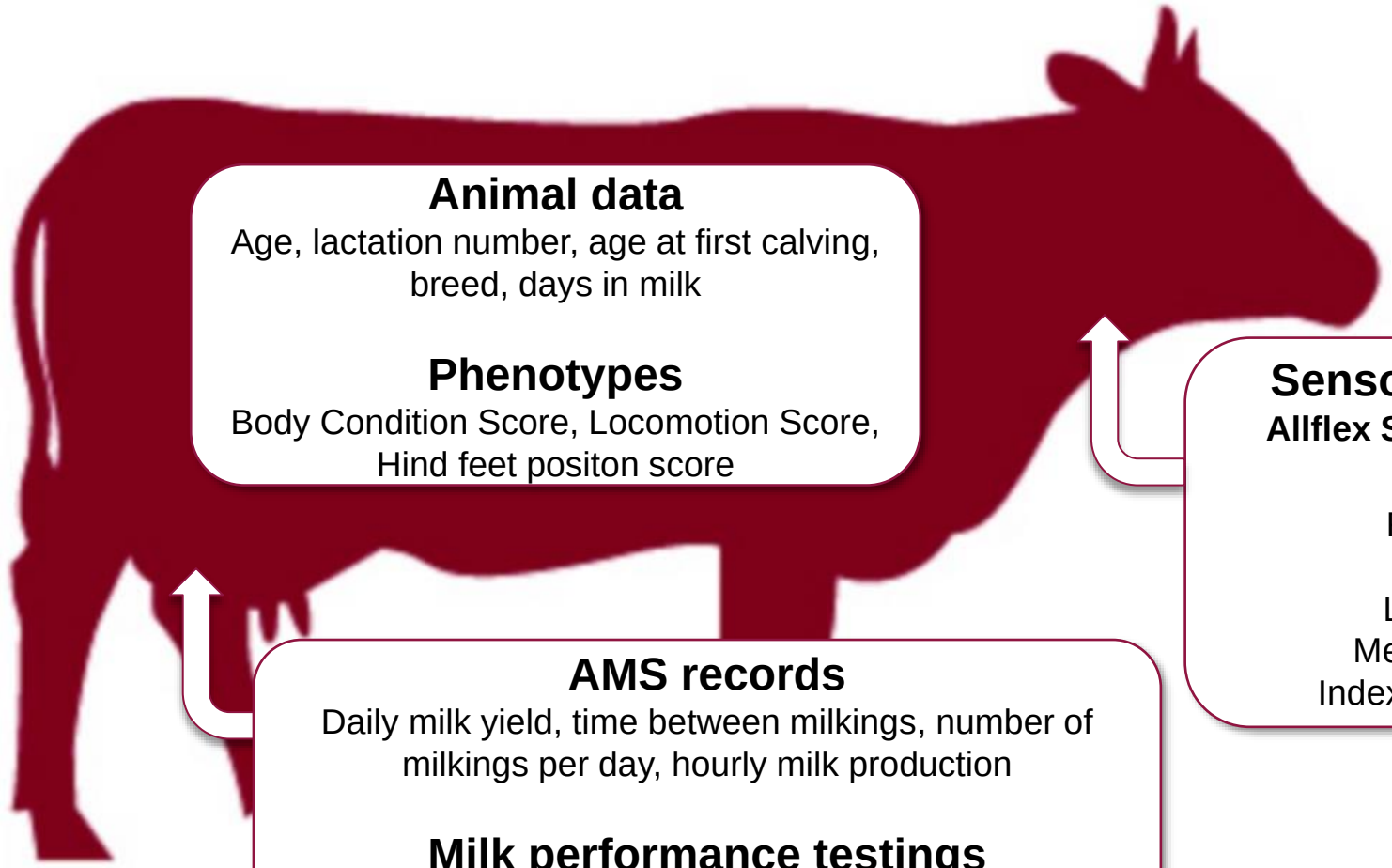
Lena Lemmens [1], Katharina Schodl [2], Birgit Fuerst-Waltl [2], Hermann Schwarzenbacher [3], Christa Egger-Danner [3], Kristina Linke [3], Marlene Suntinger [3], Mary Phelan [4], Martin Mayerhofer [3], Franz Steininger [3], Franz Papst [5,6], Lorenz Maurer [2] and Johann Kofler [1,*]

Study design

- **A total of 594 observed dairy cows (10 farms)**
  - 62% Fleckvieh, 15% Holstein Friesian, 8% Brown Swiss and 15% of mixed breed
  - Herd sizes: 46 – 84 cows per farm
  - Annual herd milk performance: 9,001 kg (range: 6,367 to 10,496 kg)
- **Mean lameness incidence risk** of 44.1% (range: 27.1 to 65.6%)
  - Scored every 30 – 42 days

	Locomotion Score (Sprecher et al. 1997)	Clinical appearance
LCS-G 1	LCS 1	Not lame
LCS-G 2	LCS 2 + LCS 3	Mildly to moderately lame
LCS-G 3	LCS 4 + LCS 5	Lame to severely lame

Combination of Data Sources



Farm data
Assessment of risk factors including:
Feeding management
Housing conditions and barn measurements
Hoof trimming and other preventive measures

Animal data
Age, lactation number, age at first calving, breed, days in milk

Phenotypes
Body Condition Score, Locomotion Score, Hind feet positon score

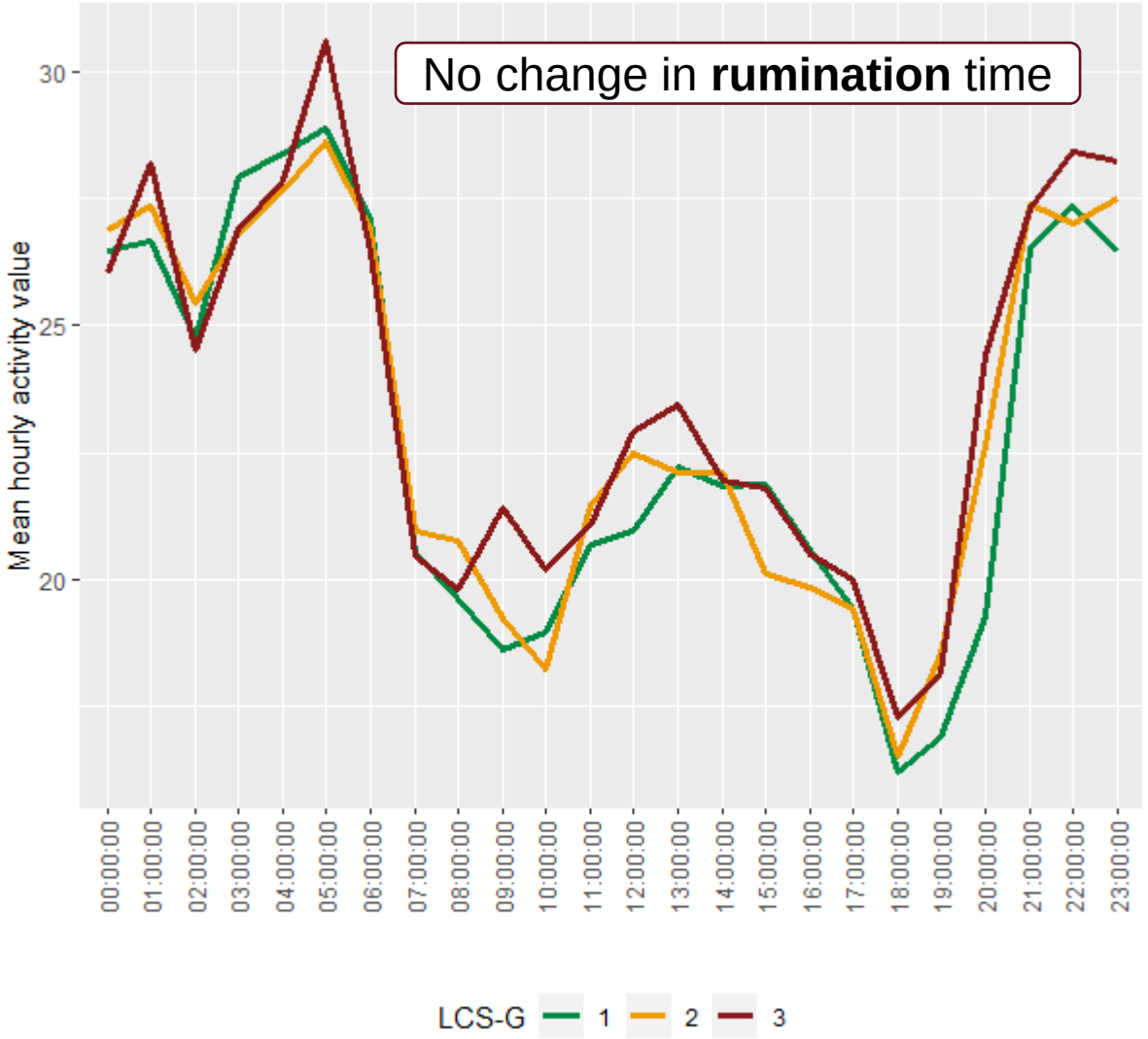
Sensor parameters
Allflex SenseHub™ Dairy

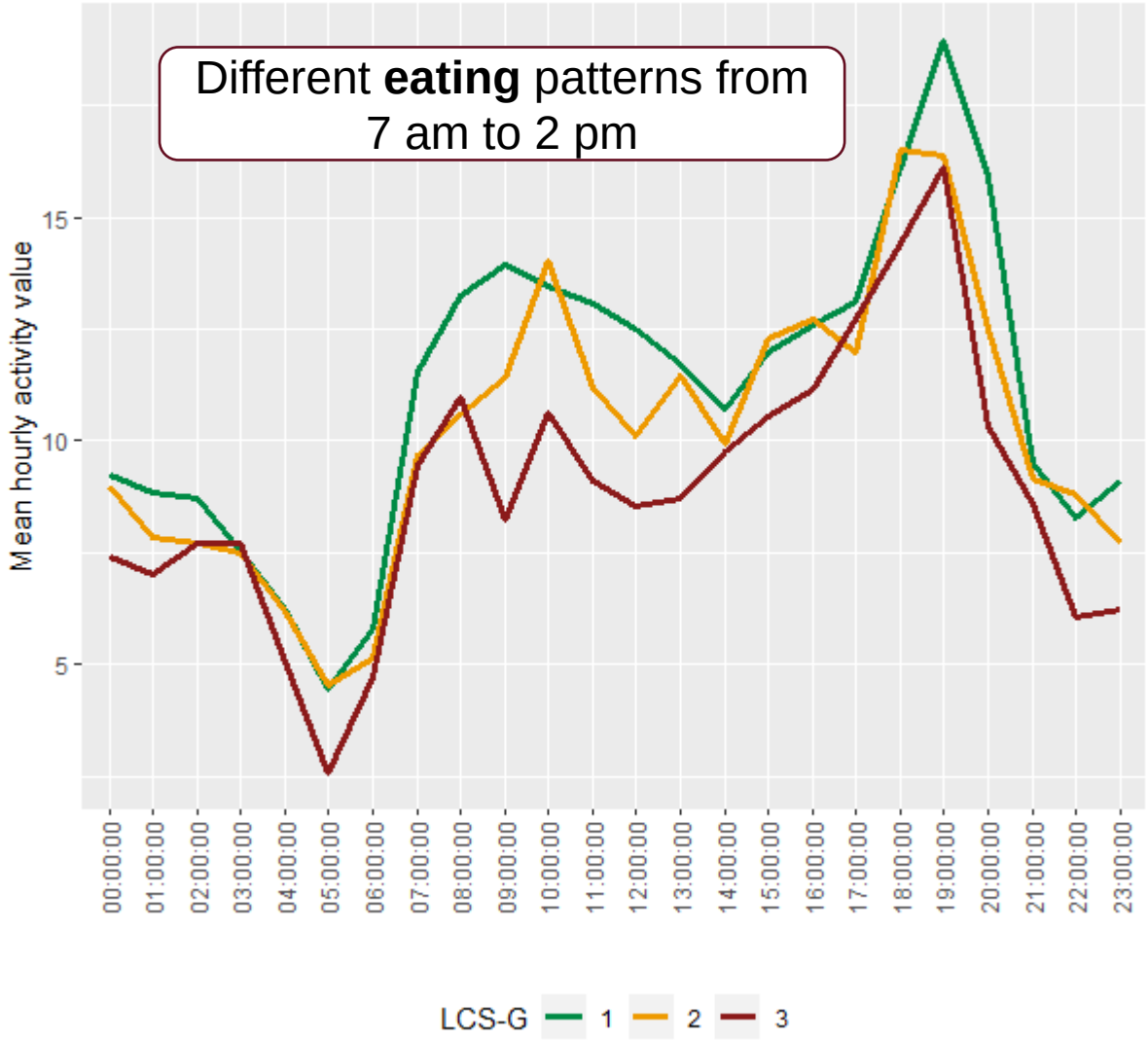
Rumination
Eating
Low Activity
Medium Activity
Index Activity_Trend

AMS records
Daily milk yield, time between milkings, number of milkings per day, hourly milk production

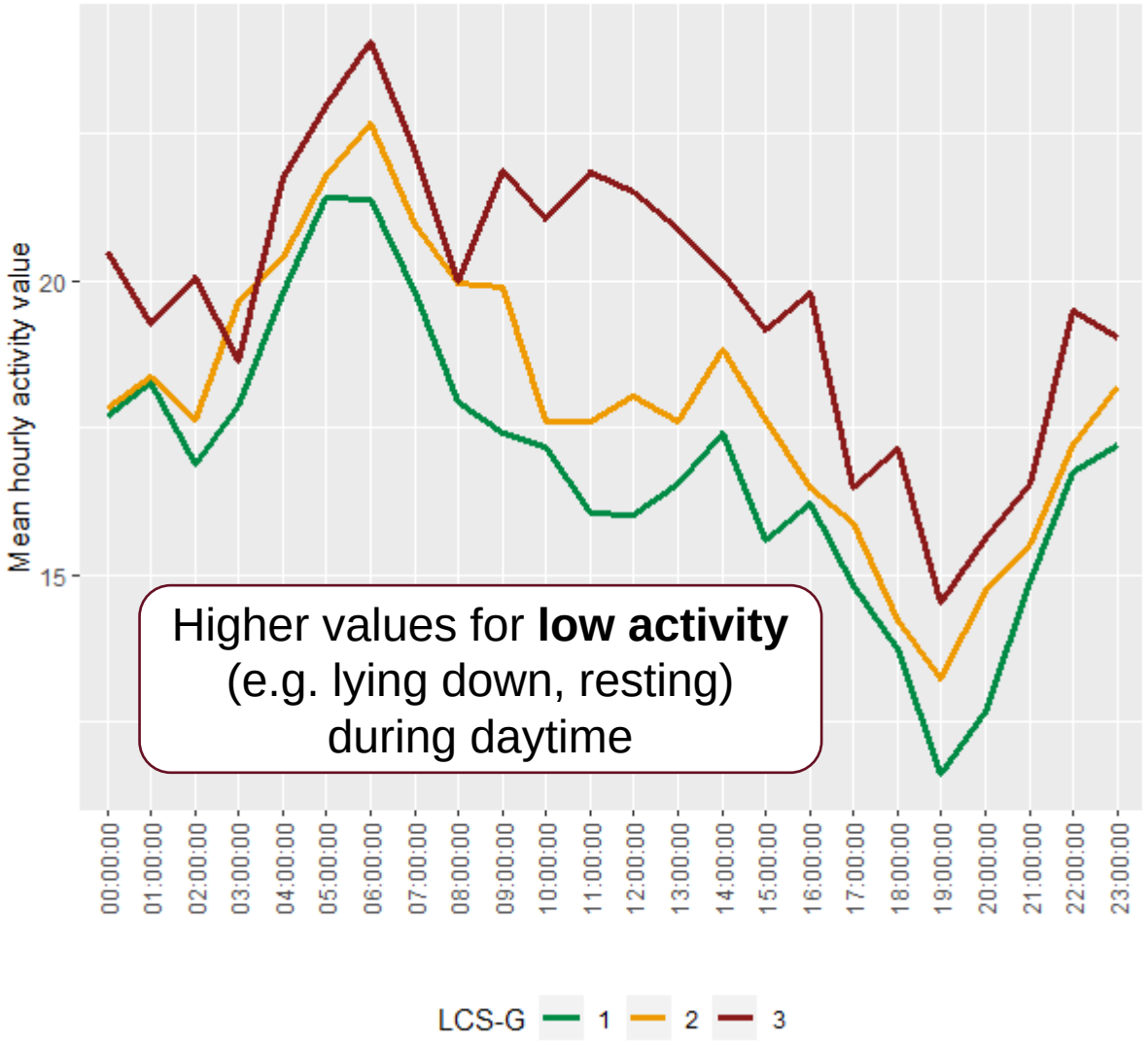
Milk performance testings
Milk contents – fat, protein, urea

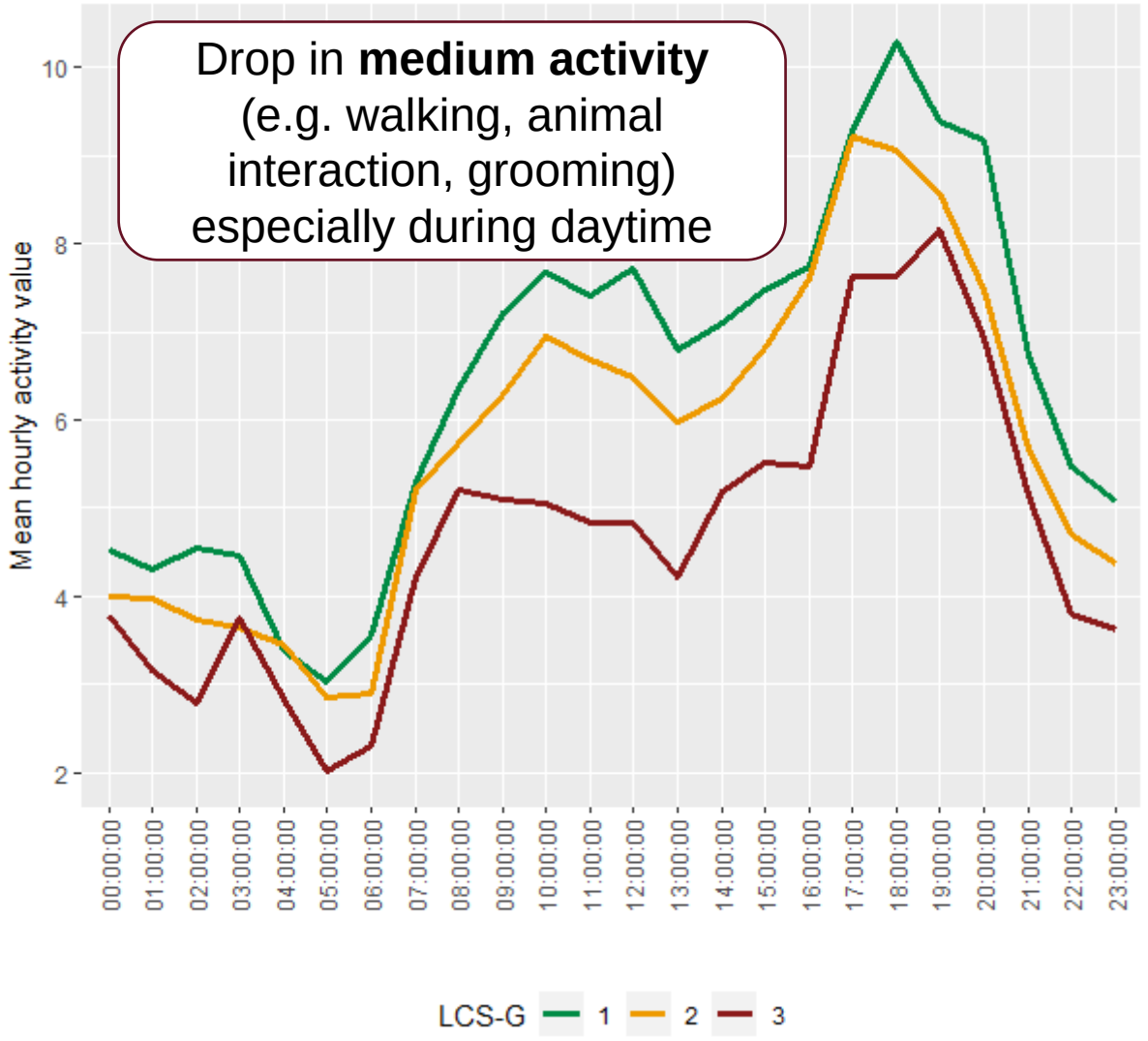
Behavioral patterns troughout the day





Behavioral patterns troughout the day





Lameness detection - Machine learning approach using a random forest model

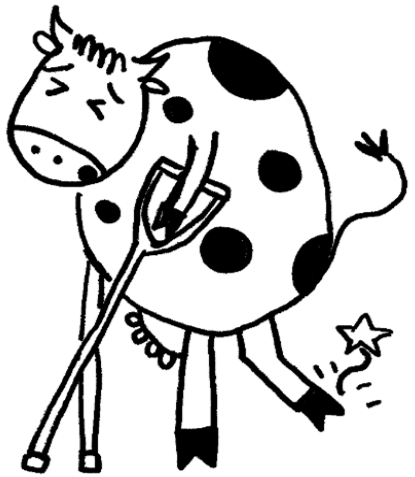
- Random forest models for lameness detection were fit by including different combinations of influencing variables:
  - Model 1: Sensor data
  - Model 2: AMS data, animal and farm information
  - Model 3: Sensor data + AMS data, animal and farm information
  - Model 4: + BCS
  - Model 5: + Hind feet position score

	Model 1	Model 2	Model 3	Model 4	Model 5
Sensitivity	0.610 (±0.009)	0.657 (±0.022)	0.695 (±0.030)	0.738 (±0.014)	0.725 (±0.090)
Specificity	0.640 (±0.005)	0.605 (±0.020)	0.668 (±0.041)	0.701 (±0.031)	0.775 (±0.025)
Accuracy	0.623 (±0.006)	0.629 (±0.020)	0.680 (±0.014)	0.719 (±0.010)	0.753 (±0.046)

Best performing model achieved accuracy of 0.75 (sensitivity of 0.72, specificity of 0.78)

Sensor derived proxies for lameness (Schodl et al., 2023)

- **35 farms** equipped with LELY sensor system
- Collar mounted sensor measures
  - **Activity**: non-dimensional number
  - **Rumination time**: min in 24 hours
  - **Eating time**: min in 24 hours
- Output every **2 hours** or **hourly**



- **Trait definition**
  - Mean (M), standard deviation (SD), median (MD)
  - Day of lameness scoring (d_0), average ±5 days and ±10 days

Heritabilities for sensor derived traits

Activity

- 9.000 observations
- **h² for means**
  0.15 – 0.23
- **h² for standard dev.**
  0.07 – 0.16
- **h² for medians**
  0.15 – 0.22
- **r_a lameness**
  Low or not significant

Rumination

- 14.000 observations
- **h² for means**
  0.24 – 0.33
- **h² for standard dev.**
  0.04 – 0.10
- **h² for medians**
  0.23 – 0.33
- **r_a lameness**
  Low or not significant

Eating

- 5.000 observations
- **h² for means**
  0.42 – 0.46
- **h² for standard dev.**
  0.11 – 0.28
- **h² for medians**
  0.41 – 0.48
- **r_a lameness**
  Low or not significant

Conclusions

- **Hind feet position scoring is a heritable trait and shows a high genetic correlation to locomotion scoring**
  - Can be used for genetic evaluations to reduce lameness incidence
  - Advantage of recording in the milking parlour as part of routine milk performance testing
- **Sensor data combined** with **routinely available data** shows potential for **early lameness detection** in dairy cattle
- Heritabilities suggest potential of sensor derived traits for breeding
  - Genetic correlations with lameness were low or not significantly different from zero
  - Further research is needed (e.g. trait definitions, …)

Thank you for your attention!

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Duration: 10/2018 – 09/2022

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