

# First results in the use of milk MIR spectra in the detection of lameness in Austrian dairy cows

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Supervisor:

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# Prevalence

- Varies greatly across farms (Austria and abroad)
  - On average: 20 - 40%
  - Certain farms: > 75%
- Many environmental factors
  - Pasture
  - Tie- or free-stall
  - ...

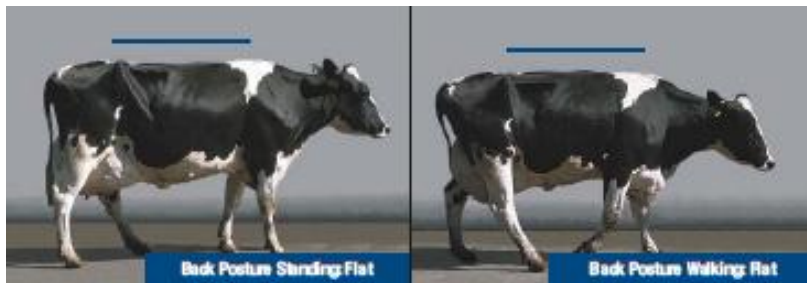
# Importance of lameness



# Locomotion scoring

- Assessment of lameness
  - Many systems
  - Based on levels
  - Differences in:
    - Gait
    - Back arch
- For this research  
⇒ Sprecher *et al.*, 1997
  - Trained staff!

1



5

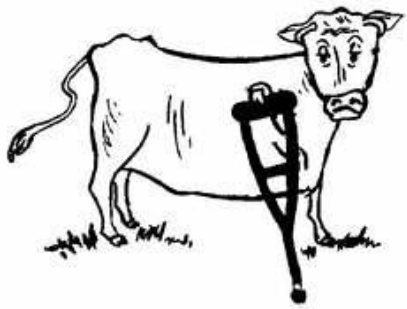


# Objective

Assess the possibility of using milk composition to detect and predict potential lameness.

# Lameness, metabolic disorders & milk composition

## Theory



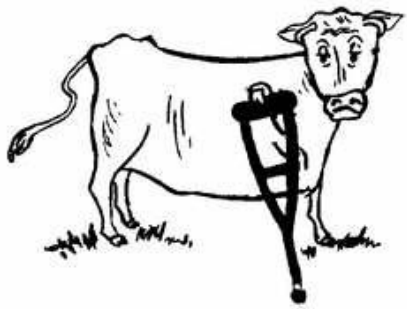
### METABOLIC DISORDERS

- Body fat mobilization – Ketosis
- Sub Acute Ruminant Acidosis



# Lameness, metabolic disorders & milk composition

## Theory

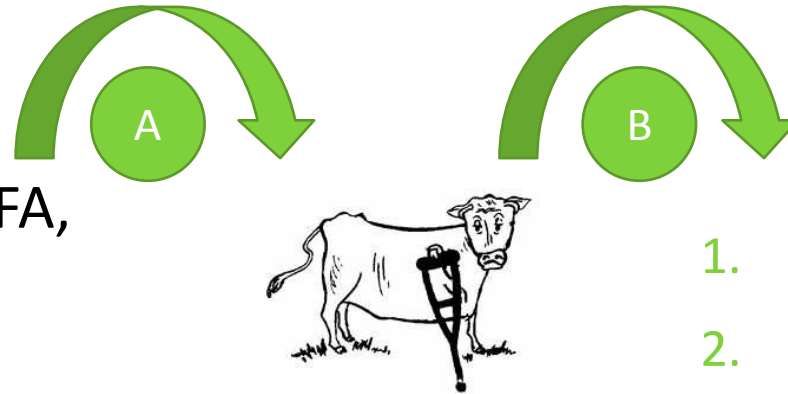


### METABOLIC DISORDERS

- **Body fat mobilization – Ketosis**
- Sub Acute Ruminant Acidosis

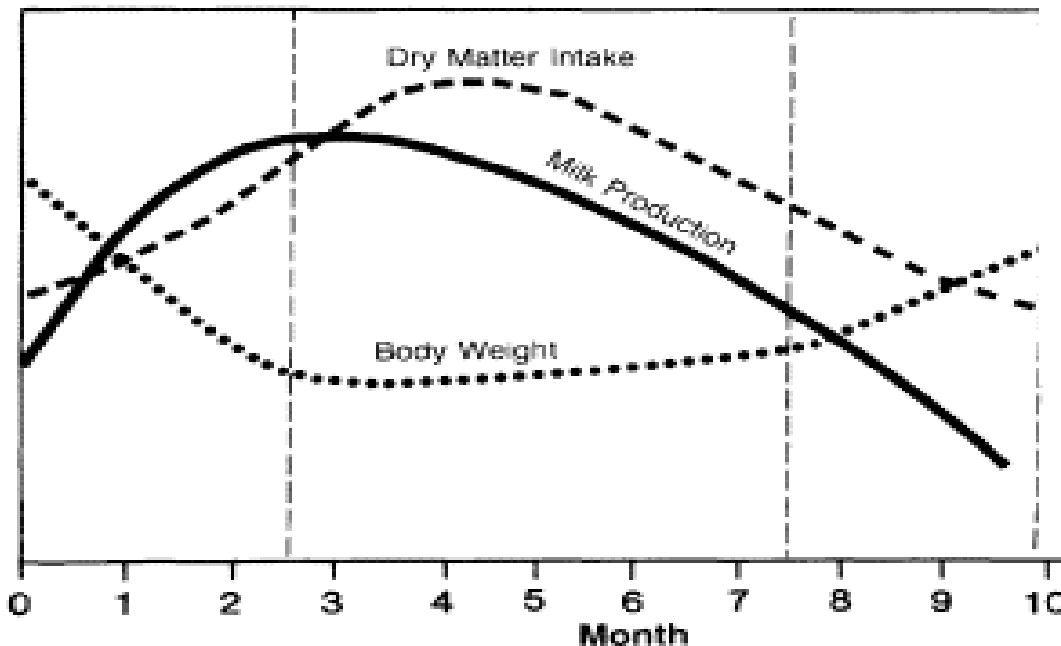


# Body fat mobilization - Ketosis



1. F:P ratio $\uparrow$ , NEFA, C18:1cis9
2. Citrate
3. BHB, acetone

1. Smaller feed intake
2. F:P ratio $\uparrow$ , NEFA, C18:1cis9
3. Citrate
4. BHB, acetone





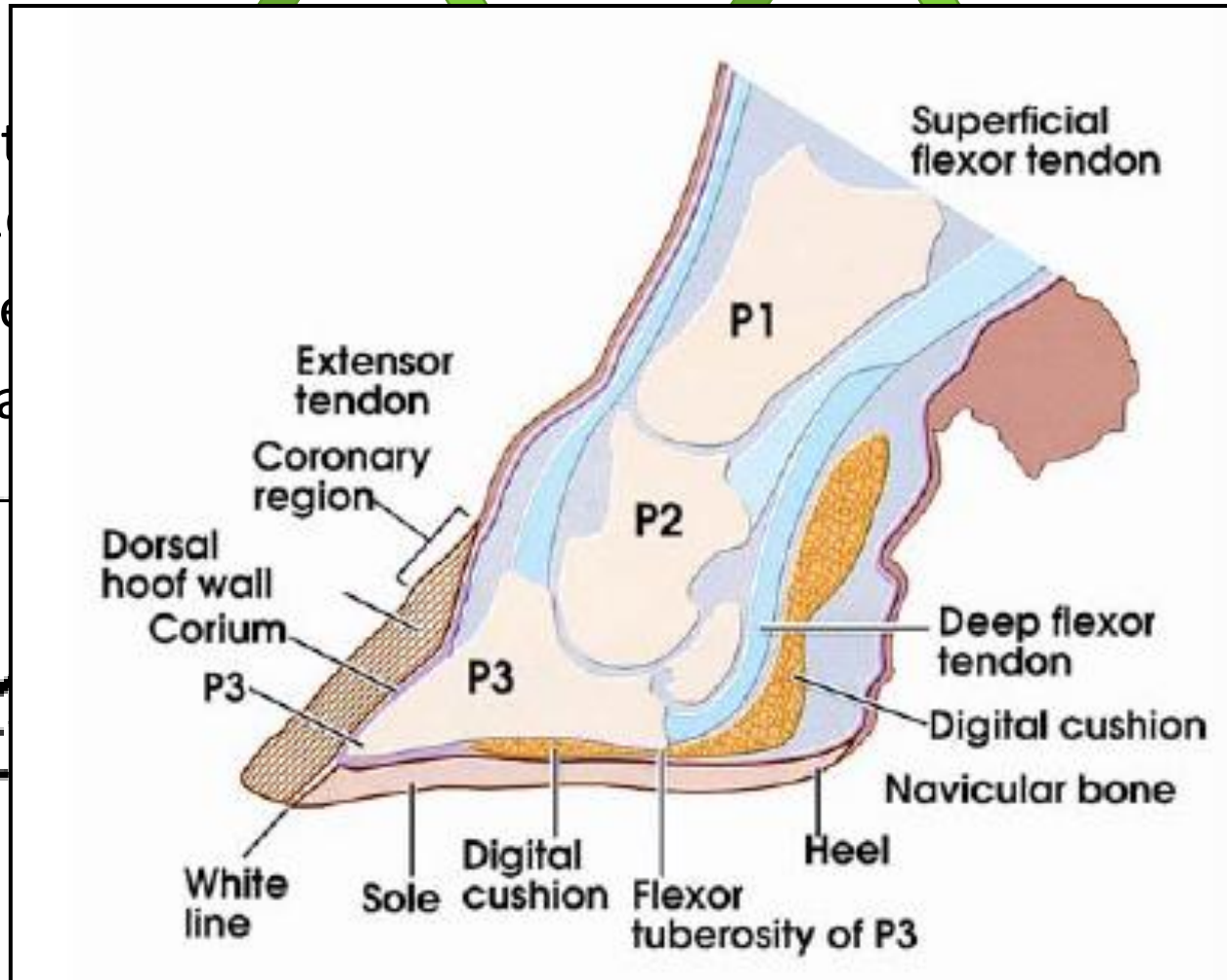
# Body fat mobilization - Ketosis

1. F:P ratio
- C18:1
2. Citrate
3. BHB, a

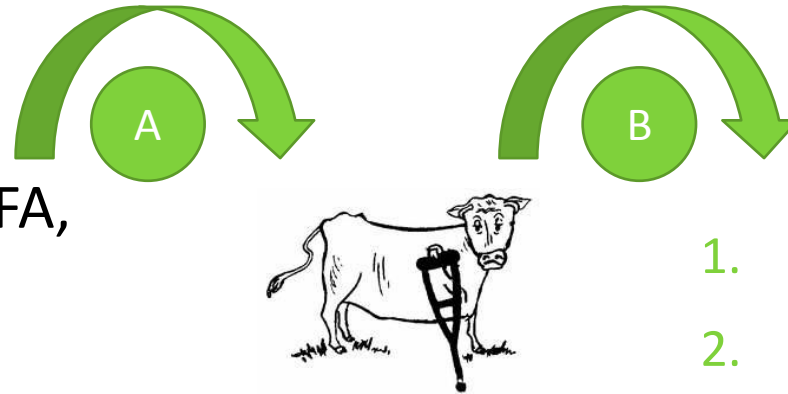
ed intake

, NEFA,

one

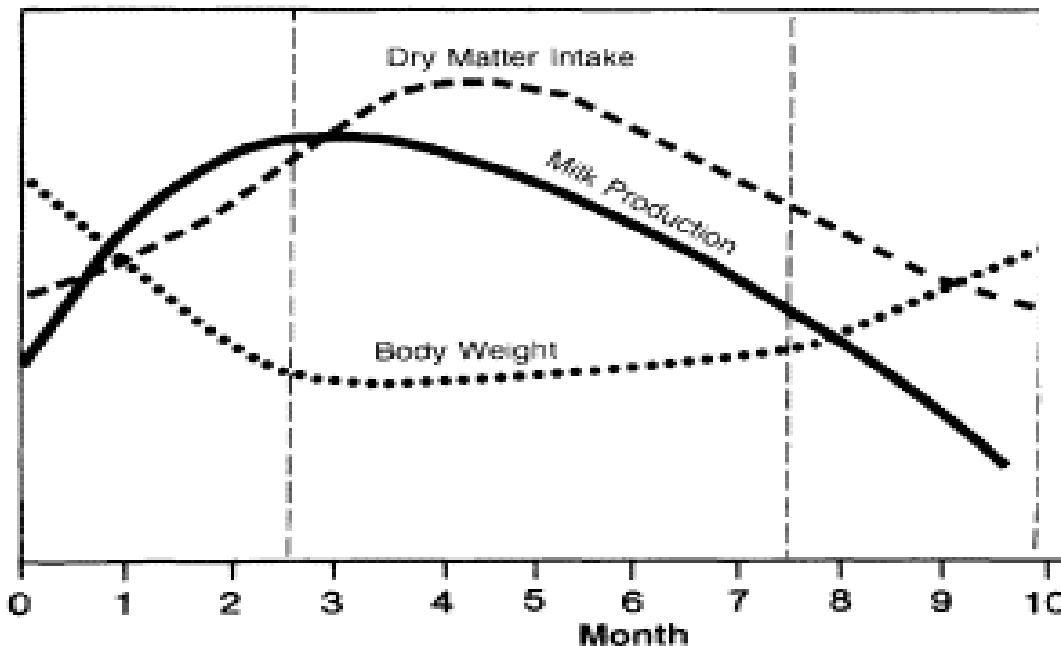


# Body fat mobilization - Ketosis



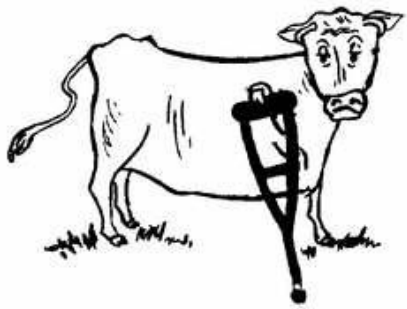
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# Lameness, metabolic disorders & milk composition

## Theory

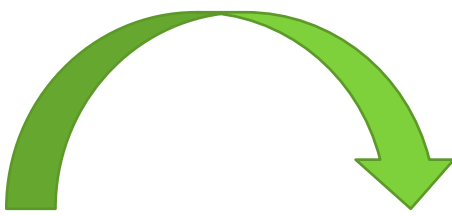


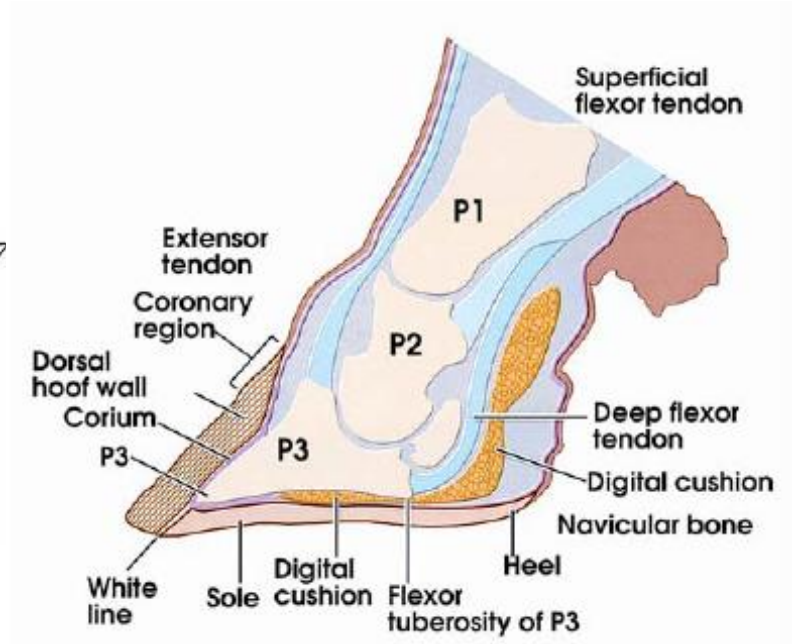
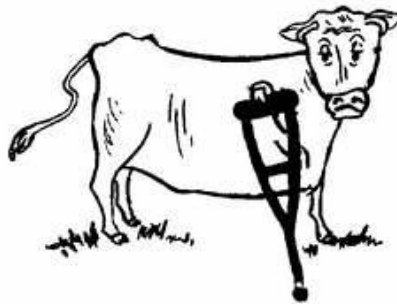
### METABOLIC DISORDERS

- Body fat mobilization – Ketosis
- **Sub Acute Ruminal Acidosis**



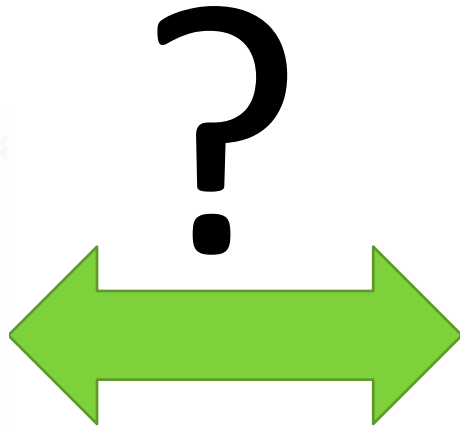
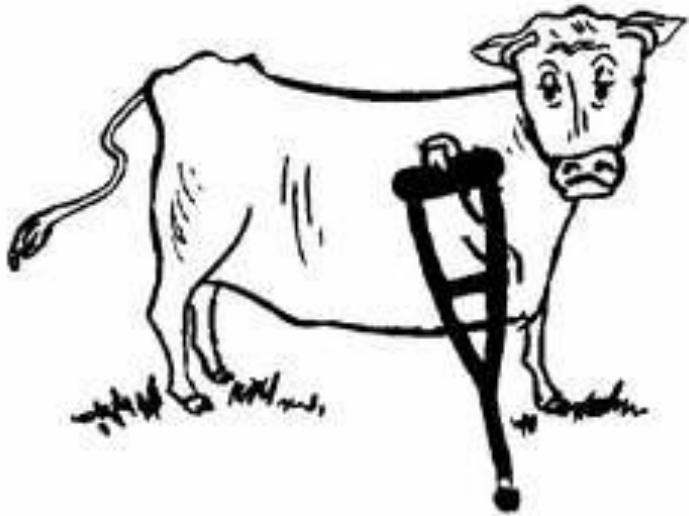
# Sub Acute Ruminal Acidosis

- 
1. Rumen pH ↓
  2. Bacteria in blood
  3. Laminitis
  4. F:P ratio ↓



# Lameness & milk composition

## Practice



# Mid-infrared (MIR) spectroscopy

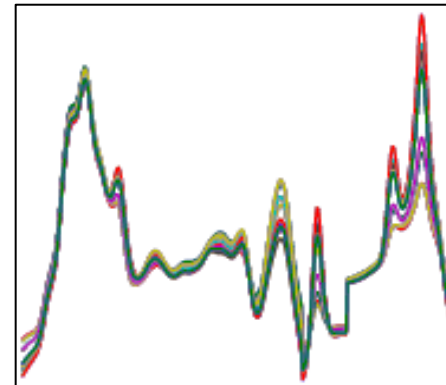
Milk samples



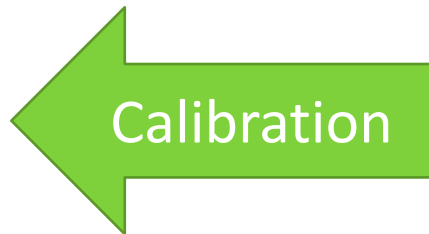
MIR analysis



MIR spectra



Calibration



Reference values

- Prediction
  - **Major milk components**
    - Fat
    - Protein
    - Urea
    - Lactose

# MIR spectroscopy

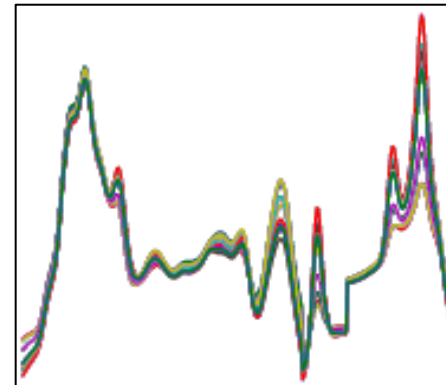
Milk samples



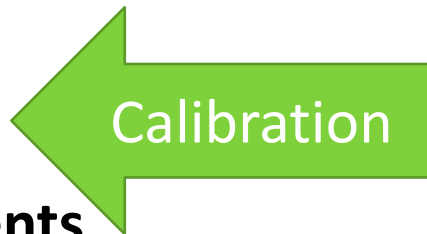
MIR analysis



MIR spectra



Calibration



Reference values

- Prediction
  - Major milk components
  - **Novel components**
    - BHB, Acetone
    - Citrate
    - Fatty acids

# MIR spectroscopy

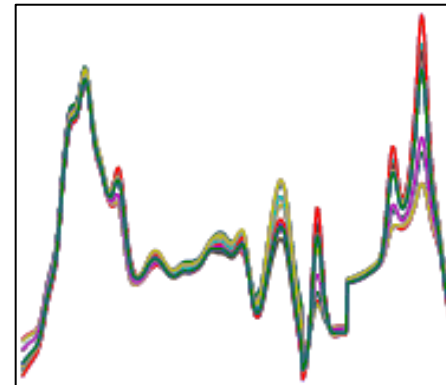
Milk samples



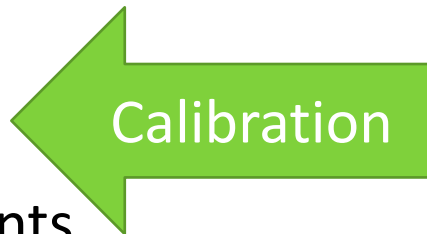
MIR analysis



MIR spectra



Calibration

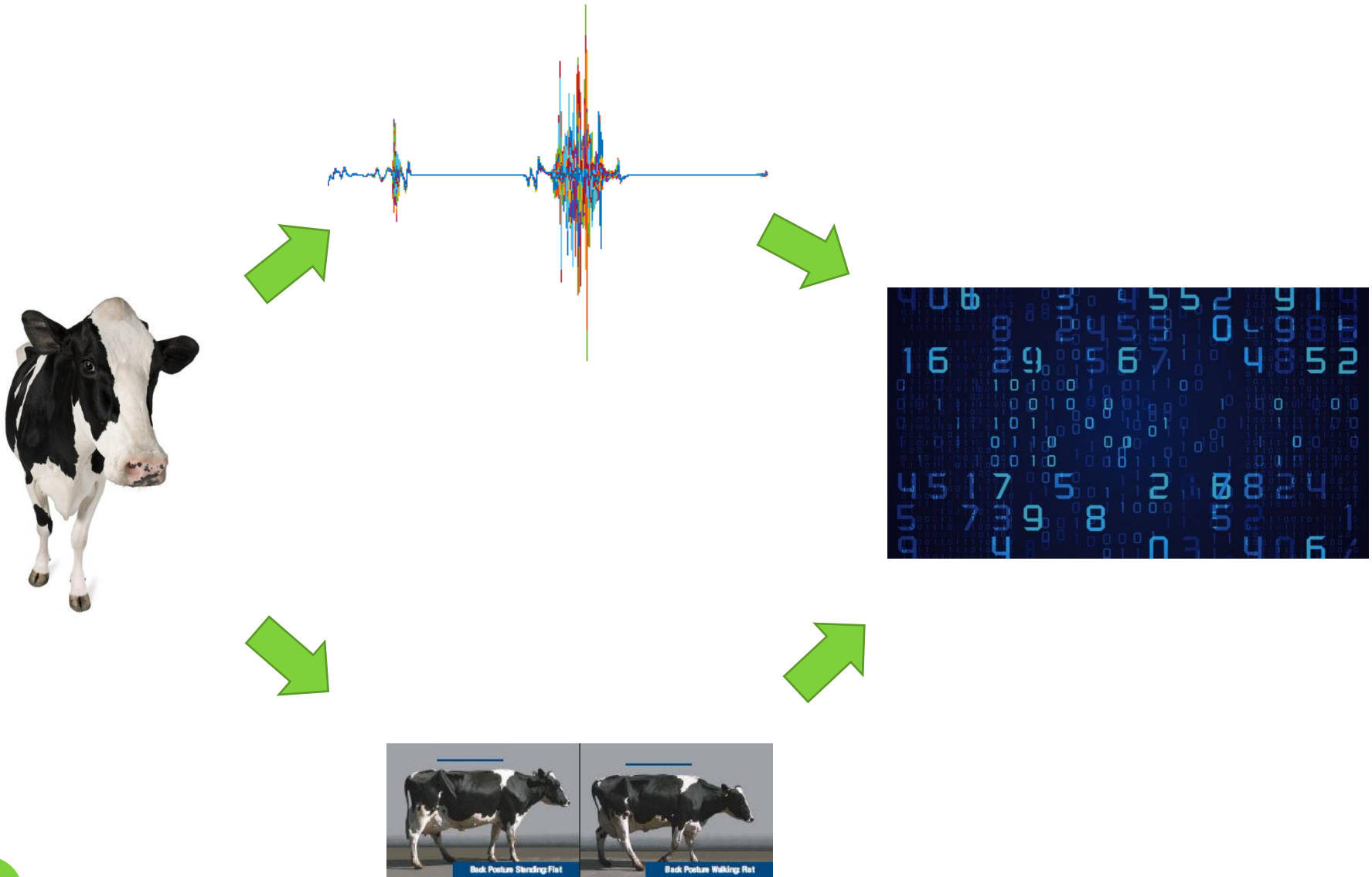


Reference values

- Prediction
  - Major milk components
  - Novel components
  - **Lameness**

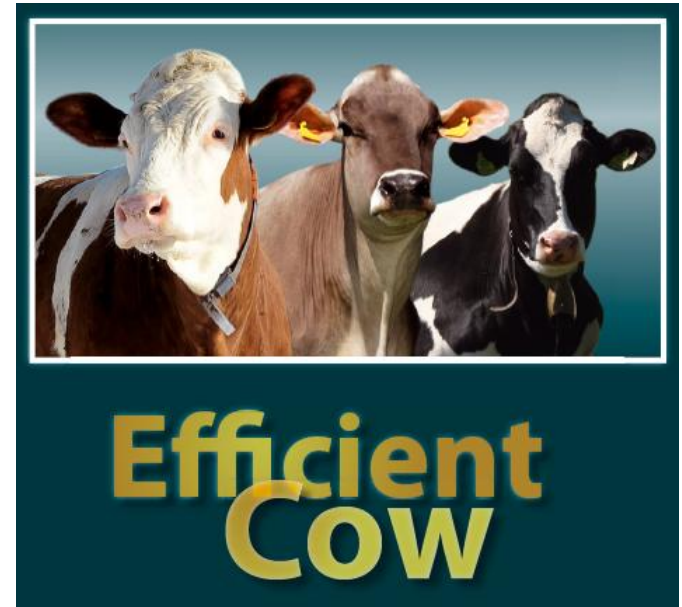


# Need of relevant data



# “Efficient Cow” data

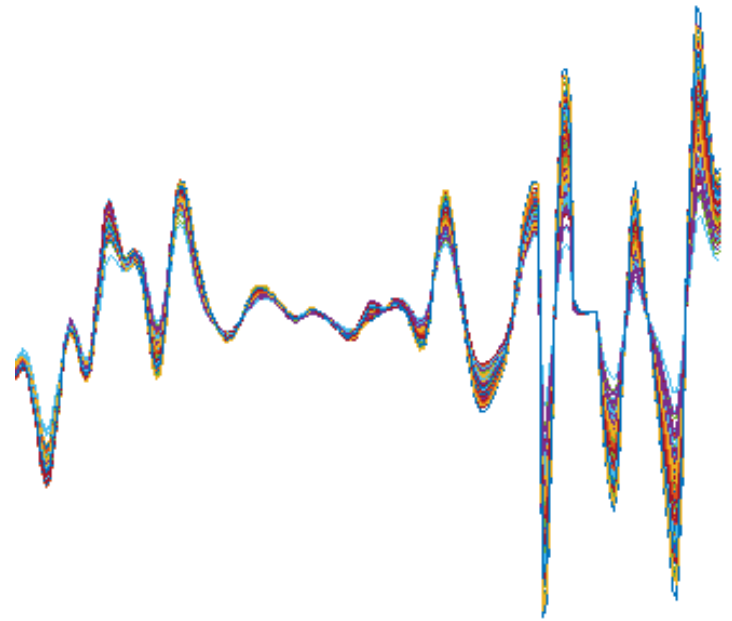
- July to December 2014
- FOSS instruments (FTIR-MIR)
- 47186 => 9324 records (3895 cows, 122 farms)
- Classification
  - Sound = locomotion scores 1, 2
  - Lamé = locomotion scores 3, 4, 5
  - 8% of lame cows



RINDERZUCHT AUSTRIA (ZAR)

# Calibrations using PLS-DA

- Calibration
  - 2/3 of records
- Validation
  - 1/3 of records
- Sensitivity = true positives
  - Truly lame
  - Locomotion scores: 3, 4, 5
- Specificity = true negatives
  - Truly sound
  - Locomotion scores: 1, 2



# Results of calibrations

- All data
  - 11 latent variables (LV)

ALL*	Sensitivity (%) (lame)	Specificity (%) (sound)
Calibration	63	63
Validation	60	62

- Subsets

# Results of calibrations

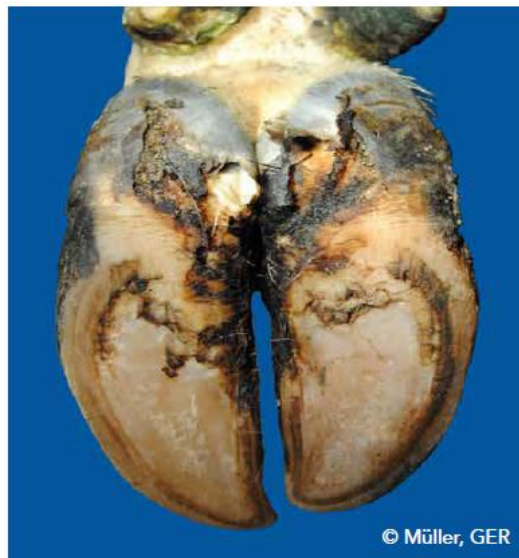
- Breed (% of lame records, locomotion score 3, 4, 5)
  - Brown Swiss: 5.6%, Simmental: 6.5%, Holstein: 9.5%
  - 11 LV

ALL subset		Sensitivity (%) (lame)	Specificity (%) (sound)
Simmental	Calibration	(71) +8	(62) -1
	Validation	(62) +2	(59) -3
Brown Swiss	Calibration	(68) -5	(70) +7
	Validation	(67) +7	(63) +1
Holstein	Calibration	(68) +5	(70) +7
	Validation	(43) -17	(71) +9

# Results of calibrations

- Best result
  - Very specific lesion: Heel horn erosion

ALL subset	Sensitivity (%) (lame)	Specificity (%) (sound)
Calibration	(88) +15	(93) +20
Validation	(85) +15	(91) +19

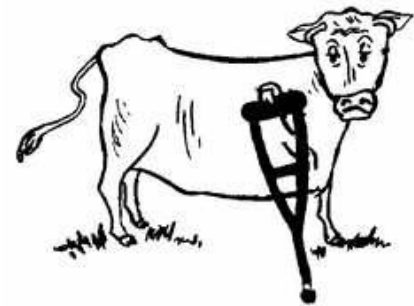


# Conclusions

- Interesting results of calibration
  - More research needed to confirm results
- Great variability – complex trait
  - Causes: potential opposite effects on milk composition
  - Breeds: difference predisposition to lameness
  - Parities: reflecting development and age differences
- More data needed => cover variability

# Perspectives and ideas for future research

- Classical + Innovative data
  - Dairy cow performance
  - MIR, vet, hoof, sensor data
- Definition of novel traits
  - Lameness
  - Metabolic disorders





# Perspectives and ideas for future research

- Genetic studies
  - Genetic variabilities
  - Correlations with other traits
- Develop genomic evaluations
- Collaboration with breeding association (AWÉ)
  - Wellness index => genomic evaluation services



# Acknowledgements

- ZAR
- CRA-W
  - Training
  - Dr. Grelet
- BOKU
  - Pr. Sölkner
- Zuchtdata
  - Dr. Egger-Danner
  - Dr. Köck
- Gembloux Agro-Bio Tech
  - Pr. Gengler

# First results in the use of milk MIR spectra in the detection of lameness in Austrian dairy cows

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# Additional tables and figures

Axelle Mineur

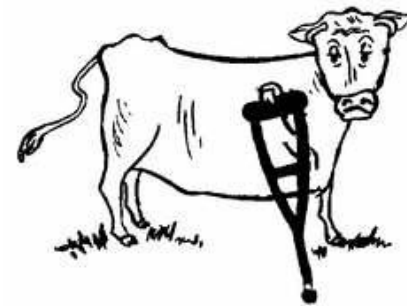
- - locomotion score and MIR
- - excluded 61 records because  $GH > 5$
- - excluded 6687 records because the lactation became longer than 305 days (based on variable days in milk at milk recording)
- - excluded 36 records because the cows were of a different breed than Simmental, Holstein or Brown-Swiss
- - excluded 1889 records that did not have phenotype

# Splitting locomotion scores

PREDICTION	Calibration		Validation	
Subset	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
Prediction	72	62	56	62
Locomotion score 1, 3, 4 and 5	64	69	62	67
Locomotion score 1, 4 and 5	75	72	62	66

# Hypocalcaemia

- Ca deficiency
- Hoof horn quality ↓
- Weakness
- Claw lesions

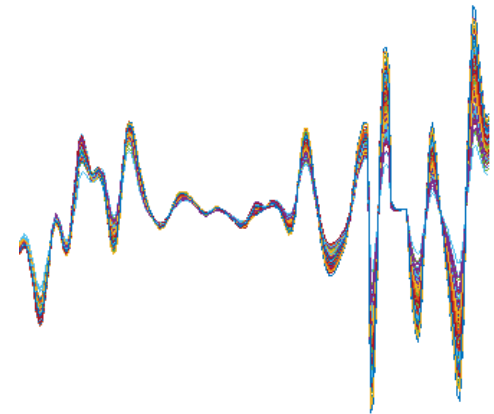




# Calibrations using PLS-DA<sup>\*</sup>

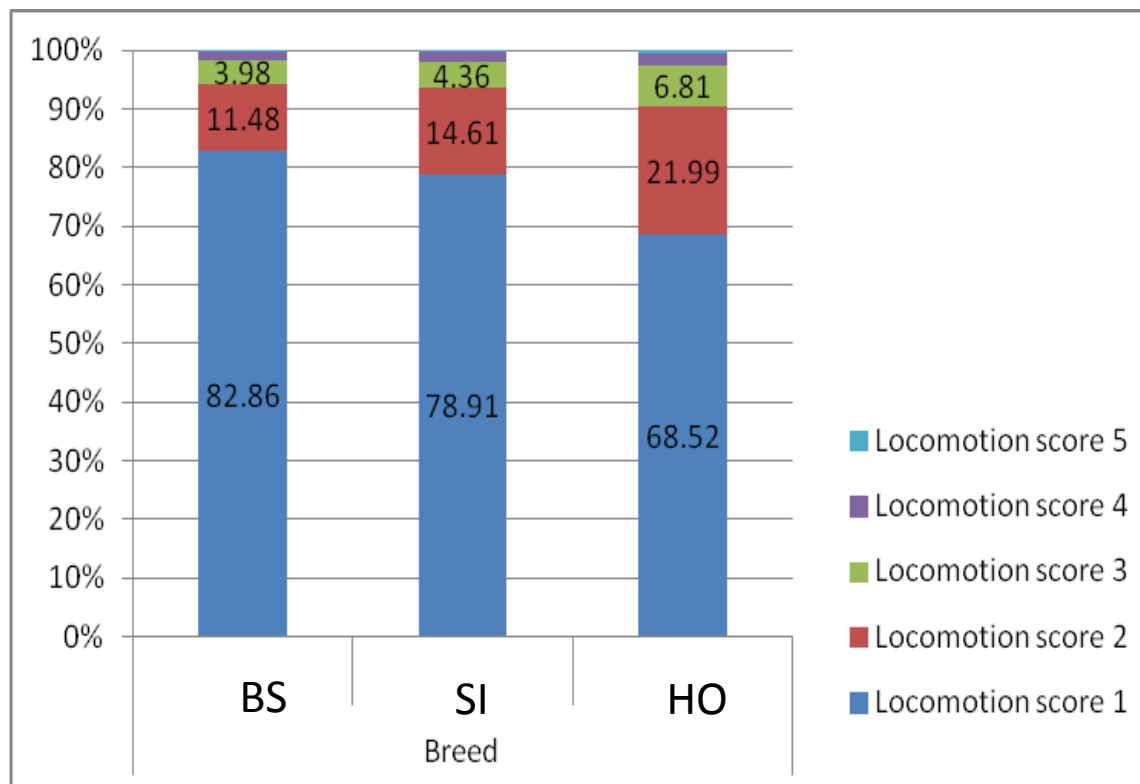
- Classic MIR
  - Spectra
    - ⇒ Sound or lame
  - Subsets

MIR predicted traits



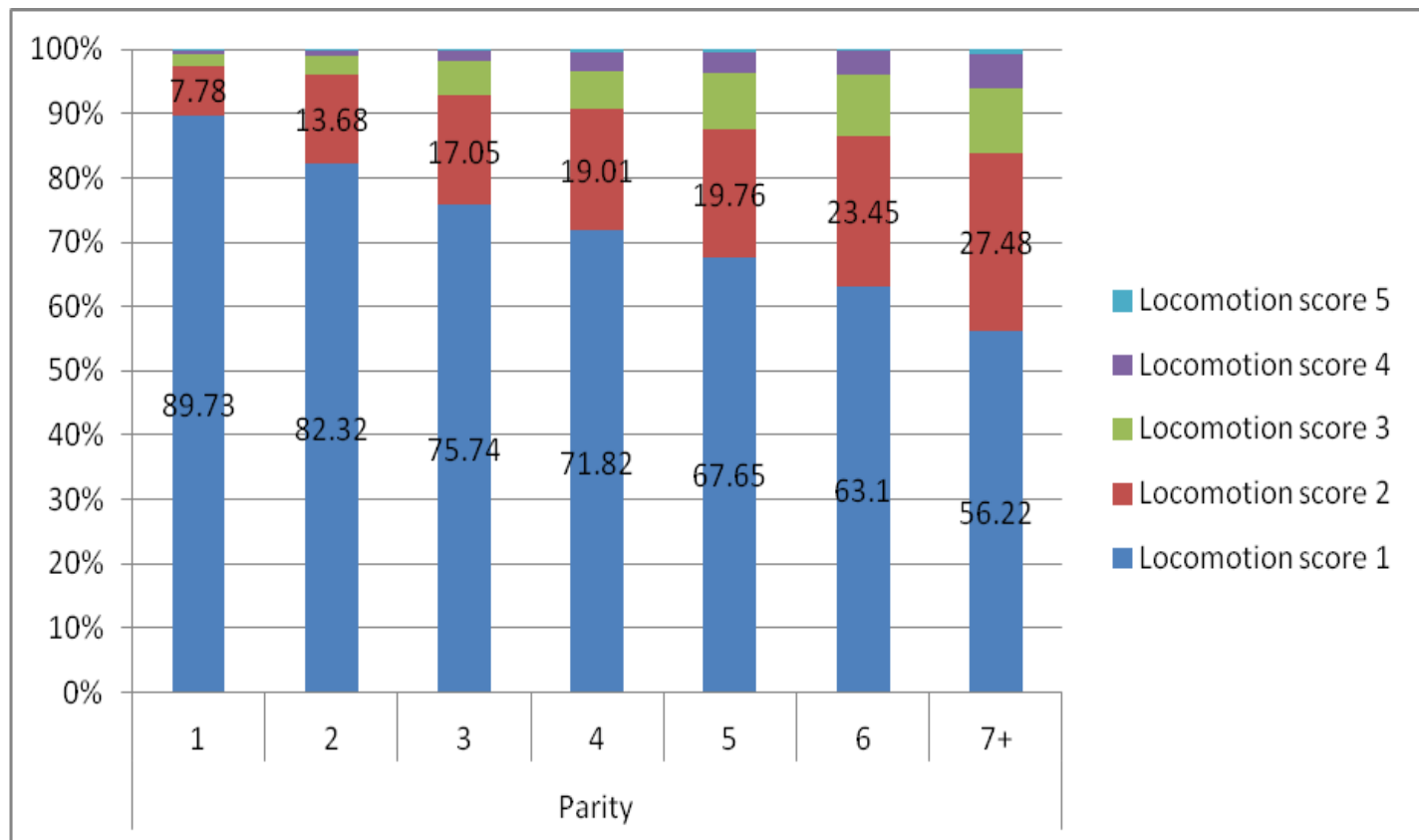
# Results of calibrations

- Breed (% of lame records, locomotion score 3, 4, 5)
  - Brown Swiss: 5.6%
  - Simmental: 6.5%
  - Holstein: 9.5%



# Results of calibrations

- Parity (% of lame records, locomotion score 3, 4, 5)
  - Heifers: 2.49%
  - 7+ lactations: 16.3%



# Results of calibrations

- Parity (% of lame records, locomotion score 3, 4, 5)
  - Heifers: 2.49%
  - 7+ lactations: 16.3%
  - 11 LV

ALL subset		Sensitivity (%) (lame)	Specificity (%) (sound)
Heifer (lact 1)	Calibration	(73) +10	(67) +4
	Validation	(56) -4	(65) +3
Young (lact 1 or 2)	Calibration	(71) +8	(59) -4
	Validation	(49) -11	(58) -4
Old (lact >2)	Calibration	(68) +5	(60) -3
	Validation	(60) =	(61) -1

# Results of calibrations

- Complex relationship
  - Lameness
  - Milk composition
- Often better for specificity (sound) than sensitivity (lame)

# Sampling distance

