LIÈGE université Gembloux Agro-Bio Tech

ZAR RINDERZUCHT AUSTRIA

ZuchtData EDV-DIENSTLEISTUNGEN GMBH

BOKU Universität für Bodenkultur Wien

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

Axelle Mineur

Co-promoters:

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Pr. Johann Sölkner (BOKU)

Supervisor:

Dr. Christa Egger-Danner (ZuchtData)

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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

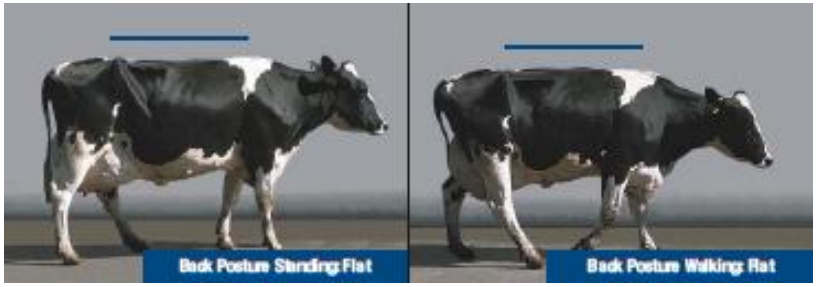
- Assessment of lameness
- Many systems
- Based on levels
- Differences in:
  - Gait
  - Back arch

- For this research

⇒ Sprecher *et al.*, 1997

- Trained staff!

1



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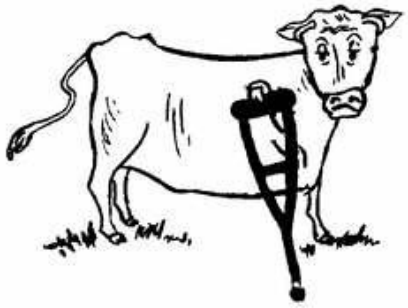
Objective

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

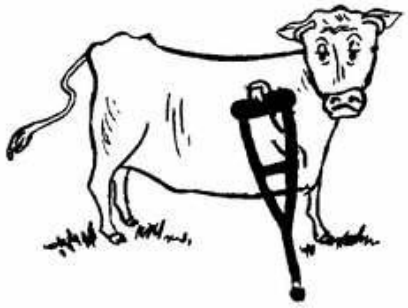
Lameness, metabolic disorders & milk composition
Theory



METABOLIC DISORDERS

- Body fat mobilization – Ketosis
- Sub Acute Ruminal Acidosis

Lameness, metabolic disorders & milk composition
Theory

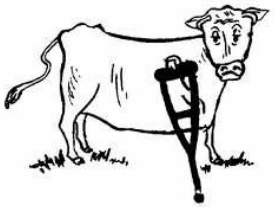


METABOLIC DISORDERS

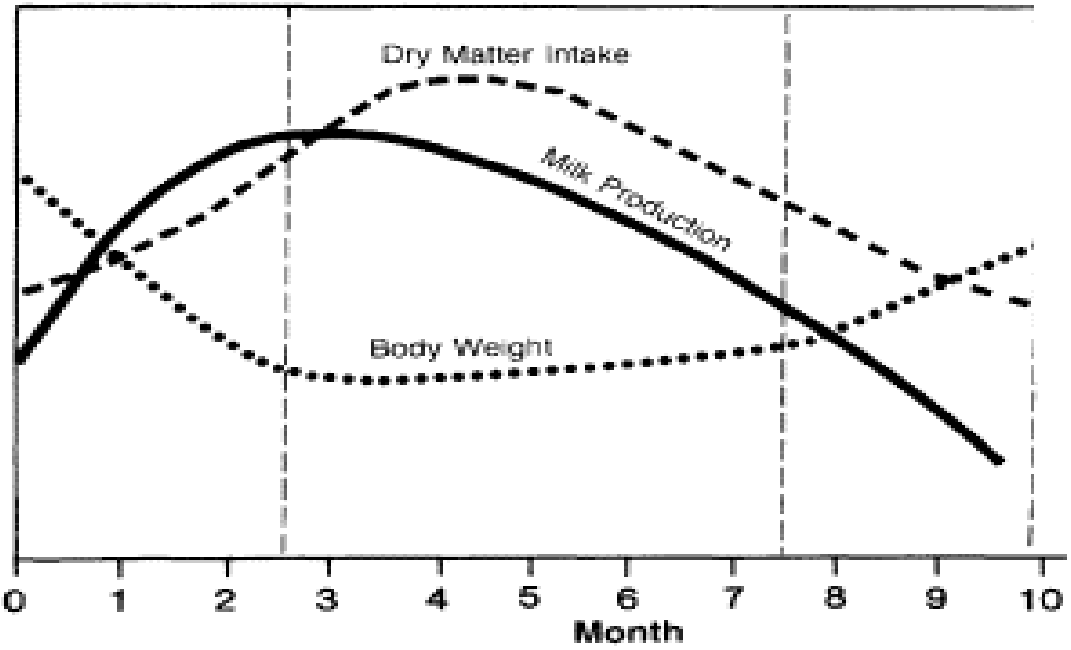
- **Body fat mobilization – Ketosis**
- Sub Acute Ruminal Acidosis

Body fat mobilization - Ketosis

1. F:P ratio↗, NEFA, C18:1cis9
2. Citrate
3. BHB, acetone

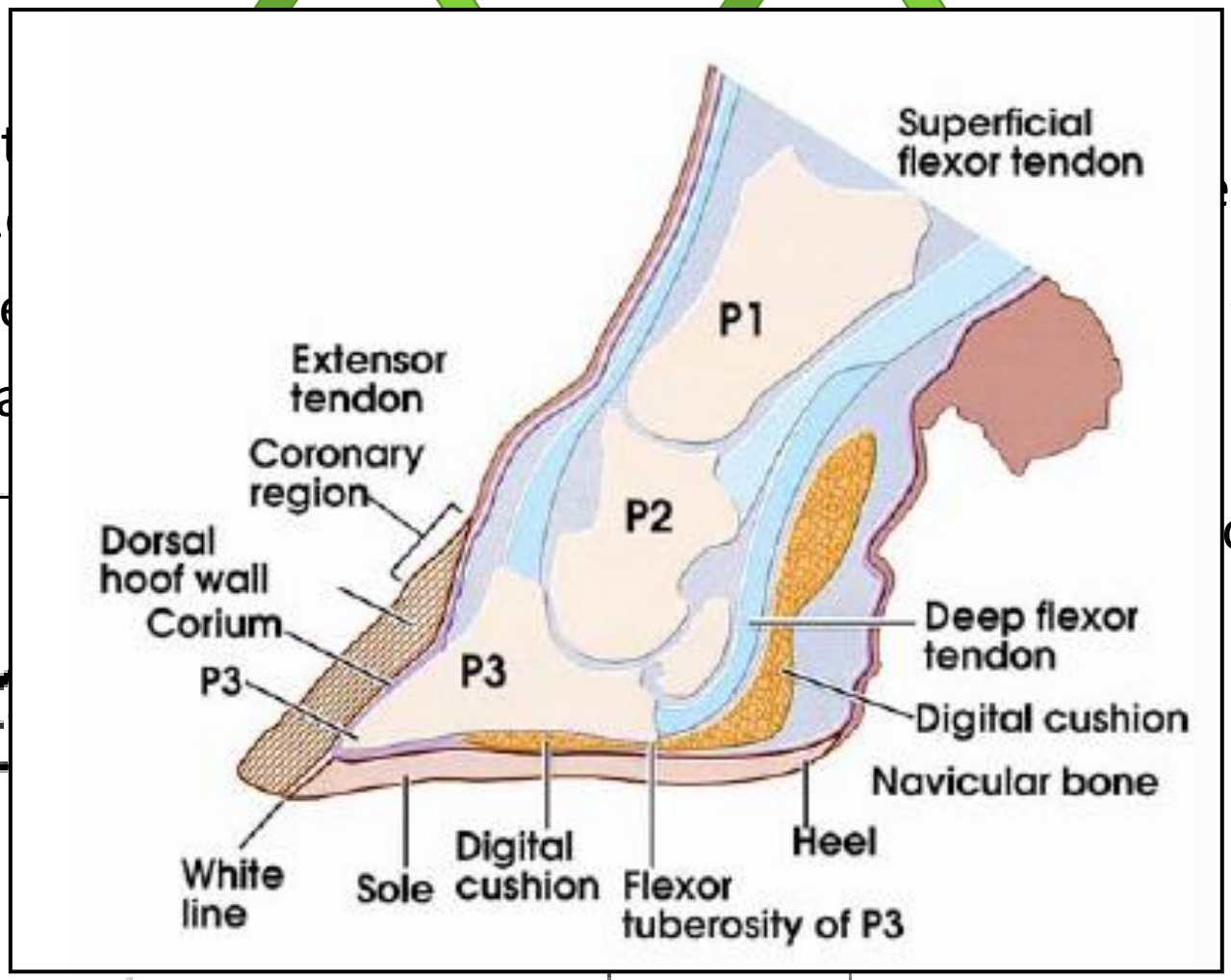


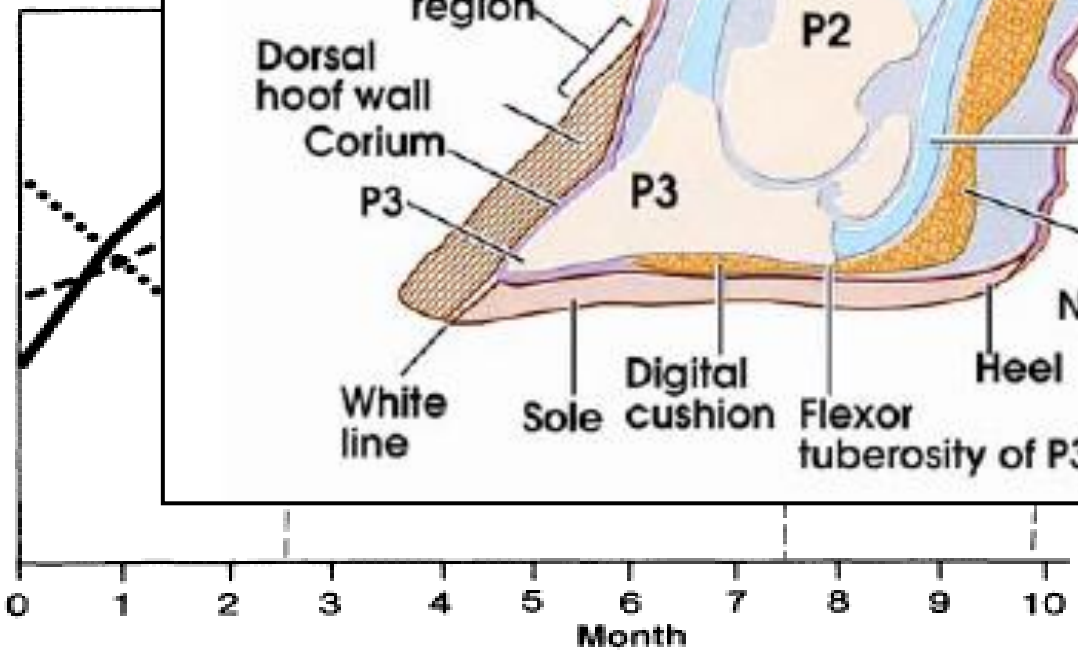
1. Smaller feed intake
2. F:P ratio↗, NEFA, C18:1cis9
3. Citrate
4. BHB, acetone



Body fat mobilization - Ketosis

1. F:P rat… C18:1… …ed intake
2. Citrate… …, NEFA,
3. BHB, a… …one





Body fat mobilization - Ketosis

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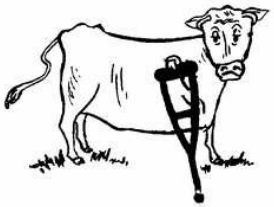

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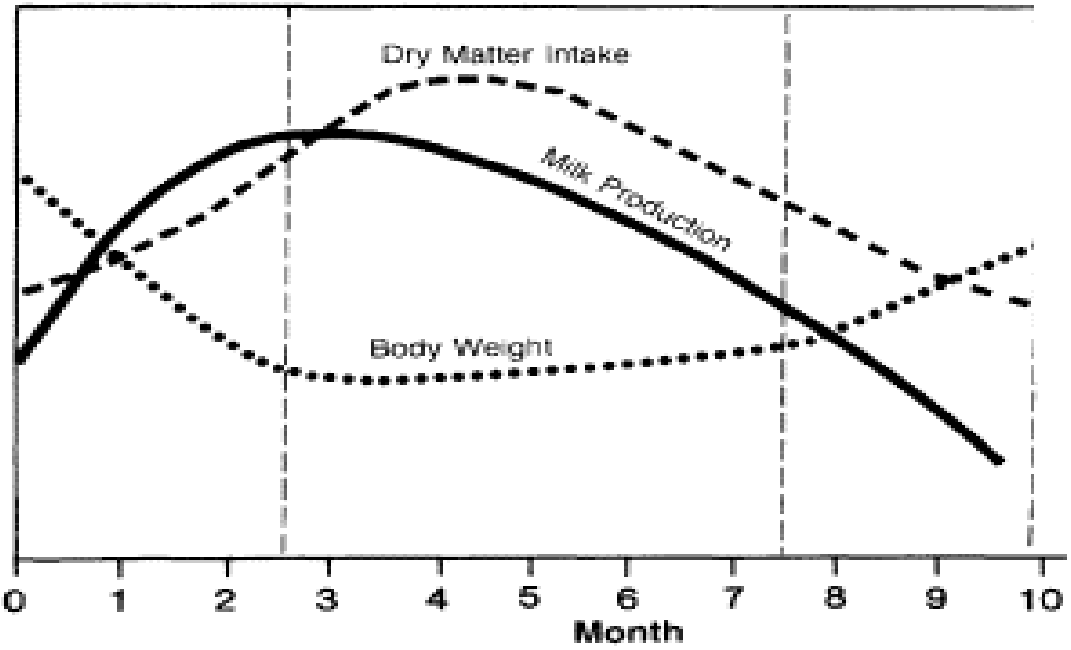
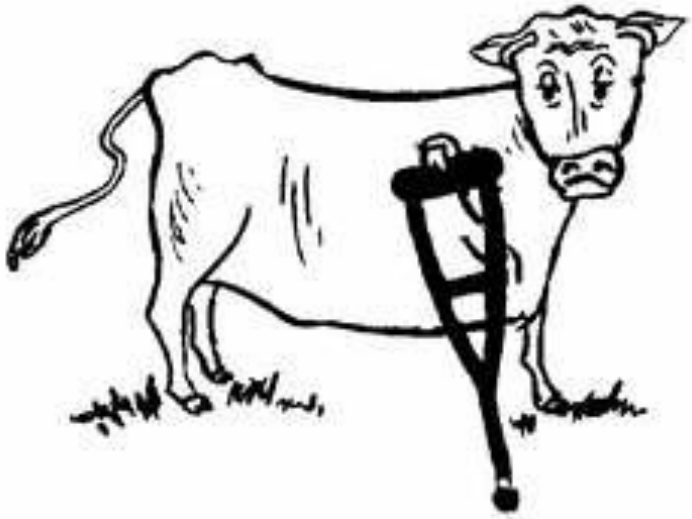


Lameness & milk composition

Practice



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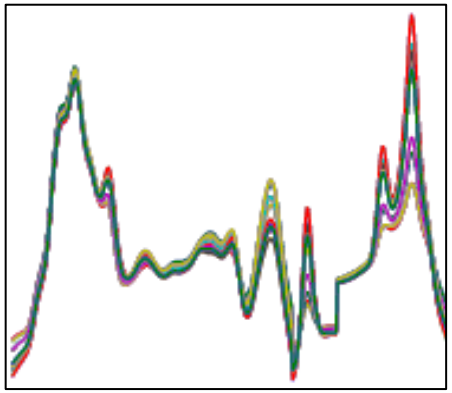
Mid-infrared (MIR) spectroscopy

Milk samples

MIR analysis

MIR spectra



Calibration

Reference values

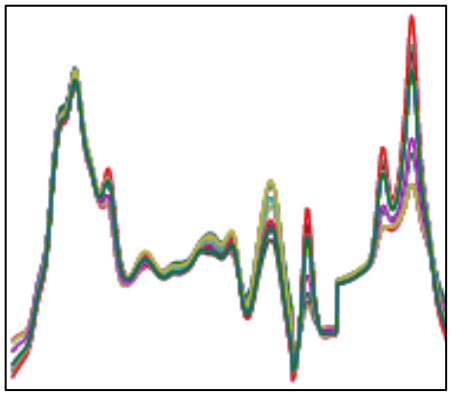
- Prediction
  - **Major milk components**
    - Fat
    - Protein
    - Urea
    - Lactose

MIR spectroscopy

Milk samples

MIR analysis

MIR spectra



Calibration

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

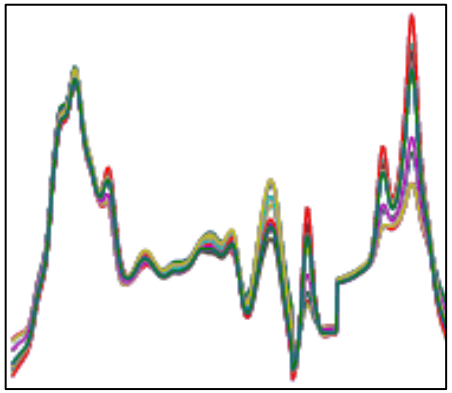
Reference values

MIR spectroscopy

Milk samples

MIR analysis

MIR spectra

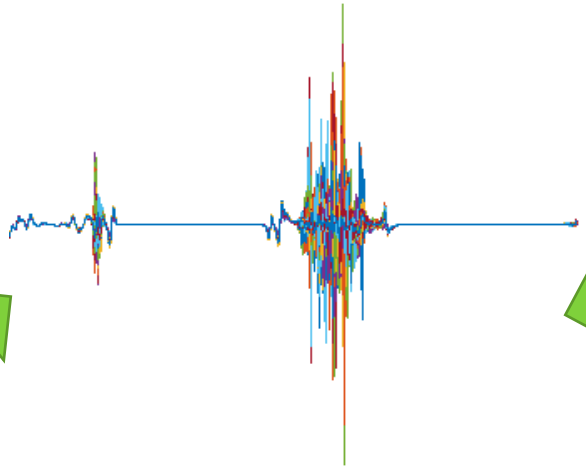


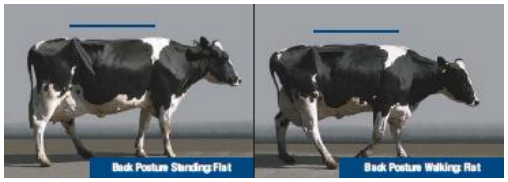
- Prediction
  - Major milk components
  - Novel components
  - **Lameness**

Calibration

Reference values

Need of relevant data





“Efficient Cow” data

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

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

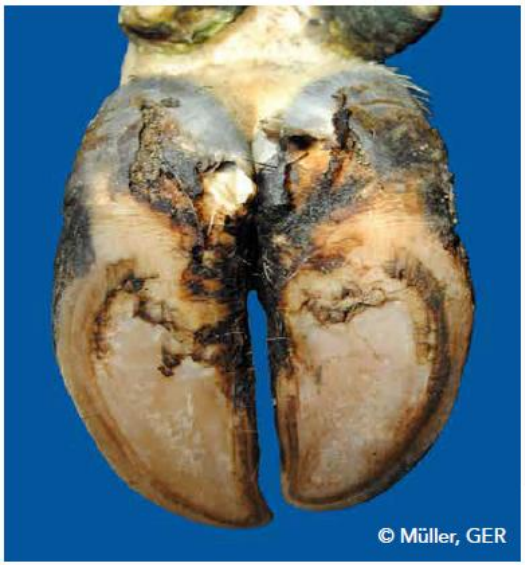
- Breed (% of lame records, locomotion score 3, 4, 5)
  - Brown Swiss: 5.6%, Simmental: 6.5%, Holstein: 9.5%
  - 11 LV

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



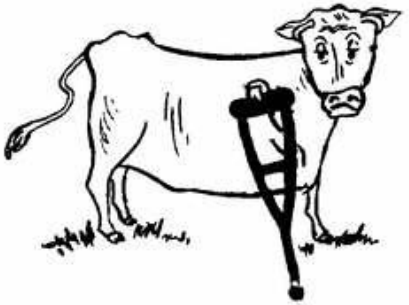
Conclusions

- 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

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Axelle Mineur

2017-09-21

Additional tables and figures

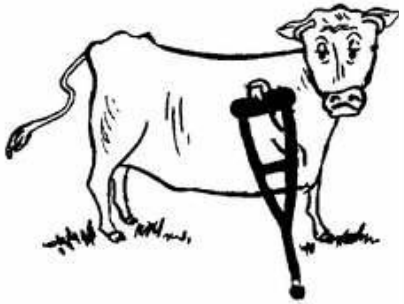
Axelle Mineur

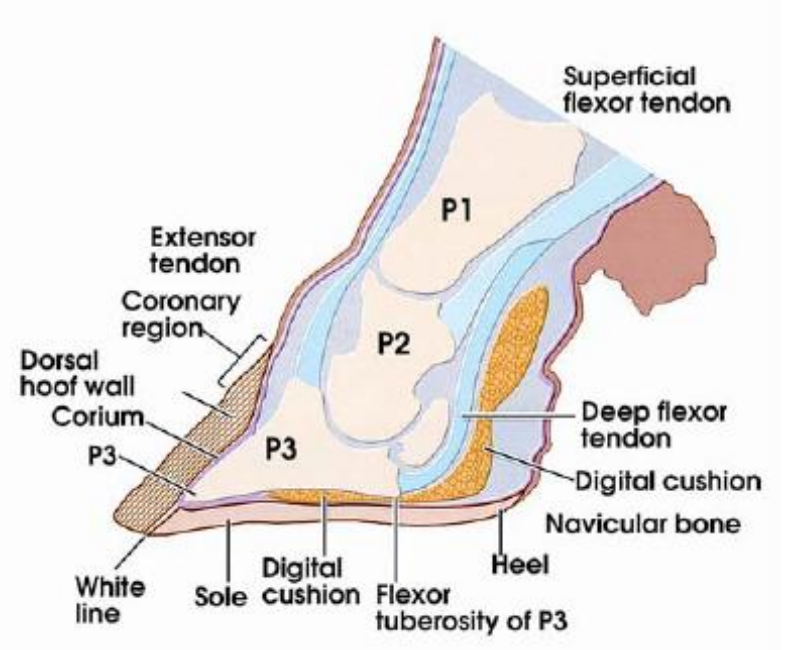
Acknowledgements

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

Sub Acute Ruminal Acidosis

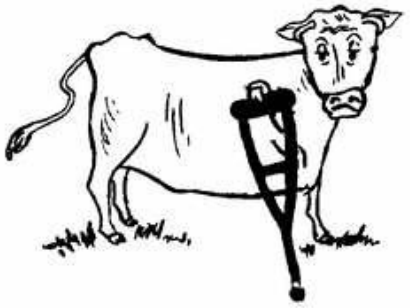
1. Rumen pH
2. Bacteria in blood
3. Laminitis
4. F:P ratio ↘





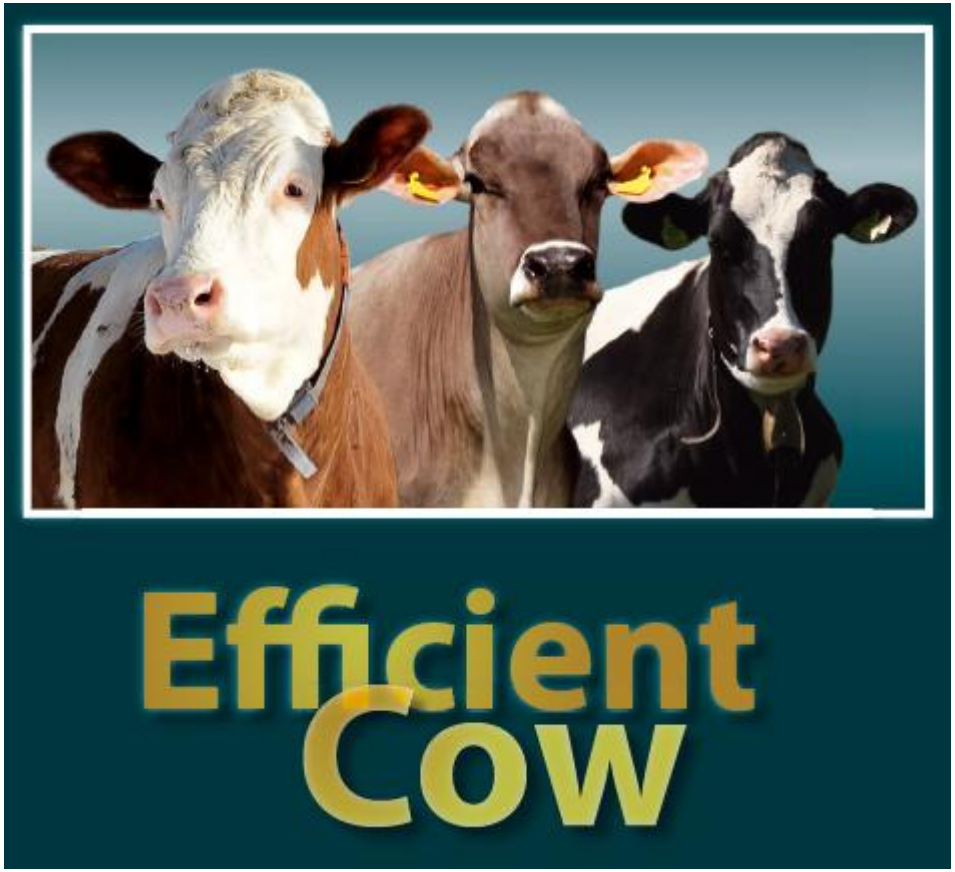
Hypocalcaemia

- Ca deficiency
- Hoof horn quality ↘



- Weakness
- Claw lesions

Luckily:



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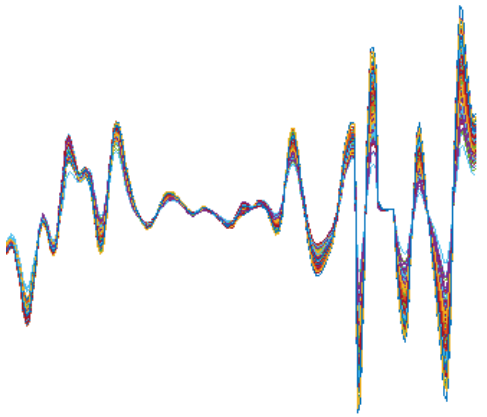
Calibrations using PLS-DA*

- Classic MIR
  - Spectra

  ⇒ Sound or lame

  - Subsets

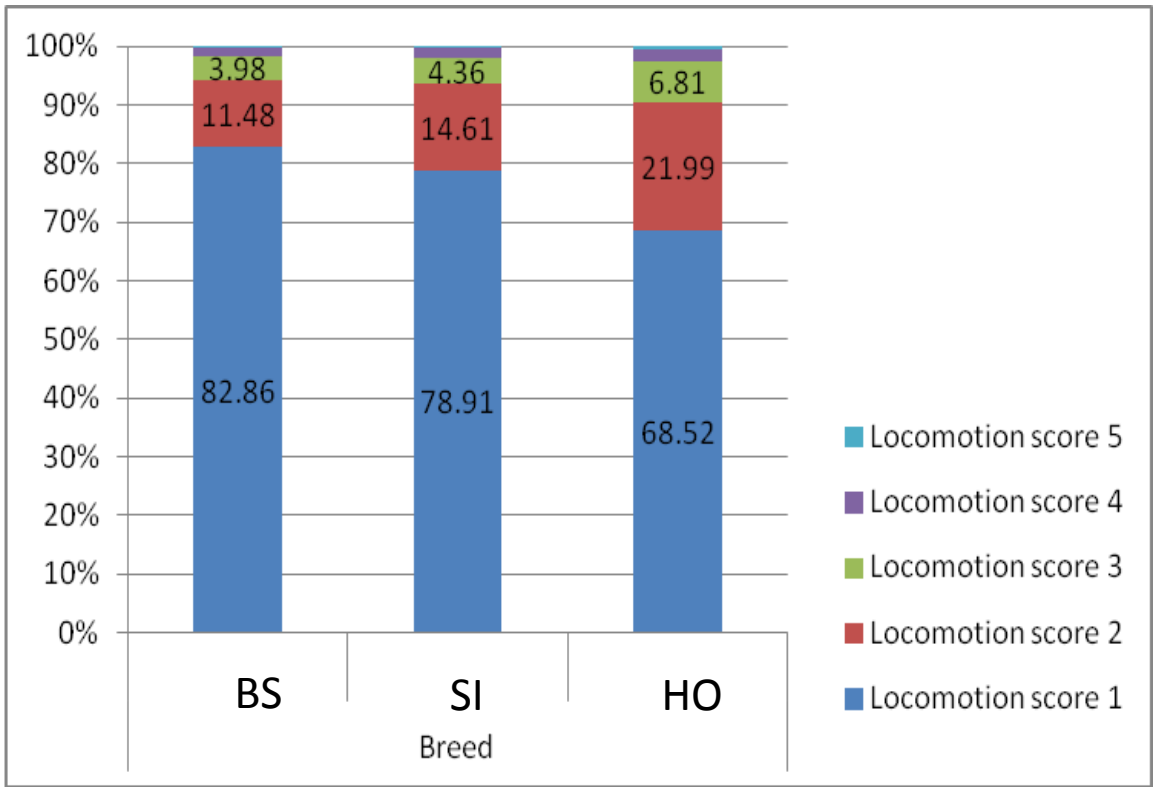
MIR predicted traits



*Partial Least Square – Discriminant Analysis

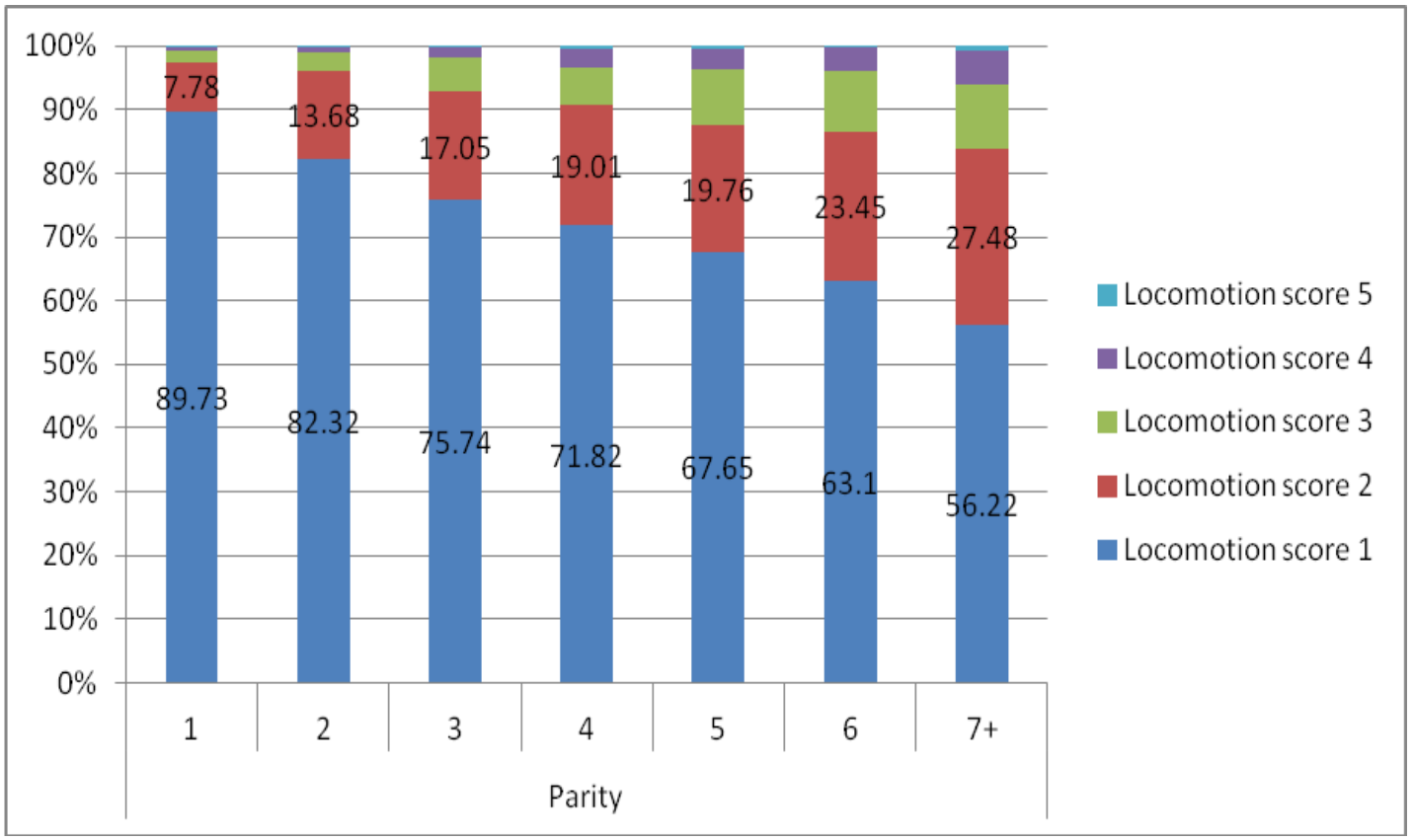
Results of calibrations

- 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

* Mineur et al., 2017 (submitted)

Results of calibrations

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