Prediction of cow pregnancy status using conventional and novel mid-infrared predicted milk traits

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Context: Management Indicator Traits (MIT)

Fertility

- Economics:
  - Main mover affecting the economical return
- Genetics:
  - Traits with low heritabilities

Innovative tools based on robust MIT’s are of interest for:

- Profitability and sustainability
  - Reduction of production costs
  - Increase of incomes
Context: Pregnancy & milk composition

- Diagnosis methods: costly, labor and investments

- Negative energy balance (NEB) ➔ delayed first ovulation and pregnancy rates

- Association “energy balance - milk composition”:
  - Variation in fat and protein / fat:protein
  - *de novo* synthesis of fatty acids (C6:0 to C14:0)
  - Body fat mobilisation (C16:0 and C18:0)

- No study looked into the associations between milk composition and probability of conception
Objective

Ability of cow milk characteristics to predict the cow pregnancy status once inseminated

- Using only conventional milk component (fat, protein, lactose, and SCC)
- Extended to fatty acids
Data

- **Data sets** “repro check program” CONVIS, Luxembourg

  - AI records (9,996) and diagnosis results (2,826)
  - Test-day records (40,548)
  - Spectral data (35,555)

  \[ \Rightarrow \] 6,147 lactations from 4,674 cows in 169 herds

- **Pregnant cow is defined as**
  - Positively checked
  - If no check (based on new registered calving)
  - Otherwise the cow was discarded from analysis
Methods

- **Predictors** (Milk components)
  - Conventional
    - Modified best prediction method (Gillon *et al.*, 2010)
      - Yields at specific DIM
      - Cumulated yields at specific DIM
      - Peaks, minimum
      - Ratios
  - Fatty acids
    - MIR equations (Soyeurt *et al.*, 2011)
      - Yields at the nearest TD to last AI
      - Cumulated yields at specific DIM
      - Ratios
Methods

- Separate **logistic regression** models
  - 3 periods
    - 35 to 44 days from last AI (DAI)
    - 45 to 60 DAI
    - 60 to 90 DAI
  - Lactation number (1, 2, 3 and plus)
  - Holsteins
- **Calibration** dataset (n=1,346 cows)
- **Validation** dataset (n=733 cows)
**Predictive power “Holsteins 1st lactation”**

Associations between predicted and observed probabilities of pregnancy at 3 periods

### Only conventional

<table>
<thead>
<tr>
<th>DAI</th>
<th>35-44</th>
<th>45-60</th>
<th>60-90</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$ (calibration)</td>
<td>0.96</td>
<td><strong>0.98</strong></td>
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</tr>
<tr>
<td>$R^2$ (validation)</td>
<td>0.76</td>
<td><strong>0.83</strong></td>
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### Conventional + FA

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Predictive power “Holsteins - 1st lact. 45-60 DAI”

Calibration model
(n= 58 cows/group)

\( y = 0.9918x + 0.5918 \)
\( R^2 = 0.9899 \)

Validation model
(n= 30 cows/group)

\( y = 0.6424x + 25.659 \)
\( R^2 = 0.8725 \)

→ good predictive power

The dots represent the average predicted probabilities of 10 groups of cows that are plotted against their respective average observed probabilities.
Expert system

- Raw spectral data
- Fine milk components prediction
- CMR + Novel traits
- Animal DB
- Data modeling
- Prediction functions
- Fertility Module
  - Pregnancy
- Health Module
  - Mastitis
- Feeding Module
  - Energy balance
- Other Modules

Farm reports and innovative tools for herd management
Conclusions

- Logistic regression model was able to predict the pregnancy status using combination of predictors based on milk routine analysis (even if the cow number was limited).

- FA predictors added to conventional milk component measurements improved slightly the prediction ability of studied models.

- Farmers could be able to identify pregnant cows and limit diagnosis to only problematic cows.
Perspectives

- Need more data and *cows with spectral data* to validate the final models.

- Apply multi-level logistic regression models (multi-lactations, breeds, production systems,…)

- Evaluate the potentiality of models fits and prediction power when additionally using extra-data (health, feeding, BCS,…).
Acknowledgments
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