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)

  ➔ 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

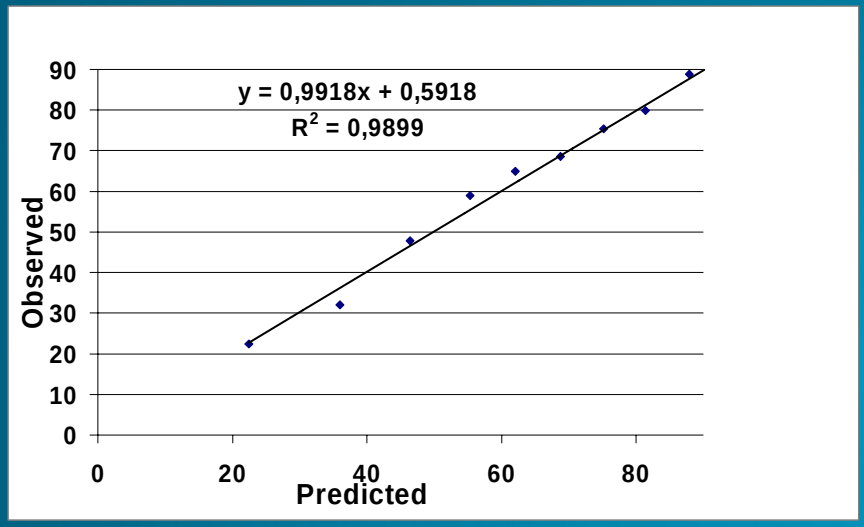
Only conventional

DAI	35-44	45-60	60-90
R^2 (calibration)	0.96	**0.98**	0.96
R^2 (validation)	0.76	**0.83**	0.76

Conventional + FA

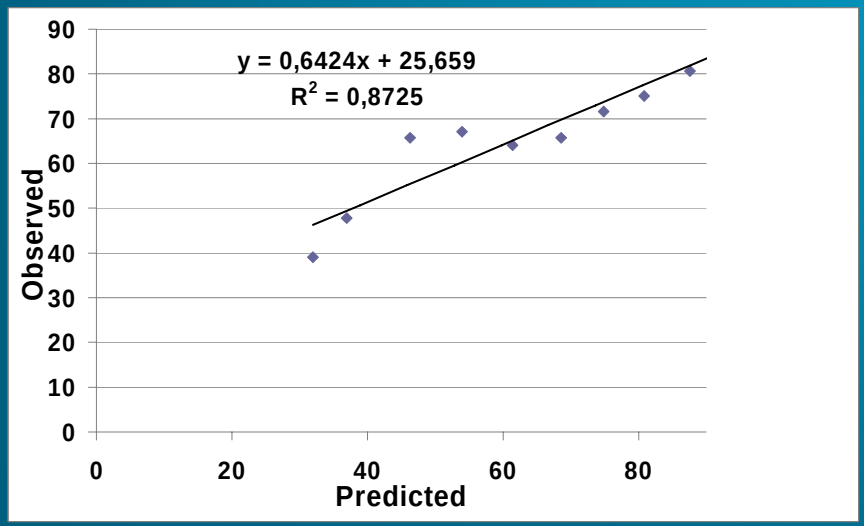
DAI	35-44	45-60	60-90
R^2 (calibration)	0.97	**0.99**	0.96
R^2 (validation)	0.79	**0.85**	0.83

Predictive power "Holsteins - 1st lact. 45-60 DAI"



Calibration model
(n= 58 cows/group)

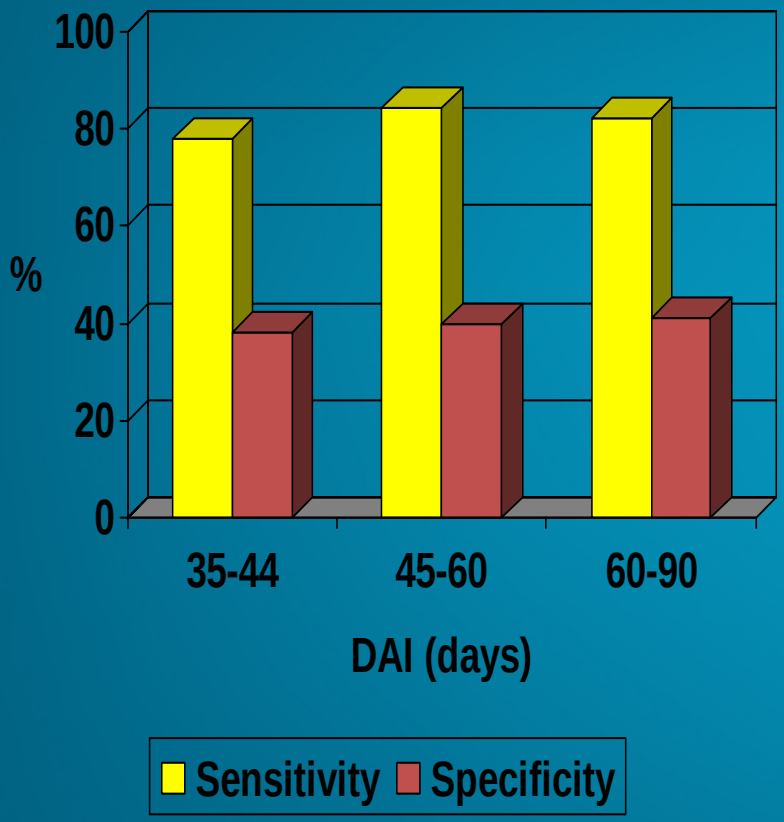
(**R^2 = 0.99**)



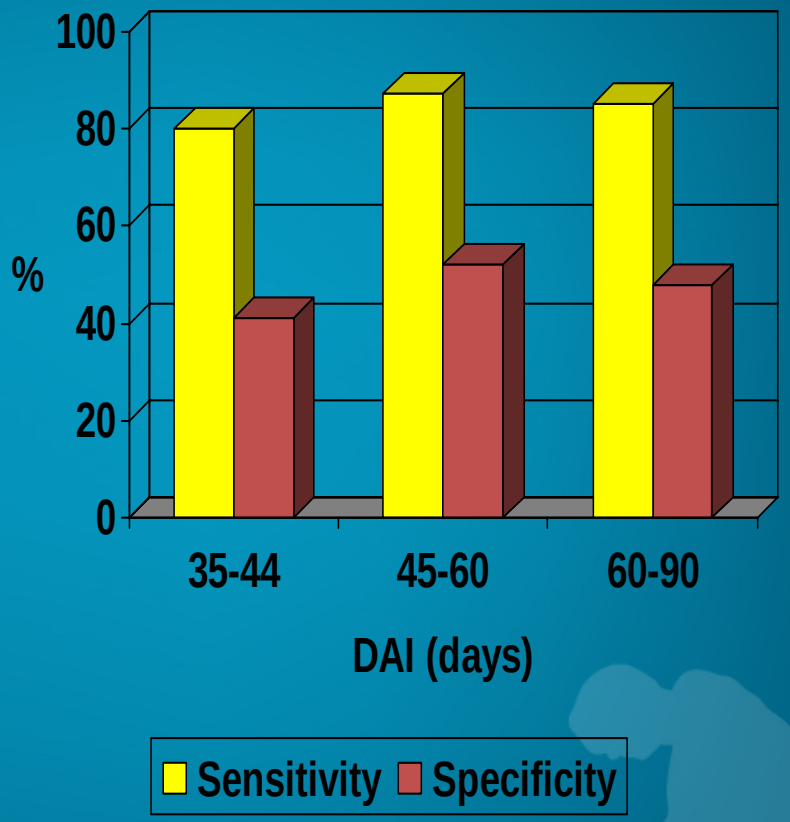
Validation model
(n= 30 cows/group)
(**R^2 = 0.87**)
→ good predictive power

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

Sensitivity and specificity

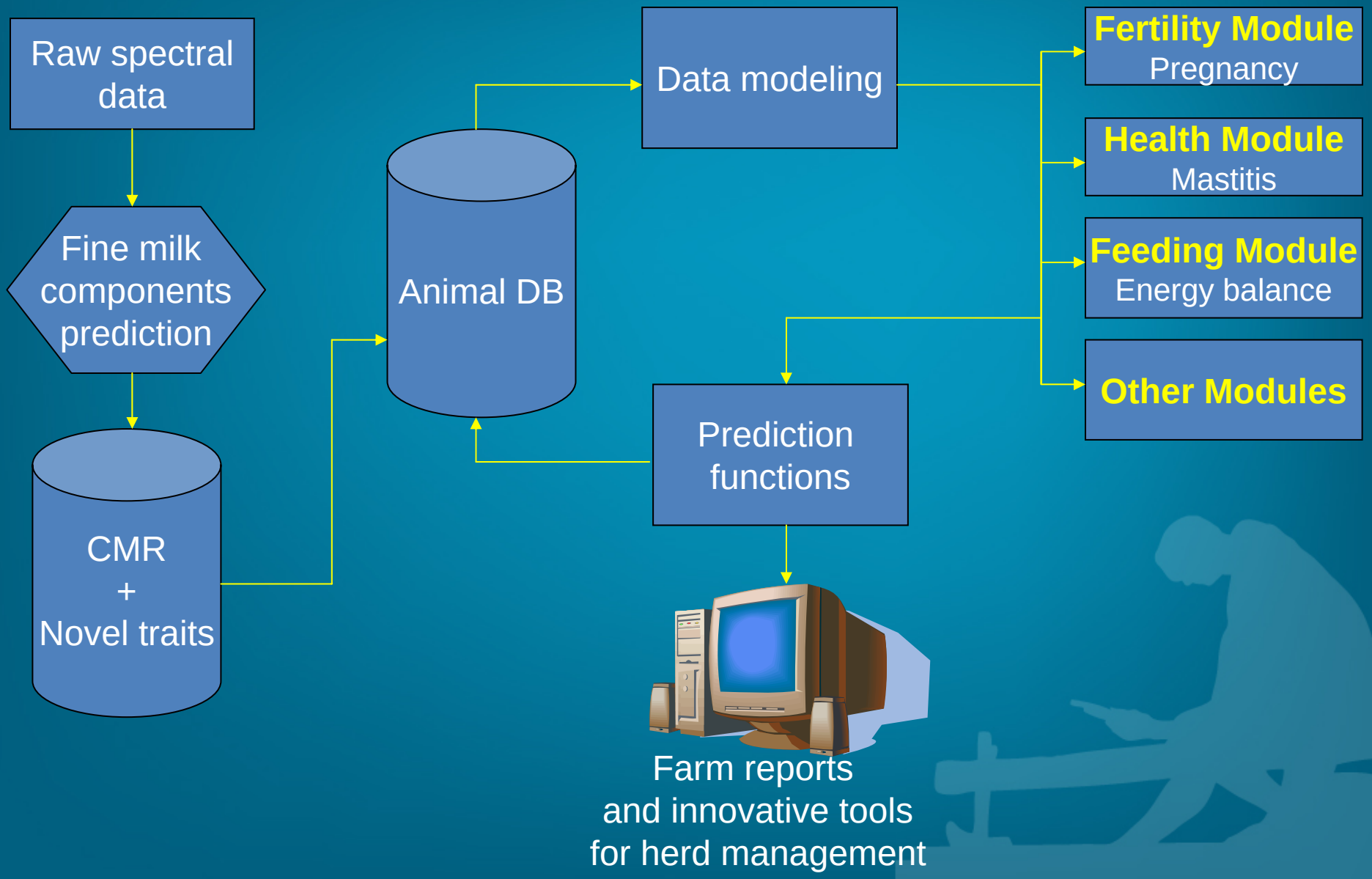


Only conventional



Conventional + FA

Expert system



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,…)

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Thanks a lot for your attention

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