GENETIC CORRELATIONS BETWEEN **ENERGY STATUS INDICATOR** TRAITS AND **FERTILITY** IN NORDIC RED DAIRY COWS

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EAAP 2019 Ghent, Belgium

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Outline

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  - Importance of energy status
  - Determining energy status
- Material and methods
  - Data
  - Model
- Results
  - Genetic parameters of energy status indicators
  - Genetic correlations between indicators and fertility
- Conclusions

The importance of energy status

- Breeding for feed efficiency has started in the Nordic countries
- Unfavourable relationship between feed efficiency and energy status
- Severe negative energy status may lead to various health and fertility problems

→ When breeding for feed efficiency considering energy status is important

Determining energy status is a challenge

1) Calculated energy balance is one indicator and requires:
   - Dry matter intake & diet energy density,
   - Body weight
   - Milk production & composition

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Rarely recorded on-farms!

- Accuracy may be low due to accumulation of measurement errors
- Are the cows in calculated negative energy balance in metabolically imbalanced state?

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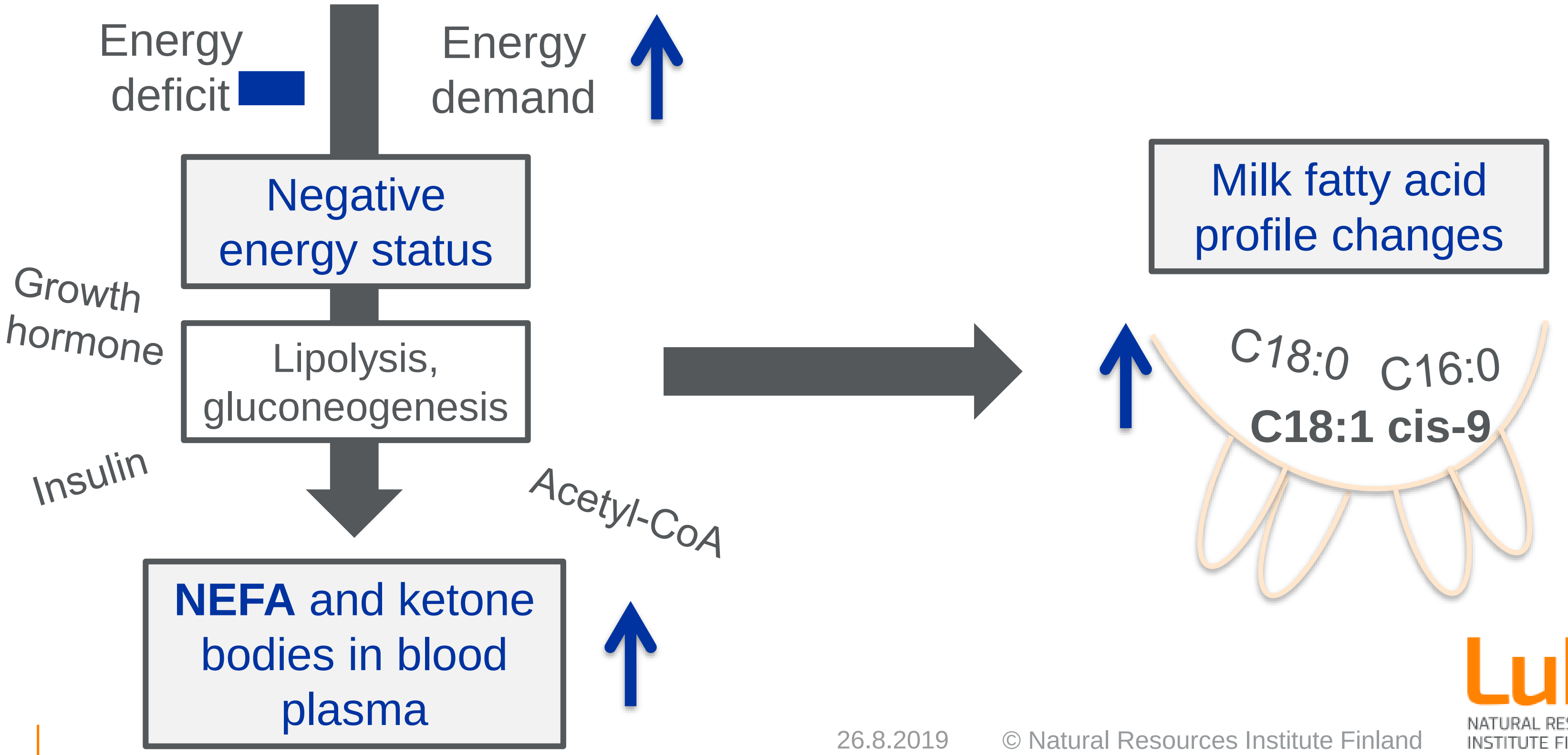
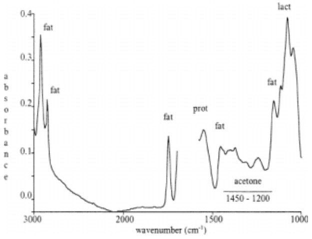
2) Energy status indicator traits

Lipolysis and related energy status indicators



Mid-infrared reflectance spectroscopy (MIR) of milk samples

- Prediction equations earlier developed for
  - Milk fatty acids
  - Blood and milk β-hydroxybutyrate (BHB)
  - Blood and milk acetone



Mid-infrared reflectance spectroscopy (MIR) of milk samples

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  - Milk fatty acids
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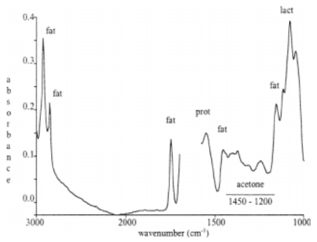
And recently blood NEFA (non-esterified fatty acids)



Objectives of this study

Are the newly developed NEFA predictions in early lactation

1. heritable,
2. correlated with fertility,
3. and how do they compare to other energy status indicators?

Studied energy status indicator traits

1) **$NEFA_{MIR}$** predicted directly from milk MIR spectra (Mehtiö et al., 2018)

2) **$NEFA_{FA}$** predicted by days in milk, FPR, milk fatty acids C10, C14,

C18:1 cis-9 and C14*C18:1 cis-9 (Mäntysaari et al., 2019)

3) Milk fatty acid **C18:1 *cis*-9** (Soyeurt et al., 2011)

4) Milk fat to protein ratio (**FPR**)

5) Milk **BHB** (FOSS, based on de Roos et al., 2007)

6) Milk **acetone** (FOSS, based on de Roos et al., 2007)

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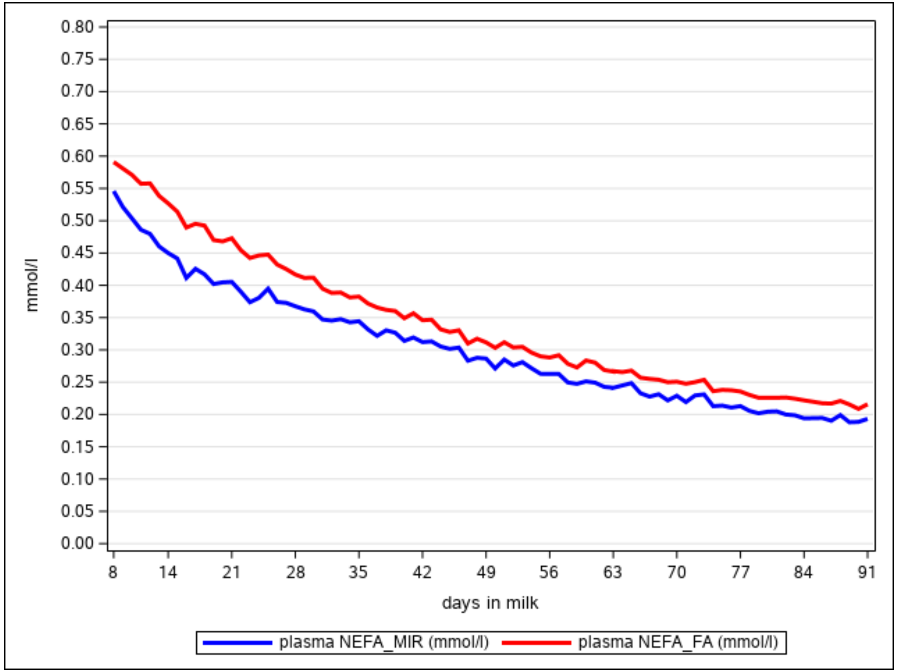
Studied fertility trait

Interval from calving to first insemination (ICF)

- One of the most important female fertility traits
- Measured in days
- Describes the ability of the cow to resume cyclicity after calving and show estrus
- Expected to be affected by negative energy status in early lactation

Data set for variance component estimation

- 37 424 primiparous Nordic Red Dairy cows
  - Routine milk test-day records between 8 and 91 days in milk



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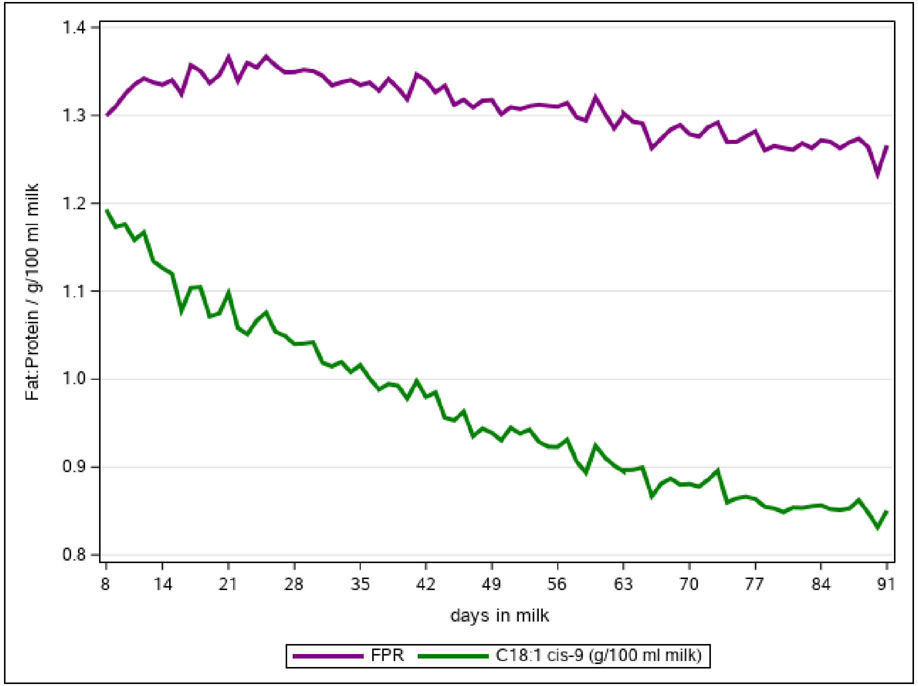

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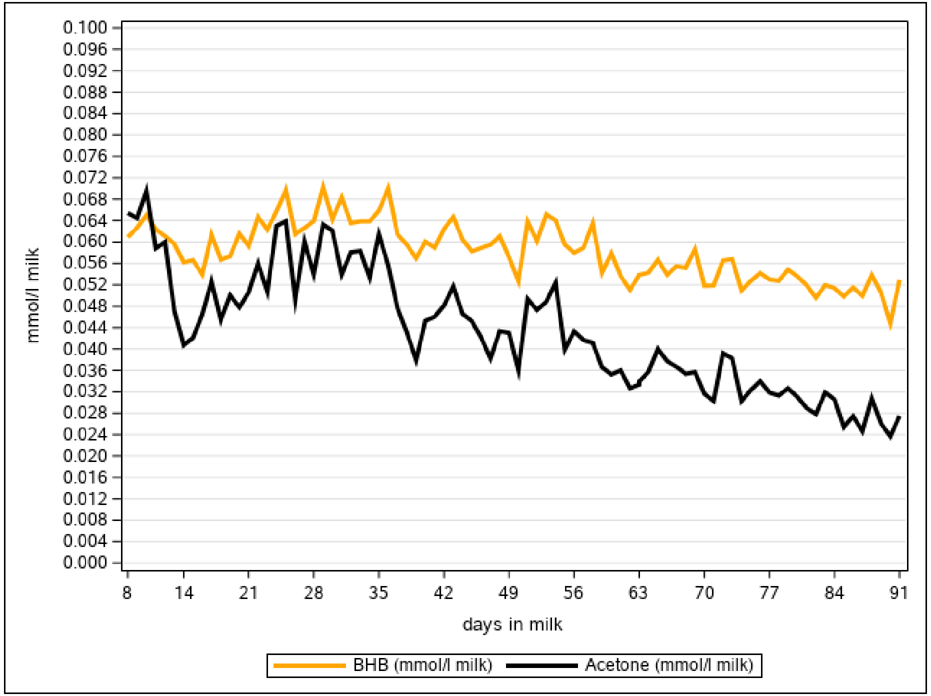

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Model

- Observations from 3 time periods, **8-35**, **36-63** and **64-91** DIM, were used
- Each period was considered as different correlated traits
- Applied model for uni- and multivariate analyses was :

$$\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \mathbf{Z}\mathbf{a} + \mathbf{e}, \text{ where}$$

y = vector of observations,

β = vector of fixed effects of herd, year-month, age at calving, and regression on DIM

a = vector of random animal additive effects

e = vector of random residuals

X and **Z** = corresponding design matrices

Estimated heritabilities from single-trait analyses for energy status indicators

Trait	8-35 DIM	36-63 DIM	64-91 DIM
$NEFA_{MIR}$	0.17	0.13	0.16
$NEFA_{FA}$	0.17	0.10	0.12
C18:1 cis-9	0.14	0.09	0.10
FPR	0.08	0.07	0.10
BHB	0.17	0.13	0.14
Acetone	0.18	0.13	0.15

Standard errors 0.01 – 0.03

Estimated genetic correlations between energy status indicators and interval from calving to first insemination

Trait	8-35 DIM	36-63 DIM	64-91 DIM
$NEFA_{MIR}$	0.39	0.43	0.19
$NEFA_{FA}$	0.40	0.28	0.12
C18:1 cis-9	0.36	0.17	-0.02
FPR	0.18	0.03	0.01
BHB	0.38	0.29	0.18
Acetone	0.33	0.16	0.13

Standard errors 0.11-0.14

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Genetic correlations between ESI traits within the first three lactation months **and fertility** trait interval from calving to first insemination (ICF)

Trait	8-35 DIM	36-63 DIM	64-91 DIM
$NEFA_{MIR}$	0.39	0.43	0.19
$NEFA_{FA}$	0.40	0.28	0.12
C18:1 cis-9	0.36	0.17	-0.02
FPR	0.18	0.03	0.01
BHB	0.38	0.29	0.18
Acetone	0.33	0.16	0.13

Standard errors 0.11-0.14

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Conclusions

- The newly developed NEFA predictions are promising indicators for energy status
- All studied indicators had
  - low to moderate heritability in early lactation,
  - highest genetic variance in 8-35 DIM,
  - and were moderately correlated with ICF in the very early lactation

  → Energy status should be determined from the first test-day results within two months post partum

Conclusions

Including feed efficiency traits into the breeding programs will also require accounting for energy status to ensure better health and fertility in dairy cows

Genetic variation in energy status in early lactation can be determined using MIR-predicted indicators

THANK YOU!

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