Dedicated Analytical Solutions

THE PURPOSE OF THE MINOR PARAMETERS/ SUBSTANCES DETERMINATION USING IR METHOD IN DAIRY PRODUCTION

Annual Meeting CZ Breeders Society November 6-7 2014

Villy Toft– Area Sales Manager, FOSS



AGENDA



- *Brief history of development of IR technology*
- *Newest FT-IR developments*
  - *Ketosis screening*
  - *Fatty Acid Profiling*
  - *Adulteration screening/ Good Product*
- *What parameters may be analyzed in future?*

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- *Brief history of development of IR technology*

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SOME HISTORY - WHAT DID MIR OFFER ?

- MIR spectroscopy has since 1970's offered rapid analysis of main constituents



Instrument	Parameters
MilkoScan 300 (late seventies)	fat & protein
MilkoScan 203	fat, protein & lactose
MilkoScan 104 / 133/ 134	fat, protein, lactose & solids
MilkoScan 605 (eighties)	fat, protein, lactose & solids
MilkoScan 4000 (early nineties)	fat, protein, lactose, solids, urea & Freezing Point

- Based upon discrete IR filters (2 per constituent)
- More information, more parameters

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WHAT CAN FT-IR OFFER US TODAY?

- FT-IR spectroscopy is the state-of-the-art method for acquiring MIR spectra analyzing.
- Introduced in routine testing in 1995
- Applying more 1000 wavelengths
  - Conventional major parameters
    - fat, true protein, crude protein, casein, casein, lactose & solids
  - Conventional minor parameters
    - Urea, Free Fatty Acids, Citric Acid
    - pH & FPD, Homogenizer Index
  - Newer parameters, in routine testing
    - Ketosis screening (BHB and Acetone)
    - Fatty Acids Profiling
    - Authentic/Adulteration screening



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- *Newest FT-IR developments*
  - *Ketosis screening*

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KETOSIS -A METABOLIC DISEASE HITTING HIGH YIELDING DAIRY COWS

- Ketosis is a metabolic disease that can be very costly for the dairy farmer.
- Acetone and Beta-Hydroxy-Butyrate (BHB) in the milk are indicators of Ketosis
- With FTIR we can predict the level of Acetone and BHB, thus enabling screening for Ketosis in routine testing schemes.



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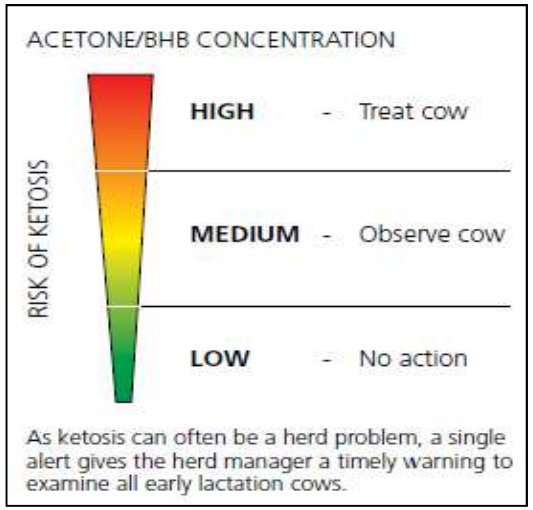
WHO ARE DOING KETOSIS SCREENING BY FTIR?

- **Holland** QLIP/ CR Delta DHI from *March 2011.*
- **Belgium** Lier DHI from *April 2011*
- **Canada** Valacta DHI from *October 2011*
  CanWest DHI will start the service in *2014*
- **France** Analis and 2 other labs started *August 2011*
- **Germany** Several LKV since *August 2011*
- **Poland** Polish Breeders Association from *January 2013*
- **Denmark** Eurofins/ Danish Cattle Fed. from *October 2013*
- **Japan** Tokashi DHI from *2013*

Under evaluation/ testing

- **Switzerland** Has analyzed w/ wet chemistry for years
- **Italy** ARAL**,** Bolzano
- **USA** Dairy Authority Colorado

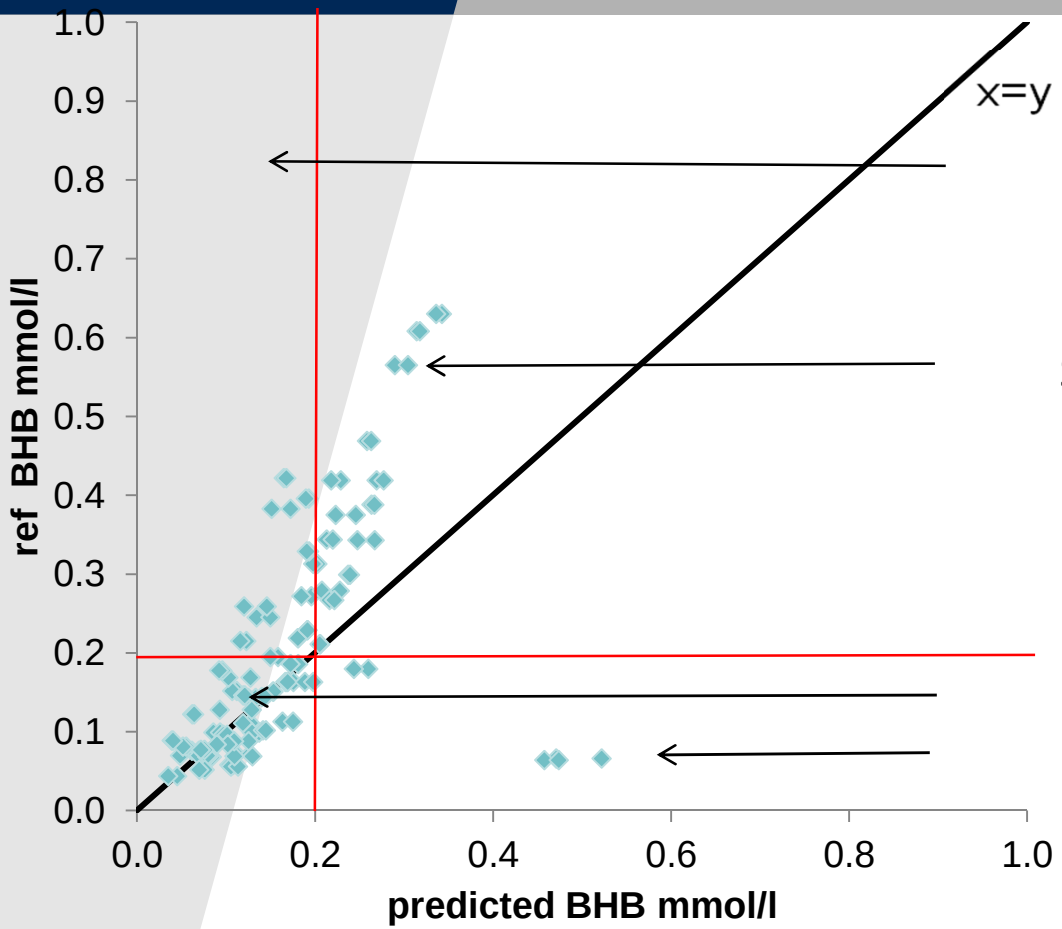
Many more organizations/ countries



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BHB VALIDATION PLOT (CA DATA)



False negatives

Sick cows

Healthy cows

False positives

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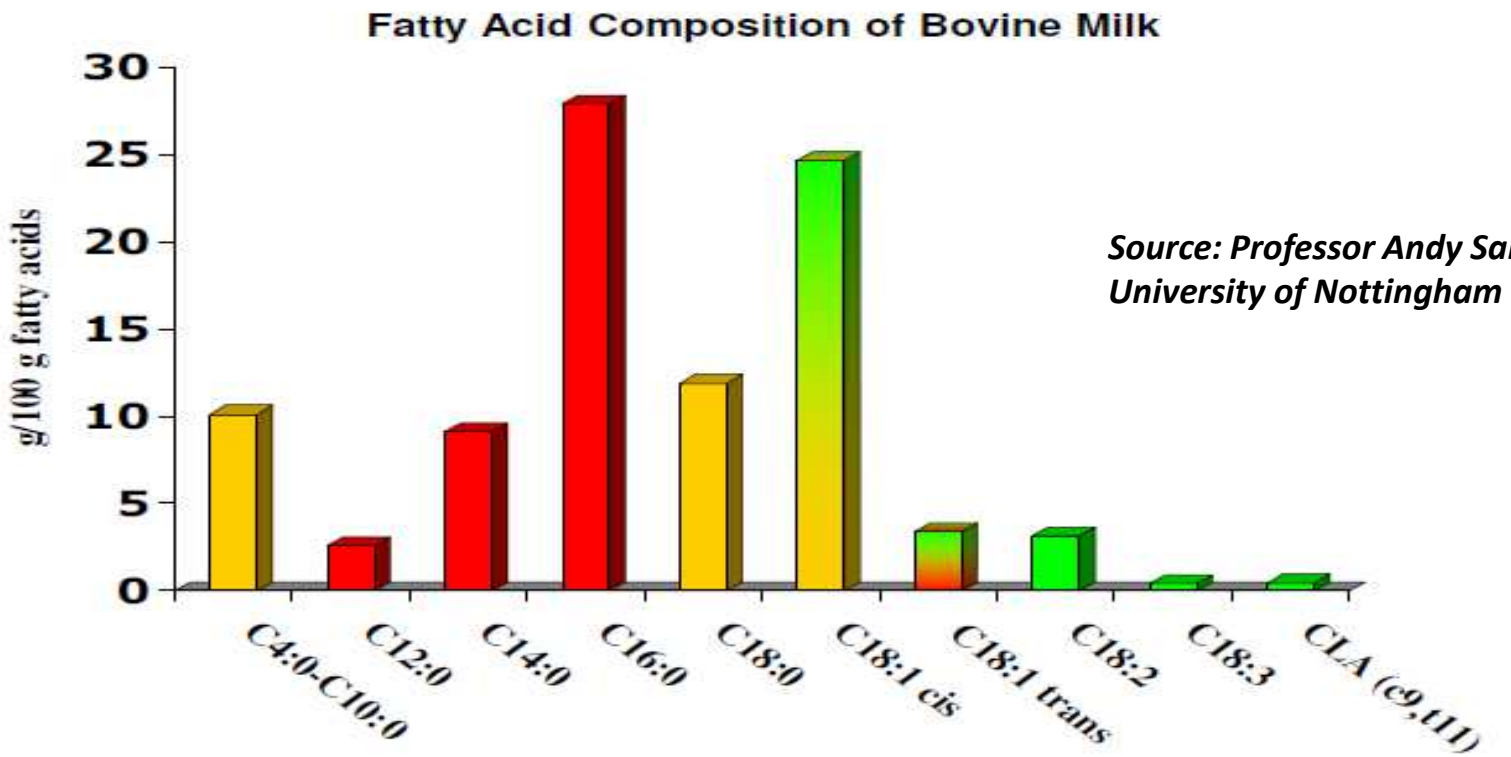
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- *Newest FT-IR developments*
  - *Fatty Acid Profiling*

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GOOD AND BAD FATS

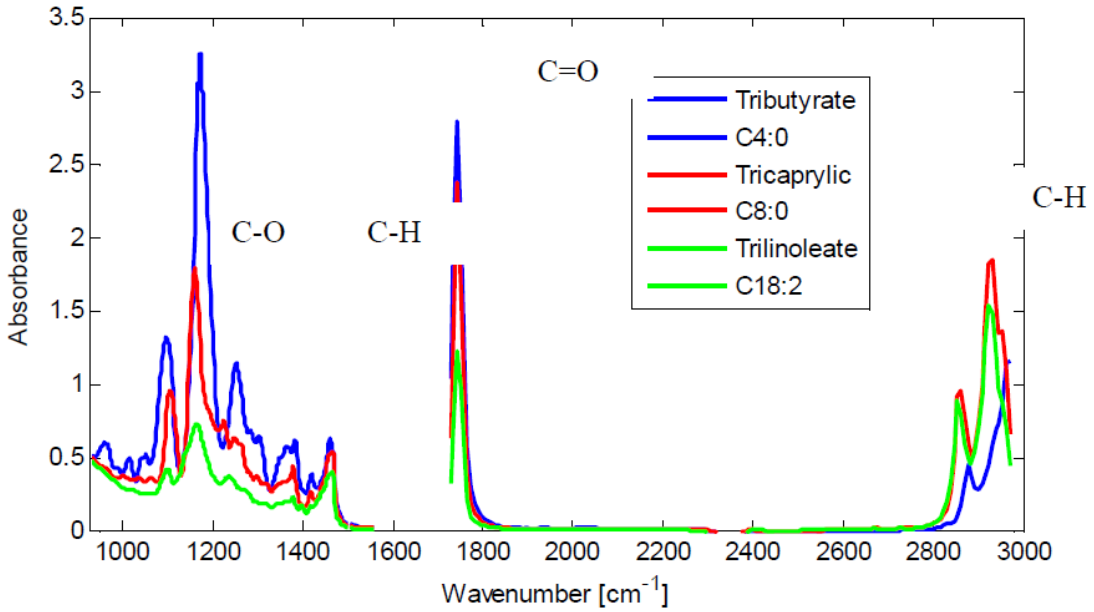


Source: Professor Andy Salter, University of Nottingham

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FATTY ACID PROFILING & FTIR

- Experience with the FAP and FTIR since 2007 has proven viable to determine:
  - C=O and C-O bonds
  - CH3, CH2 and CH groups
  - Chain length
  - Deg. of unsaturation



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IDF BULLETIN 447



Bulletin of the International Dairy Federation 447/2010

New Applications of Mid-Infra-Red Spectrometry for the Analysis of Milk and Milk Products

New Applications of Mid-Infra-Red Spectrometry for the Analysis of Milk and Milk Products

Saturated and unsaturated fatty acids

D.B. Oldrup[1], H. van den Bijgaart[2], O. Leray[3], M. Ferrand[4], B. Müller[5]

Abstract

The increasing health concerns among consumers of milk and milk products have resulted in an interest in producing dairy products with an elevated content of unsaturated fatty acids. Using Fourier Transform Infra-Mid Red technology (FTMIR), the fractions of saturated and unsaturated fatty acids can be rapidly determined with good accuracy. The principal aspects of the infrared determination, the calibration models, the analytical performance of infrared technology and required controls are discussed in this paper.

The best performance is achieved for groups of fatty acids, i.e. saturated, unsaturated, mono- and polyunsaturated fatty acids. An inventory of available data on cow, goat and ewe milk show repeatability values ($r=2.83*s_r$) between 0.03 and 0.10 g/100 g milk and standard errors of prediction between 0.04 and 0.09 g/100 g milk for both saturated and unsaturated fatty acids.

The application can serve as a cost-effective screening method, as a milk payment parameter and as a tool for optimizing dairy cattle feeding.

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FAP PREDICTION MODELS

UPDATED 2014







- Models updated and validated with > 24.000 samples:
  - Milk from individual animals
  - Milk from different species: Cow, sheep & goat
  - Samples from the NL, FR, SE, NO, ES, DE & UK

Parameter	Number of Calibration Samples
C14:0	1419
C16:0	2490
C18:0	2498
C18:1 total	2502
Saturated fatty acids	3605
Mono unsaturated fatty acids	3629
Poly unsaturated fatty acids	3647
Short chain fatty acids	999
Long chain fatty acids	1343
Medium chain fatty acids	998
Trans fatty acids	1065

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- *Newest FT-IR developments*

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Tools to secure an effective and safe supply chain

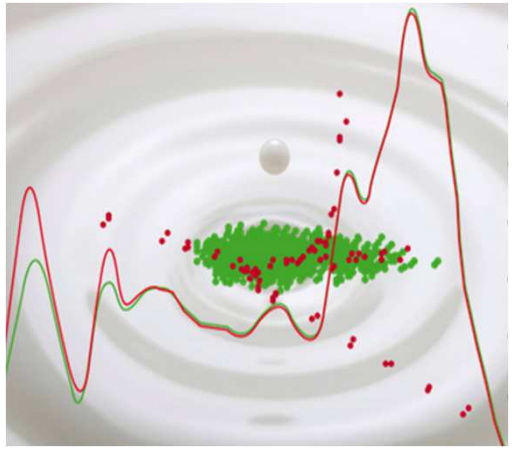


Screen the feed for abnormalities

Screen the milk & dairy product for abnormalities

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FOSS COMMITMENT IN TESTING AGAINST MILK ADULTERATION



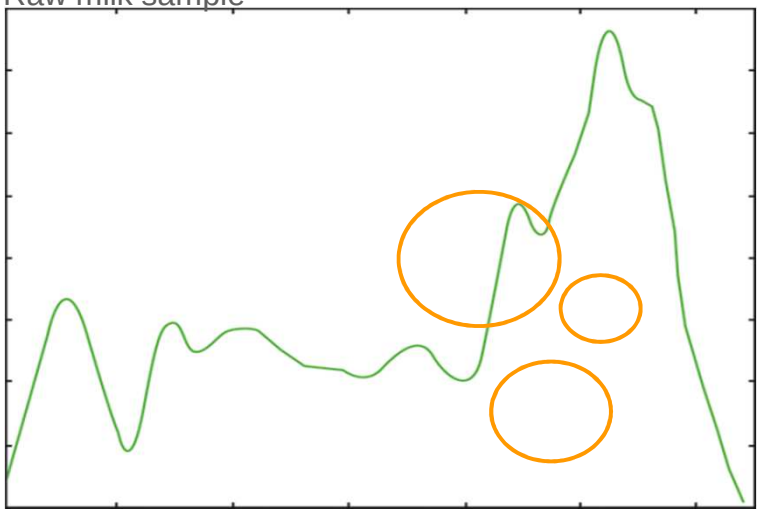
- FOSS started in the nineties with Infrared analysis against simple and known adulterants. Such as tests for screening for added water.
- As the adulteration schemes became more complex FOSS developed new tools for making screening models against unknown adulterants (Melamin / China).
- Today we offer Ready to Use screening model against abnormalities in the milk as well as offering many targeted calibrations against specific adulterants.

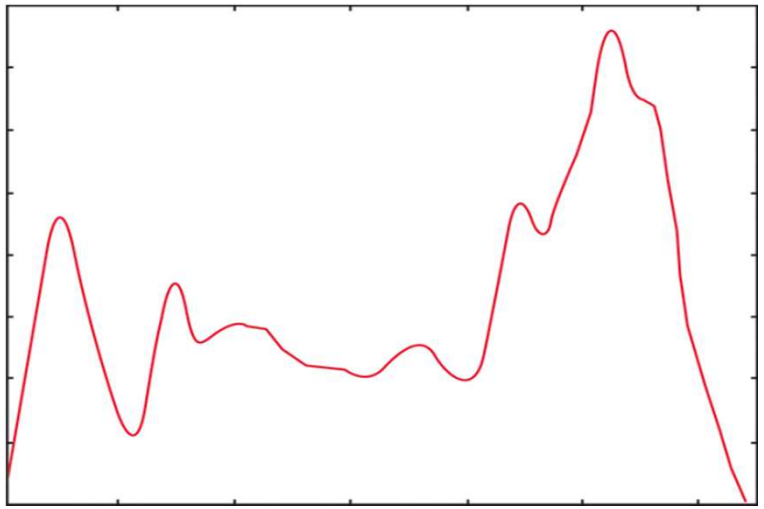
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NORMAL VS ABNORMAL SPECTRUM

- FTIR spectra from natural raw milk samples is a unique finger print of normal milk

Raw milk sample





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”UNTARGETED” VS ”TARGETED” SCREENING MODELS



- Untargeted: You can screen all the incoming milk against abnormalities. It will not tell you what is in the milk only if it is normal (authentic) milk or not.
- Targeted: Specific Calibrations on unwanted “minor” constituents.

WHAT CAN BE SCREENED AGAINST WITH THE "UNTARGETED" MODEL FROM FOSS

- The table shows the Limit of Detection for the adulterants which could be detected as abnormal by the model.
- The LoD´s correspond to a threshold of 3.

Adulterant	LoD	LoD Adulterant	LoD	LoD Adulterant	LoD
Allantoin	300 ppm	Cyanuric acid	170 ppm	Sodium bicarbonate	400 ppm
Amidourea	500 ppm	Cyromazine	300 ppm	Sodium hydroxide	0.06 %
Aminotriazine	800 ppm	Dicyandiamide	300 ppm	Sodium nitrite	200 ppm
Ammonium nitrate	200 ppm	Formaldehyde	400 ppm	Thiourea	500 ppm
Ammonium sulphate	300 ppm	Hydroxyproline	900 ppm	Triuret	800 ppm
Biuret	600 ppm	Maltodextrine	1100 ppm	3-aminotriazole	1100 ppm
CIP agent	1%	Melamine	300 ppm	4-aminotriazole	1400 ppm

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"TARGETED" MODELS

- Examples of "targeted" models which are now available.

Model	N samples	Min. (ppm)	Max (ppm)	Acc. (abs)
Hydroxyproline	3118	0	1997	36
Sodium Nitrite	3118	0	499	9.1
Melamine	3118	0	499	18
Maltodextrine	3118	0	3499	74
Cyanuric acid	3118	0	300	5.6

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SAFE PRODUCTS



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- *What parameters may be analyzed in future?*

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POTENTIAL NEW PARAMETERS

- Many research projects are researching new parameters from FT-IR
  - CRA-W, Agramir, Phénofinlait, OptiMIR, Robust Milk, University Padova and many more
  - FOSS is involved in above projects and in several other projects with key customers
  - Numerous publications are available

- Some new potential parameters
  - Milk coagulation properties
  - Pregnancy confirmation
  - Protein composition
  - And there are many more……!



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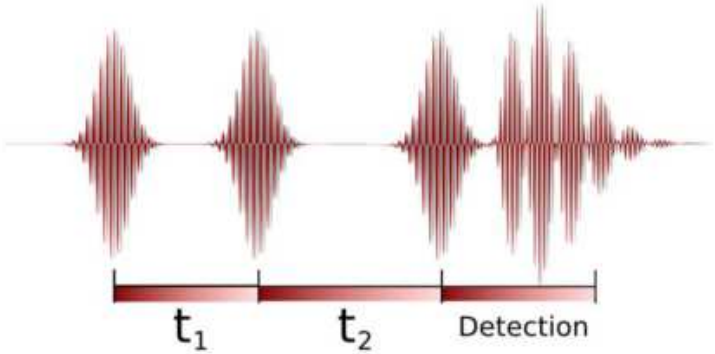
OPTIMIR

The drop reflecting the health of dairy farms

The project aims to develop
innovative farm management web applications
that will use the spectral analysis of the Milk Recording
samples to enable a sustainable and profitable
management of the milk production



The Mid Infra Red (MIR) spectrum will be used as a mirror
of the cows' state giving indicators on their:

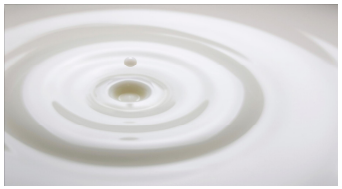


- Fertility
- Feeding
- Health
- Rejection of pollutants
- Milk quality

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FUTURE CHALLENGES & OPPORTUNITIES

- We have by now covered the standard major and many minor components, where calibrations can be made against good reference methods.
  - It now becomes more challenging – but not impossible to develop new parameters and models based on what FT-IR.
  - Sometimes the uncertainty of a reference method is a problem, but
- Accuracy is not everything
  - We can still provide valuable information for Classification and Screening.
- Looking at trends by following individual cows



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Thank you for your attention

Questions

and

discussion

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