Milk Phenomics to advice dairy farmers

Present and prospects

Prof. Hélène Soyeurt
hsoyeurt@uliege.be
Dairy Farmers

Rules

Feeding

Landscape
Sustainable Farm

Production cost

Volatility of milk price

Economic sustainability
Farm Management

- Production
- Environment
- Quality
- Health
- Well-being
Farm Management

Hour/animal

Cause

Effect

Computer assisted management
Computer assisted management

- Cow ID
- Birth date
- Calving date
- Lactation
- Milk yield
- %Fat
- %Protein
- Body weight
- Dry matter intake
- ...
Computer assisted management

Milk Phenomics
Milk Phenomics to advice dairy farmers

Present and prospects
Milk Phenomics

Integrated information

Mathematical modelling, Machine learning

Scientifically-based decision support breeding-nutrition-management-housing

Data base

Phenomics

Metabolism, Fertility, Weight, BCS, Health, Milk, Behaviour
Discover expected and/or unexpected relationships
Large use of infrared signal in the food chain
Infrared signal, more than a quantification ...
Infrared signal, more than a quantification ...

Milk recording (+/- 4 weeks)
Infrared signal, more than a quantification ...

Milk recording (+/- 4 weeks)

Milk payment (+/- 3 days)
Infrared signal, more than a quantification ...

Milk recording (+/- 4 weeks)

Milk payment (+/- 3 days)

(Foss, 2008)
Infrared signal, more than a quantification ...

Milk recording (+/- 4 weeks)

Milk payment (+/- 3 days)
Infrared signal, more than a quantification ...

Summary of more than 1000 spectral points

Calibration equations
Farm Management
Infrared signal, more than a quantification ...

Calibration equations

Fat
Protein
Fatty acids

Mid-infrared prediction of bovine milk fatty acids across multiple breeds, production systems, and countries

H. Soyeurt1,1, F. Dehareng1, N. Gengler2, S. McParland3, E. Wall1, D.P. Berry1, M. Coffey4, P. Dardeau5

http://dx.doi.org/10.3168/jds.2010-3408
Infrared signal, more than a quantification ...

Calibration equations

Fat
Protein
Fatty acids
Minerals
Infrared signal, more than a quantification ...

Calibration equations

Fat
Protein
Fatty acids
Minerals
Lactoferrin ...

Mid-infrared prediction of lactoferrin content in bovine milk: potential indicator of mastitis

H. Soyeurt (a1) (a2), C. Bastin (a1), F. G. Colinet (a1), V. M.-R. Arnauld (a1) (a2), D. P. Berry (a4), E. Wall (a5), F. Dehareneg (a6), H. N. Nguyen (a6), P. Dardenne (a6), J. Schefers (a7), J. Vandenplas (a1) (a2), K. Weigel (a7), M. Coffey (a5), L. Théron (a8), J. Detilleux (a8), E. Reding (a8), N. Gengier (a1) (a2) and S. McParland (a4)

DOI: http://dx.doi.org/10.1017/S1751731112000791
Published online: 01 April 2012
Farm Management
Infrared signal, more than a quantification ...

Calibration equations

Fat
Protein
Fatty acids
Minerals
Lactoferrin ...
Infrared signal, more than a quantification ...

Equations de calibration

The use of mid-infrared spectrometry to predict body energy status of Holstein cows

Energy balance
Infrared signal, more than a quantification ...

Development of Fourier transform mid-infrared calibrations to predict acetone, β-hydroxybutyrate, and citrate contents in bovine milk through a European dairy network

- Fat
- Protein
- Fatty acids
- Minerals
- Lactoferrin ...

Energy balance
Acidosis
Farm Management

Quality
Environment
Health
Well-being
Infrared signal, more than a quantification ...
Farm Management
Infrared signal, more than a quantification ...

Prediction of coagulation properties, titratable acidity, and pH of bovine milk using mid-infrared spectroscopy

M. De Marchi,*† C. C. Fagan,† C. P. O'Donnell,† A. Cecchinato, * R. Dal Zotto, * M. Cassandro,* M. Penasa,* and G. Bittante*  
*Department of Animal Science, University of Padova, Viale dell'Università 16, 35020 Legnaro, Padova, Italy  
†Biosystems Engineering, UCD School of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland
Infrared signal, more than a quantification ...

Energy balance
Acidosis
Methane

Fat
Protein
Fatty acids
Minerals
Lactoferrin ...
Milk Phenomics

Direct predictions

Scientifically-based decision support breeding-nutrition-management-housing
Development of calibration equations

• Not so easy:
  • Covering the variability existing in the cow population
    • Constraint: Price, time, staff

collaborations
Development of calibration equations

• Not so easy:
  • Cover the variability existing in the cow population
  • Correct the variability of infrared signal through the time and between instruments
    • Ring test with common milk samples + Piece-wise regressions

Standardization of milk mid-infrared spectra from a European dairy network

C. Grelet, J. A. Fernández Pierna, P. Dardenne, V. Baeten, and F. Dehareng
Walloon Agricultural Research Center, Valorisation of Agricultural Products Department, 24 Chaussée de Namur, 5030 Gembloux, Belgium
Standardisation

Omega-3 predictions without standardisation

Prediction with instrument A

Prediction with instrument B

Biased predictions

© Grelet, 2016
Standardisation

Principal component analysis to reduce the dimensionality of milk MIR spectra

Piece-wise regressions using common milk samples analysis on different instruments
Development of calibration equations

• Not so easy:
  • Cover the variability existing in the cow population
  • Correct the variability of infrared signal through the time and between instruments
  • Know and inform about the accuracy of the predictions
    • Not often available

External validation
Development of calibration equations

• Not so easy:
  • Cover the variability existing in the cow population
  • Correct the variability of infrared signal through the time and between instruments
  • Know and inform about the accuracy of the predictions
  • Estimate the feasibility of the prediction to avoid extrapolation
    • Never done currently on routine because the calibration set is unknown by the users

GH distance from the calibration set
Milk Phenomics

Direct predictions

Combining information

(e.g. prediction of methane using MIR spectrometry + day in milk)
On farm ...
Smart Farming

**SURVEY DRONES**
Aerial drones survey the fields, mapping weeds, yield and soil variation. This enables precise application of inputs, mapping spread of pernicious weed blackgrass could increasing Wheat yields by 2-5%.

**FLEET OF AGRIBOTS**
A herd of specialised agribots tend to crops, weeding, fertilising and harvesting. Robots capable of microdot application of fertiliser reduce fertiliser cost by 99.9%.

**FARMING DATA**
The farm generates vast quantities of rich and varied data. This is stored in the cloud. Data can be used as digital evidence reducing time spent completing grant applications or carrying out farm inspections saving on average £5,000 per farm per year.

**TEXTING COWS**
Sensors attached to livestock allowing monitoring of animal health and wellbeing. They can send texts to alert farmers when a cow goes into labour or develops infection increasing herd survival and increasing milk yields by 10%.

**SMART TRACTORS**
GPS controlled steering and optimised route planning reduces soil erosion, saving fuel costs by 10%. 
New sources of phenotypes on farm

Milk analysis

Near infrared spectrometer

In line milk analysis
New sources of phenotypes on farm
New sources of phenotypes on farm

- Heat detection system
- Activity (accelerometer)
- Localisation (RFID)
- Activity (pedometer)
Challenges

- Conservation
- Accessibility
- Quality
- Exploitation

Lots of data
Complex data
Rapidly evolving data
More than individual data ... New **business** by the development of data exchange platform

© Wolfert, 2016
FARMOBILE IS
#FARMERPOWER

Farmobile is the farm data company.
Farmers own their data outright.

https://www.farmobile.com
Own, License and Sell your data

Complete EFRs via the Farmobile PUC
Electronic Field Records include:

- Activity Dates
- Commodity
- Variety
- Population
- Acres
- Grain Moisture
- Yield
- Total Production
- Much More

The Data Store
Farmobile is the neutral party.

Farmobile facilitates transactions on behalf of the farmer.

50/50 profit split with Farmobile.
Ex: If Farmobile facilitates a transaction for $4/acre, the farmer gets paid $2/acre for their data, providing a new revenue stream.
FISPACE PUBLIC
You can access the public FISPACE Applications.

BUSINESS APPLICATIONS
Fispace provides reusable Apps addressing various challenges of farmers, growers, transporters, retailers, service providers and many more.

Crop Protection Information Sharing
Fish Distribution and Re-Planning
Flowers & Plants Chain Monitoring
Fresh Fruit and Vegetables
Greenhouse Management and Control
Import and Export of Consumer Goods
Meat Information Provenance
Tailored Information for Consumers

www.fispace.eu
Cooperating Applications in the CPIS Trial

Future Internet Business Collaboration Networks in Agri-Food, Transport & Logistics
More than individual data ...

New **business** by the development of data exchange platform

**Innovation:**
- IoT
- New sensors
- New apps
- Methodology
- Storage
- Visualisation ...

© Wolfert, 2016
Google Farm

Google AI builds a better cucumber farm

Machine learning helps sort veggies so the farmer can focus on more important work.
A team since 2005

• Nicolas Gengler, Hélène Soyeurt, Colinet Frédéric

• Frédéric Dehareng, Eric Froidmont, Clément Grelet, Amélie Vanlierde

• Carlo Bertozzi, Catherine Bastin

• Didier Veselko

• Many national and international collaborations and projects
Milk Phenomics to advice dairy farmers

Present and prospects

Prof. Hélène Soyeurt
hsoyeurt@uliege.be