



Milk
Phenomics
to advice
dairy farmers

Present and
prospects

Prof. Hélène Soyeurt
hsoyeurt@uliege.be

Sustainable Farm



Production cost



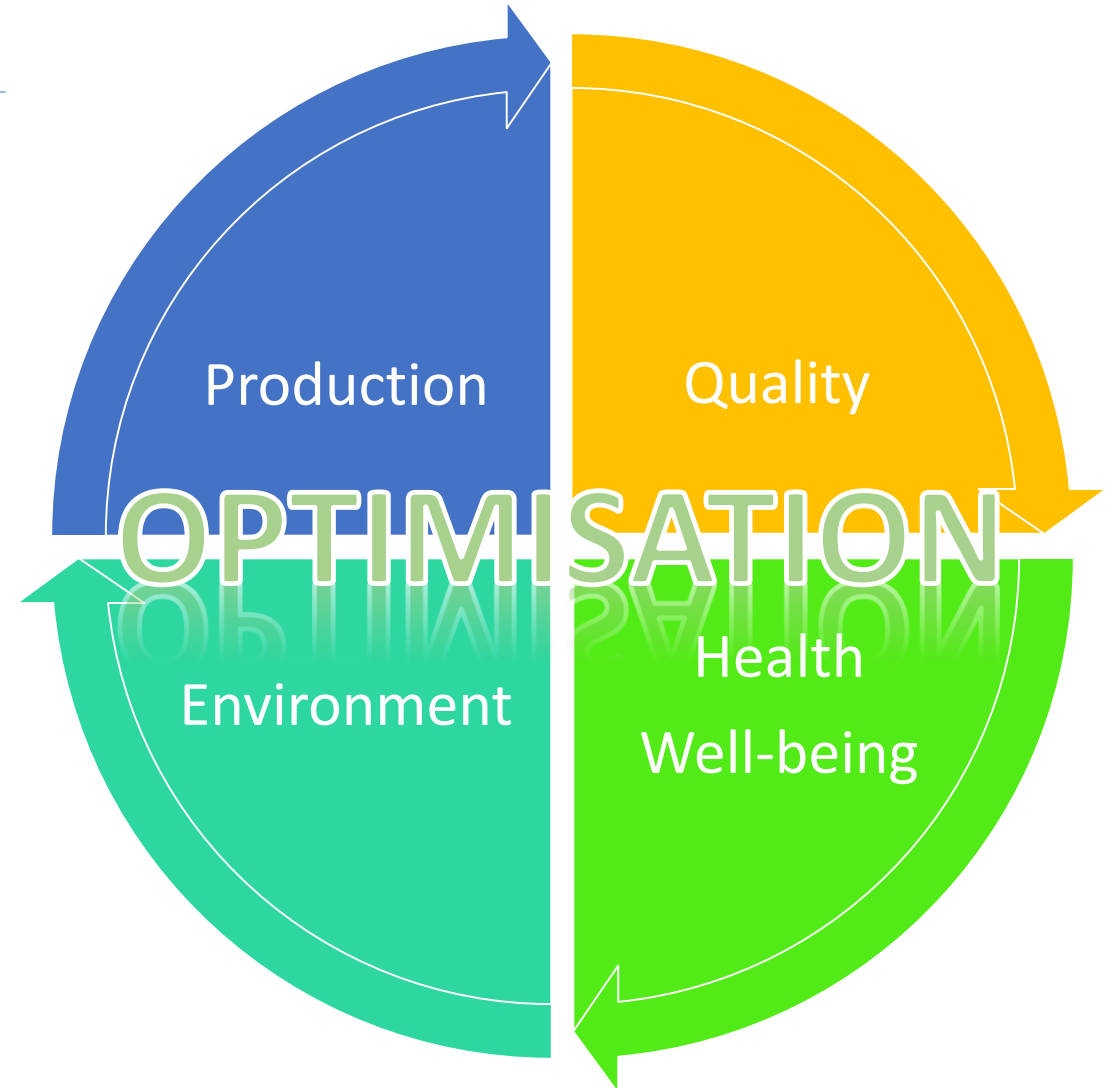
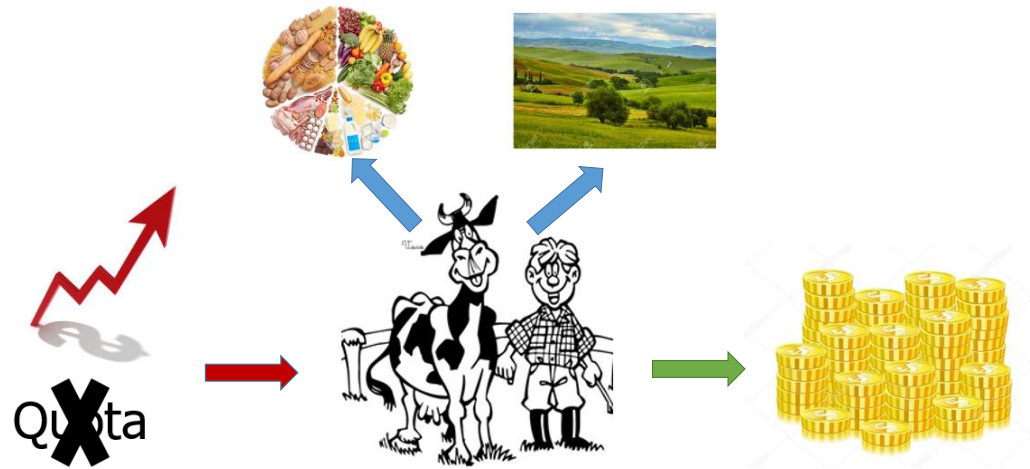
Qu~~X~~ta

Volatility of milk price

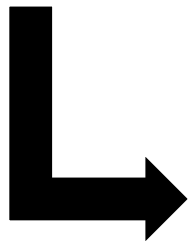


Economic sustainability

Farm Management



Farm Management

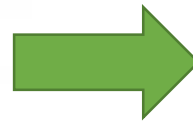


Computer assisted management

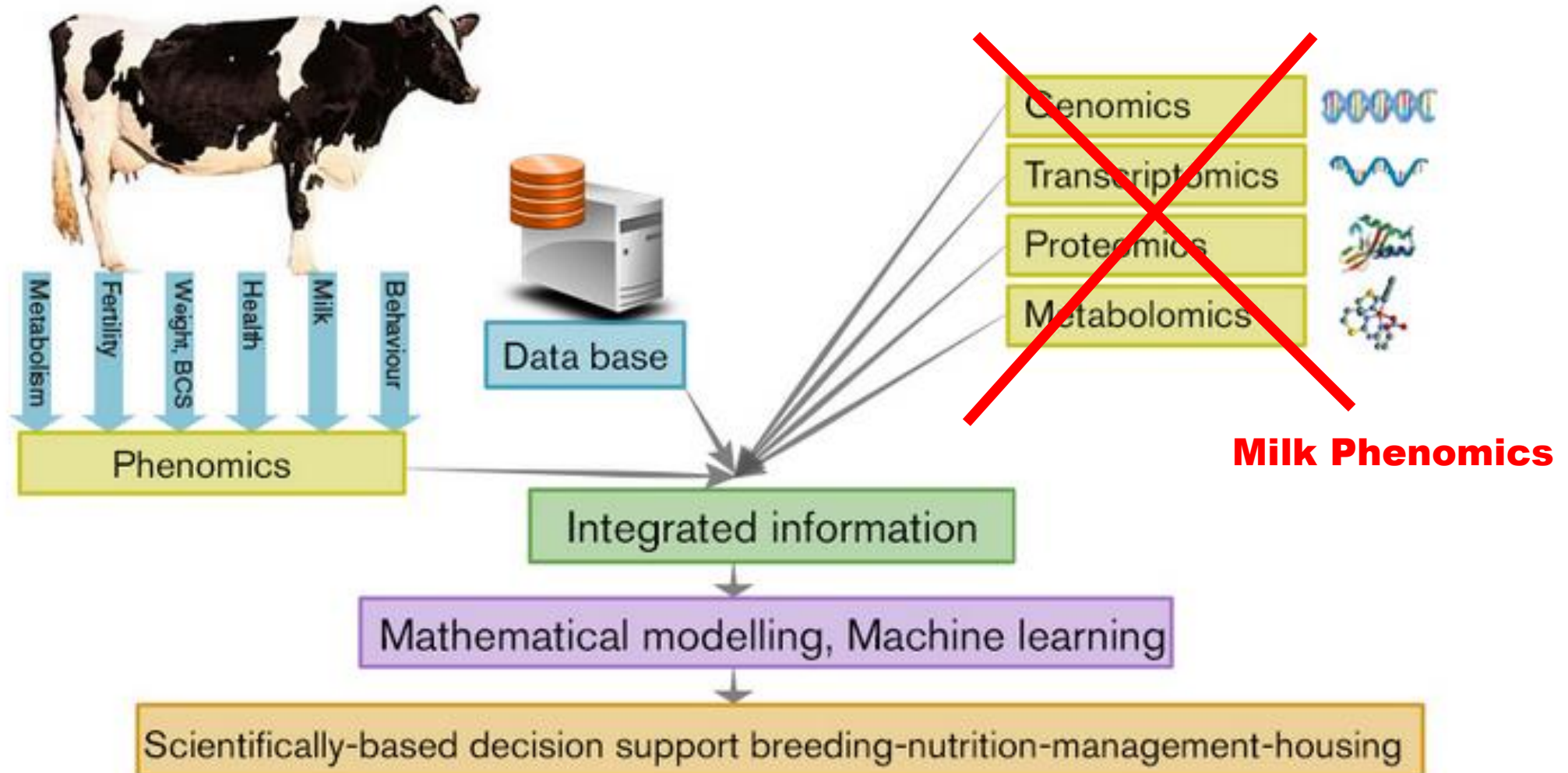
Computer assisted management



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



Computer assisted management

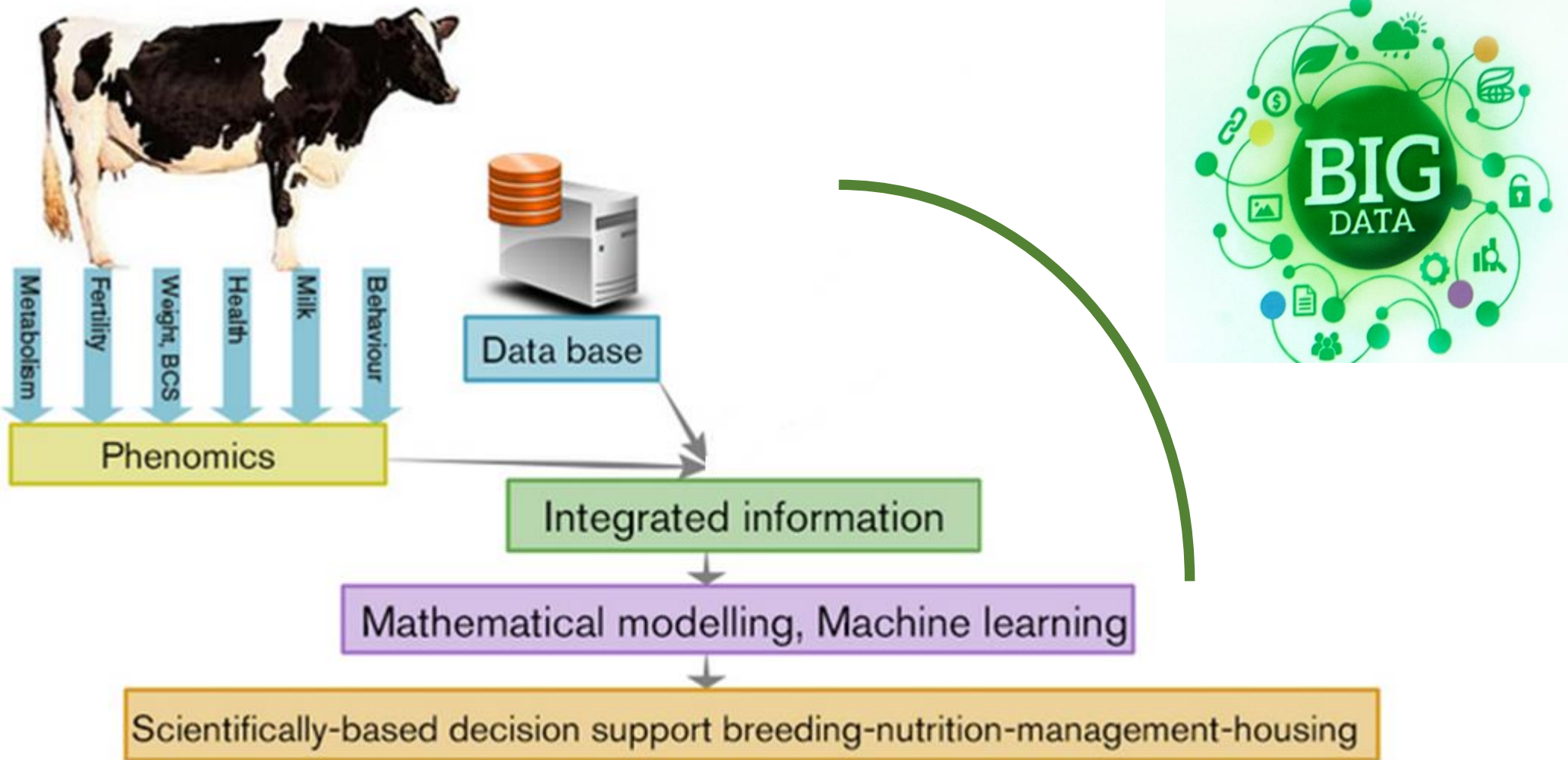




Milk
Phenomics
to advice
dairy farmers

Present and
prospects

Milk Phenomics

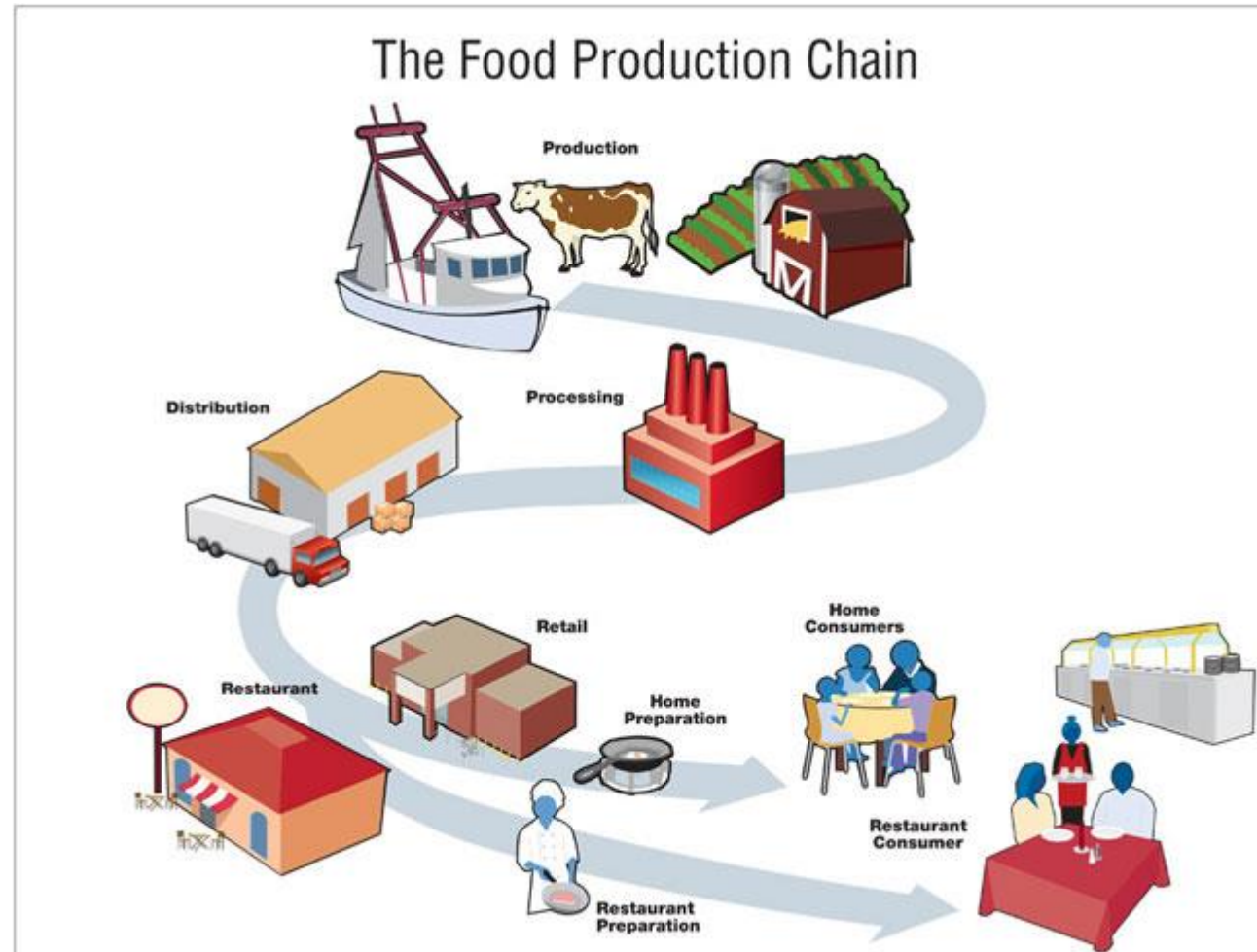






NOW!

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 ...

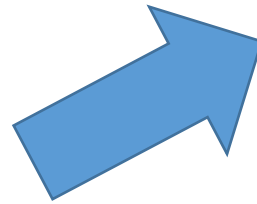


Milk recording (+/- 4 weeks)

Milk payment (+/- 3 days)



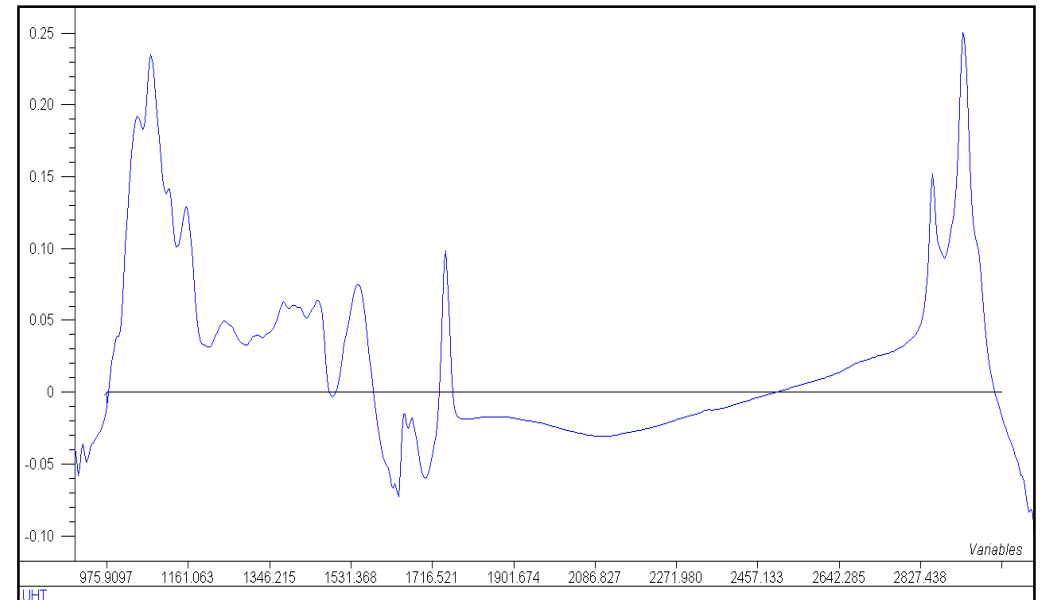
Infrared signal, more than a quantification ...



(Foss, 2008)

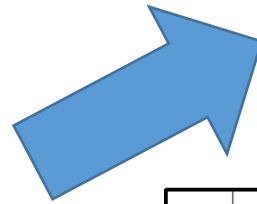
Milk recording (+/- 4 weeks)

Milk payment (+/- 3 days)



UHT

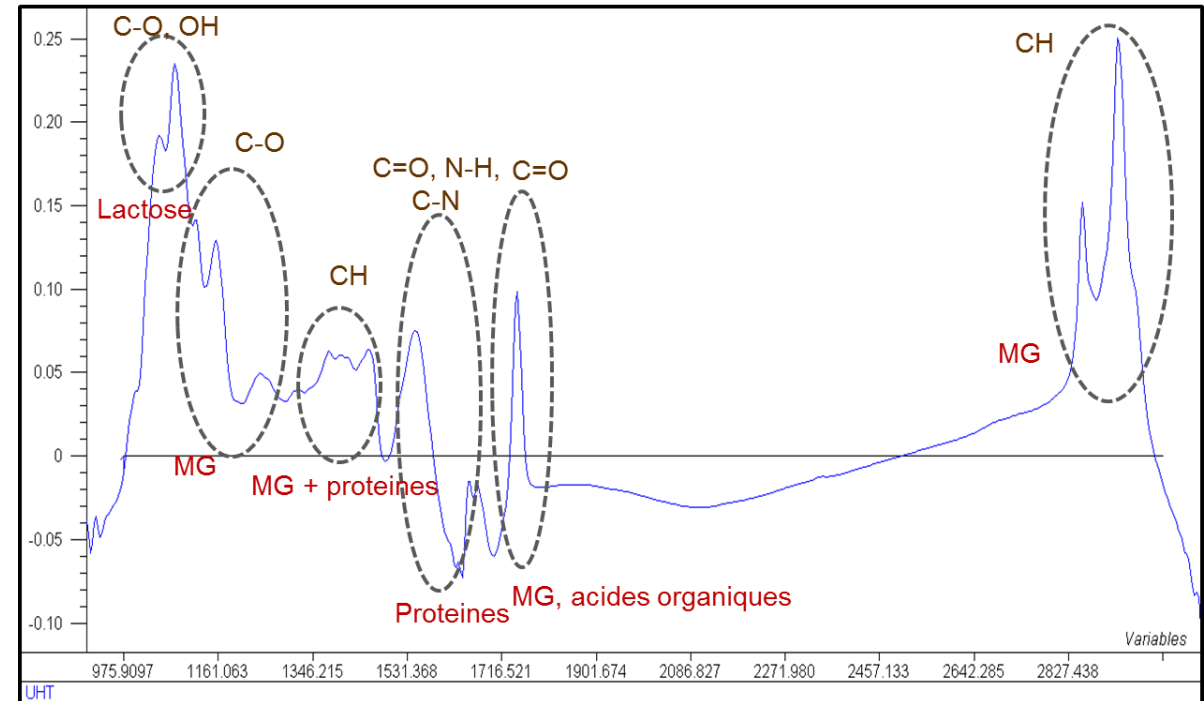
Infrared signal, more than a quantification ...



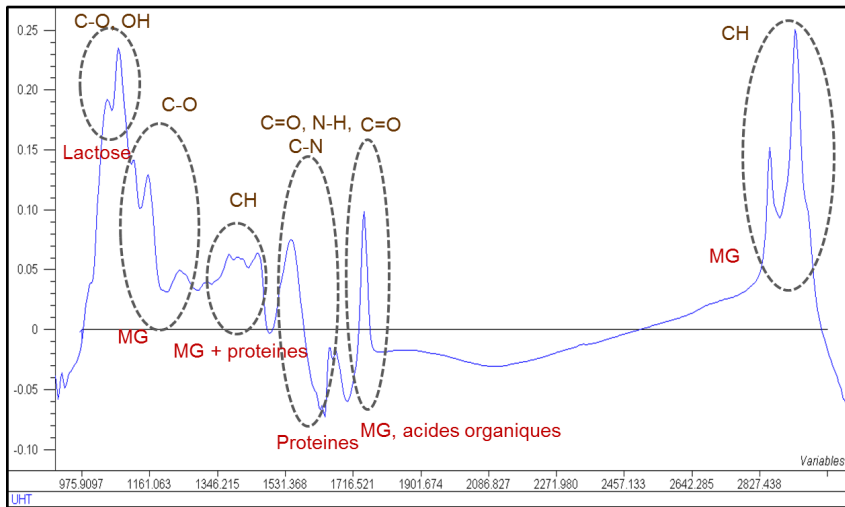
(Foss, 2008)

Milk recording (+/- 4 weeks)

Milk payment (+/- 3 days)



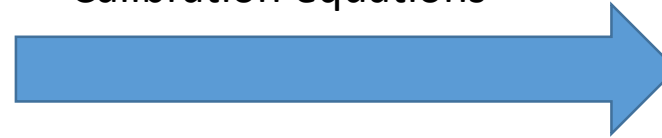
Infrared signal, more than a quantification ...



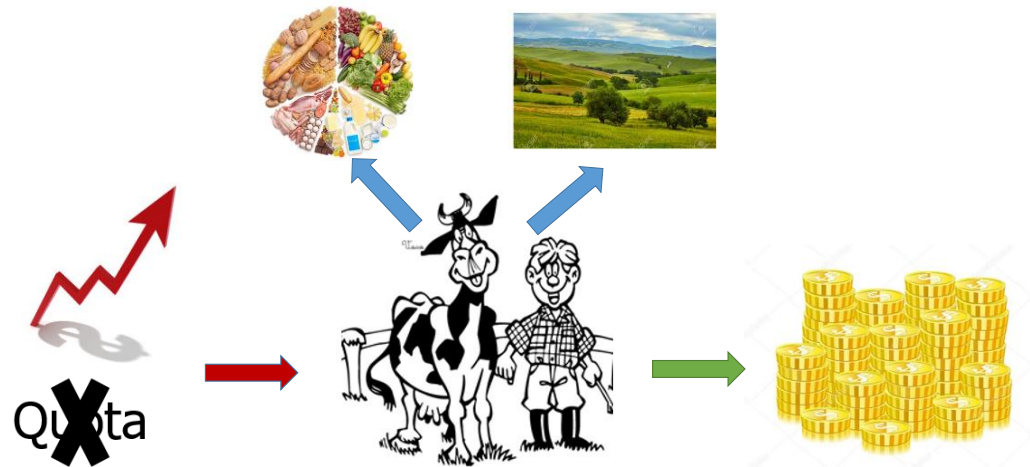
Summary of more than 1000 spectral points



Calibration equations



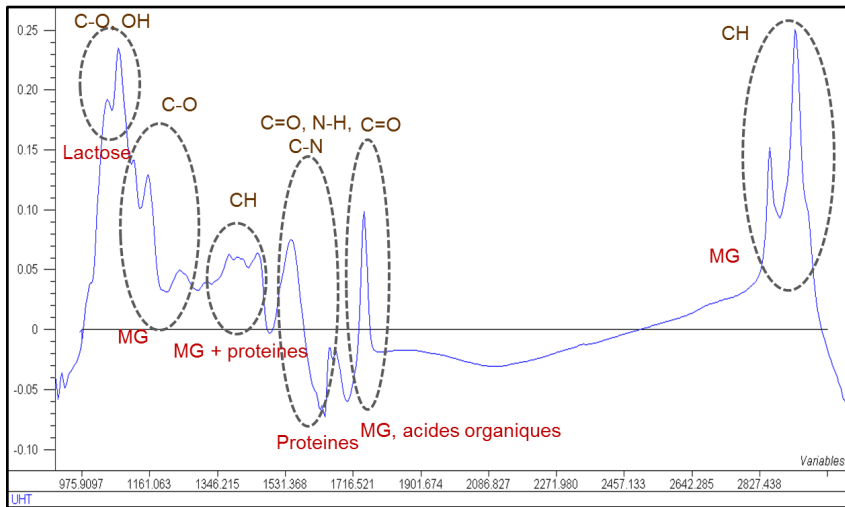
Farm Management



OPTIMISATION

Quality

Infrared signal, more than a quantification ...



Calibration equations



Fat
Protein
Fatty acids



Journal of Dairy Science

Volume 94, Issue 4, April 2011, Pages 1657–1667



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

H. Soyeurt^{*,†,1}, F. Dehareng^{‡,1}, N. Gengler^{†,1}, S. McParland[§], E. Wall[‡], D.P. Berry[§], M. Coffey[¶],

P. Dardenne[‡]

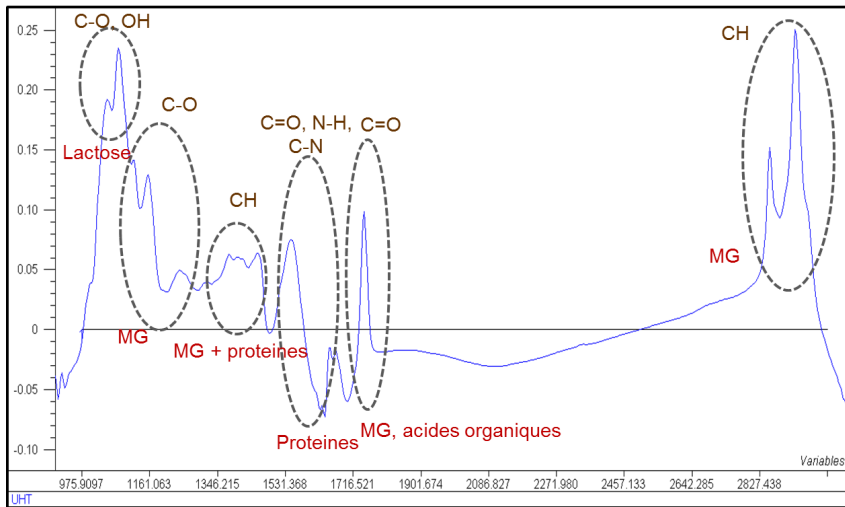
[Show more](#)

<http://dx.doi.org/10.3168/jds.2010-3408>

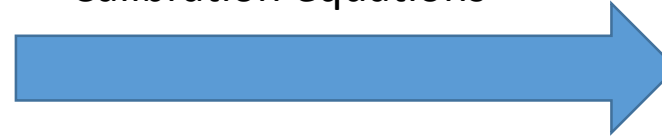
[Get rights and content](#)



Infrared signal, more than a quantification ...



Calibration equations



Fat
Protein
Fatty acids
Minerals

Journal of Dairy Science
Volume 92, Issue 6, June 2009, Pages 2444–2454

Research-article
Potential estimation of major mineral contents in cow milk using mid-infrared spectrometry

H. Soyeurt^{*}, D. Bruwier^{*}, J.-M. Romnee[†], N. Gengler^{* ‡}, C. Bertozzi[§], D. Veselko[#], P. Dardenne[†]

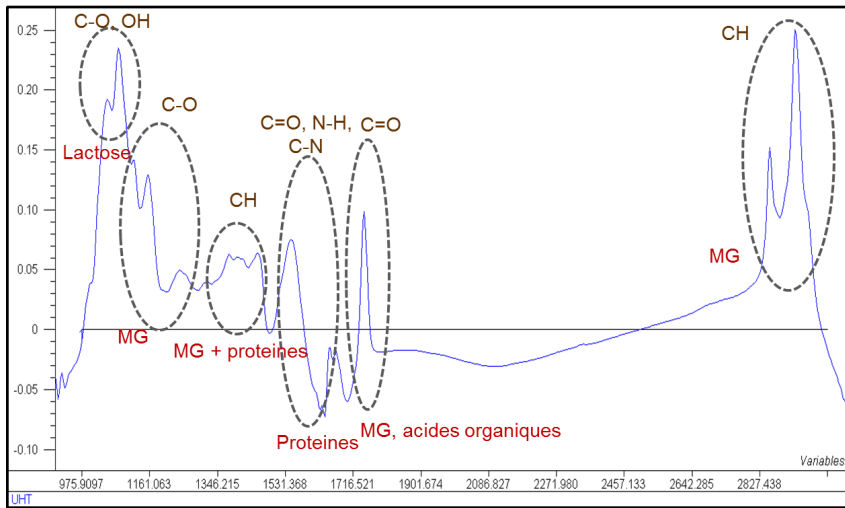
[Show more](#)

<http://dx.doi.org/10.3168/jds.2008-1734>

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Infrared signal, more than a quantification ...



Calibration equations



Fat
Protein
Fatty acids
Minerals
Lactoferrin ...

animal, Volume 6, Issue 11

November 2012, pp. 1830-1838

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

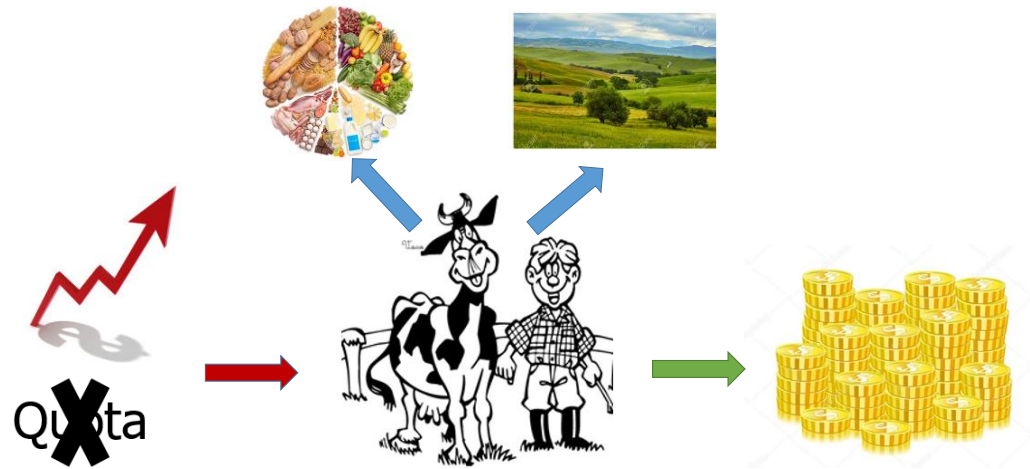
H. Soyeurt ^{(a1) (a2)}, C. Bastin ^(a1), F. G. Colinet ^(a1), V. M.-R. Arnould ^{(a1) (a3)}, D. P. Berry ^(a4), E. Wall ^(a5), F. Dehareng ^(a6), H. N. Nguyen ^(a6), P. Dardenne ^(a6), J. Schefers ^(a7), J. Vandenplas ^{(a1) (a2)}, K. Weigel ^(a7), M. Coffey ^(a5), L. Théron ^(a8), J. Detilleux ^(a8), E. Reding ^(a9), N. Gengler ^{(a1) (a2)} and S. McParland ^(a4) 

DOI: <http://dx.doi.org/10.1017/S1751731112000791>

Published online: 01 April 2012



Farm Management



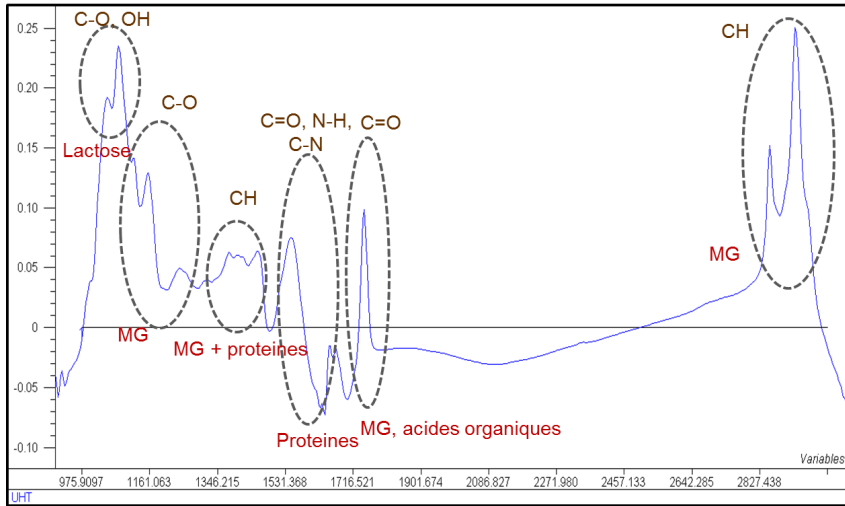
OPTIMISATION

Quality

Health

Well-being

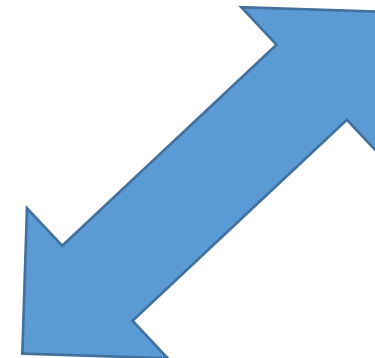
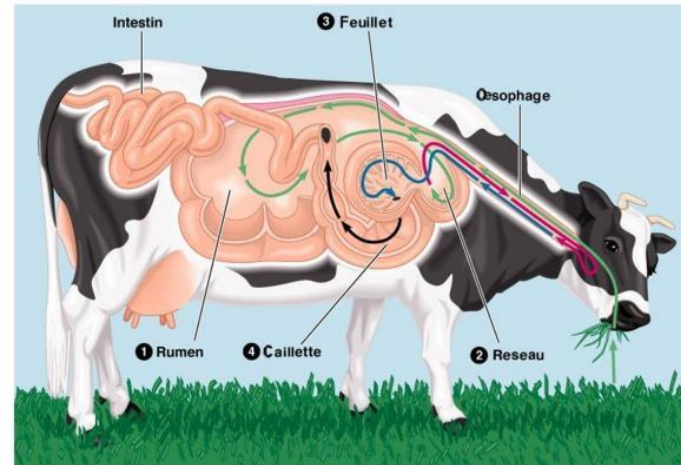
Infrared signal, more than a quantification ...



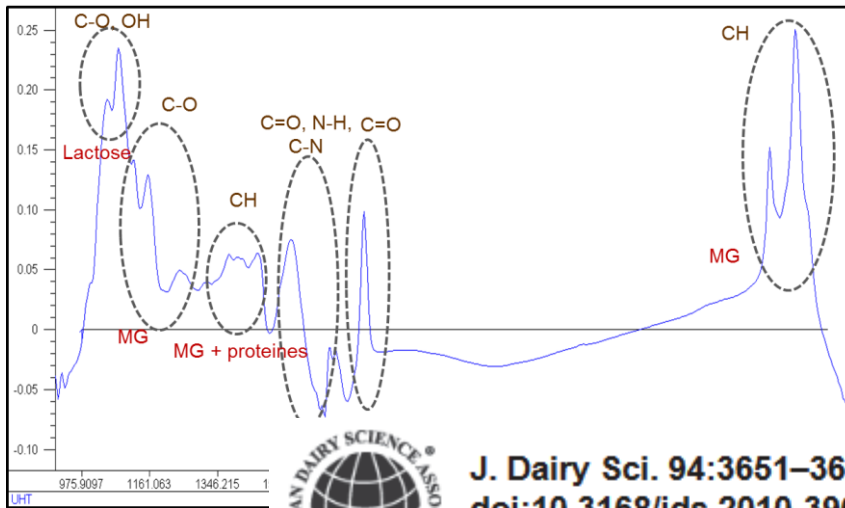
Calibration equations



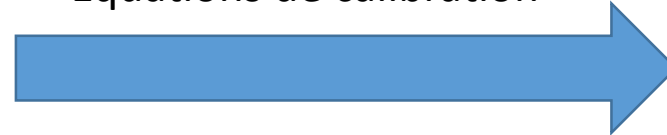
Fat
Protein
Fatty acids
Minerals
Lactoferrin ...



Infrared signal, more than a quantification ...



Equations de calibration



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



J. Dairy Sci. 94:3651–3661
doi:10.3168/jds.2010-3965

© American Dairy Science Association®, 2011.

The use of mid-infrared spectrometry to predict body energy status of Holstein cows¹

S. McParland,^{x2} G. Banos,[†] E. Wall,[‡] M. P. Coffey,[‡] H. Soyeurt,^{§#} R. F. Veerkamp,^{||} and D. P. Berry^{*}

^{*}Animal and Bioscience Research Department, Animal and Grassland Research and Innovation Centre, Teagasc, Moorepark, Co. Cork, Ireland

[†]Department of Animal Production, Faculty of Veterinary Medicine, Aristotle University of Thessaloniki, Greece 52124

[‡]Sustainable Livestock Systems Group, Scottish Agricultural College, EH25 9RG United Kingdom

[§]Gembloux Agro Bio-Tech - University of Liège, Animal Science Unit, Gembloux B-5030, Belgium

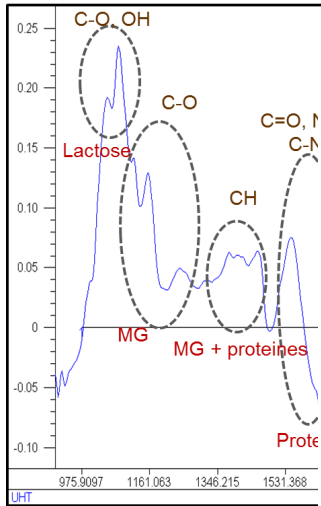
[#]National Fund for Scientific Research, Brussels, Belgium

^{||}Animal Breeding and Genomics Centre, Wageningen UR Livestock Research, Lelystad6708WC, the Netherlands

Energy balance



Infrared signal, more than a quantification ...



Journal of Dairy Science
Volume 99, Issue 6, June 2016, Pages 4816–4825

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

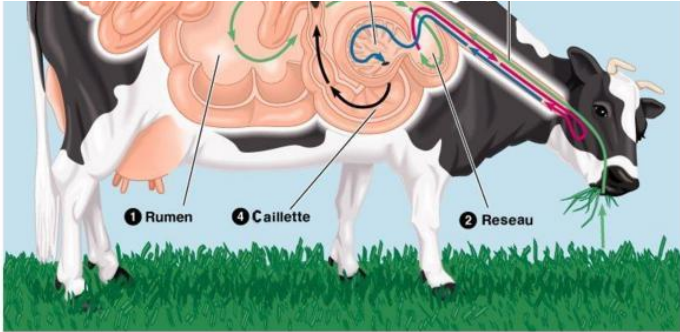
C. Grelet¹, C. Bastin[†], M. Gelé[‡], J.-B. Davière[§], M. Johan[§], A. Werner[#], R. Reding[†], J.A. Fernandez Pierna^{*}, F.G. Colinet[†], P. Dardenne^{*}, N. Gengler[†], H. Soyeurt[†], F. Dehareng^{*}

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<http://dx.doi.org/10.3168/jds.2015-10477>

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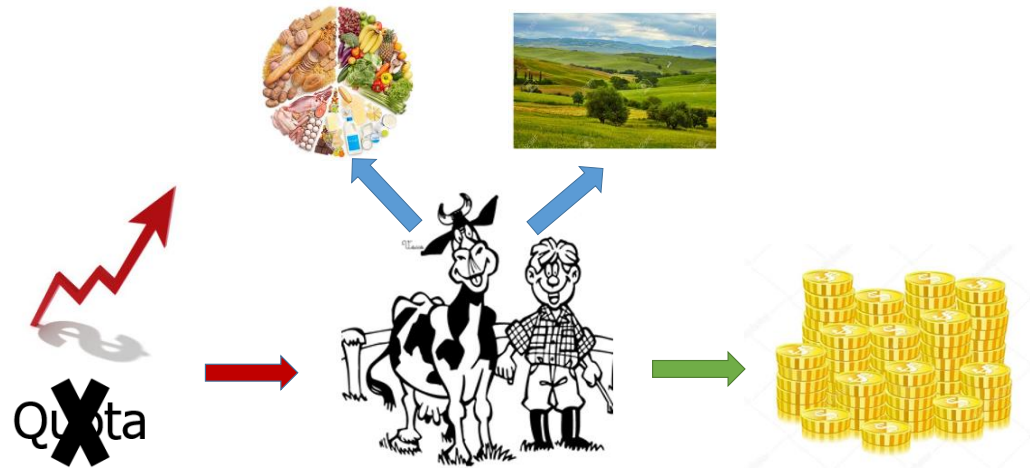
Energy balance
Acidosis



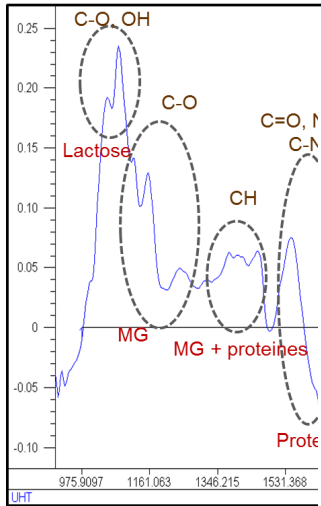
Fat
Protein
Fatty acids
Minerals
Lactoferrin ...



Farm Management



Infrared signal, more than a quantification ...



Journal of Dairy Science

Volume 98, Issue 8, August 2015, Pages 5740–5747



Hot topic: Innovative lactation-stage-dependent prediction of methane emissions from milk mid-infrared spectra

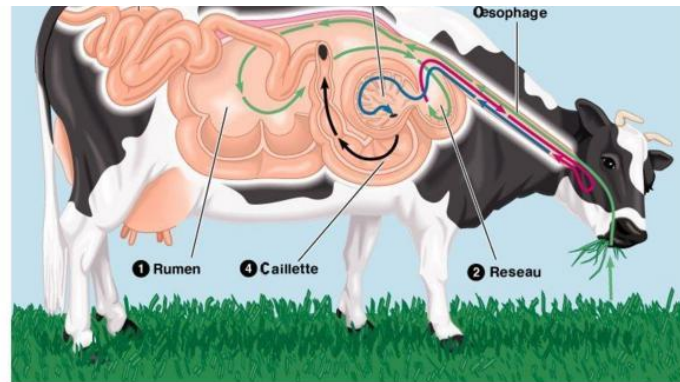
A. Vanlierde¹, M.-L. Vanrobays¹, F. Dehareng^{*}, E. Froidmont[‡], H. Soyeurt[†], S. McParland[§], E. Lewis[§], M.H. Deighton[#], F. Grand^{||}, M. Kreuzer^{||}, B. Gredler^{||}, P. Dardenne^{*}, N. Gengler[†]

[Show more](#)

<http://dx.doi.org/10.3168/jds.2014-8436>

Fat
Protein
Fatty acids
Minerals
Lactoferrin ...

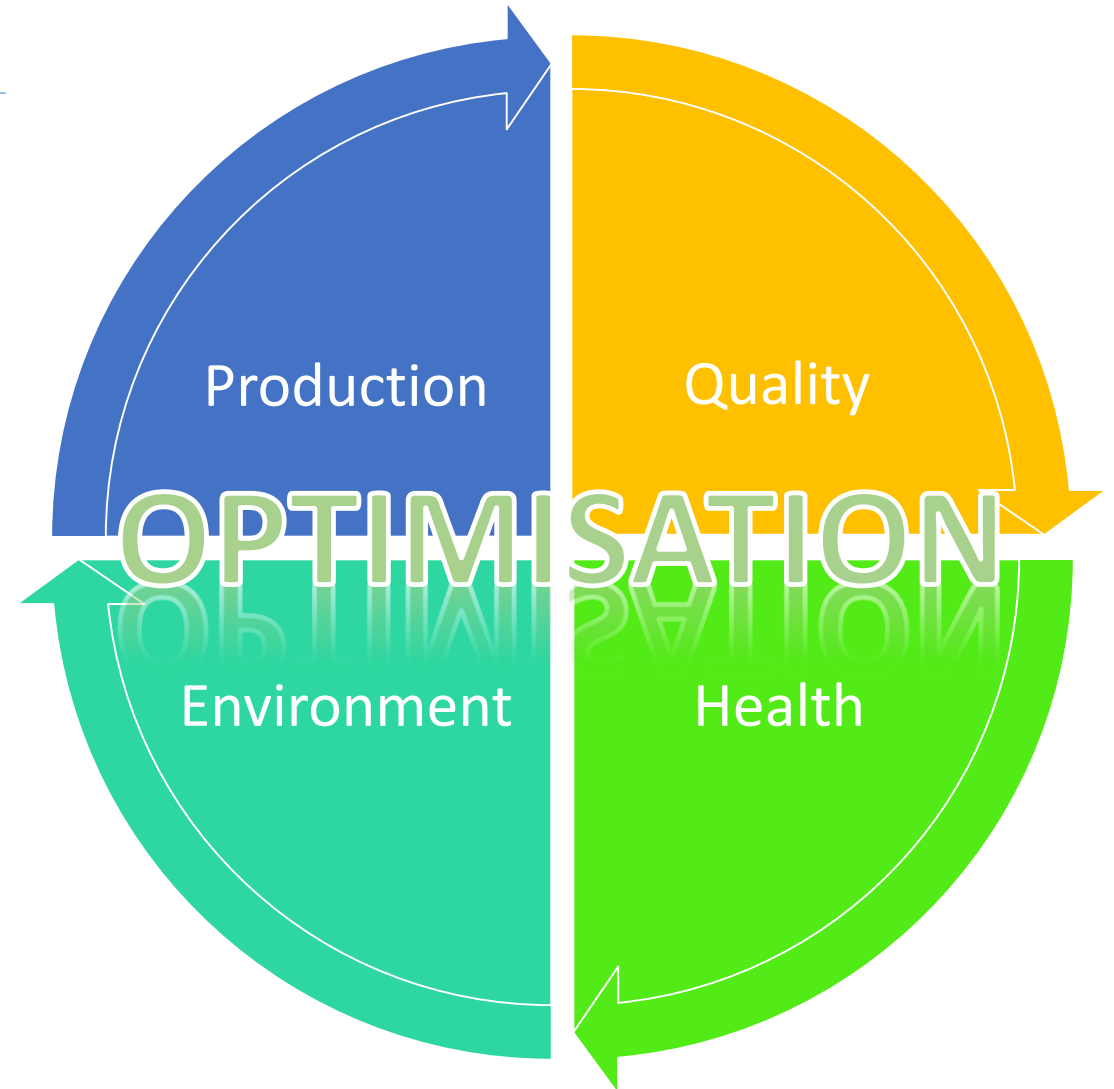
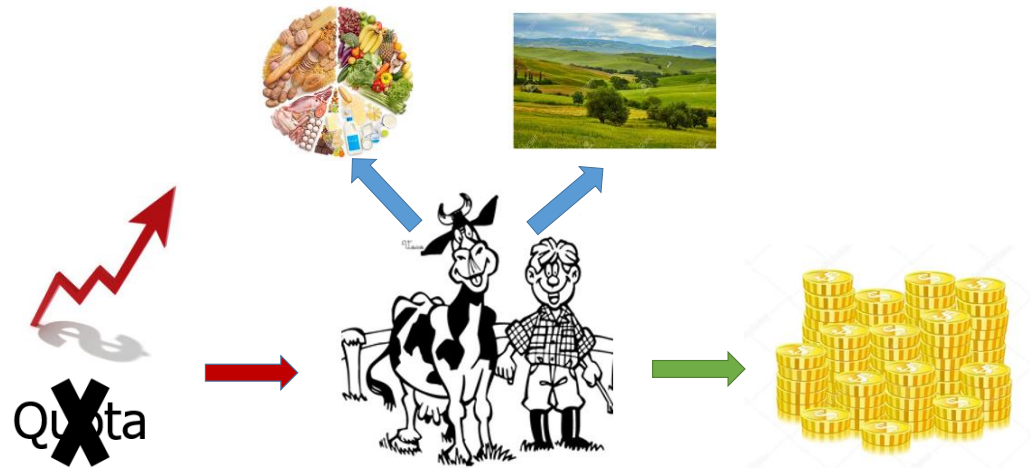
Energy balance
Acidosis
Methane



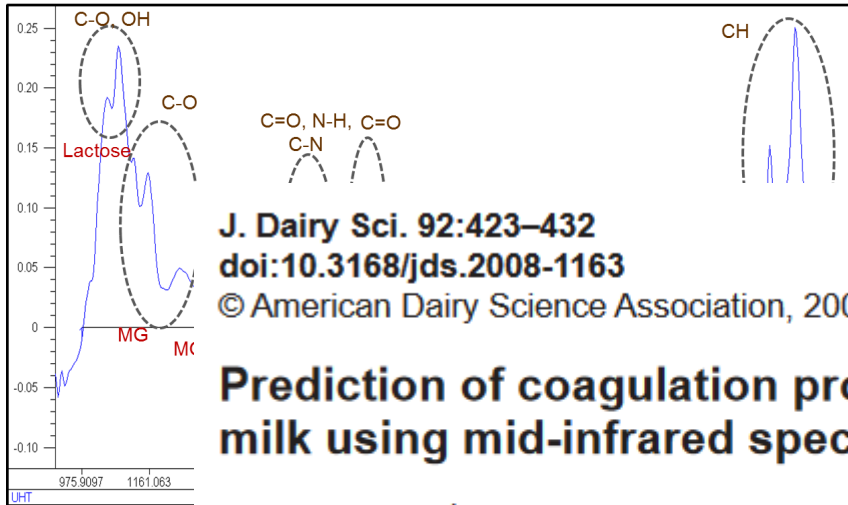
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Farm Management



Infrared signal, more than a quantification ...



J. Dairy Sci. 92:423–432
doi:10.3168/jds.2008-1163
© American Dairy Science Association, 2009.

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

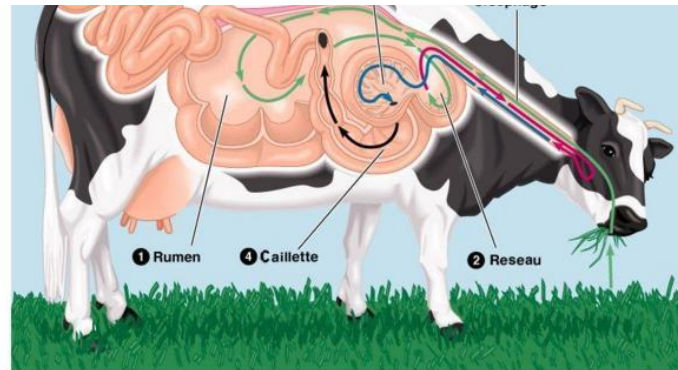
M. De Marchi,^{*1} C. C. Fagan,[†] C. P. O'Donnell,[†] A. Cecchinato,^{*} R. Dal Zotto,^{*} M. Cassandro,^{*} M. Penasa,^{*} and G. Bittante^{*}

^{*}Department of Animal Science, University of Padova, Viale dell'Università 16, 35020 Legnaro, Padova, Italy

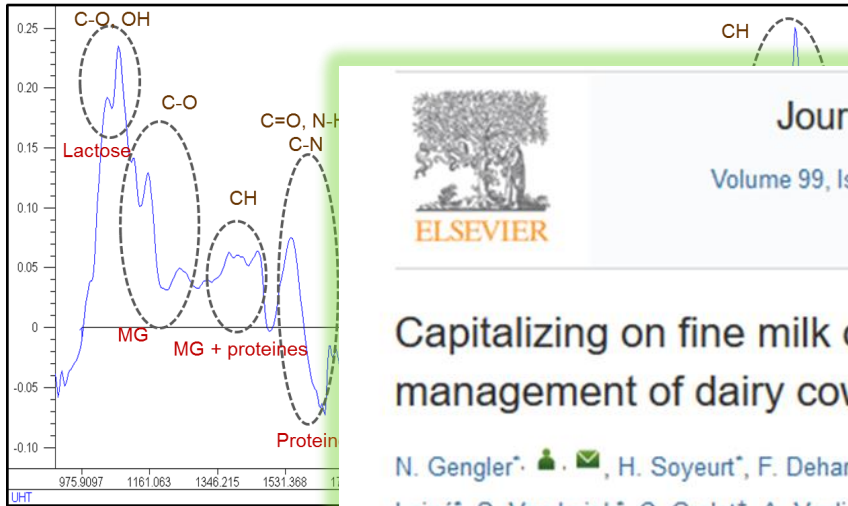
[†]Biosystems Engineering, UCD School of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Belfield, Dublin 4, Ireland

Fat
Protein
Acids
Minerals
Lactin ...

Energy balance
Acidosis
Methane
...



Infrared signal, more than a quantification ...



Journal of Dairy Science
Volume 99, Issue 5, May 2016, Pages 4071–4079

Capitalizing on fine milk composition for breeding and management of dairy cows¹

N. Gengler*, H. Soyeurt*, F. Dehareng†, C. Bastin*, F. Colinet*, H. Hammami*, M.-L. Vanrobays*, A. Lainé*, S. Vanderick*, C. Grelet†, A. Vanlierde†, E. Froidmont†, P. Dardenne†

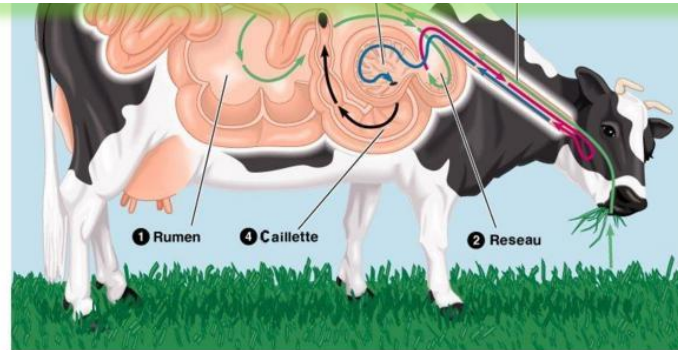
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<http://dx.doi.org/10.3168/jds.2015-10140>

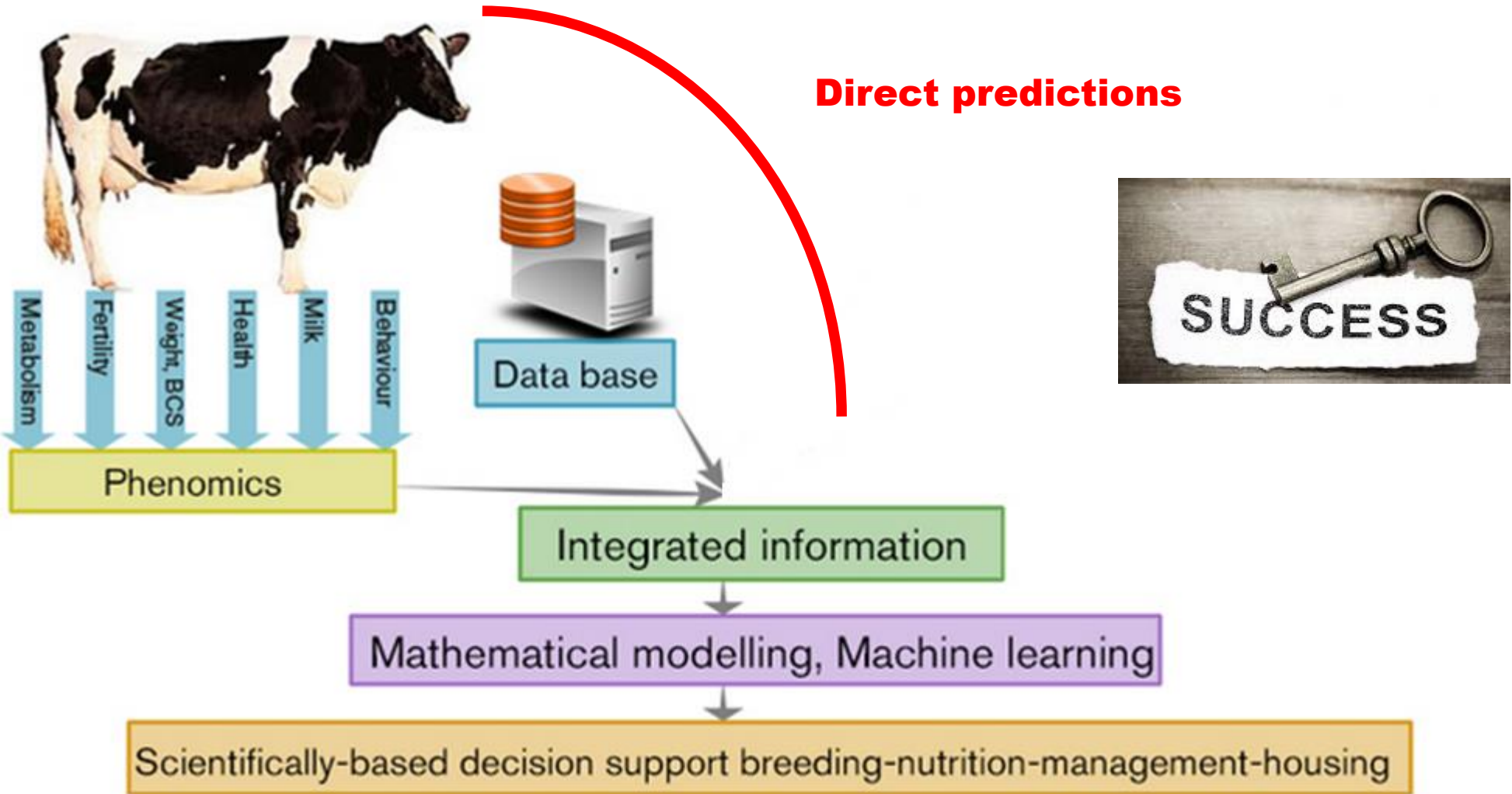
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Fat
Protein
Fatty acids
Minerals
Lactoferrin ...

Energy balance
Acidosis
Methane
...



Milk Phenomics



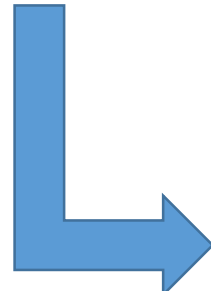
Development of calibration equations

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



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



standardisation



European Milk Recording
(www.milkrecording.eu)

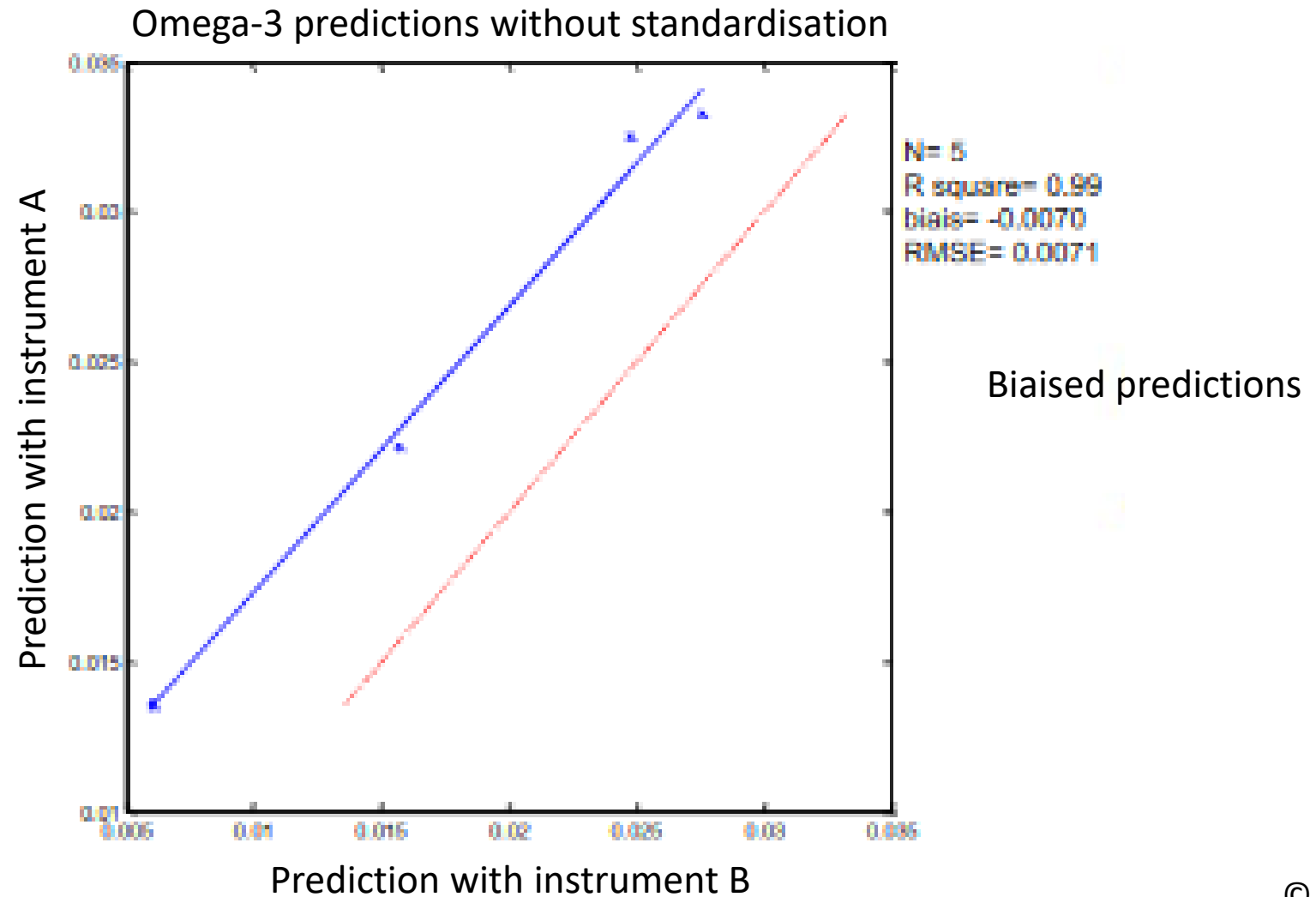


J. Dairy Sci. 98:2150–2160
<http://dx.doi.org/10.3168/jds.2014-8764>
© American Dairy Science Association®, 2015.

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

C. Grelet,¹ J. A. Fernández Pierna,¹ P. Dardenne, V. Baeten, and F. Dehareng²
Walloon Agricultural Research Center, Valorisation of Agricultural Products Department, 24 Chaussée de Namur, 5030 Gembloux, Belgium

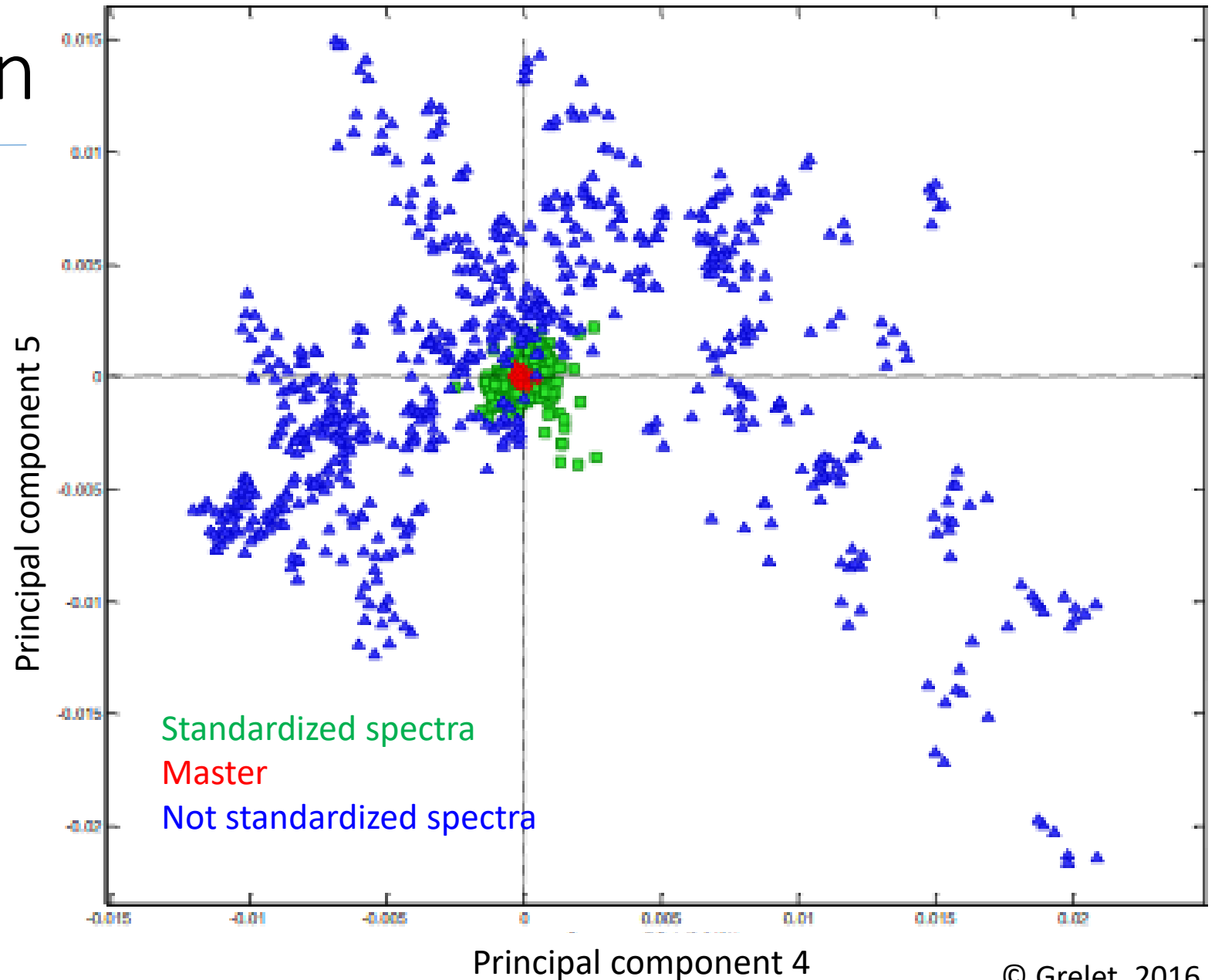
Standardisation



Standardisation

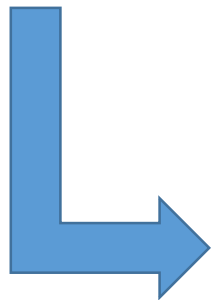
Principal component analysis to reduce the dimensionality of milk MIR spectra

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

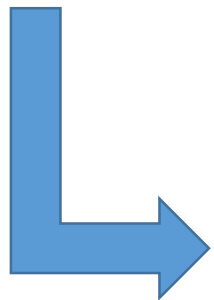


External validation



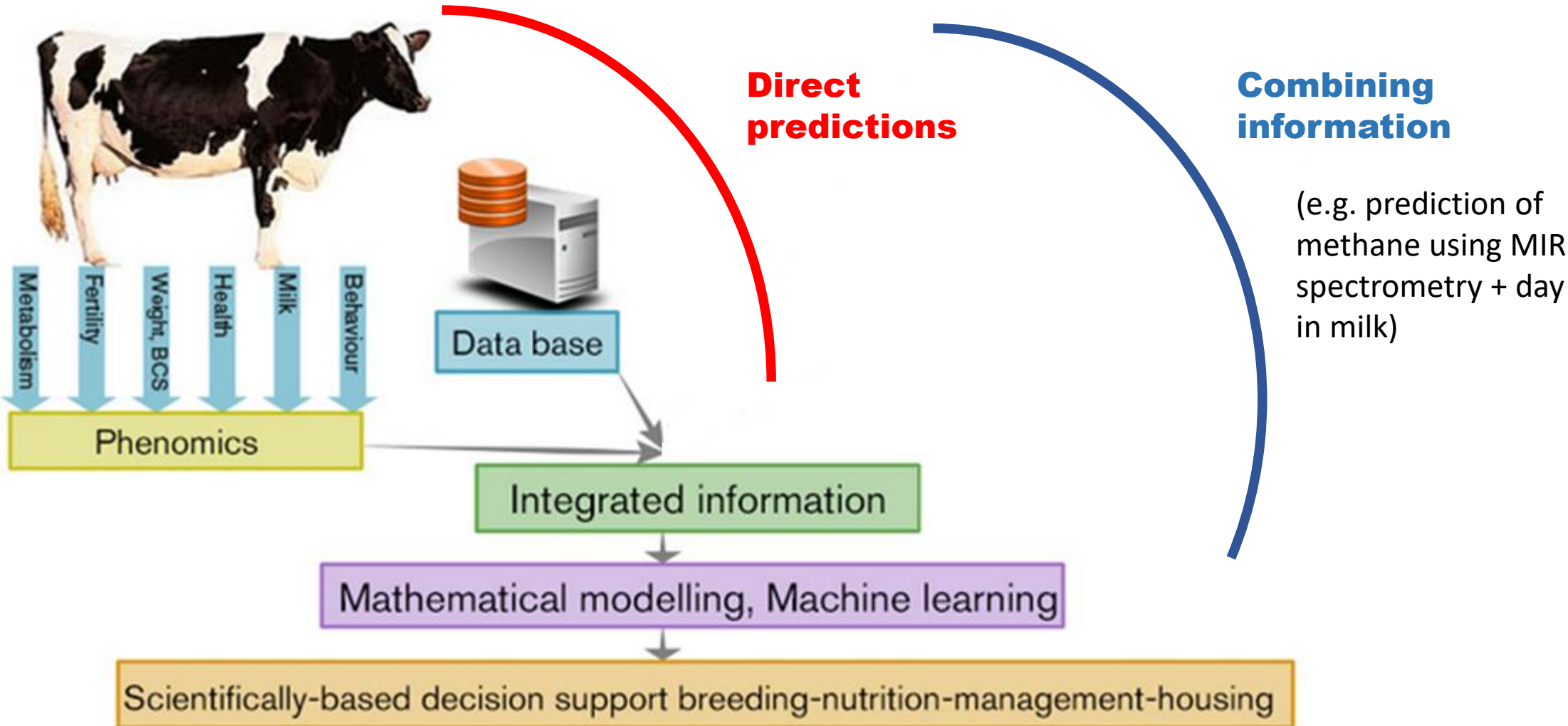
Development of calibration equations

- 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



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 increase 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 £5,500 per farm per year.

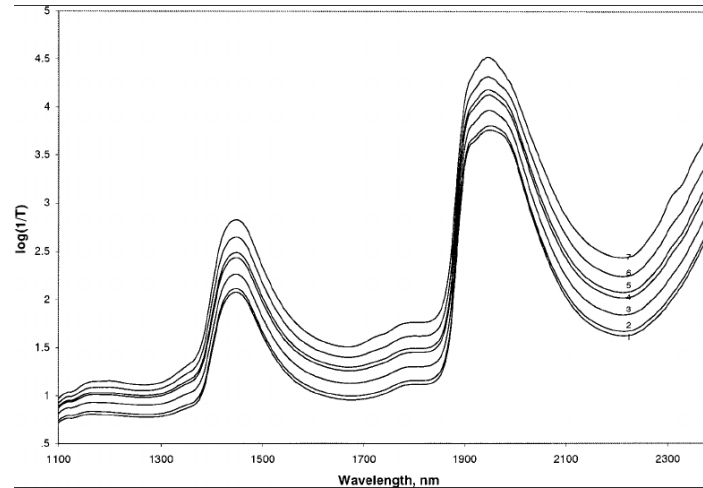
TEXTING COWS

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



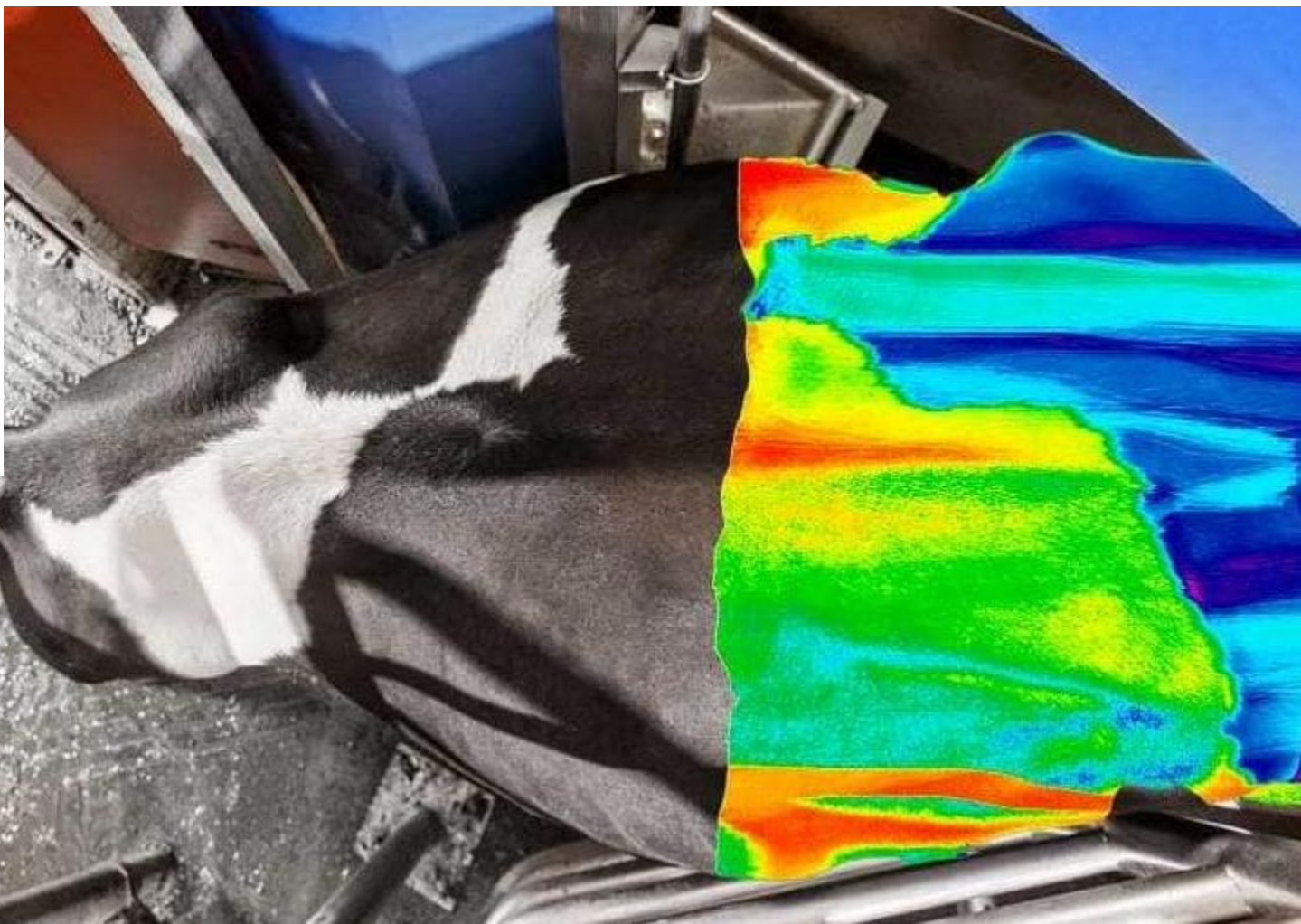
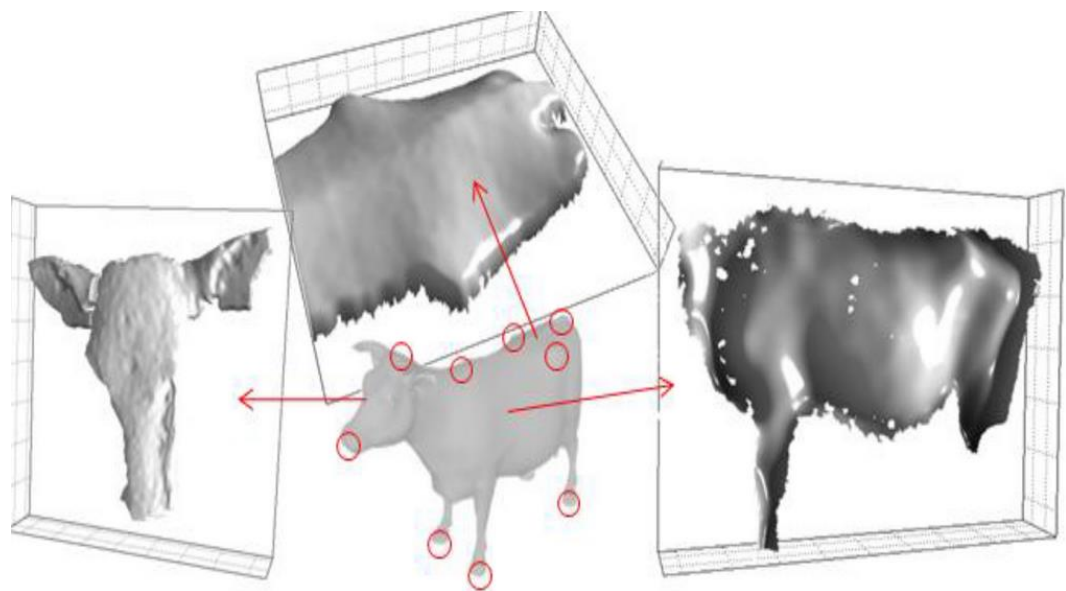
Near infrared spectrometer

In line milk analysis

**Milk
analysis**



New sources of phenotypes on farm



Image

New sources of phenotypes on farm



Heat detection system

IoT



Localisation
(RFID)

Activity
(accelerometer)



Activity
(pedometer)

Challenges



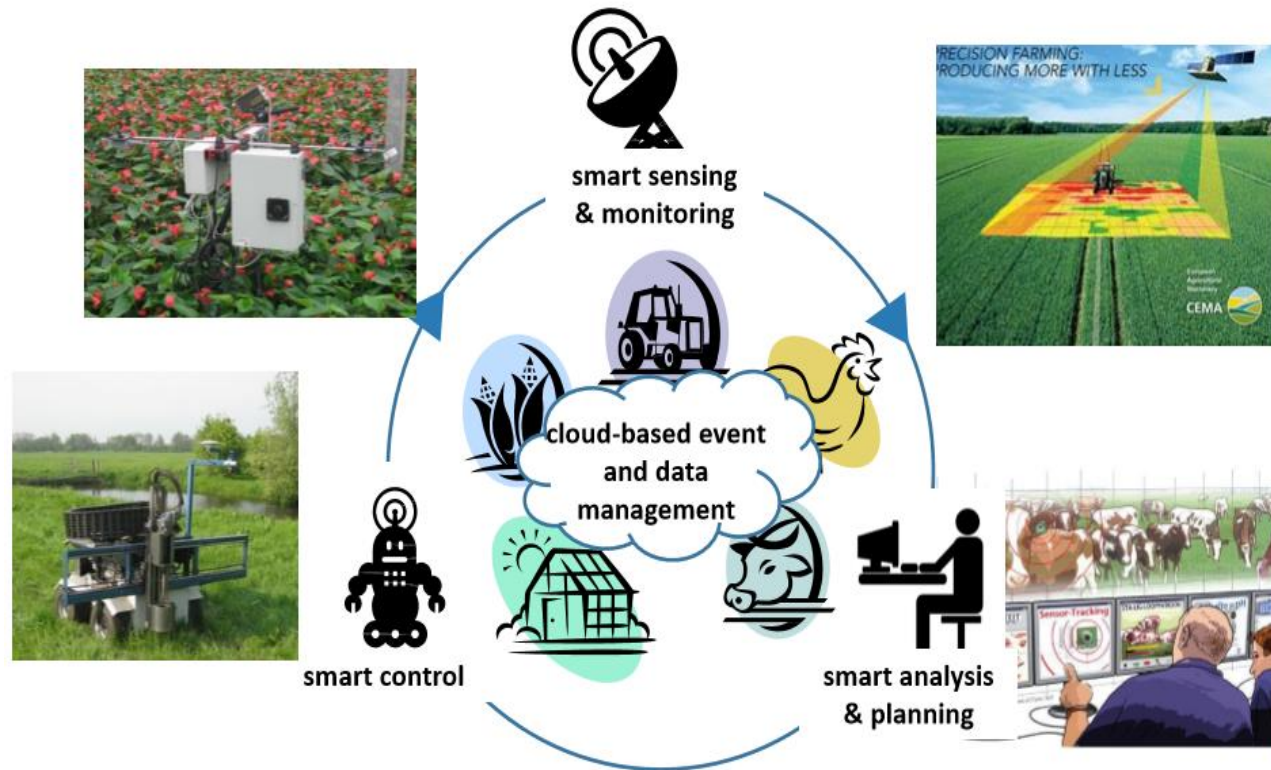
Conservation

Accessibility

Quality

Exploitation

More than individual data ...



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

Data owner ?





#FARMERPOWER

FARMOBILE PUC ▾

DATA STORE

ABOUT US ▾

SIGN IN



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!

<https://www.farmobile.>

FISPACE PUBLIC I

You can access the public F

BUSINESS A

Crop Protection Information Sharing

Fish Distribution and Re-Planning

Flowers & Plants Chain Monitoring

Fresh Fruit and Vegetables

Greenhouse Management and Control

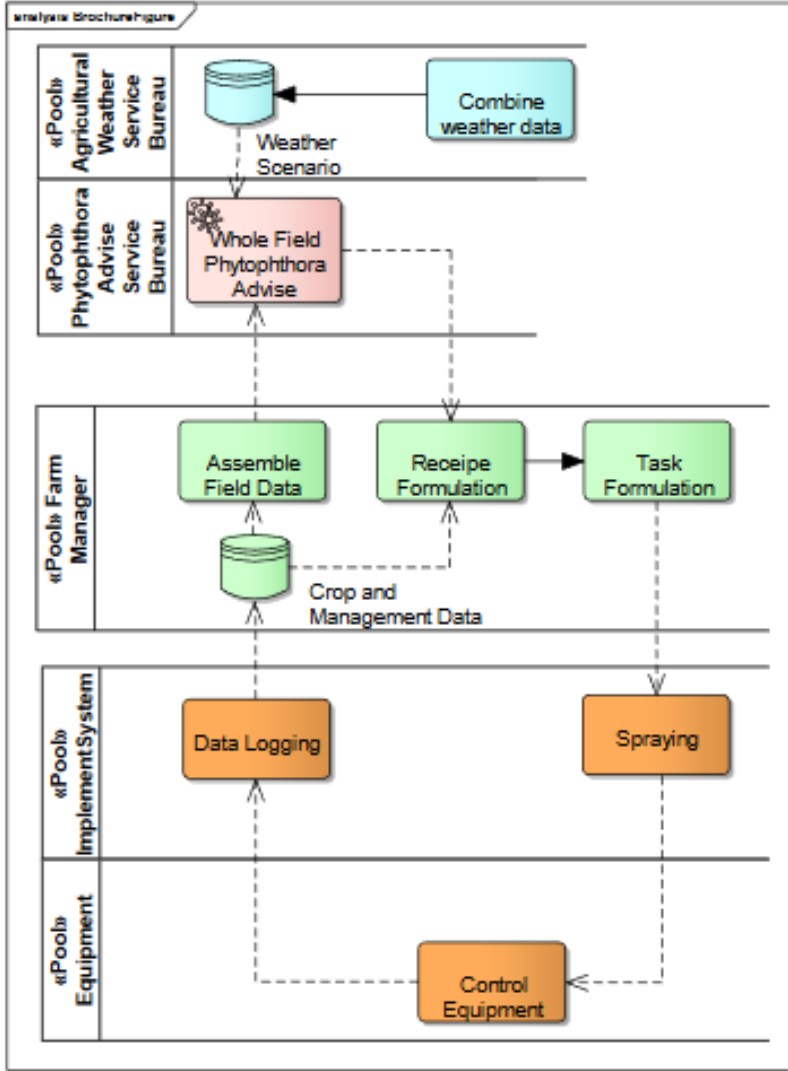
Import and Export of Consumer Goods

Meat Information Provenance

Tailored Information for Consumers

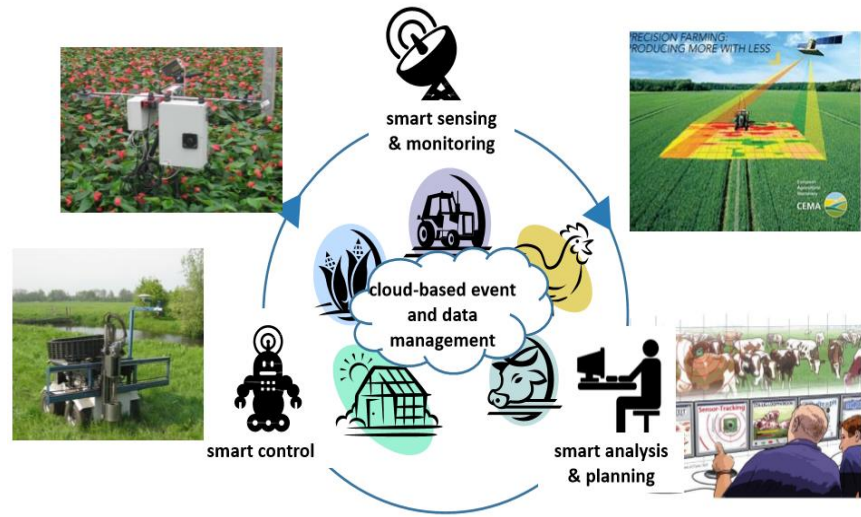
Fispace provides reusable Apps addressing various challenges of farmers, growers, transporters, retailers, service providers and many more.

Cooperating Applications in the CPIS Trial



Future Internet Business Collaboration
Networks in Agri-Food, Transport & Logistics

More than individual data ...



© Wolfert, 2016

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

Innovation :

- IoT
- New sensors
- New apps

- Methodology
- Storage
- Visualisation ...



Growing interest

Google Farm

Google AI builds a better cucumber farm

Machine learning helps sort veggies so the farmer can focus on more important work.



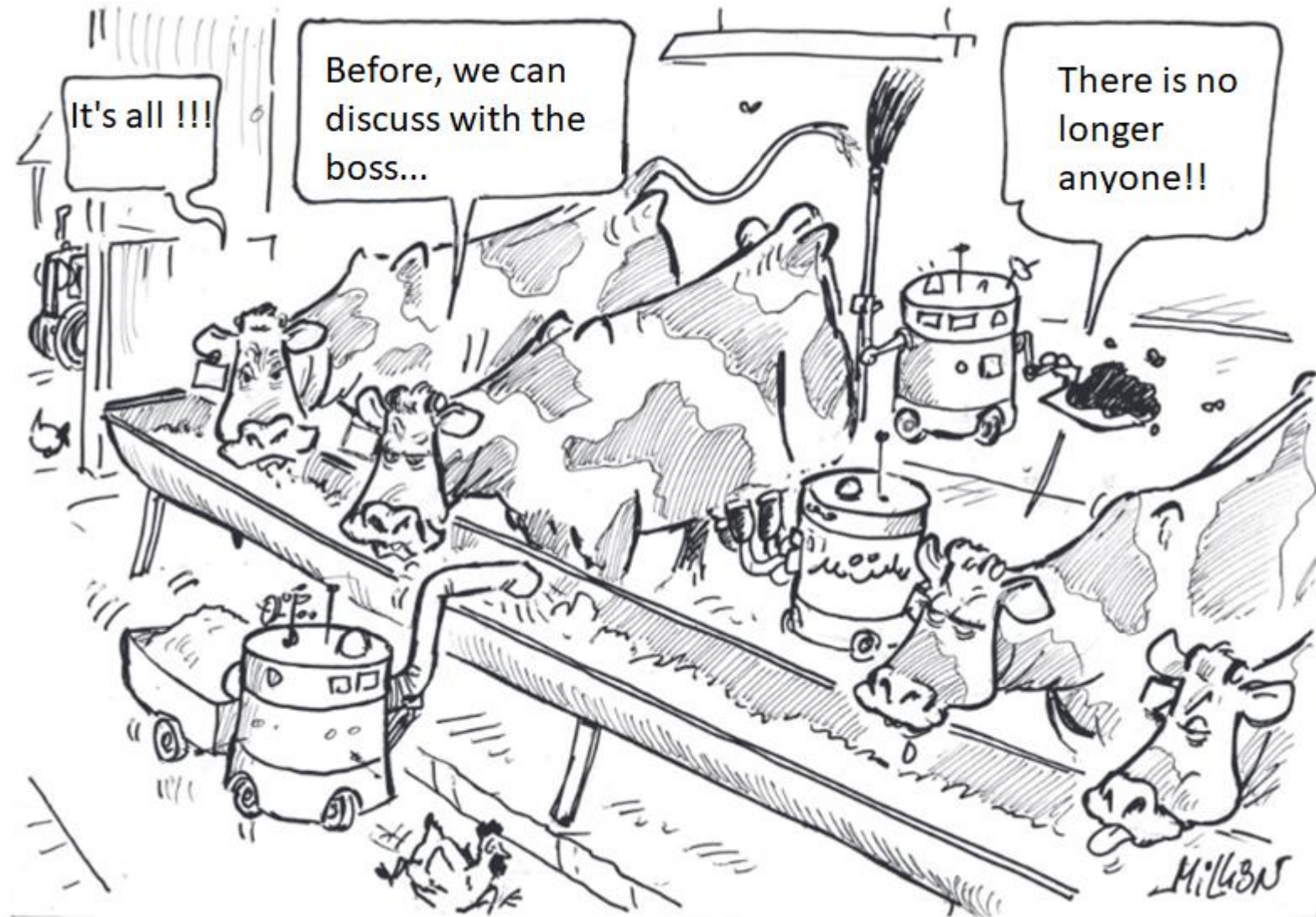
Jon Fingas, @jonfingas
08.31.16 in [Robots](#)

2
Comments

1083
Shares



Social issue ?



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