

Wallonie recherche CRA-W

Consortium building allowing the creation of common models for MIR based prediction of CH₄

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La port



Context

► CH₄ ← large scale phenotyping

- Difficult, time consuming, expensive
- Proxies ?
- Use of a milk mid-infrared (MIR) spectra based proxy
 - Was illustrated as being a real opportunity

Animal, page 1 of 8 © The Animal Consortium 2012 doi:10.1017/S1751731112000456

Potential use of milk mid-infrared spectra to predict methane emission of dairy cows

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 http://dx.doi.org/10.3168/jds.2014-8436
 @American Dairy Science Association[®], 2015.

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

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¶Qualitas AG, 6300 Zug, Switzerland

ASGGN Meeting 2019 Ghent



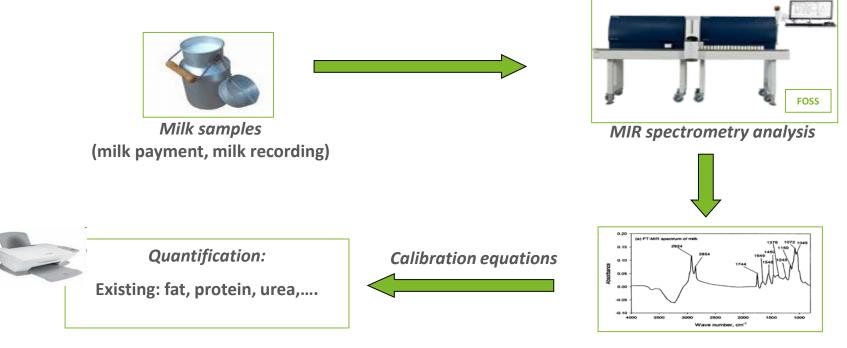
J. Dairy Sci. 101:7618–7624 https://doi.org/10.3168/jds.2018-14472

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Short communication: Development of an equation for estimating methane emissions of dairy cows from milk Fourier transform mid-infrared spectra by using reference data obtained exclusively from respiration chambers

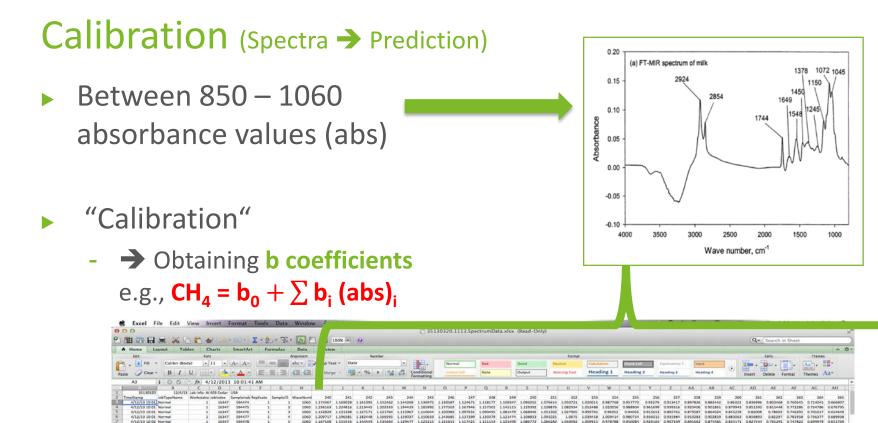


How Do MIR Based Predictions Work ?



Raw data = MIR spectra





1.133002 1.127066 1.122078

1.146019

1 117671 1 109208 1 107273 1.096476

1190874 1182911 1172735 1161865 1151669 1143049 113631 1130957 1125694 1117533

1 180014 1 175545

1 138466 1 12752

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1.096017 1.076372

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4/12/13 10:02 Norma

4/12/13 10:02 Normal

4/12/13 10:02 Normal

4/12/13 10:02 Normal

4/12/18 10:02 Norma

4/12/13 10:02 Normal

4/12/13 10:02 Norm

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6/12/13 10:02 Normal

4/12/13 10:03 Normal

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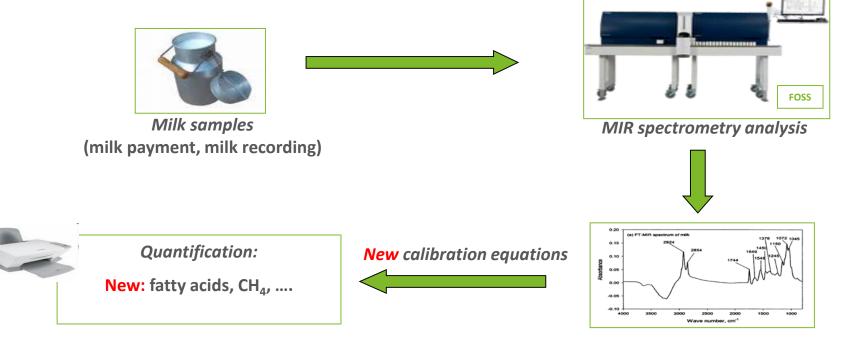
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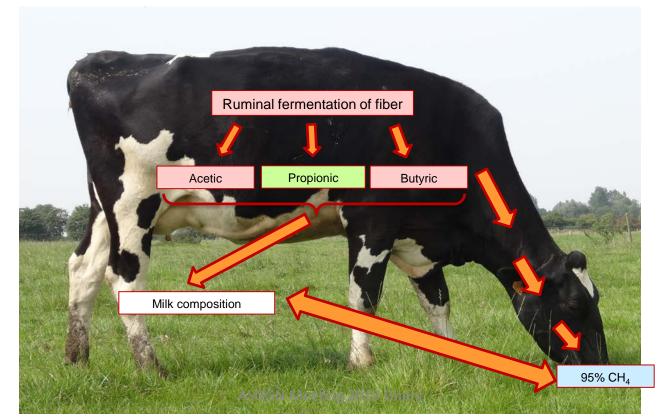
New MIR Predicted Phenotypes



Raw data = MIR spectra



$CH_4 \leftarrow \rightarrow Milk Composition$



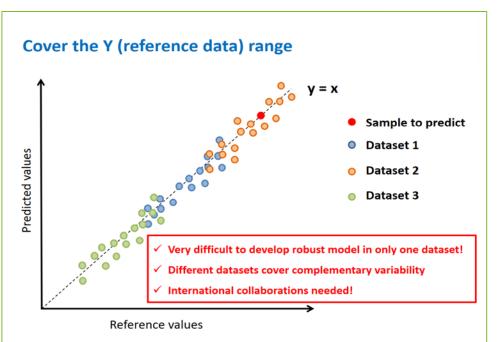
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Calibration Needs....

Largest possible (and expected) variability

- In reference phenotypes
 - E.g., if values between
 1 and 10 are expected,
 reference data from
 1 to 10 are needed
 for calibration,
 potentially 1/10 of each

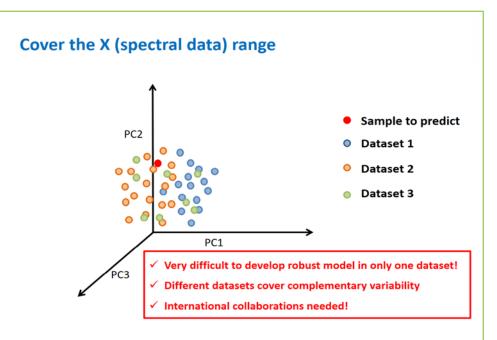




Calibration Needs....

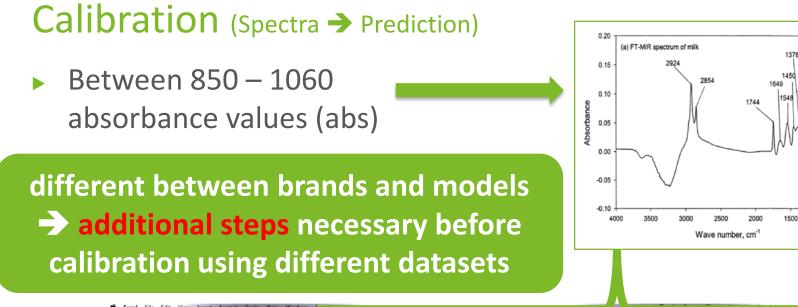
Largest possible (and expected) variability

- In reference phenotypes
- But also in spectral data
 - I.e., spectra used during calibration process should cover expected range of spectra used when predicting





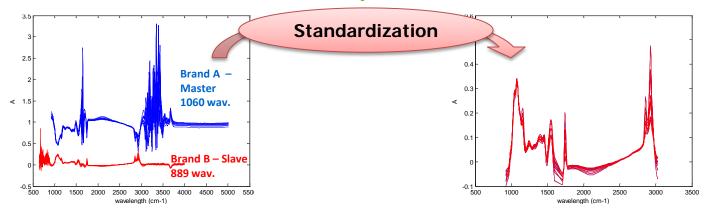
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Standardization of MIR Spectra....

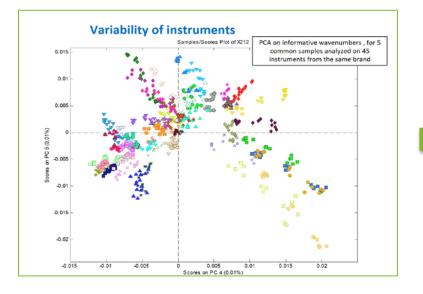


► Two steps to generate "standardized" (harmonized) spectral data

- 1. Transforming from different ranges of wavelength to a common one
- 2. Applying "bias" and "slope" corrections for each wavelength



Standardization of MIR Spectra....

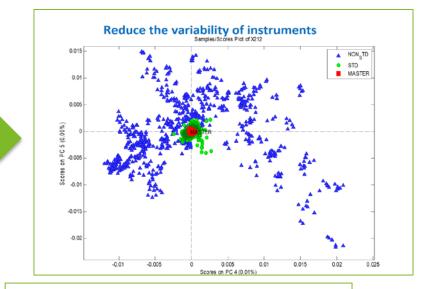




J. Dairy Sci. 98:2150–2160 http://dx.doi.org/10.3168/jds.2014-8764 © American Dairy Science Association[®], 2015.

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





J. Dairy Sci. 100:7910–7921 https://doi.org/10.3168/jds.2017-12720 © American Dairy Science Association[®], 2017.

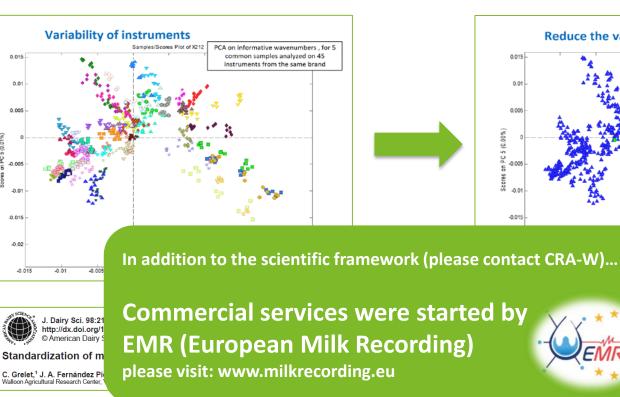
Standardization of milk mid-infrared spectrometers for the transfer and use of multiple models

C. Grelet,* J. A. Fernández Pierna,* P. Dardenne,* H. Soyeurt,† A. Vanlierde,* F. Colinet,† C. Bastin,‡ N. Gengler,† V. Basten,* and F. Dehareng*¹ "valorization of Adricultural Products Department, Walloon Adricultural Research Center, 5030 Gembloux, Belgium

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Standardization of MIR Spectra....



PC 5 (0.01%)

Reduce the variability of instruments NON_TD . STD MASTER 0.01 0.015 0.02 0.025 4 (0.01%)

eters

Vanlierde,* F. Colinet,† C. Bastin,1

5030 Gembloux, Belgium ux Aaro-Bio Tech, 5030 Gembloux, Belaium



Calibration Needs....

- Largest possible (and expected) variability
 - In reference phenotypes
 - But also in spectral data

→ Importance of international collaborations obvious

Needed: Consortium building allowing the creation of common models for MIR based prediction of CH₄



Innovative Consortium Building

- ► Why → last slides!
- ► How → building an efficient consortium ?
 - In the MIR world tradition of machine-builder equations 🙁
- But inspiration from Near-Infrared Spectrometry (NIRS) world .
 - Existence of NIRS forage and feed testing consortia
 - > A well documented example: NIRSC in the USA (see: http://www.nirsconsortium.org)

→ "Open" consortium building



"Open" Consortium Building: Principles

- Defining calibration building organizations
 - Can be different for each equation, here CH₄: CRA-W and ULiège-GxABT
- Consortium members retain full ownership and control of their data
 - Providing their data only to equation builders
 - Data can only be used to improve equations under development
- By helping improving equations, consortium members get:
 - Access to calibrated equations
 - Access to all future updates when additional data from new members is included
 - "Open" as everybody can join same conditions





As Scientists → Why Joining?

First interest in "Open" calibration process
 Jusers of equations -> industry!

But from a scientific point of view?
 interest for scientists?

Creation and use of MIR based prediction (of CH₄ or other traits) → additional contributions and research efforts needed



Additional Contributions and Research Efforts

- Many aspects as development of CH₄ MIR based proxies large research needs as:
 - Different types of CH_4 reference traits \rightarrow alternative equations
 - Novel calibration strategies, e.g. machine learning
 - Important questions outside the direct scope of calibration (e.g. of usefulness of equations): genetic vs. phenotypic correlations → breeding
- Leading to interesting publications during process

→ Some examples next slides

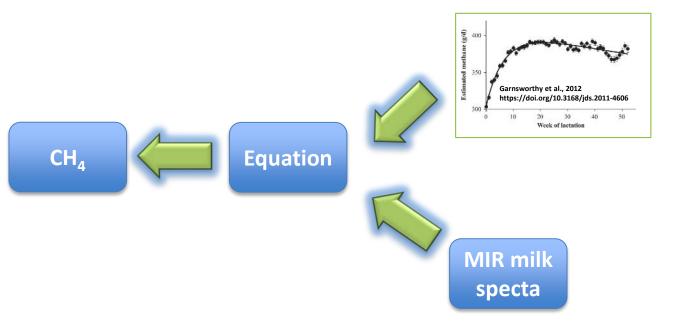


CH₄ Equation



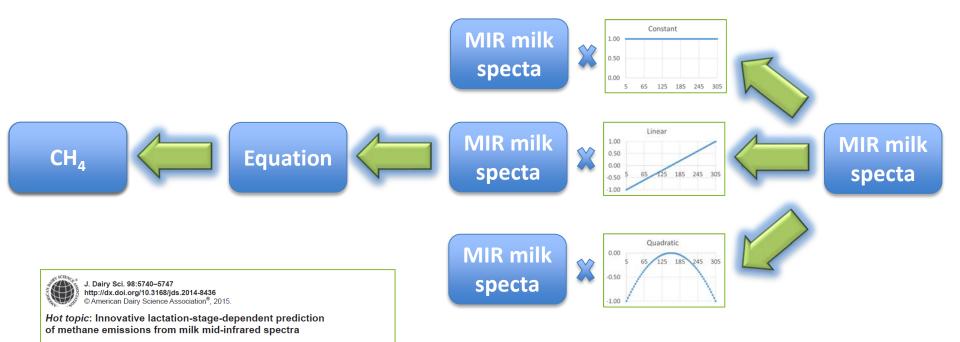


CH₄ Equation → Lactation Stage Dependent





CH₄ Equation → Lactation Stage Dependent



A. Vanlierde,^{x1} M.-L. Vanrobays,†¹ F. Dehareng,^{*} E. Froidmont,‡ H. Soyeurt,† S. McParland,§ E. Lewis,§ M. H. Deighton,# F. Grandl,II M. Kreuzer,II B. Gredler,¶ P. Dardenne,^{*} and N. Gengler†²



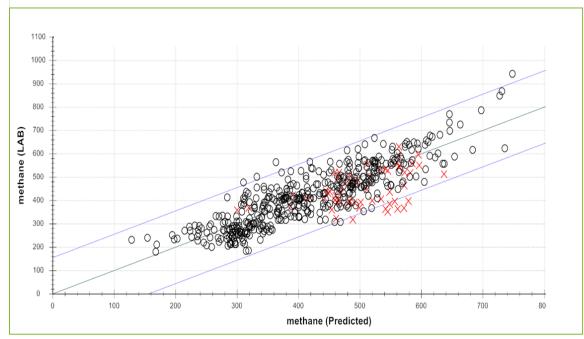
First Test of Chamber Data

- ▶ X chamber CH₄
- \triangleright O reference SF₆
- Reported in

J. Dairy Sci. 98:5740–5747 http://dx.doi.org/10.3168/jds.2014-8436 © American Dairy Science Association[®], 2015.

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

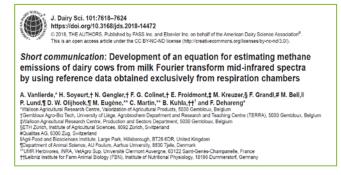
A. Vanlierde,*¹ M.-L. Vanrobays,†¹ F. Dehareng,* E. Froldmont,‡ H. Soyeurt,† S. McParland,§ E. Lewis,§-M. H. Deighton,# F. Grandi,II M. Kreuzer,II B. Gredler,¶ P. Dardenne,* and N. Gengler†²

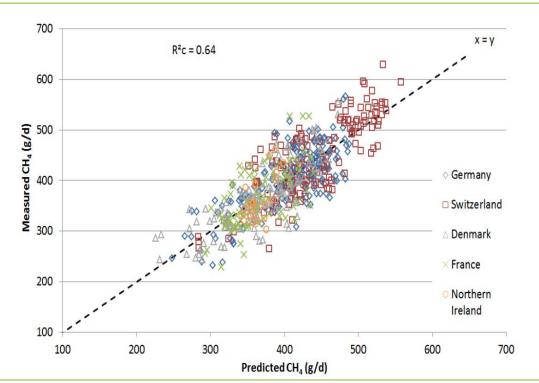




Use of Chamber Data

- Collaboration throughout
 Collaboration throu
- Created opportunity to generate first chamber equation
- Please see in:

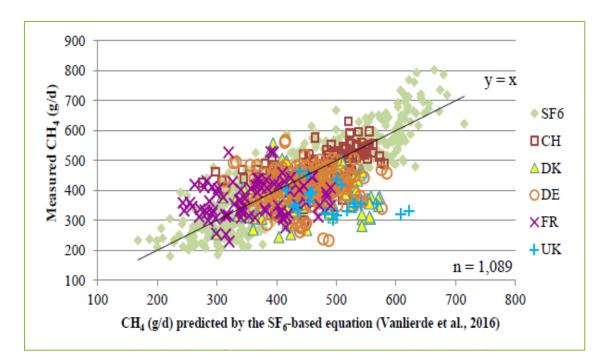






Improving Robustness and Accuracy

- Glimpse to ongoing research
- Here
 - How a SF₆based equation predicts chamber data
 - Not included in calibration

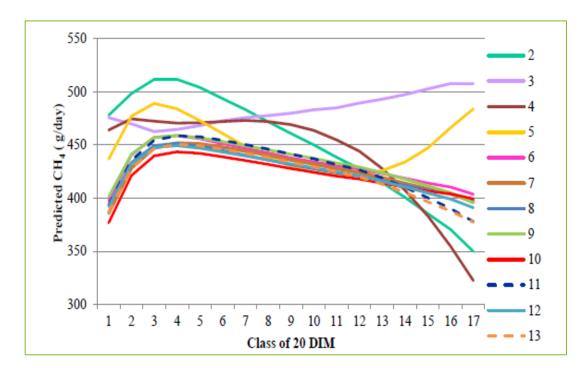




Evolution of Equations Applied to ½ x 10⁶ TDR

- Differences between equations:
 - Based on more data*
 - Chamber and SF₆ \rightarrow 6 to 13 \leftarrow RC + SF₆
 - Adding effects:
 - > 6 → 13

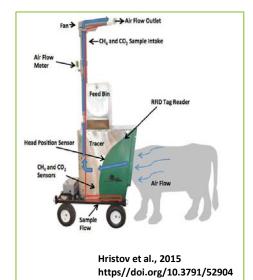
*equation 3 not lactation stage dependent





Research Focuses → Opportunities

- Equations with more data
- Equations with novel variables
 - Milk, live-weight, parity, breed,....
- Other methods....
 - Machine learning
 - Federated learning,...
- Opportunity widespread use of Greenfeed:
 - Creating Open "Greenfeed MIR" consortium
- Important: adding genetic and genomic context
 - Phenotypic vs. genetic correlations → interest of proxies





Other Advantages (And Disadvantages) of Our "Open" Type of Consortia

- Compared to "joint" databases
 - There partners contribute to, but also have (restricted) access
- Our approach has one major advantage
 - We can accommodate many different data protection schemes
 - From highly proprietarian data (e.g. from industry projects) to publically available "open data"
- Should compensate major disadvantage as obviously
 - → Use of this calibration database only for equation building
- But objectives different!
 - Situations where other type of consortia fit better



Belgian Motto

L'union fait la force – Eendracht maakt macht - Einigkeit macht stark





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C.E.C.I 】



