EAAP 2014

Innovative lactation stage specific prediction of CH_4 from milk MIR spectra

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Walloon Agricultural Research Centre
Valorisation of Agricultural Products Department
Agricultural Product Technology Unit
www.cra.wallonie.be

Context : Methane produced by ruminants

- Greenhouse gas + loss of gross energy intake (6 to 12%)

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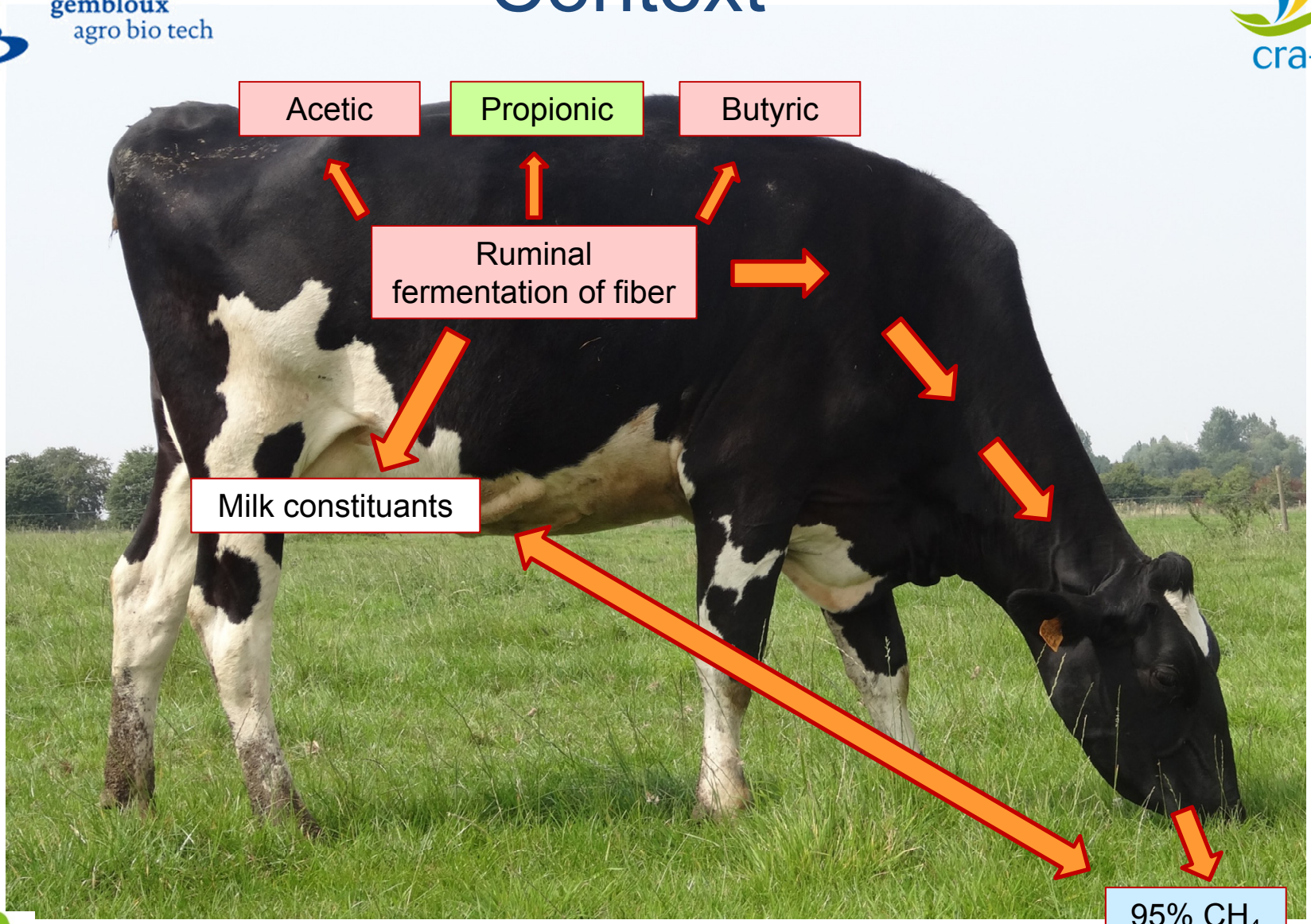
→ Possibility to reduce enteric CH_4 emissions

→ Before reducing it is necessary to study the link between those levers and methane emissions

→ Development of a technique that allows large scale studies

Context



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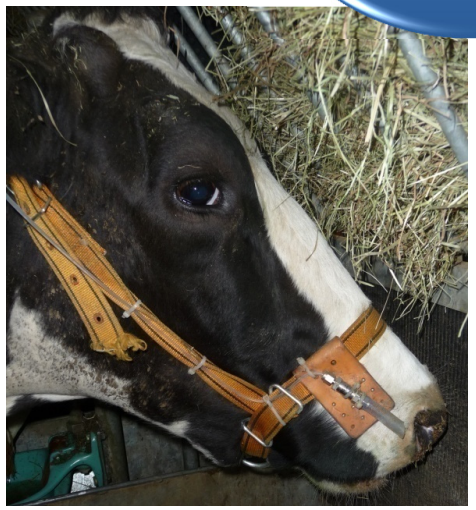
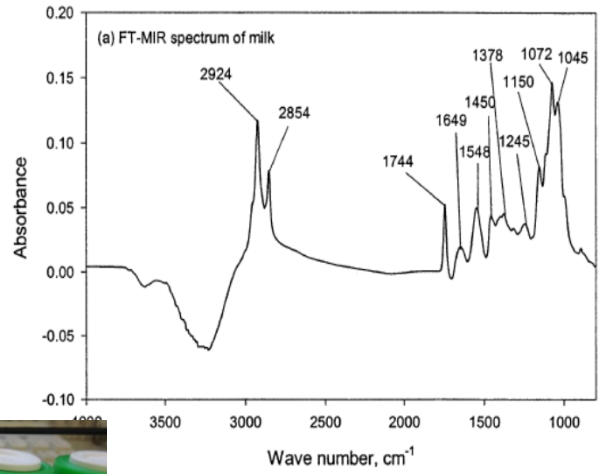
Principle

Enteric CH_4

MIR milk spectra

Equation





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Principle

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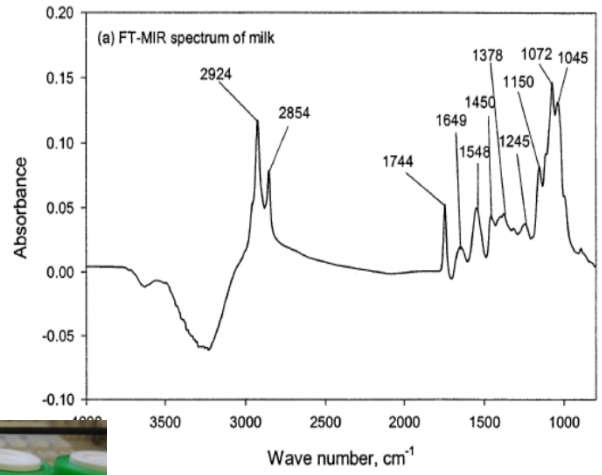

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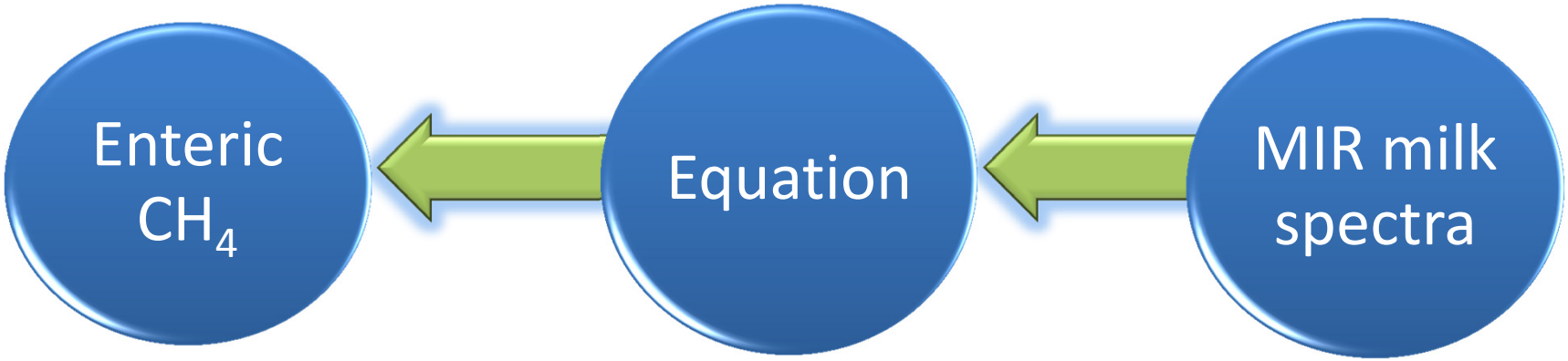
Previous work



Animal (2012), **6:10**, pp 1694–1701 © The Animal Consortium 2012
doi:10.1017/S1751731112000456

animal

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

F. Dehareng[1*†], C. Delfosse[1*], E. Froidmont[2], H. Soyeurt[3,4], C. Martin[5], N. Gengler[3,4], A. Vanlierde[1] and P. Dardenne[1]

[1]*Valorisation of Agricultural Products Department, Walloon Agricultural Research Centre, B-5030 Gembloux, Belgium;* [2]*Department of Production and Sectors, Walloon Agricultural Research Centre, B-5030 Gembloux, Belgium;* [3]*Animal Science Unit, Gembloux Agro Bio-Tech, University of Liège, B-5030 Gembloux, Belgium;* [4]*National Fund for Scientific Research, B-1000 Brussels, Belgium;* [5]*UR1213 Herbivores, INRAClermont-Theix Research Centre, F-63122 Saint Genès Champanelle, France*

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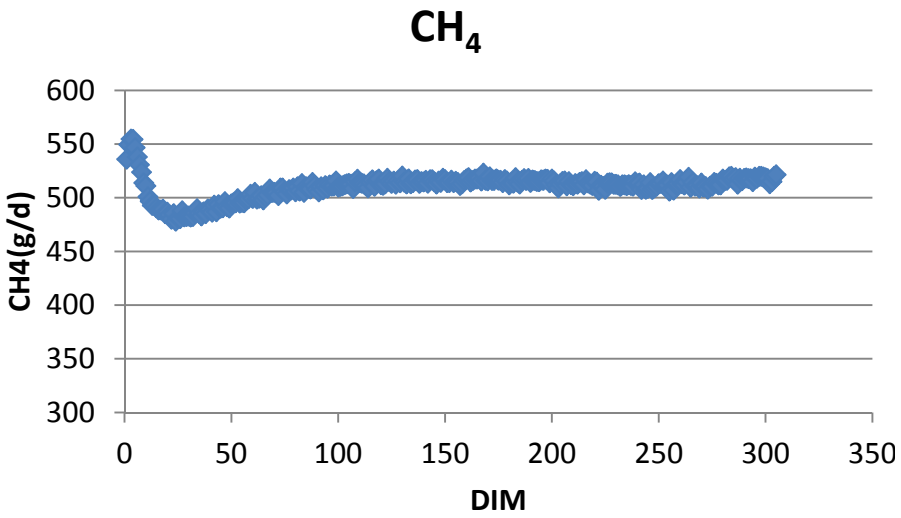
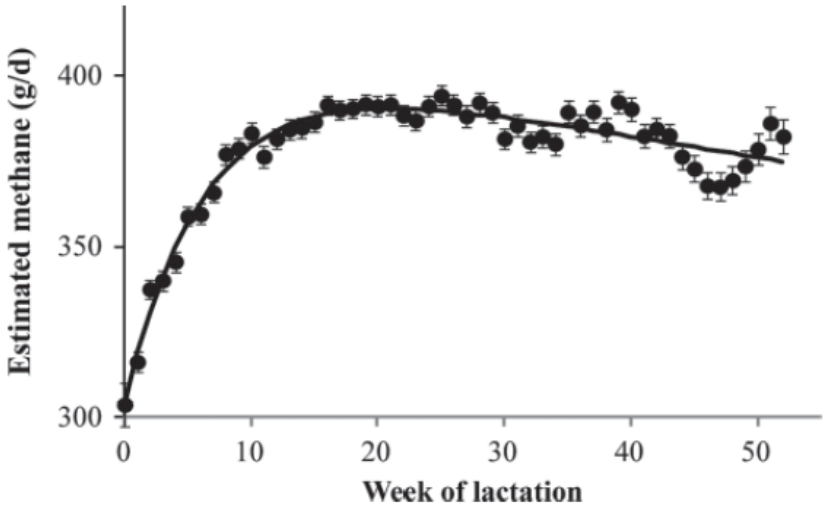
Methane predictions depending on lactation stage



Garnworthy *et al.*, 2012



→ Reversed curves

→ Need to improve our model

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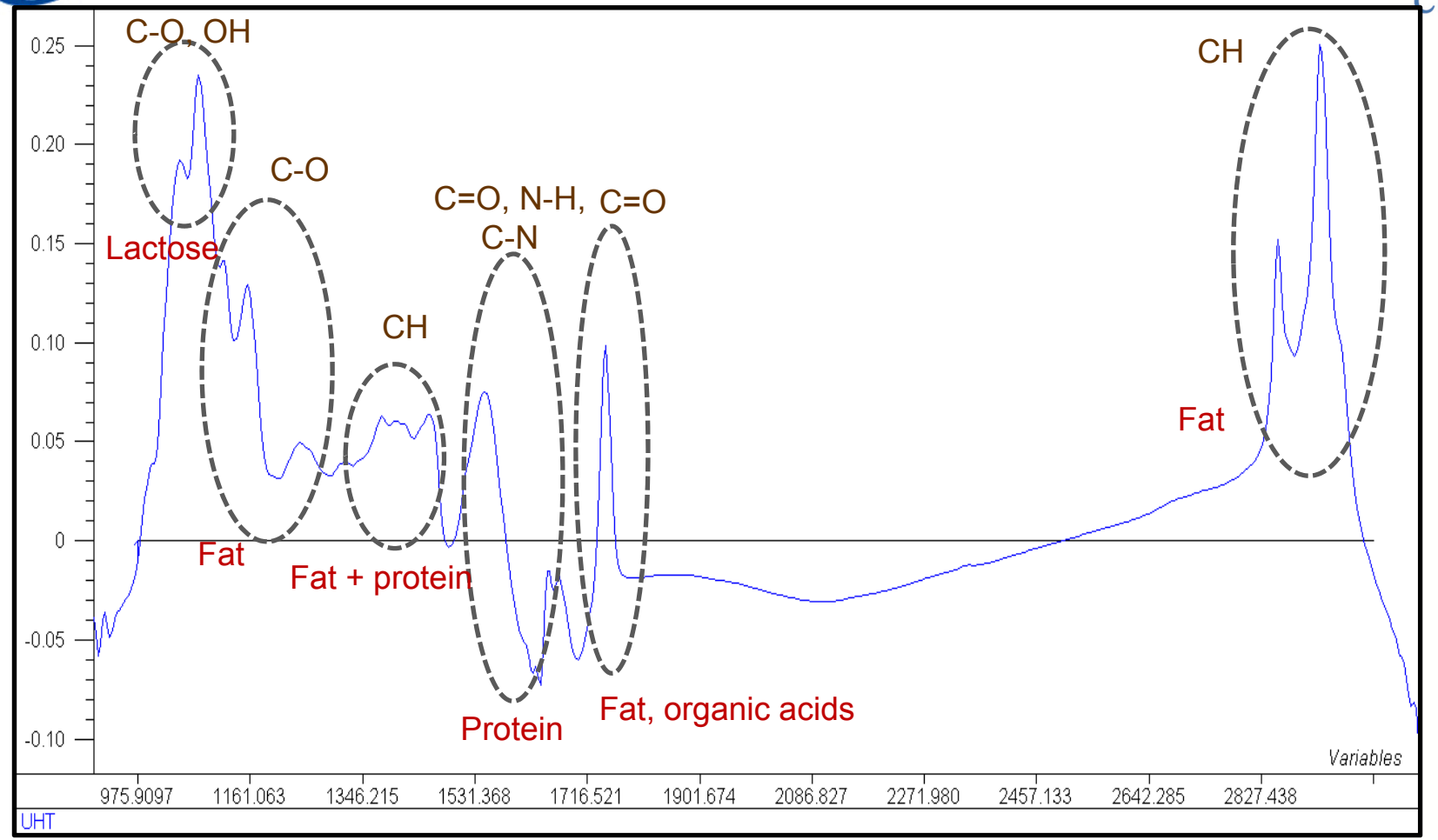
Milk MIR spectra



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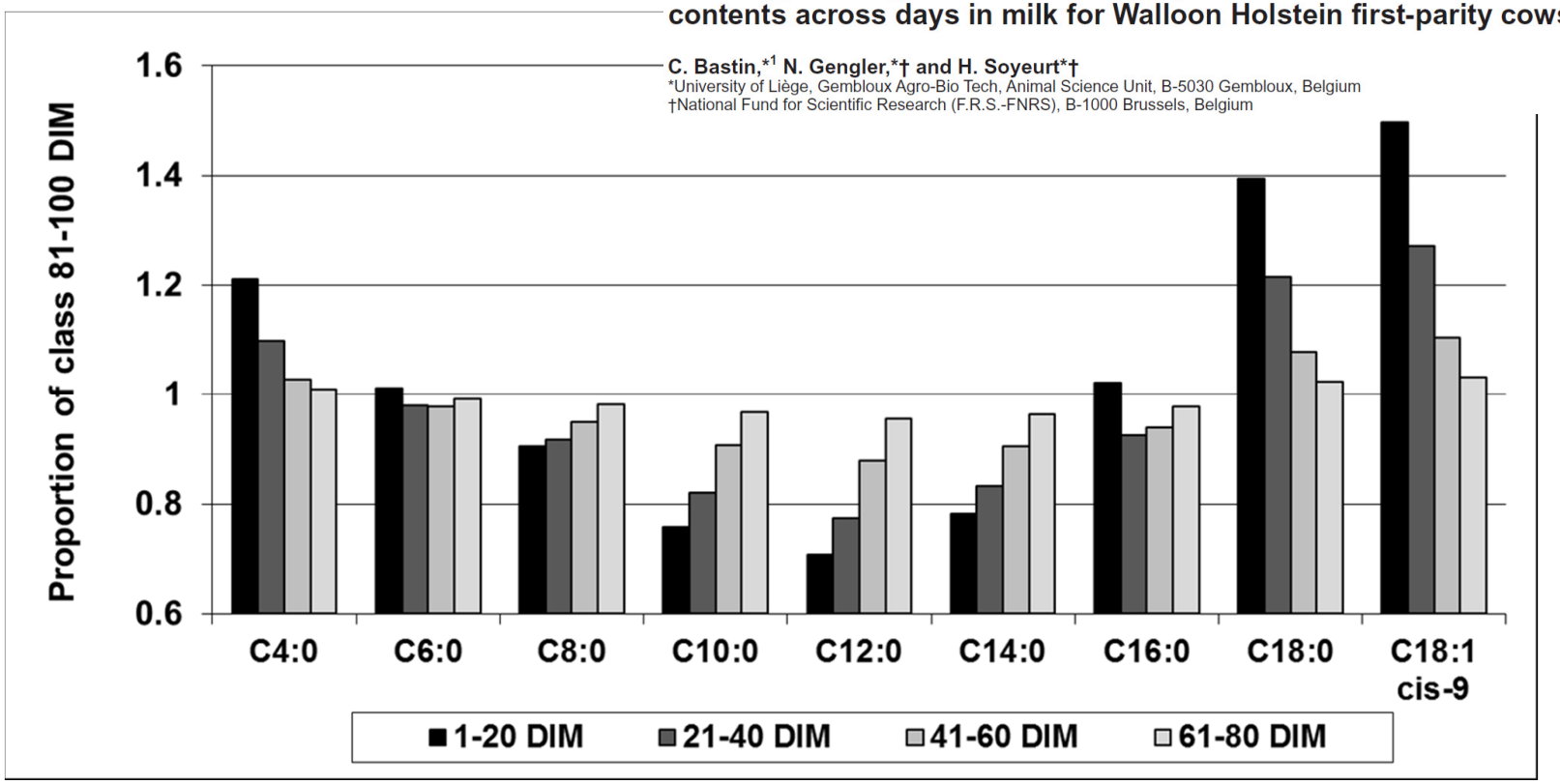
Influence of lactation stage (DIM) on milk fatty acids

J. Dairy Sci. 94:4152–4163
doi:10.3168/jds.2010-4108

Phenotypic and genetic variability of production traits and milk fatty acid contents across days in milk for Walloon Holstein first-parity cows

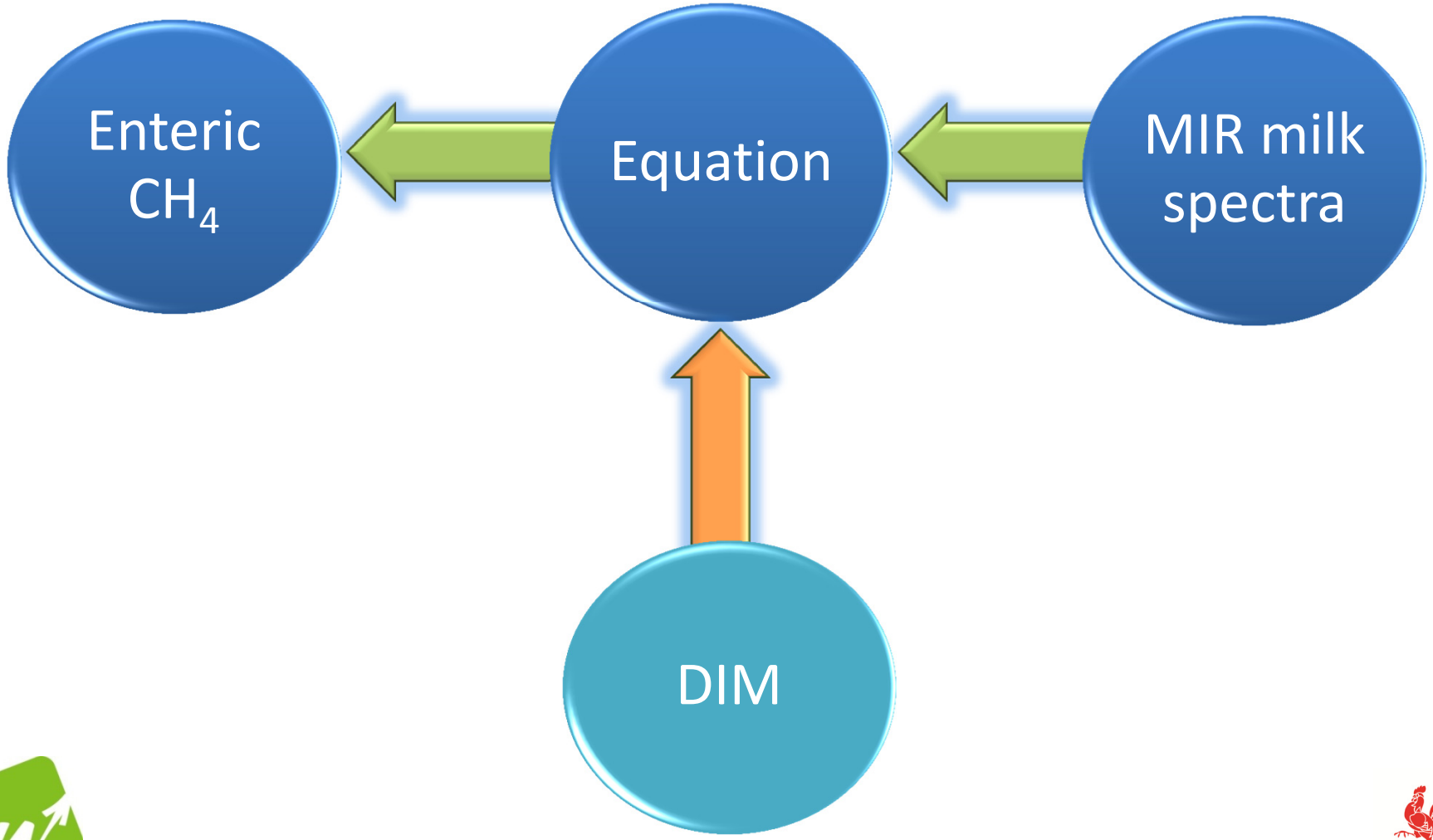
C. Bastin,*[1] N. Gengler,*† and H. Soyeurt*†
*University of Liège, Gembloux Agro-Bio Tech, Animal Science Unit, B-5030 Gembloux, Belgium
†National Fund for Scientific Research (F.R.S.-FNRS), B-1000 Brussels, Belgium



→ Influence on the milk MIR spectra

→ Influence the relationship between MIR spectra and CH_4

Objective : Inclusion of DIM information in methane equation



Material and Methods

- Comparison of equations including or not the DIM information

- 446 reference data : milk MIR spectrum // enteric CH_4 (SF_6)

→ A maximum variability is needed

  - Belgium (CRA-W) and Ireland (Teagasc – Moorepark)
  - 142 cows
  - Lactations : 60 x 1st, 36 x 2nd , 45 x 3rd or + AV1
  - Holstein, Jersey and Cross-breed (Hol x Jer)
  - Different diets : basic diet enriched in - maize
    - fresh grass
    - linseed

    classic total mixed ration
    starch morning, fiber evening
    grassland

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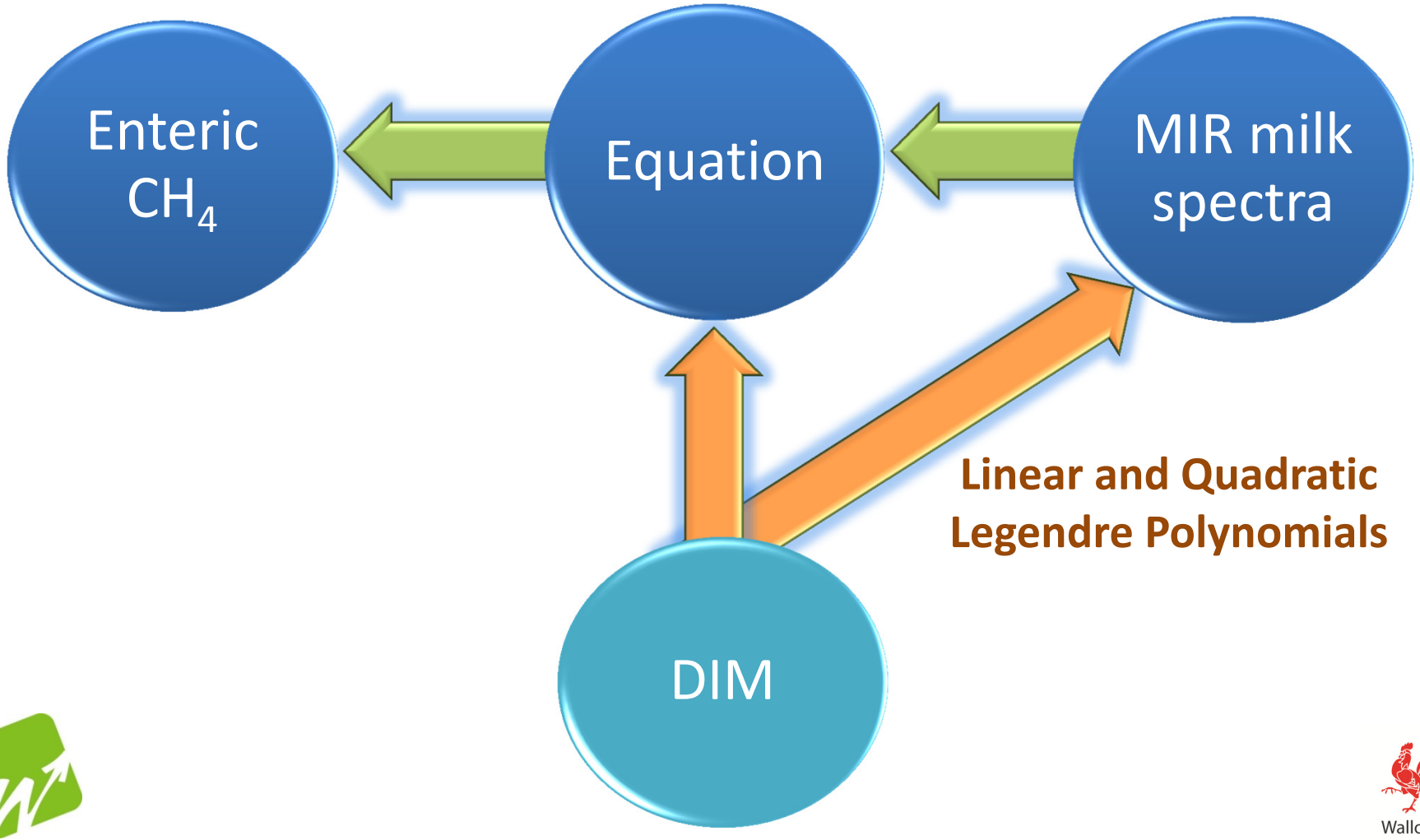
Dias nummer 14

AV1 Peut-être rajouter le nombre de vache par classe de DIM. mais que prendre comme classe...? je pensais reprendre celles de la dia 9.
Amélie VANLIERDE, 08/08/2014

Material and Methods : Inclusion of DIM information in methane equation



Material and Methods : Legendre Polynomials

Estimation of (Co)variance Function Coefficients for Test Day Yield with a Expectation-Maximization Restricted Maximum Likelihood Algorithm

N. GENGLER,*,† A. TIJANI,†,1 G. R. WIGGANS,‡ and I. MISZTAL§

1999 J. Dairy Sci.(Aug.)

Legendre polynomials has been adapted depending on the lactation stage to take into account the expected metabolic status of the cow.

→ Adapted polynomials can be applied on milk MIR spectra.

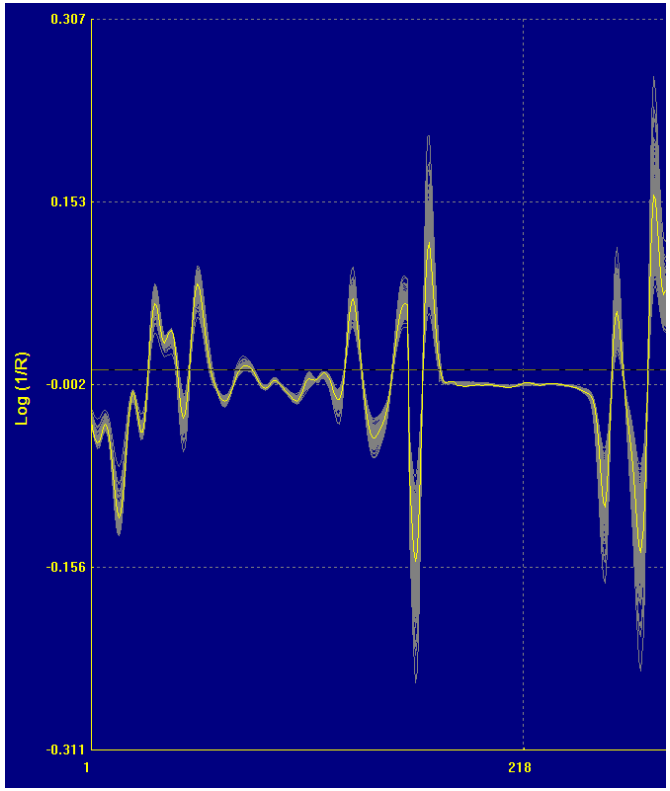
Material and Methods : Legendre Polynomials

- First derivatives of milk MIR spectra are multiplied by :

  - 1 (**constant**)
  - adapted **linear** Legendre polynomial
  - adapted **quadratic** Legendre polynomial

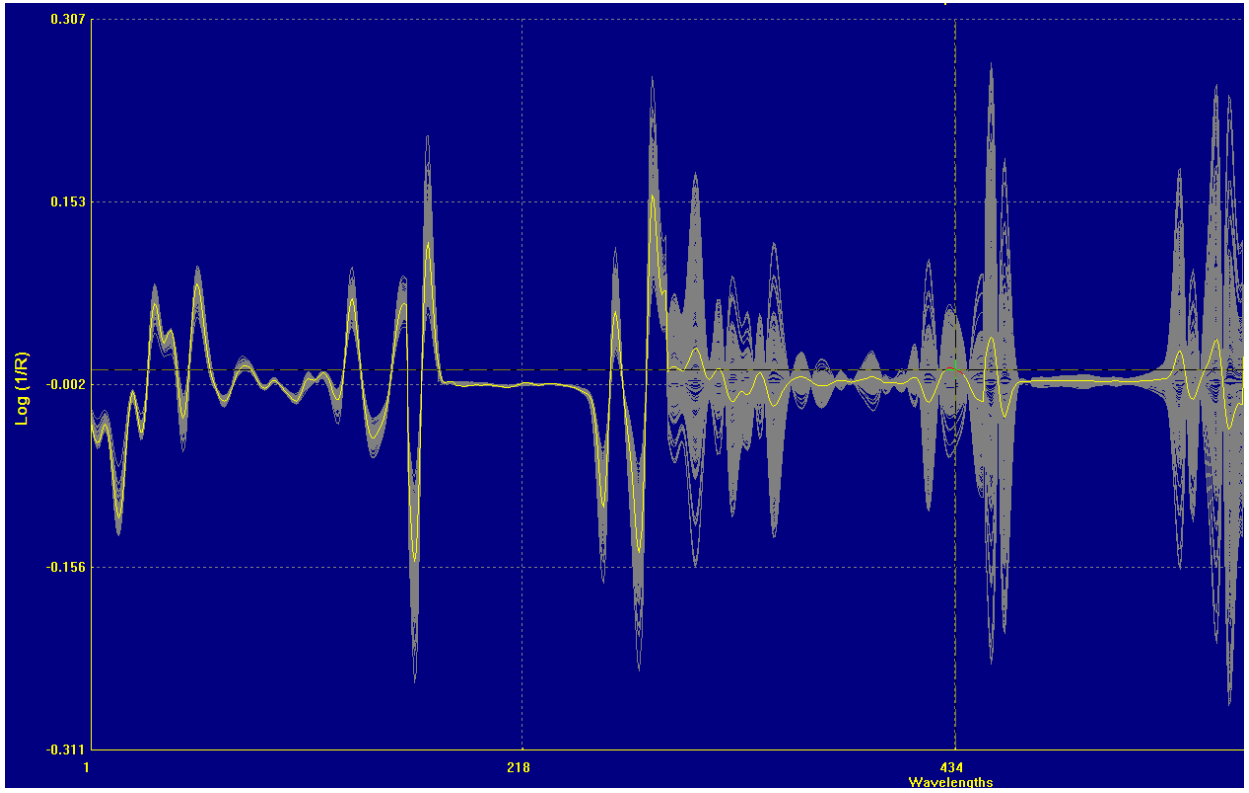
Vary for each spectra according to the DIM of the linked cow

Material and Methods : Legendre Polynomials



Constant

Material and Methods : Legendre Polynomials



Constant

Linear

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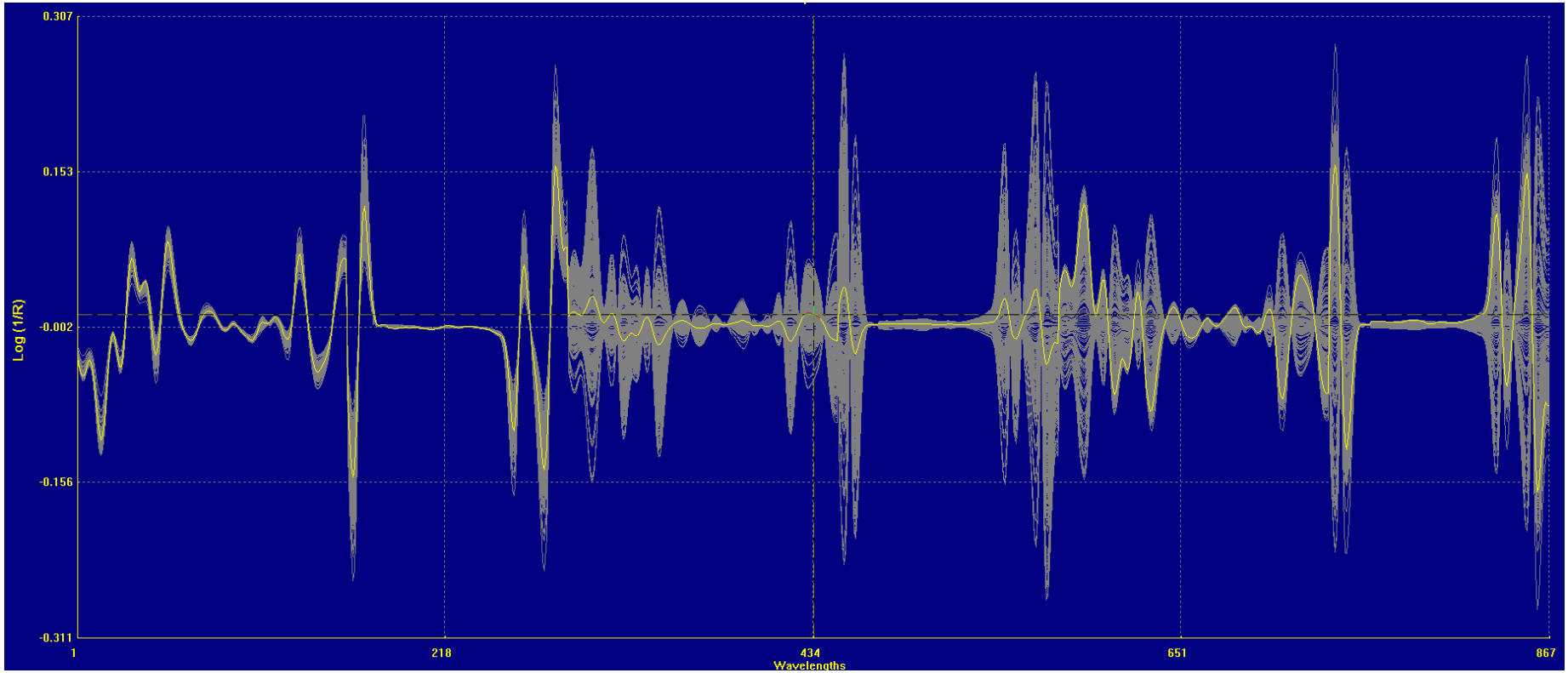
Material and Methods : Legendre Polynomials



Constant

Linear

Quadratic

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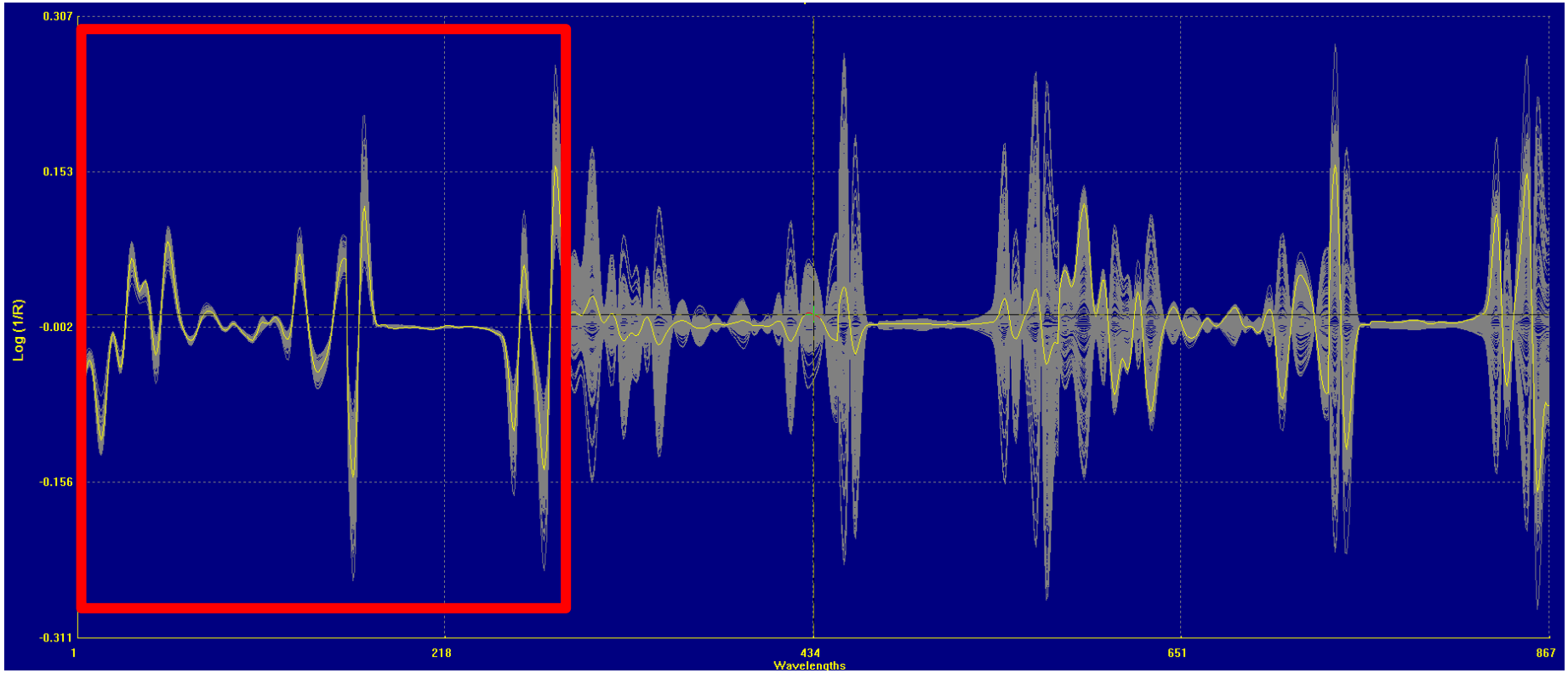
Material and Methods

Spectra used to develop the equation independant of DIM



Constant

Linear

Quadratic

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Equations to predict CH_4 from MIR milk spectra

Equation (g/day)	N	SD	R^2c	R^2cv	SEC	SECV
CH_4	446	132.6	0.78	0.74	63	68
CH_4 and DIM	446	127.5	0.75	0.67	63	72

N = number of observations; SD = standard deviation; R^2c = calibration coefficient of determination; R^2cv = cross-validation coefficient of determination; SEC = calibration standard error; SECV = cross-validation standard error

→ Statistical parameters are a slighty lower…

…BUT!

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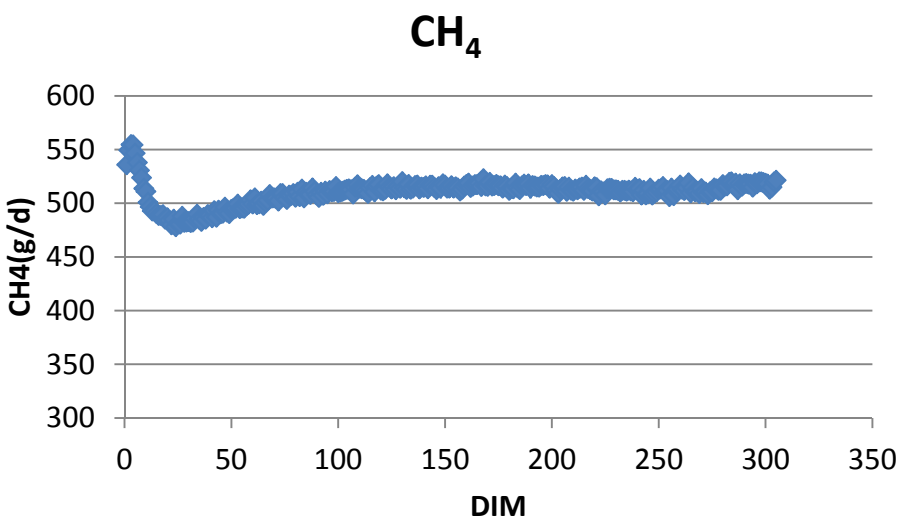
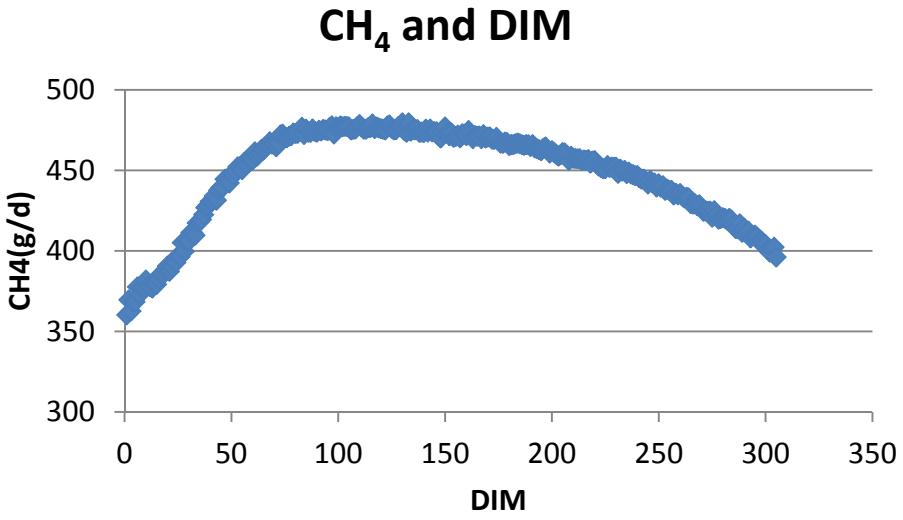
Equations to predict CH_4 from MIR milk spectra

Application of CH_4 equations on Belgian spectral database

– 1st lactation Holstein cows





→The only modification in our calibration is the incorporation of the lactation stage information

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Equations to predict CH_4 from MIR milk spectra

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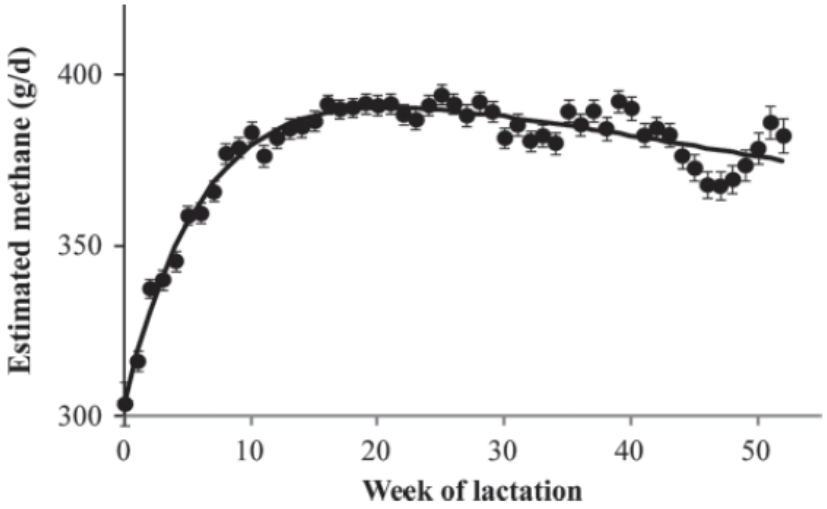
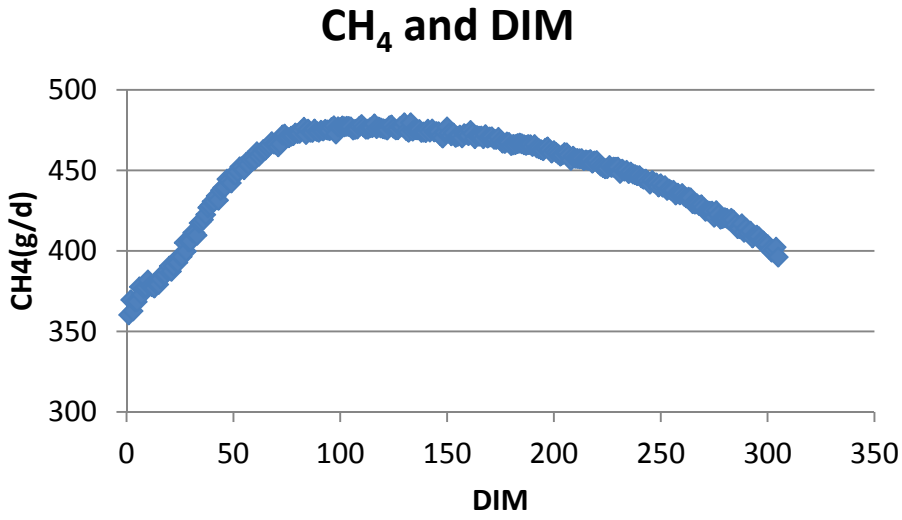
– 1st lactation Holstein cows

Garnworthy *et al.*, 2012





→In accordance with literature

Equations to predict CH_4 from MIR milk spectra

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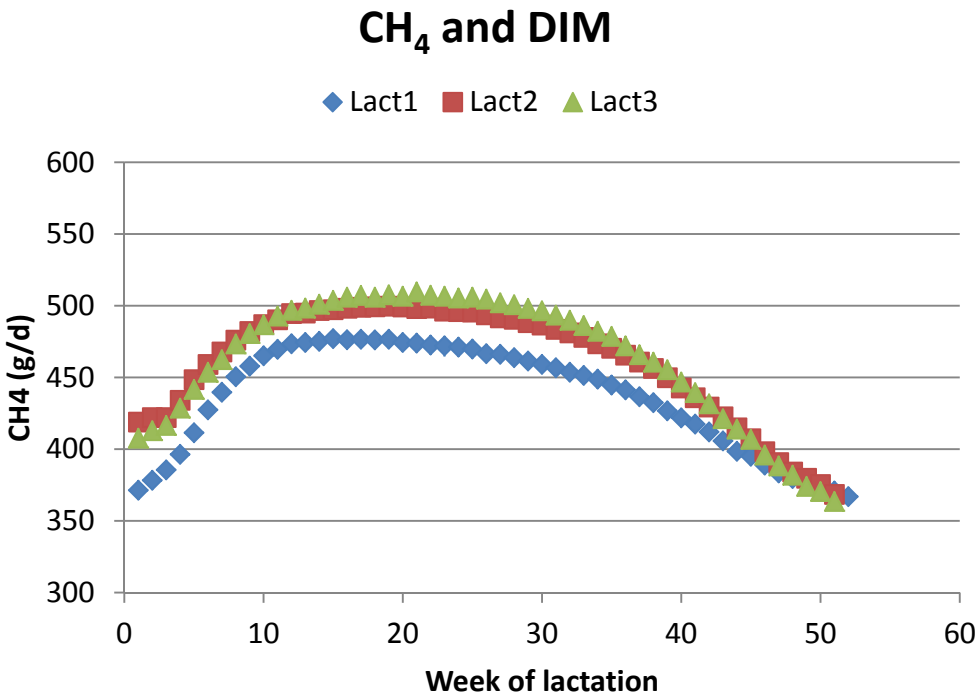
– Holstein cows



Trends over lactations correspond to what is expected

Conclusions

- Possible to predict enteric methane from milk MIR spectra
- Important to check if the applications at large scale are logical at a metabolic level
- Integration of DIM information seems to be a good strategy to :
  - take a better account of the metabolic status of cows
  - improve the equation
- More data are needed to - include more variability
  - cover better the beginning and the end of lactation
  - improve performance of the equation


Thank you!