Development of Infrared reflectance spectroscopy databases for efficient livestock management

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Context
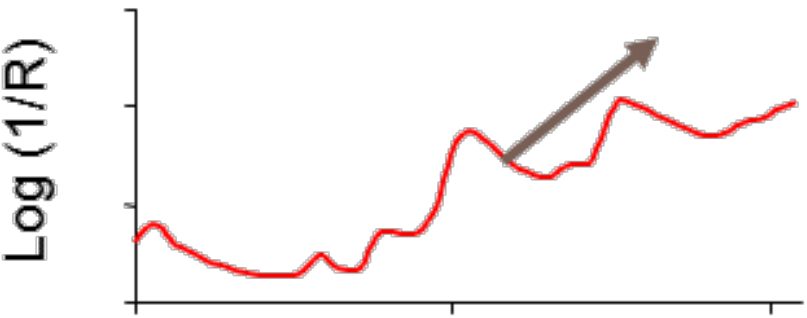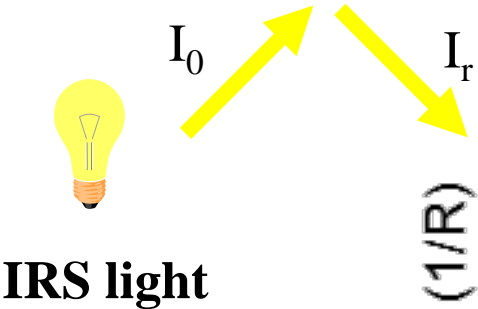
✓ **Strong expectance towards livestock for high quality products and services but with limited environmental impacts.**

✓ **Consumer expectation for grazing systems is high.**

✓ **Needs of rapid and low cost methods able to characterize various organic substrates and to provide useful informations for Decision Support Tools (DST)**

✓ **Needs of DST to achieve:**
  o better livestock management and to obtain high food production (quality and quantity)
  o the evaluation of environmental pressure (greenhouse gazes…) at farm and regional scales;
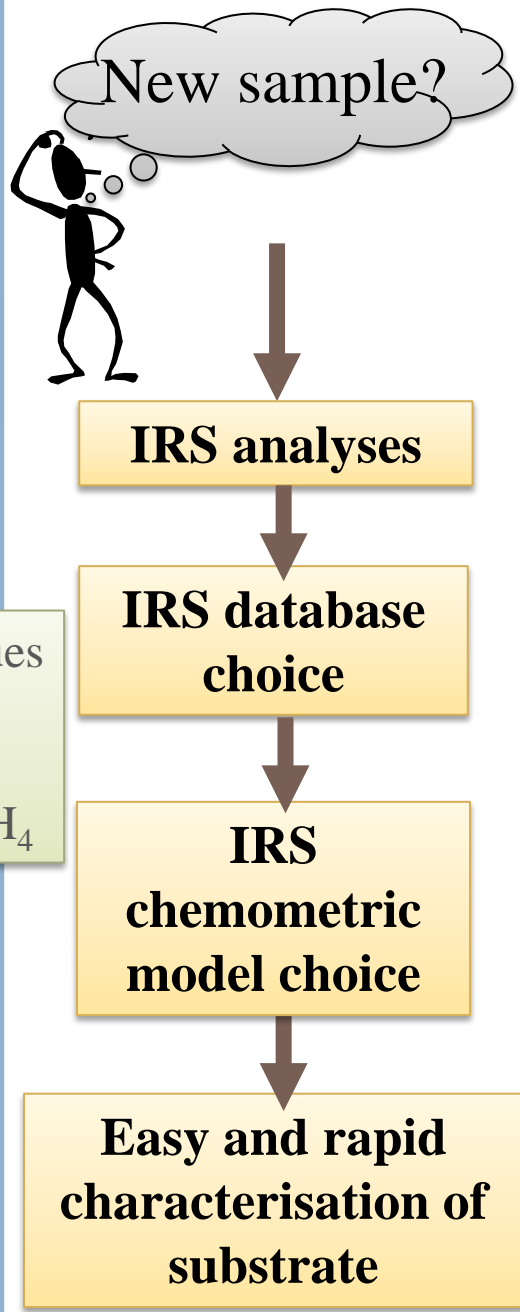 o the monitoring of various elements as nitrogen

IRS databases

New sample?

IRS light

I_0 I_r

Link between spectrum and reference values obtained
▪**in laboratory…**chemical composition
▪**in experiments…**digestibility, intake, CH_4

Log (1/R)

IRS spectrum

IRS analyses

IRS database choice

IRS chemometric model choice

Easy and rapid characterisation of substrate

Why IRS databases can be used for DST?

Availability and diversity of IRS databases
        coupled with classical reference measurements

- ***Tropical and temperate forages*** :
    - CP, fibres…
    - Species composition, morphological composition…
    - Digestibility
- ***Diet ingredients*** : CP, starch, fat…
- ***Faeces*** :
    - CP, fibres, ash…
    - In situ parameters as intake, digestibility, composition of intake…
- ***Milk*** :
    - Protein, fat, fatty acids…
    - Methane emission…
- ***Other organic substrates….***

Real progress in development of chemometric models

How IRS databases can be used for DST?

Building global merged databases that encompas a maximum of variability (production area, species…)

Use appropriate chemometric models for estimating the parameter of interest

Example : Faecal NIRS database (temperate + tropical forages, goats + sheep + cattle faeces) with 2 models (**MPLS** *vs.* **SVM).**
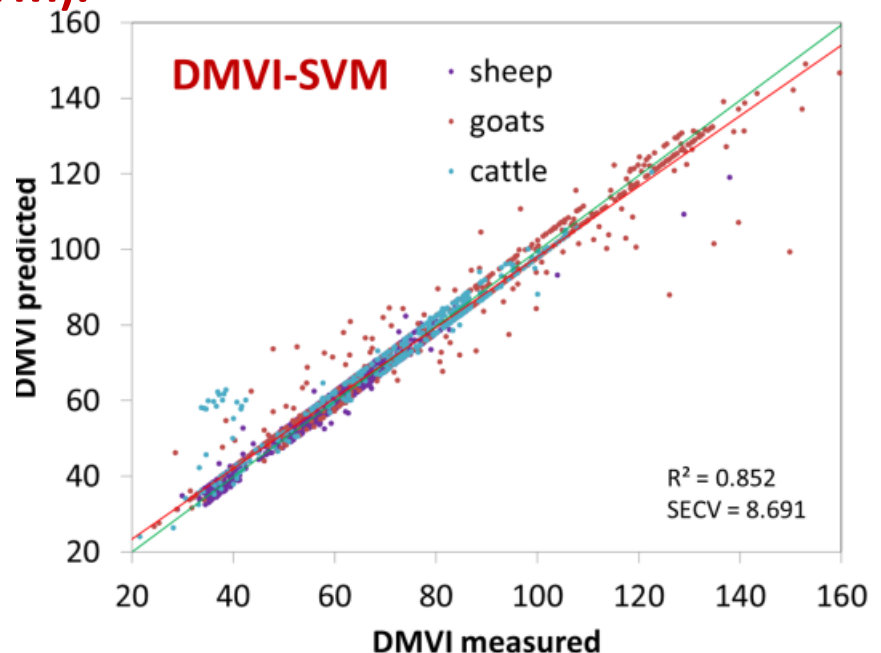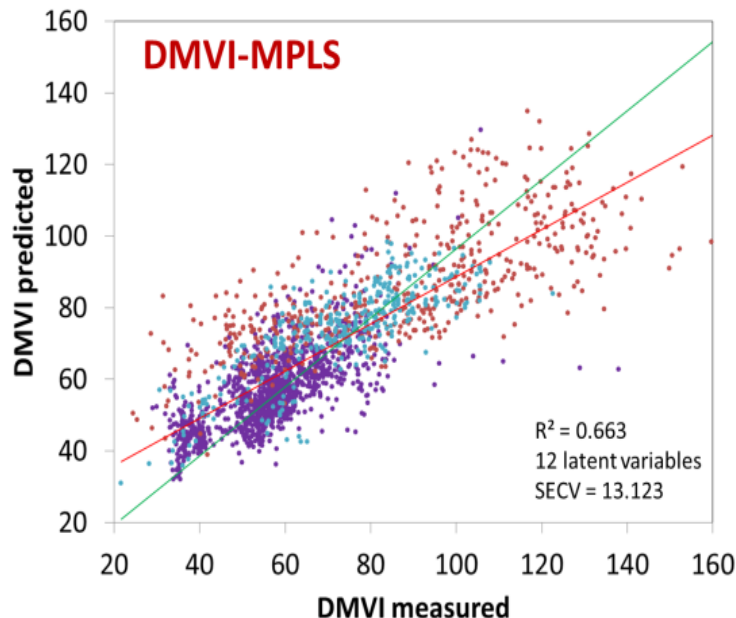
3 Examples of potentials of IRS databases

To predict digestible organic matter intake (DOMI) and estimate animal performances (ADG, milk), livestock environmental impact (CH_4 emission) in temperate or tropical contexts
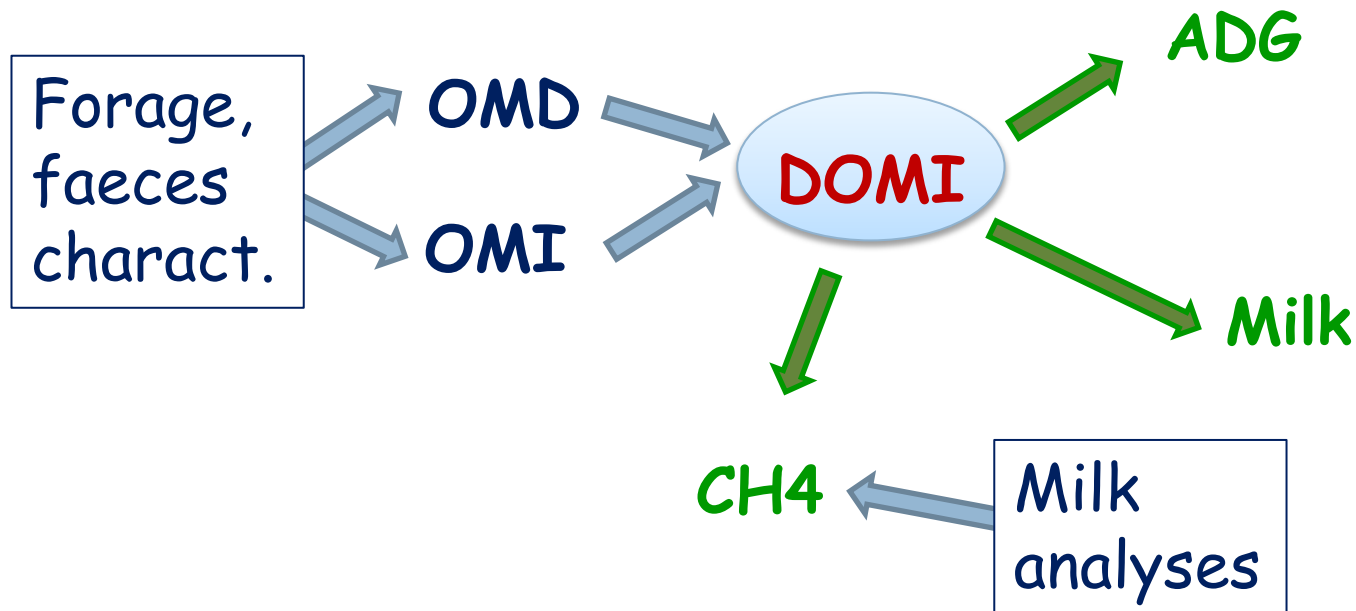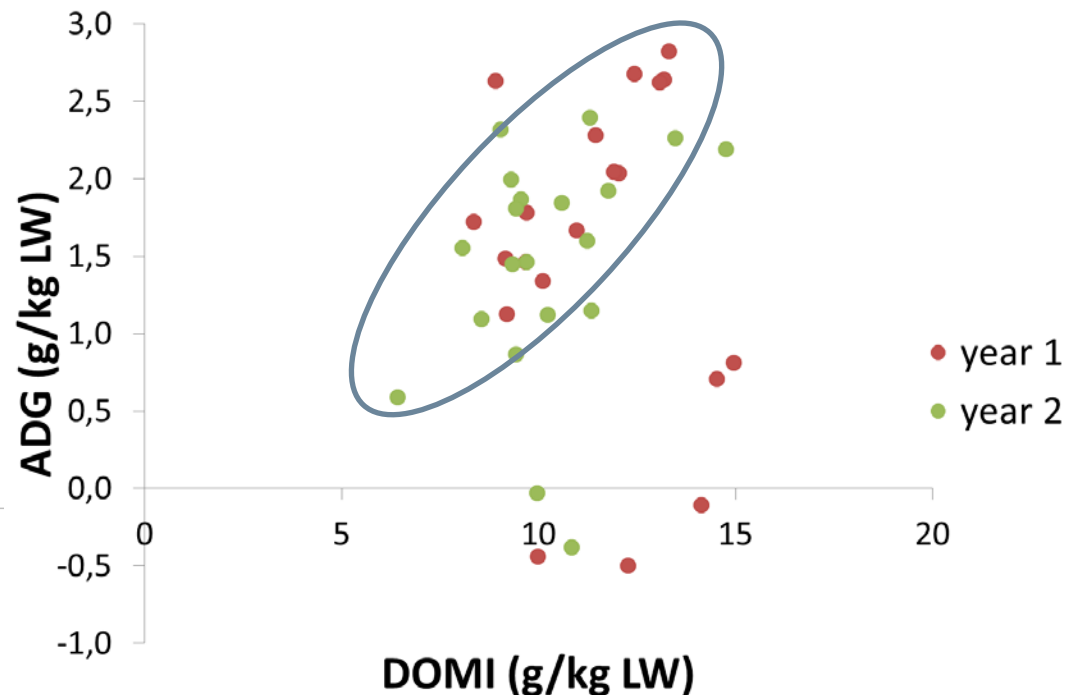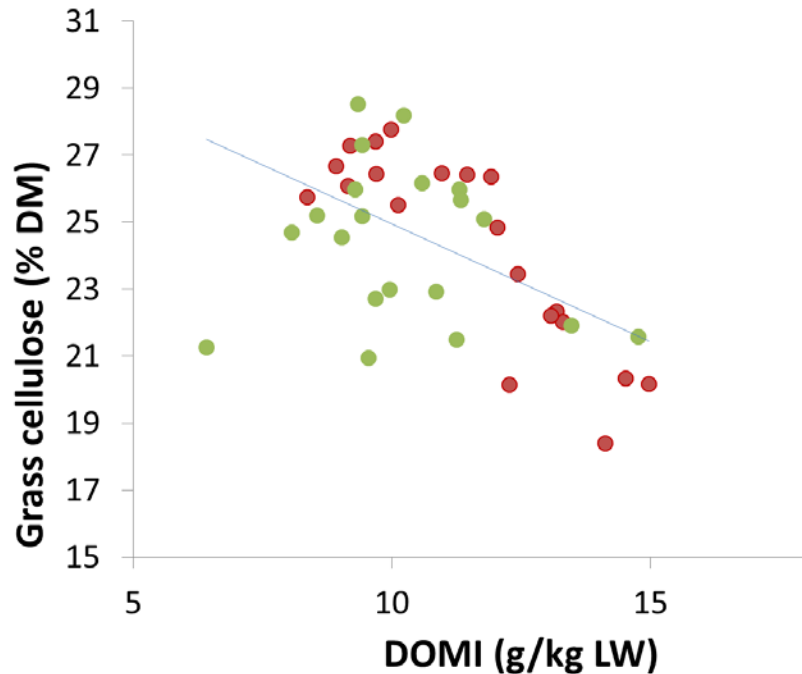
Diet characteristics and grazing animal performances.

NIRS applied to faeces and forage as indicator of grazing ADG

- Mixed grazing trials (sheep and heifers), temperate pasture
  - *White clover – Rye grass* based pasture
- FNIRS database ➔ estimation of *in situ heifers* diet characteristics
- Forage NIRS database ➔ estimation of grass quality
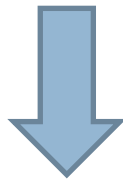
Estimation of methane emission by grazing cattle.

M. Boval[1] and V. Blanfort[2], unpublished data

[1] Tropical Animal Production Unit (URZ), INRA Centre West-Indies-Guyane, Domaine Duclos, 97170 Guadeloupe, FRANCE
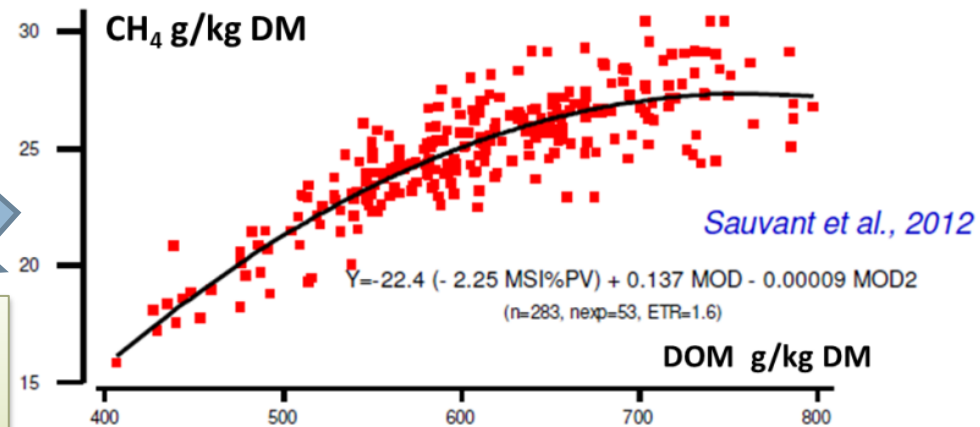[2] CIRAD, UMR Selmet, Kourou, French Guyana

Mobilisation of FNIRS to estimate CH_4 emission at grazing

- FNIRS database ➜ estimation of *in situ* diet characteristics (OMD and OMI)

- Digestible organic matter intake (DOMI, g/kg LW) estimation
    - Young *Bos indicus* cattle (400 kg LW)
    - *Brachiaria* based pasture

CH₄ g/kg DM

Sauvant et al., 2012

$$Y = -22.4 (-2.25 MSI\%PV) + 0.137 MOD - 0.00009 MOD2$$
(n=283, nexp=53, ETR=1.6)

DOM g/kg DM

« Rumener » database, UMR MoSAR
Graph values for DM intake level = 1 % live weight

DOMI ranged from 10 – 14 g/kg LW

CH_4 emission ranged from 40 – 58 kg/year

FNIRS = convenient approach to estimate intake and CH_4 emission in grazing cattle in farm conditions

Improvement of a method to predict individual enteric methane emission of cows from milk MIR spectra.

A. Vanlierde[1], F. Dehareng[1], E. Froidmont[1], N. Gengler[2], H. Soyeurt[2], P. B. Kandel[2], S. McParland[3], E. Lewis[3], M. Deighton[3] and P. Dardenne[1]

[1] Walloon Agricultural Research Centre, BE
[2] University of Liège, Gembloux Agro-Bio Tech, BE
[3] Animal and Grassland Research & Innovation Centre, Moorepark, IRL

Milk MIR analyses to estimate CH_4 emission

- Relation between MIR spectra of milk and **enteric** CH_4 emission

  - Reference method for CH_4 (SF_6)
  - Maximal variation of enteric CH_4 emission in exp. conditions (diet, cows…)
  - Larger scale studies – more accurate relation milk *vs* enteric CH_4 mission

Building a global database…

- Integrating a maximum of variability linked to
  - Cows
  - Diets, herd managements
  - Regions
  - …
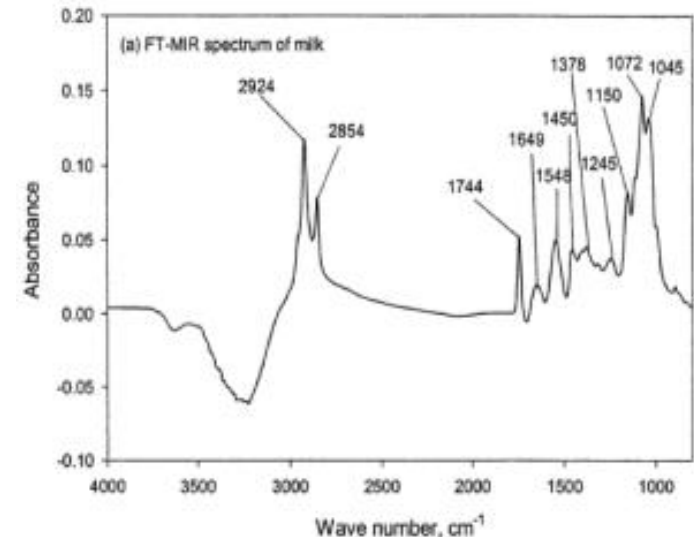
- Example of mixed database : Ireland and Belgium MIR milk spectra

Parameter	N	R²c	R²cv	SECV
g CH_4/day	452	0.76	0.70	62

For which use?

Valorisation of milk MIR spectra (from dairy control) for genetic selection (cows with lower enteric emission), for diet management (feedback in farms directly).

To conclude…

- **Through these examples, potential of IRS databases for the development of effective DST appears promising, both in tropical and temperate area.**

- **Development of large merged databases associated with appropriate chemometric models is a key point to generate predictive regressions**
  - → from general calibrations using large heterogeneous data sets
  - → from local calibrations, using a specific appropriate set of data