Potential use of MIR spectrometry to assess the origin of milk produced in a PDO area

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Belgian local products

Cheese
e.g. Fromage de Herve

Ham
e.g. Jambon d'Ardenne

Beer
e.g. Vieille Gueuze

European protected products

PDO

PGI

TSG

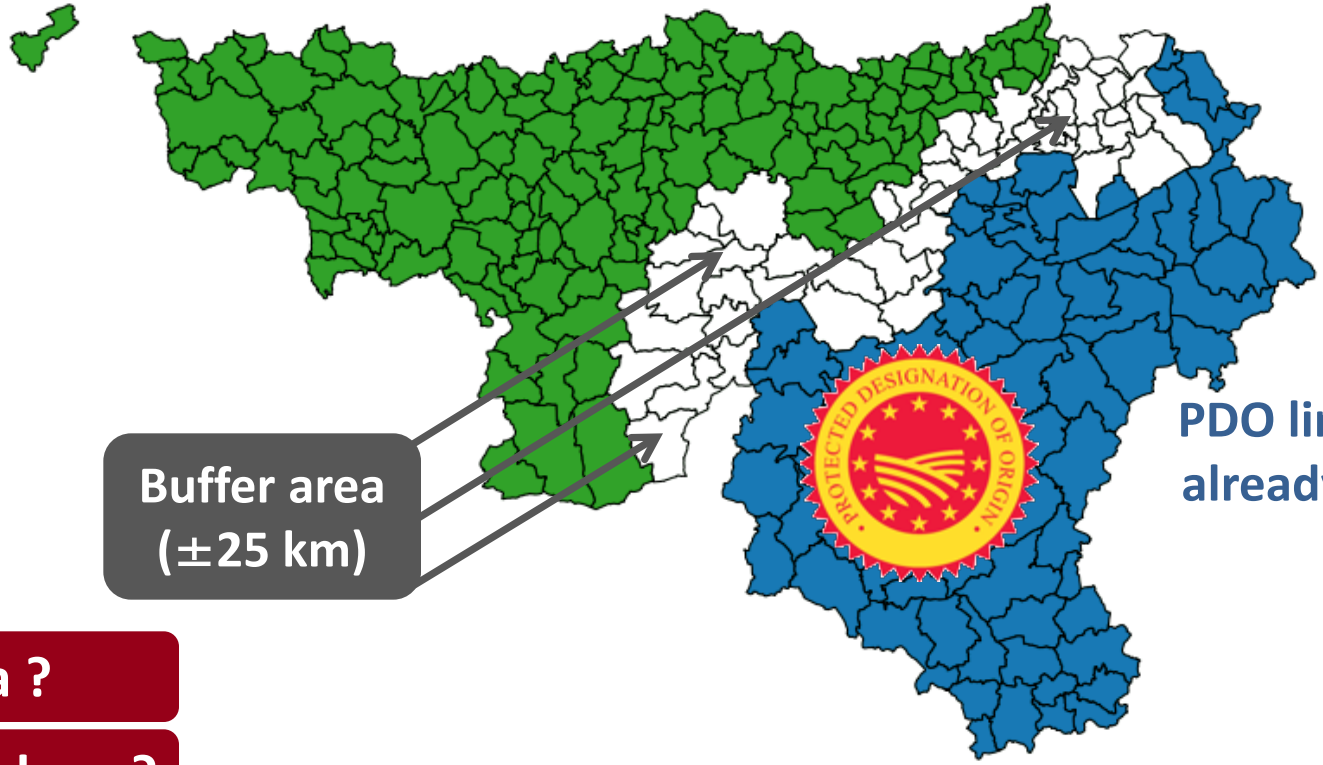
Assessing the milk origin within Wallonie

PDO linked area already defined

Data ?

Methodology ?

Assessing the milk origin within Wallonie



Data ?

Methodology ?

Are data available ?

- Milk delivered to dairies
- Bulk milk sampling ➔ Milk composition to set the price
- Mid Infrared (MIR) spectrometry analysis ➔ Fast and cost-efficient

➔ Walloon bulk milk MIR spectra data base

How to discriminate milk from the 2 areas ?

- 1st data editing
  - Bovine raw milk bulk samples from January 2012 to December 2015
  - Standardized MIR spectra (Grelet *et al.*, 2015)

➔ **1 800 000 spectra from ±3 300 milk producers**

- Partial Least Square Discrimination Analysis (PLS-DA)
  - Pretraitment: Savitsky-Golay 1st derivative (5 wavenumbers window size)
  - PLS Toolbox (Eigenvector research, Inc.)

Many data & sampling every 2-3 days

➔ **Daily datasets analysis instead of whole dataset analysis**

Editing of the daily datasets

D-6	D-5	D-4	D-3	D-2	D-1	D	D+1	D+2	D+3
						V			

- External validation dataset
  - **Samples collected today**

Editing of the daily datasets

D-6	D-5	D-4	D-3	D-2	D-1	D	D+1	D+2	D+3
	C	C	C	C	C	V			

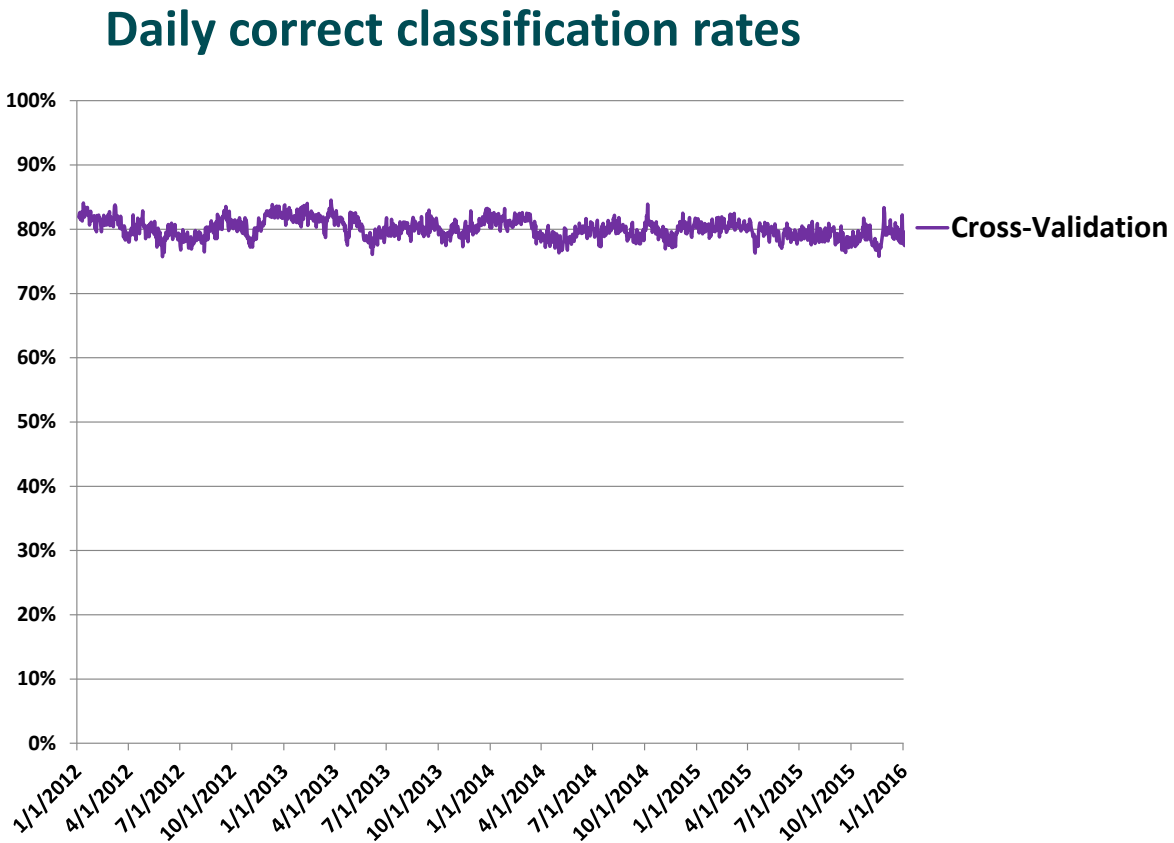
- Calibration dataset
  - 5 days window
  - 1 sample randomly selected per producer
  - Producer not included in validation dataset

Editing of the daily datasets

D-6	D-5	D-4	D-3	D-2	D-1	D	D+1	D+2	D+3
	C	C	C	C	C	V			
		C	C	C	C	C	V		
			C	C	C	C	C	V	

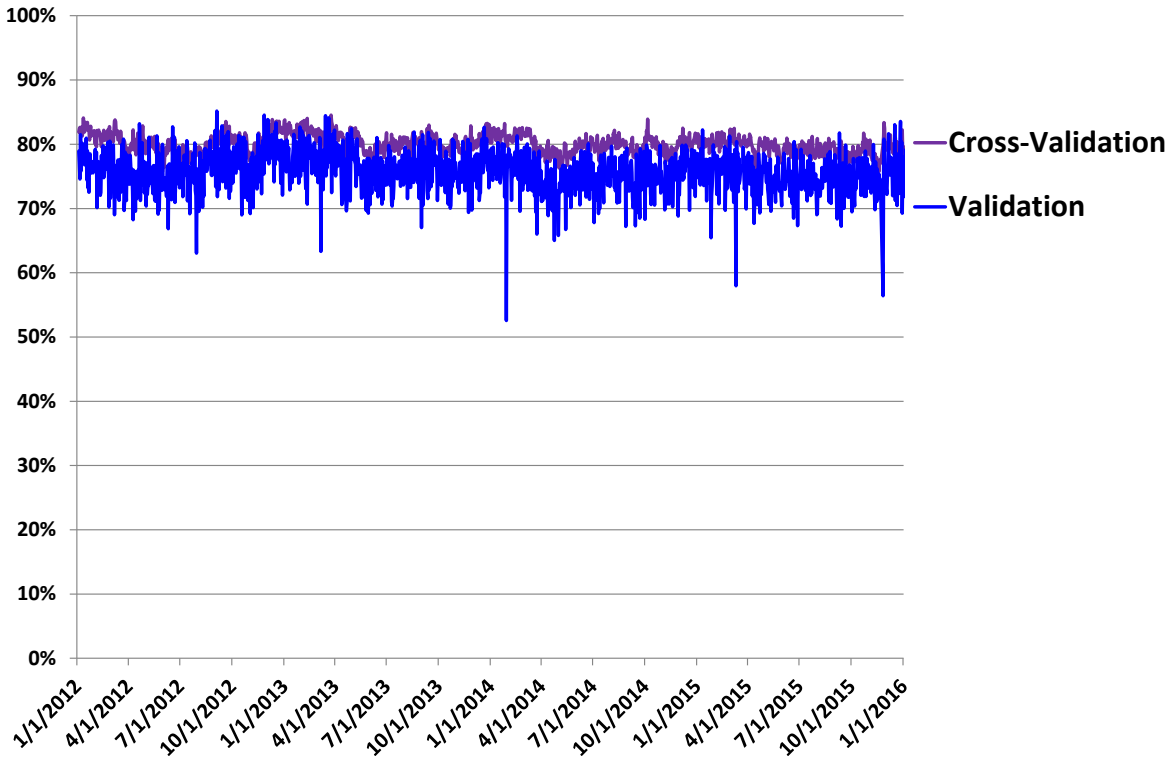
1 640 pairs of datasets → **1 640 PLS-DA models**

1 640 calibrations by PLS-DA



1 640 calibrations by PLS-DA

Daily correct classification rates



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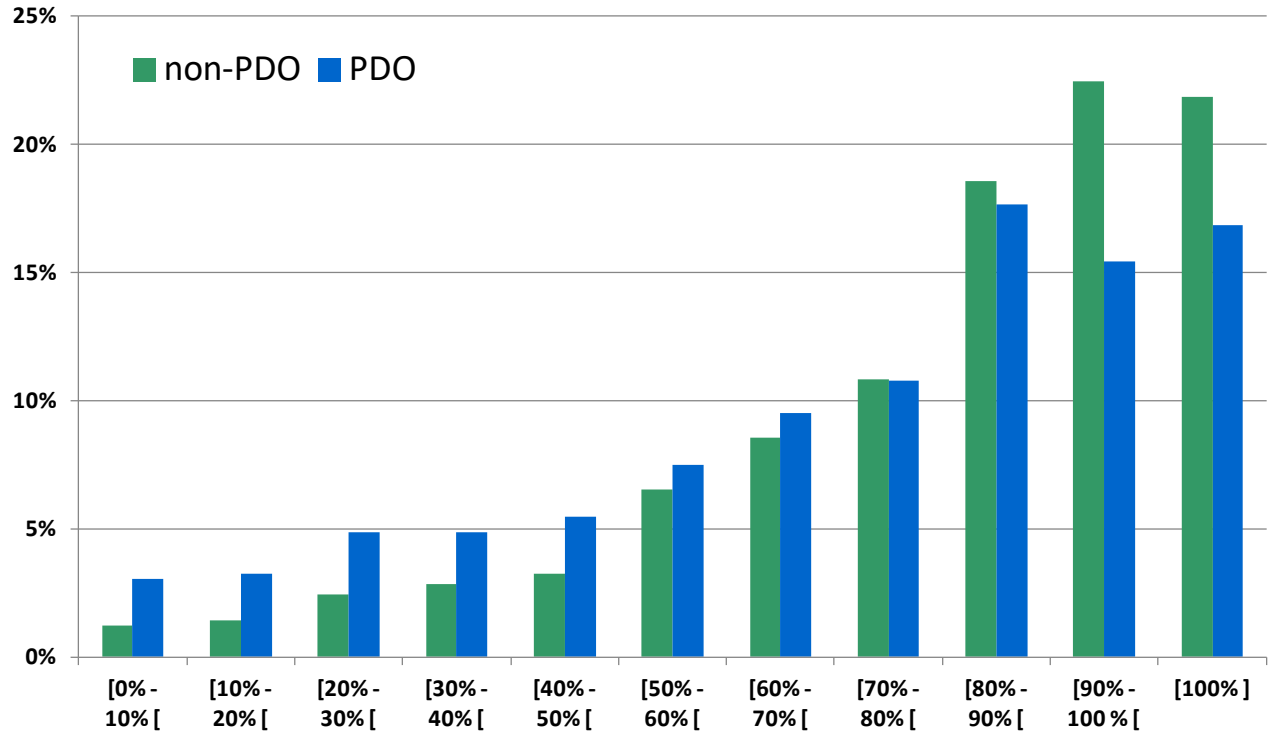
Positive Predicted Value	$\frac{\text{Correct classified PDO samples}}{\text{Classified PDO samples}}$	74.1 % (±2.2)
Negative Predicted Value	$\frac{\text{Correct classified non-PDO samples}}{\text{Classified non-PDO samples}}$	84.3 % (±1.7)

Characteristics of the 1 640 models

		Cross-Validation	Validation
Correct classification rate		79.9 % (±1.6)	75.4 % (±3.2)
Sensitivity	$\frac{\text{Correct classified PDO samples}}{\text{PDO samples}}$	78.1 % (±2.0)	69.4 % (±7.6)
Specificity	$\frac{\text{Correct classified non-PDO samples}}{\text{non-PDO samples}}$	81.1 % (±1.9)	79.8 % (±6.1)
Positive Predicted Value	$\frac{\text{Correct classified PDO samples}}{\text{Classified PDO samples}}$	74.1 % (±2.2)	71.4 % (±6.0)
Negative Predicted Value	$\frac{\text{Correct classified non-PDO samples}}{\text{Classified non-PDO samples}}$	84.3 % (±1.7)	78.6 % (±4.8)

Varying results between milk producers

Frequencies for each class of correct classification rate by producers in 2014

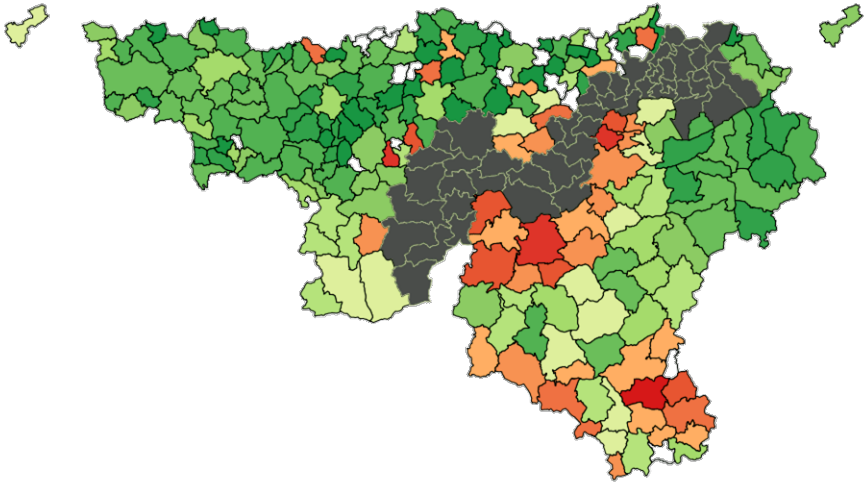


Varying results at zip code area level

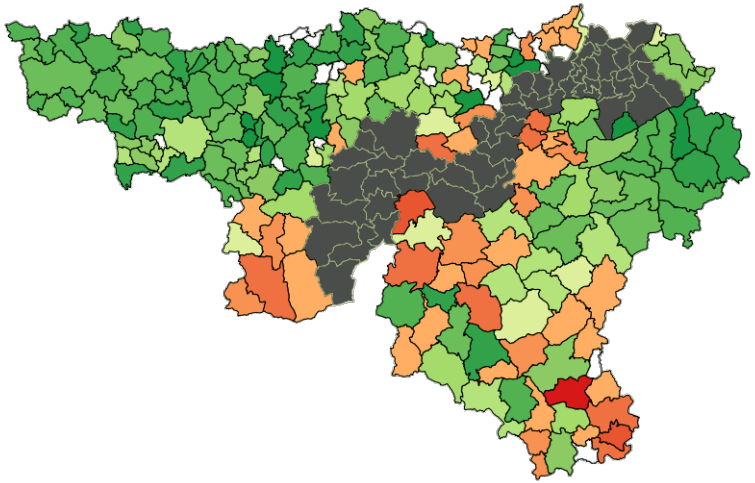
Correct classification rate

- 0.00 - 10.0
- 10.0 - 20.0
- 20.0 - 30.0
- 30.0 - 40.0
- 40.0 - 50.0
- 50.0 - 60.0
- 60.0 - 65.0
- 65.0 - 70.0
- 70.0 - 75.0
- 75.0 - 80.0
- 80.0 - 85.0
- 85.0 - 90.0
- 90.0 - 95.0
- 95.0 - 100.0

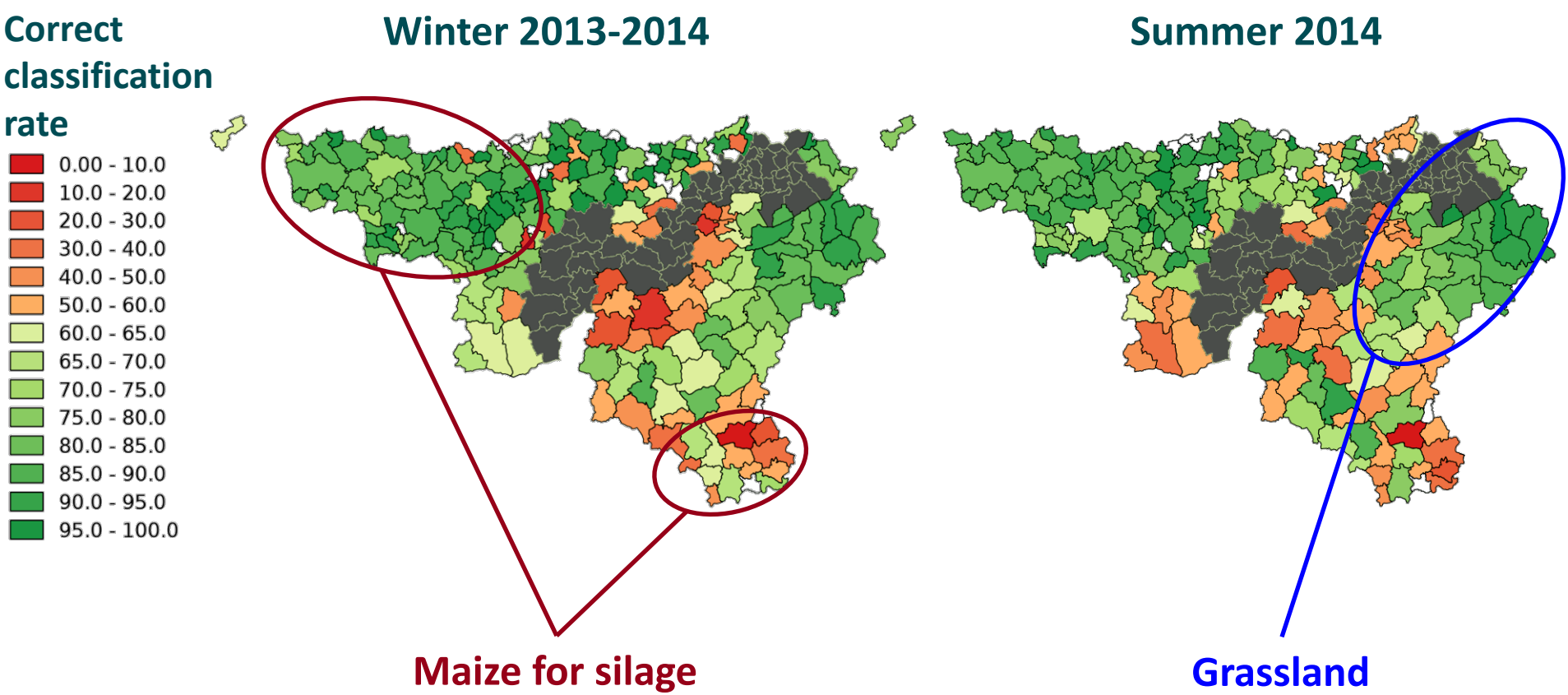
Winter 2013-2014



Summer 2014



Main land uses



Take home message

- Feasability to discriminate milk samples
  - **Produced in 2 areas from Walloon Region**
  - **Based on MIR spectra**
  - **Daily PLS-DA models**
  - **70-80 % of corrrect classification, sensitivity and specificity**

Possibility to assess the origin of milk produced in a PDO area

- Results linked to pedoclimatic conditions and to main land uses for feeding dairy cows
  - **Grassland**
  - **Maize for silage**

- Acknowledgments for financial support
  - **Service Public de Wallonie (SPW – DGO3, Belgium) through project D32-0196**

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