Blanc-Bleu VERT

Development of a proxy to estimate individual daily DMI of Belgian Blue bulls using fecal NIR spectra

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Consortium composed of :

With the support of :

Objectives of Blanc-Bleu VERT project

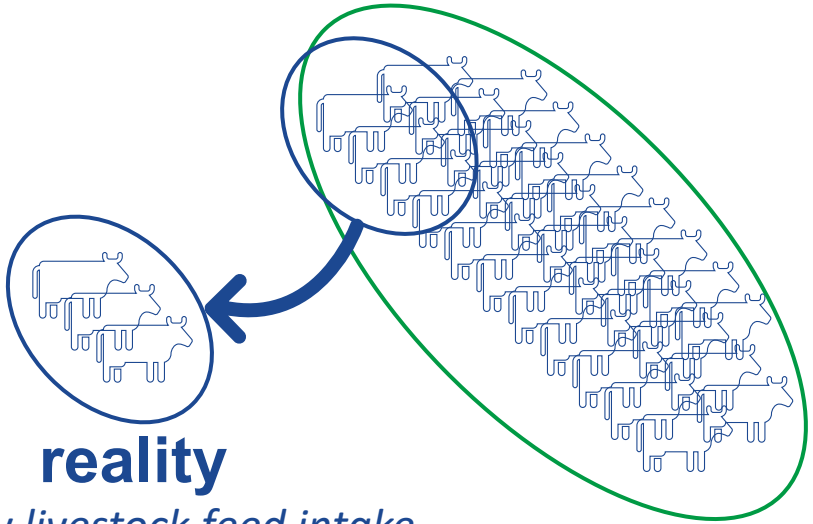
Improvement of livestock feed efficiency and farming sustainability

Improvement of livestock feed efficiency is a way to:

- reduce the feed-food competition
- reduce environment impact and reach European Climate objectives

How ? with cattle **genetic selection** (feed efficiency)

A large number of **individual cattle feed intake** data is necessary



reality

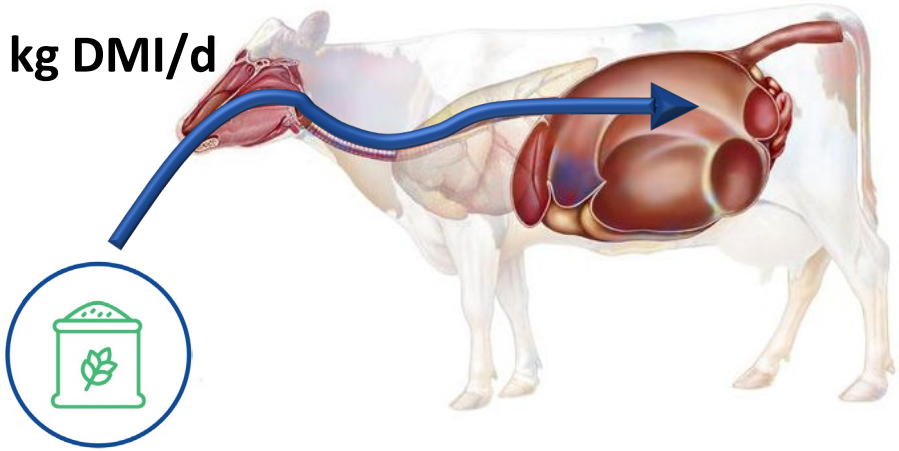
quantify livestock feed intake on a routine basis/large scale is difficult

aim

Quantify livestock feed intake on a large scale

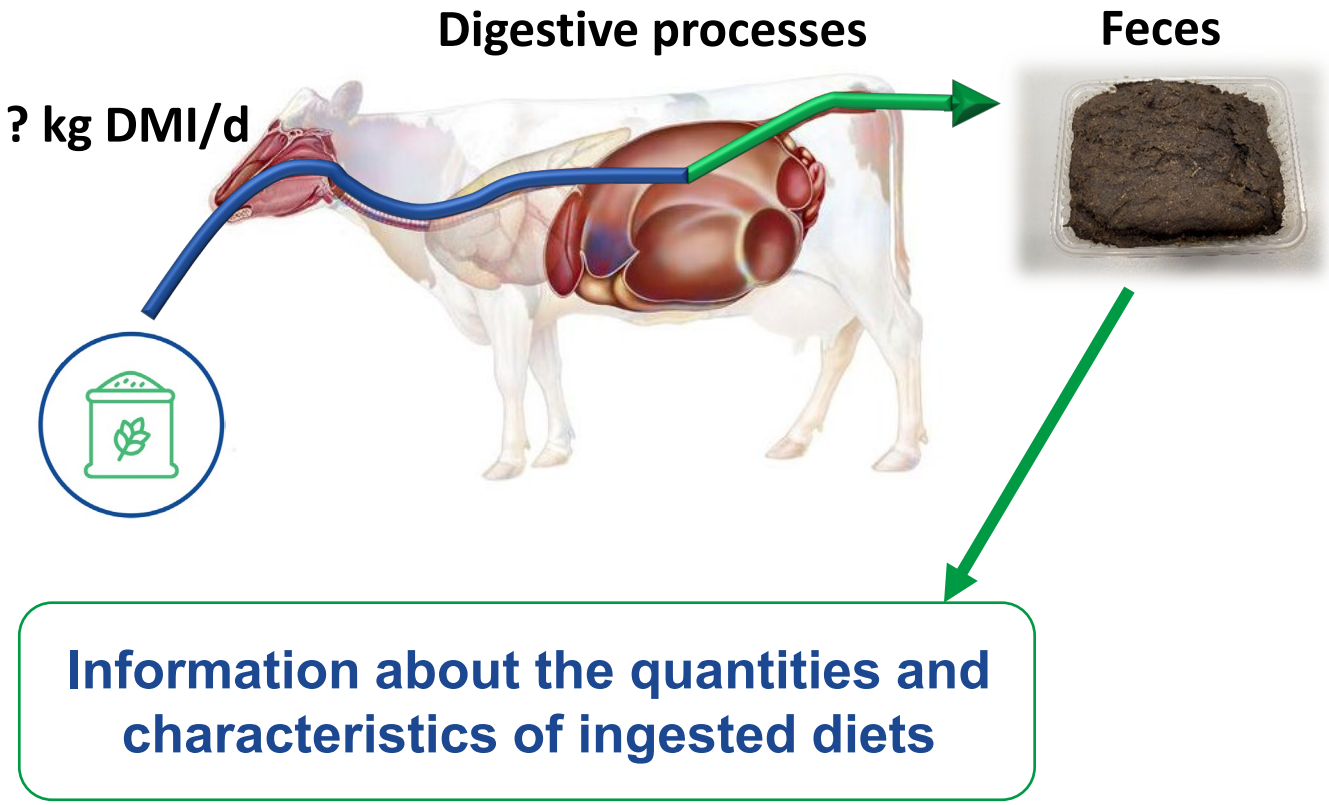
Establish a proxy to estimate intake from feces

? kg DMI/d



Quantify livestock feed intake on a large scale

Establish a proxy to estimate intake from feces



Information about the quantities and characteristics of ingested diets

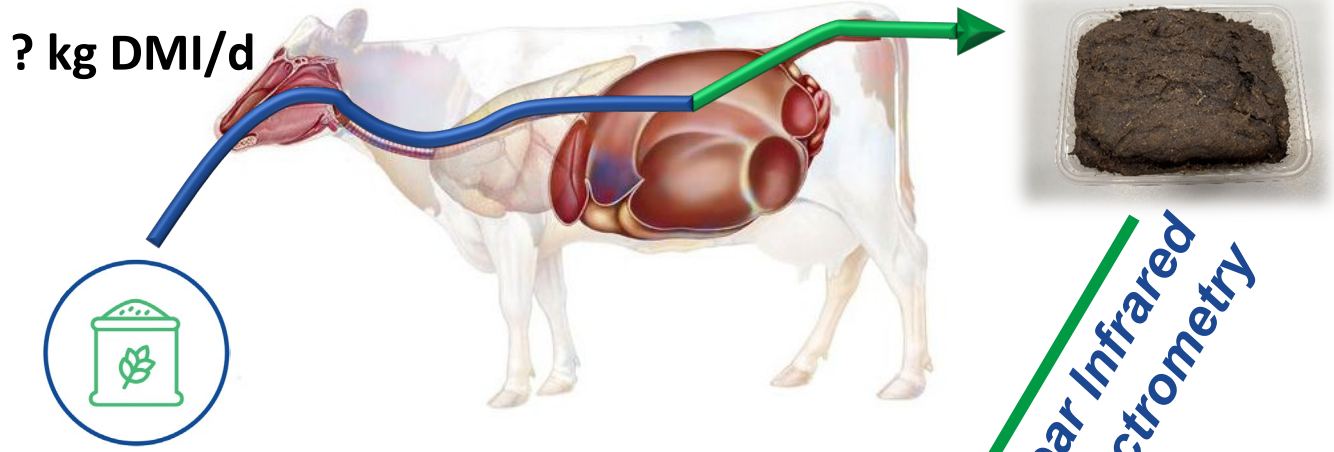
Quantify livestock feed intake on a large scale

Establish a proxy to estimate intake from feces

Digestive processes

Feces

? kg DMI/d



Near Infrared Spectrometry

Information about the quantities and characteristics of ingested diets

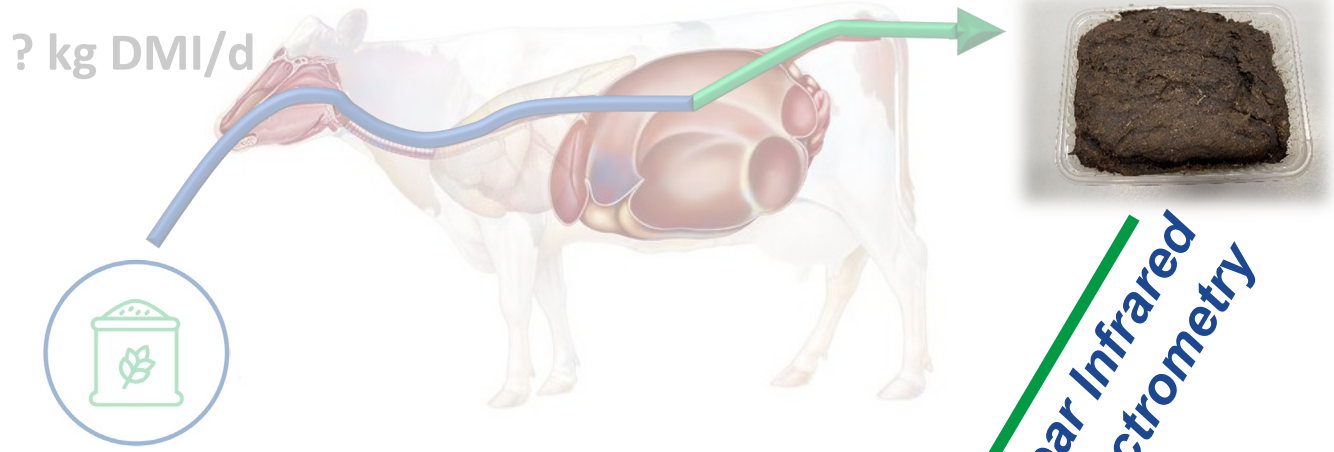
Quantify livestock feed intake on a large scale

Establish a proxy to estimate intake from feces

Digestive processes

Feces

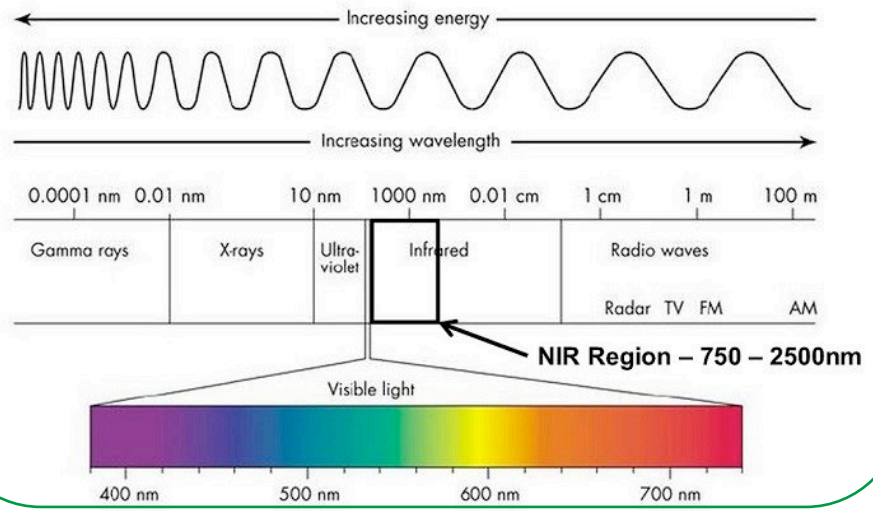
? kg DMI/d



Near Infrared Spectrometry

Information about the quantities and characteristics of ingested diets

Near Infrared Spectroscopy

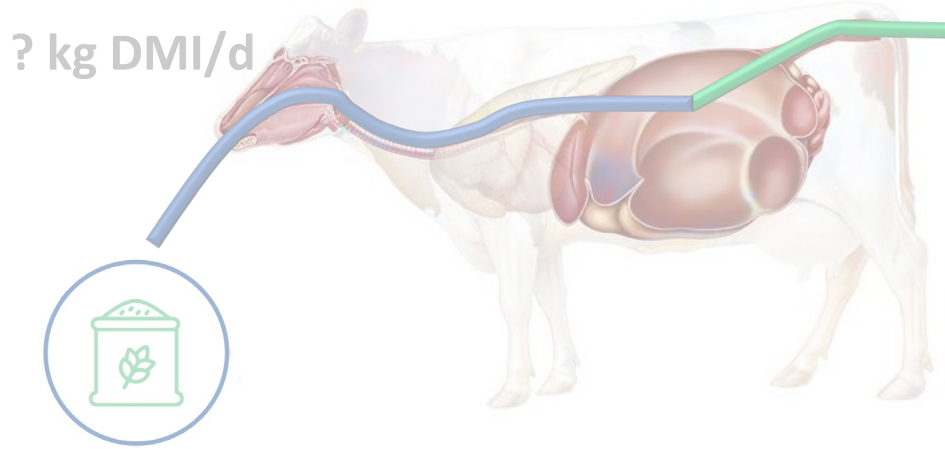


Quantify livestock feed intake on a large scale

Establish a proxy to estimate intake from feces

Digestive processes

? kg DMI/d

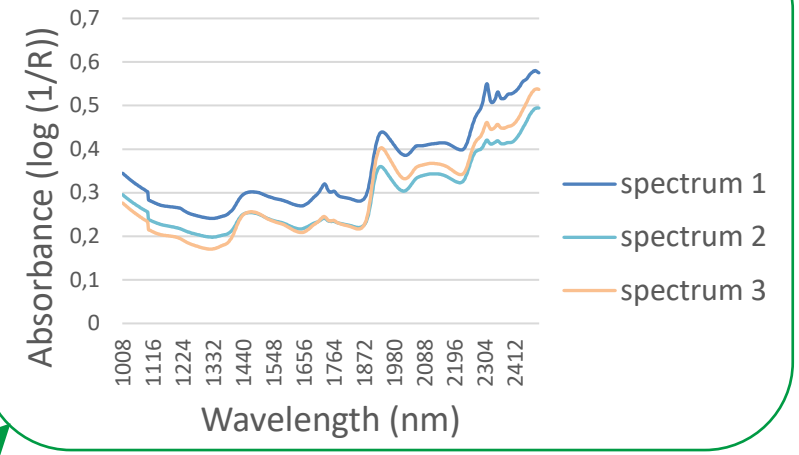


Feces

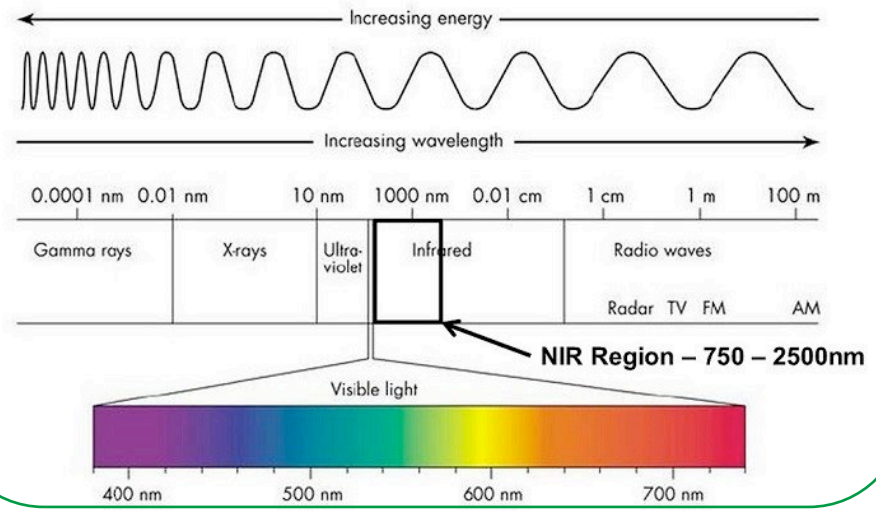
Near Infrared Spectrometry

Information about the quantities and characteristics of ingested diets

Feces NIR spectra



Near Infrared Spectroscopy



Establish a proxy to estimate intake from feces

Reference data :

Feces NIR spectra

Spot sampling of feces
(1 sampling every 3 weeks
or 1 sampling every 10 days)

Spot sampling of feces

Establish a proxy to estimate intake from feces

Reference data :

DMI

Daily measurement of :
- distributed feed
- refused feed

+

Partial least squares (PLS) regression
+
20 groups CV

Feces NIR spectra

Spot sampling of feces
(1 sampling every 3 weeks
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Spot sampling of feces

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Feces NIR spectra

Spot sampling of feces
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different reference value tests

Test *a*
(DMI/day)

Spot
sampling
of feces

… J-3 J-2 J-1 J

Establish a proxy to estimate intake from feces

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Daily measurement of :
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Spot sampling of feces
(1 sampling every 3 weeks
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different reference value tests

Test *c* *(DMI/day)*

Test *b* *(DMI/day)*

Test *a* *(DMI/day)*

Spot sampling of feces

… J-3 J-2 J-1 J

Establish a proxy to estimate intake from feces

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Daily measurement of :
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different reference value tests

Test *c* *(DMI/day)*

Test *b* *(DMI/day)*

Test *a* *(DMI/day)*

Spot sampling of feces

… J-3 J-2 J-1 J

mean

Test *d (DMI/day)*

mean

Test *e (DMI/day)*

Establish a proxy to estimate intake from feces

Need of phenotypic and spectral variability

Table 1. Feces NIR spectra and DMI pairs

Diet (% DM)	Animal	N spectrum	Age	DMI (kg)		
				Min	Mean ± SD	Max
Corn silage (40-50%) Concentrates (50-60%)	16 BB bulls	183	9-19 months	6.2	8.8 ± 1.1	11.6
Corn silage or corn silage & grass silage (45-70%) Concentrates (30-55%)	14 BB bulls 14 crossbred bulls (BB x Holstein)	111	6-18 months	5.7	8.2 ± 1.3	11.3
TOTAL	**44**	**294**				

DM = Dry Matter ; BB = Belgian Blue (Blanc-Bleu Belge) ; Min = minimum ; Max = maximum

Legend:

Blanc-Bleu VERT trial

- **294 feces NIR spectra // DMI pairs**
- **Partial least squares (PLS) regression**
- **20 groups CV**

What value of DMI ?

Fresh diet : 50-60% silage *(corn or corn and grass)* & 40-50% concentrates

X days before fecal sampling …

Reference value	N	Mean	SD	SEC	R^2C	SECV	R^2CV
J-1 (kg DMI/d)	294	8.6	1.3	1	0.43	1.1	0.29
J-2 (kg DMI/d)	294	8.6	1.3	1.1	0.26	1.2	0.19
J-3 (kg DMI/d)	294	8.6	1.3	1.2	0.20	1.2	0.12

… or average the DMI over a period ?

N = Number ; kg DMI/d = kilogram of Dry Matter Intake per day ; SD = Standard Deviation ; SEC = Standard Error of Calibration ; R^2C = coefficient of determination for Calibration ; SECV = Standard Error of Cross-Validation; R^2CV = coefficient of determination for Cross-Validation

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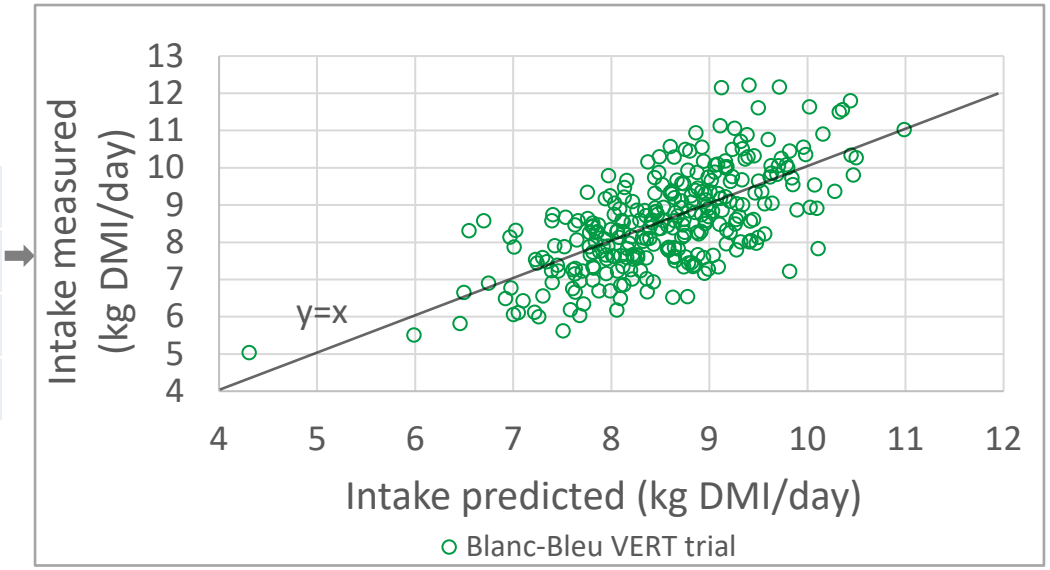

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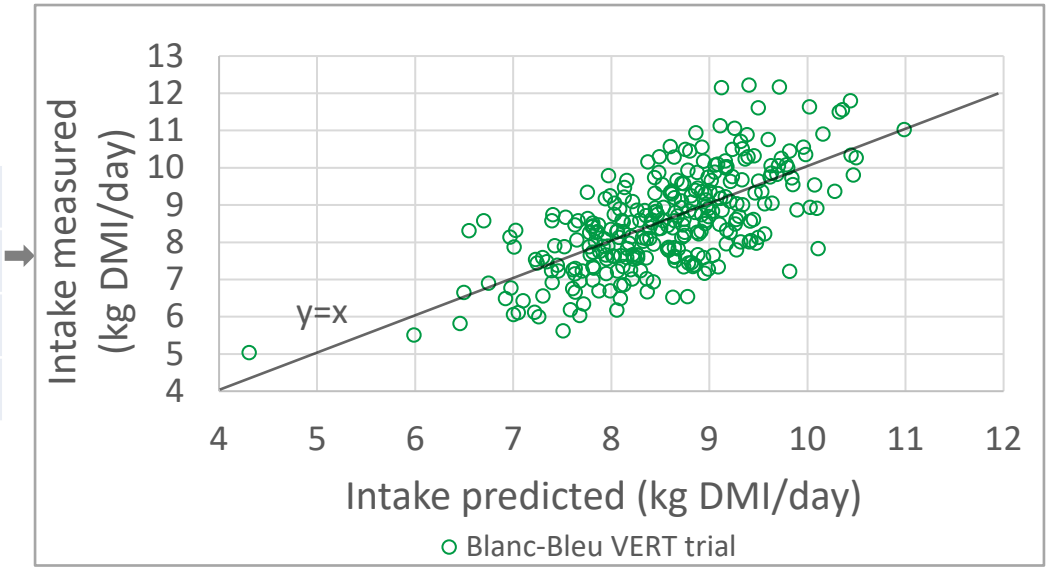

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Reference value	N	Mean	SD	SEC	R^2C	SECV	R^2CV
Average DMI over 2 days (kg DMI/d)	294	8.6	1.3	0.9	0.53	1	0.33
Average DMI over 3 days (kg DMI/d)	294	8.6	1.2	0.9	0.48	1	0.29

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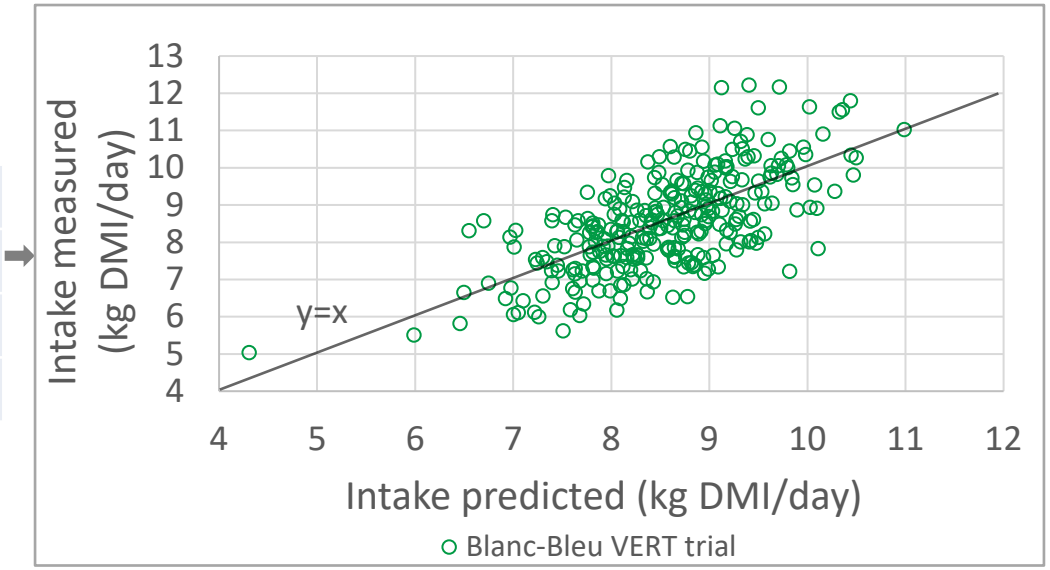

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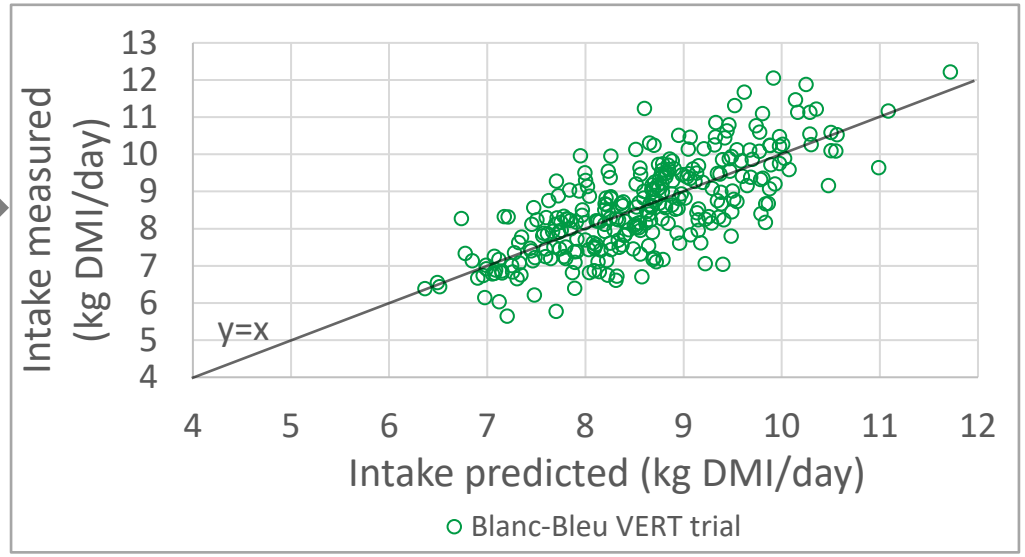

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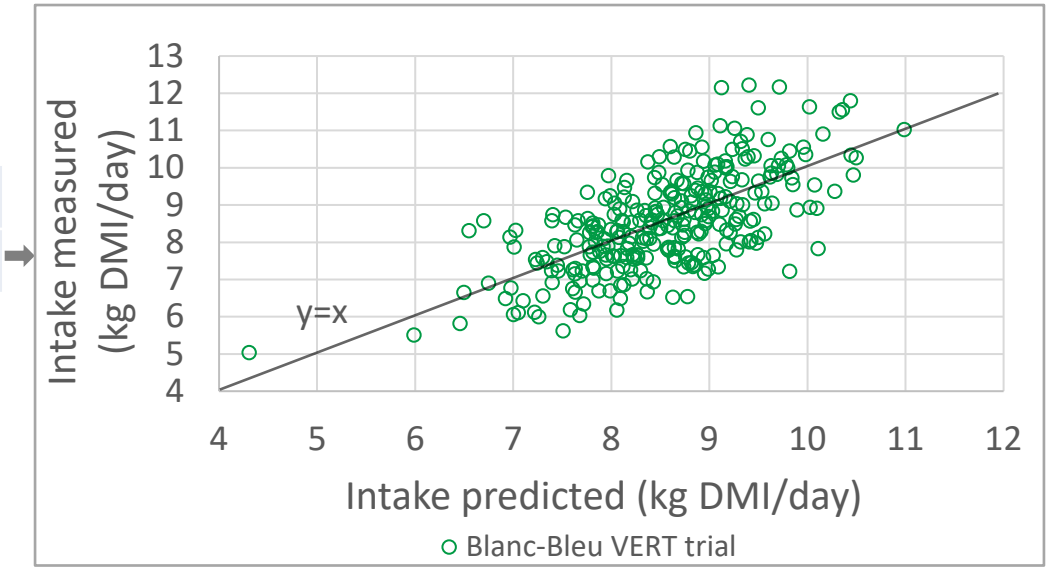

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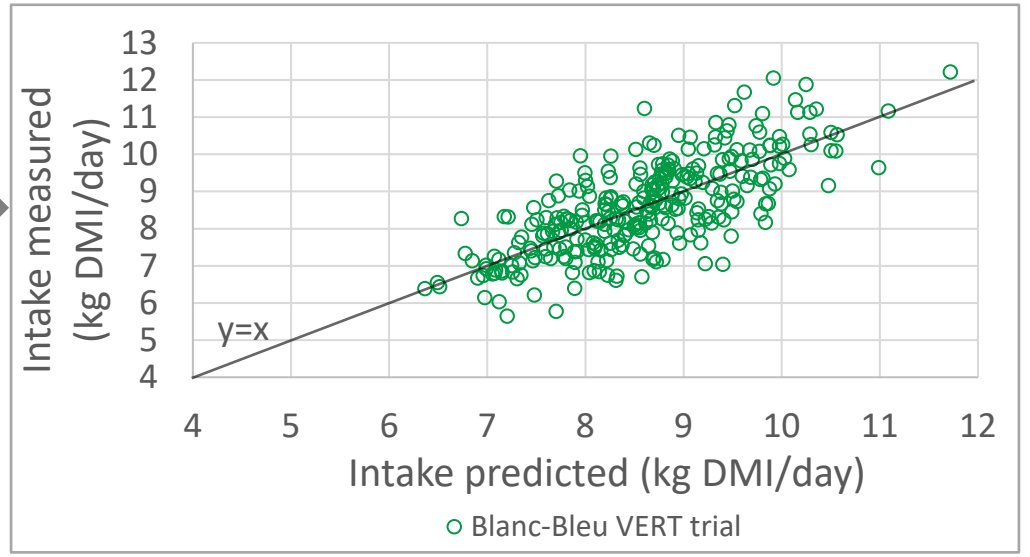

Average DMI over a few days before fecal sampling:

- lower SEC and SECV;
- higher R^2C and R^2CV.

➢ attenuation of daily variations

➢ animal's DMI more representative

Establish a proxy to estimate intake from feces

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Corn silage or corn silage & grass silage (45-70%) Concentrates (30-55%)	14 BB bulls 14 crossbred bulls (BB x Holstein)	111	6-18 months	5.7	8.2 ± 1.3	11.3
+						
Hay (30-80%) Concentrates (20-70%)	23 BB cows	80	4-9 years	10	12.4 ± 1.2	15.9
TOTAL	**67**	**374**				

DM = Dry Matter ; BB = Belgian Blue (Blanc-Bleu Belge) ; Min = minimum ; Max = maximum

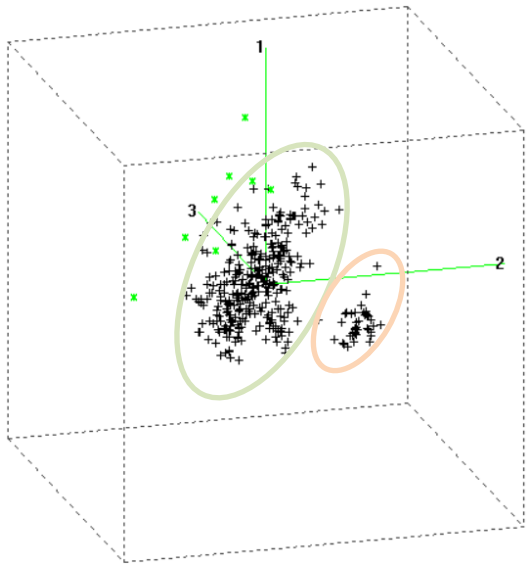
➢ **374 feces NIR spectra // DMI pairs**

Legend:

Blanc-Bleu VERT trial

CRA-W trial

Principal component analysis (PCA)

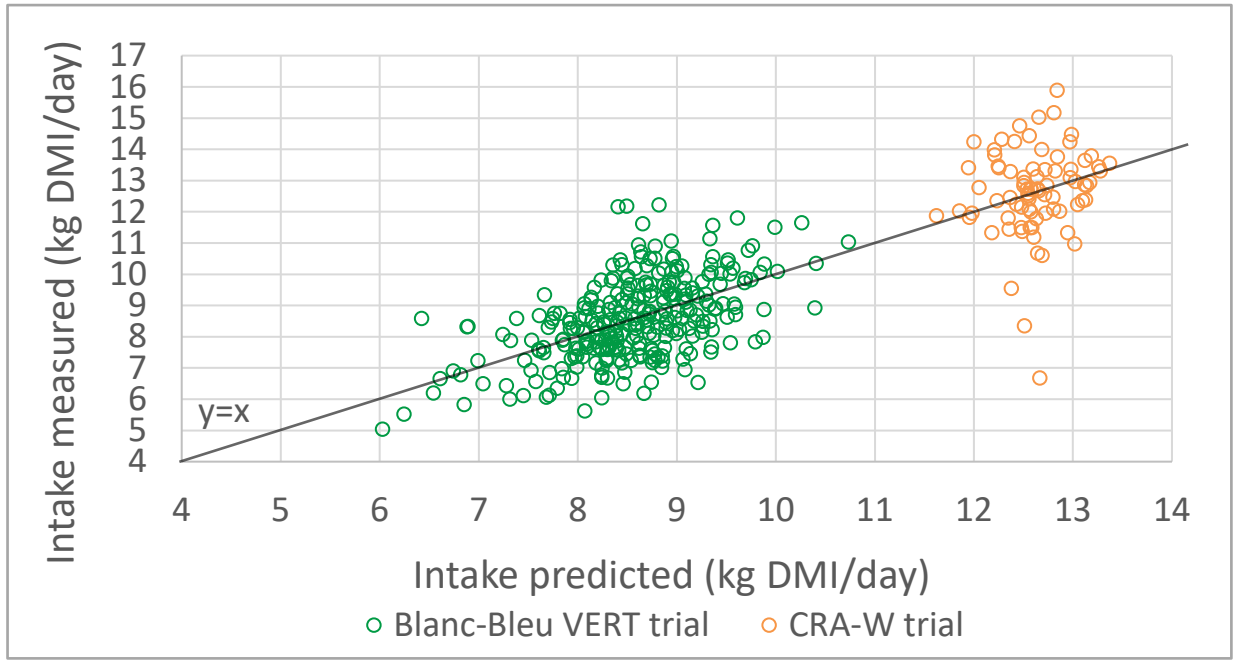


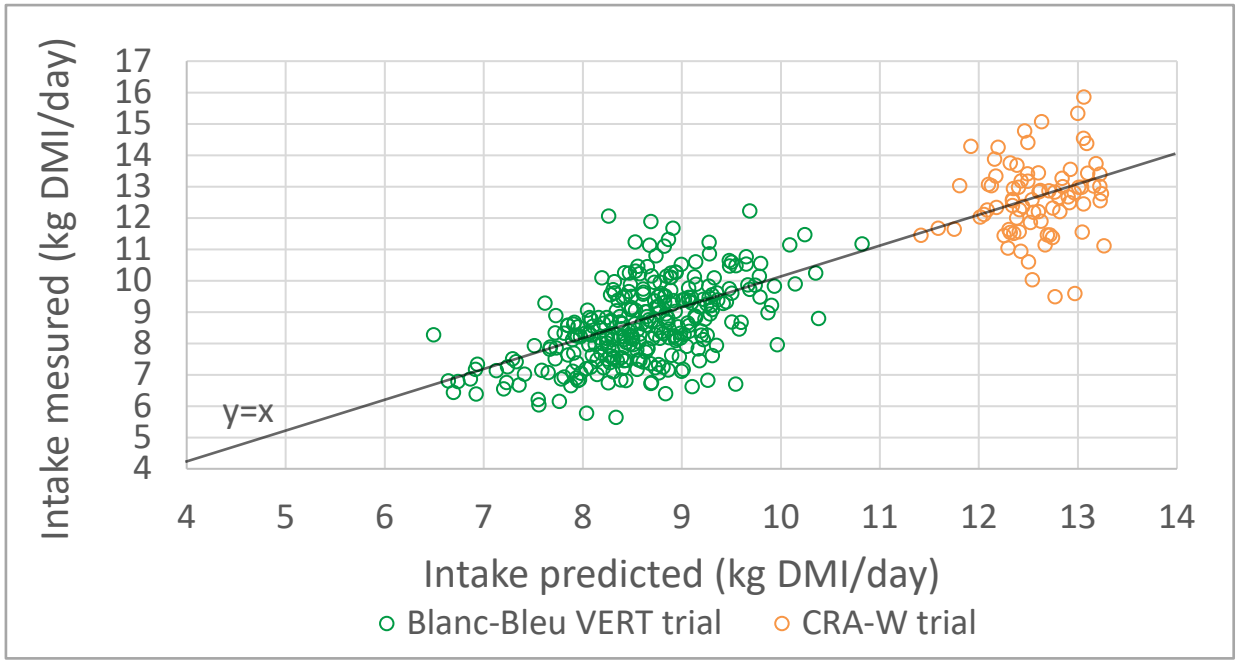
➢ Spectral variability = groups

Addition of variability

Fresh diet (50-60% silage *(corn or corn and grass)* & 40-50% concentrates) **+ hay**

+ hay diet (20 – 70% concentrates) collected from BB cows (CRA-W trial, 2019):





Reference value	N	Mean	SD	SEC	R^2C	SECV	R^2CV
J-1 (kg DMI/d)	374	9.5	2.1	1.2	0.70	1.2	0.66

Reference value	N	Mean	SD	SEC	R^2C	SECV	R^2CV
Average DMI of 2 days (kg DMI/d)	374	9.5	2.1	1.1	0.72	1.1	0.69

N = Number ; kg DMI/d = kilogram of Dry Matter Intake per day ; SD = Standard Deviation ; SEC = Standard Error of Calibration ; R^2C = coefficient of determination for Calibration ; SECV = Standard Error of Cross-Validation; R^2CV = coefficient of determination for Cross-Validation

Conclusions & Next Steps

- Results confirm NIRS interest to predict directly DMI from feces
- More variability with new data is needed to develop a robust model *(e.g. different diets, measuring cattle at other physiological stages, in different counties, climatic conditions)*
- Once model has been established → requires only fecal samples to predict DMI
- The addition of mainly concentrate-based diets data in the model is being studied
- NIRS is a powerful tool to be used in precision livestock farming

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