Estimation of individual CH_4 emissions using fecal near infrared spectra for young, dairy and beef cattle

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Walloon Agricultural Research Centre
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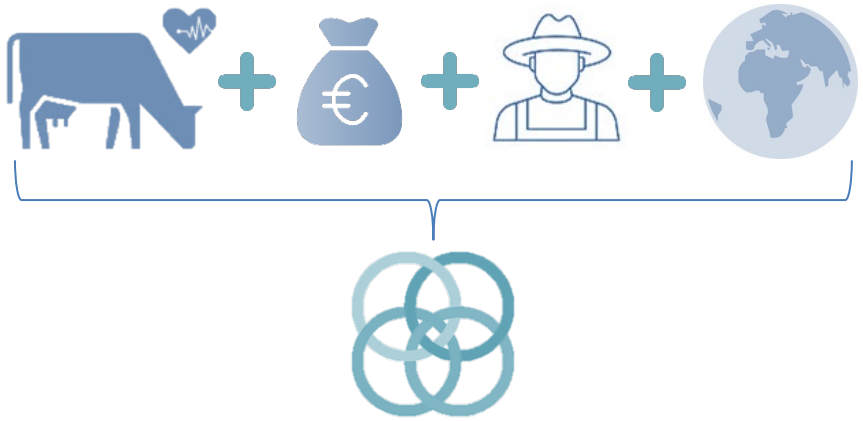
Context & Aim

Provide tools to improve breeding **sustainability** would be useful



Focus on **environmental impact** & livestock **feed efficiency**

Global Methane Pledge (COP26) → - 30% 2030 and - 50% by 2050 *vs*. 2020

Reduction of **enteric methane (CH_4)** emissions from livestock sector remains a central question

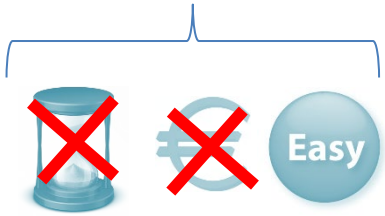
The main levers of action are: **Diet** composition – Cattle **management** – **Genetics**

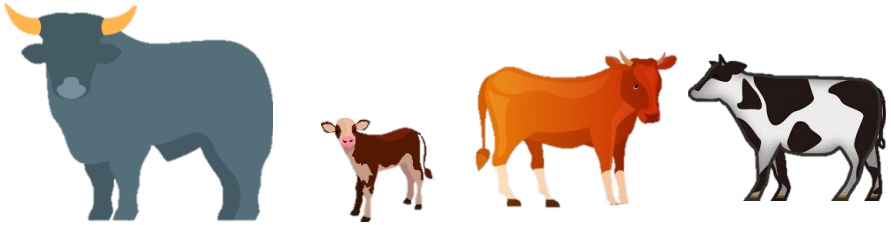
Context & Aim

Need to generate CH_4 emissions records in routine

to be able to follow herds/animals and perform large scales studies.

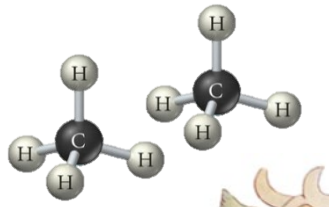
Proxies for individual CH_4 emissions are of great interest

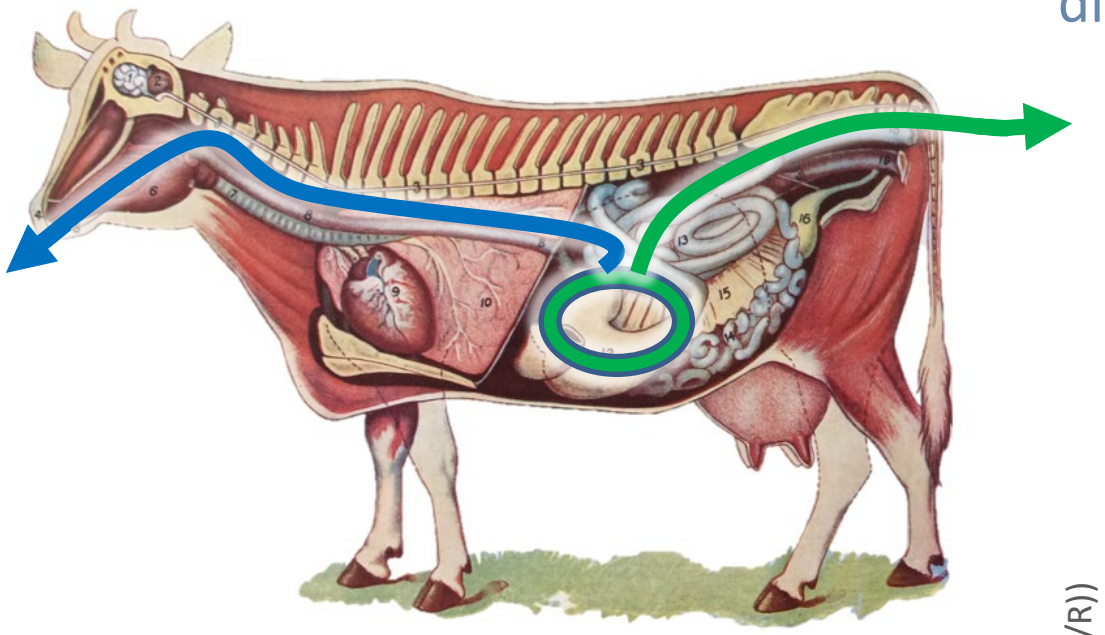




Development of a proxy for individual CH_4 emissions from non lactating animals usable in commercial farms (no DMI information).

Proxy for CH_4 emitted by non-lactating cows?





Veterinarial *ex libris* – Internal bovine anatomy - 1920

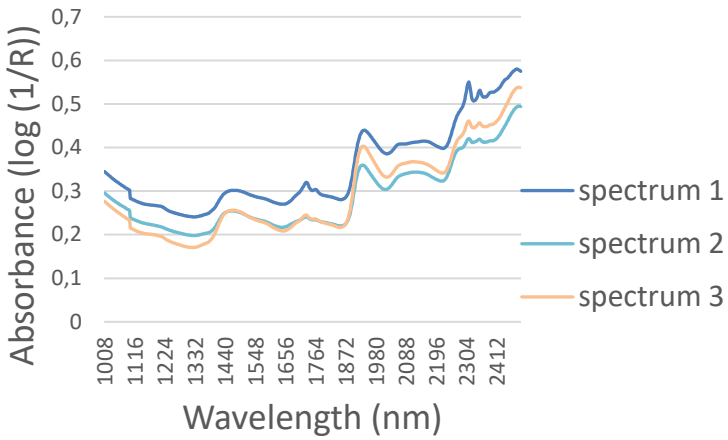
Eructed methane

//

rumen fermentation

Feces directly related to digestibility parameters

NIR spectrometry



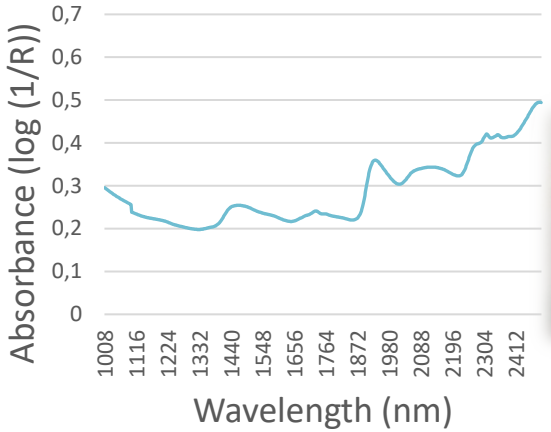
Standardized apparatus !

Develop a proxy to estimate CH_4 from feces

Reference data:

CH_4 measurement (g/d)

Greenfeed® System



60° C & #1mm

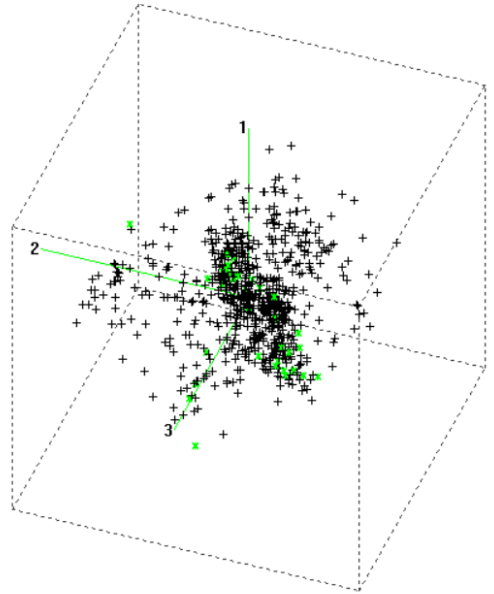
14 days

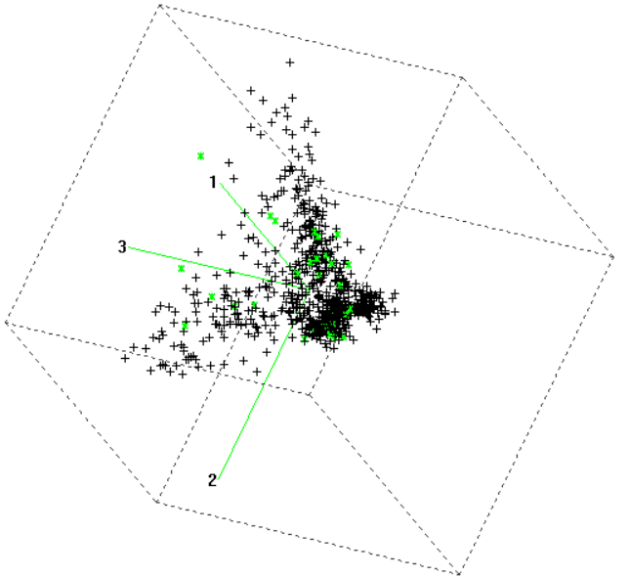
Min 3 minutes per visit & Min 20 visits

Develop a proxy to estimate CH_4 from feces

Reference data:

Country	Trial	N data	N animals	Breed	Class	Mean ± SD
FR	1	268	268	Charolais	Beef	213 ± 33
	2	45	45	Holstein	Dairy	375 ± 57
	3	27	27	Holstein	Dairy	398 ± 93
	4	162	162	Holstein	Dairy	495 ± 60
	5	19	19	Holstein	Dairy	299 ± 64
BE	6	77	38	BBB & BBM	Beef & Young	262 ± 48
	7	9	9	Beef (BBM) X Dairy (HO)	Young	159 ± 15
	8	63	18	Holstein	Young	235 ± 64
	9	177	140	BBB	Young	139 ± 51
CH	10	55	55	Beef (SI, AN, LM) X Dairy (BS)	Beef	221 ± 23
TOT		905	781			270 ± 132





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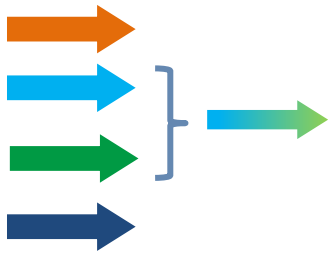
10% of animals from each dataset dedicated to external validation

Develop a proxy to estimate CH_4 from feces

Reference data & modeling

Category	N data	N animals	Mean ± SD	N data calibration	N data validation
Dairy	255	255	447 ± 93	230	25
Beef	401	401	223 ± 41	352	39
Young	249	167	175 ± 66	230	29
TOT	**905**	**781**	**270 ± 132**	**812**	**93**



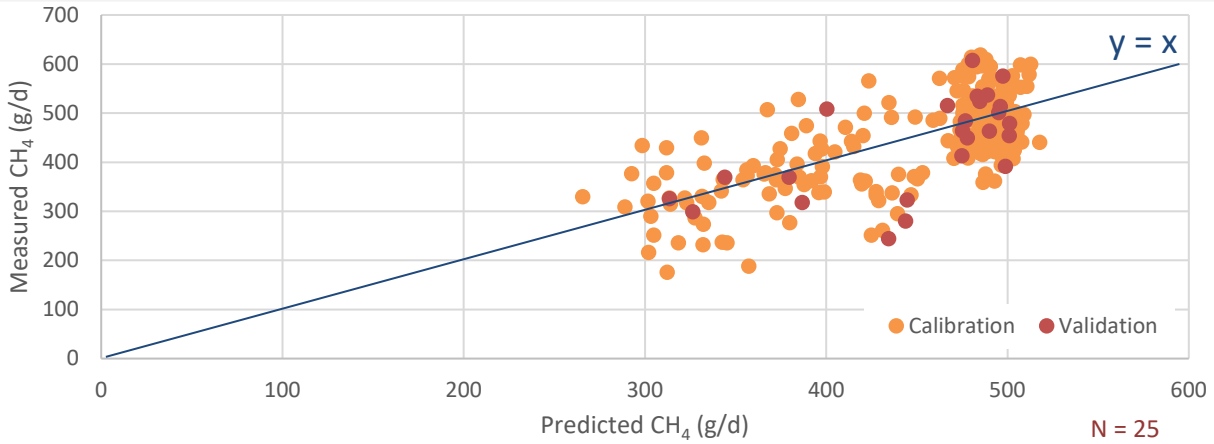
5 models

Partial least squares regression
First derivative

+ 5 groups CV
+ External Validation step

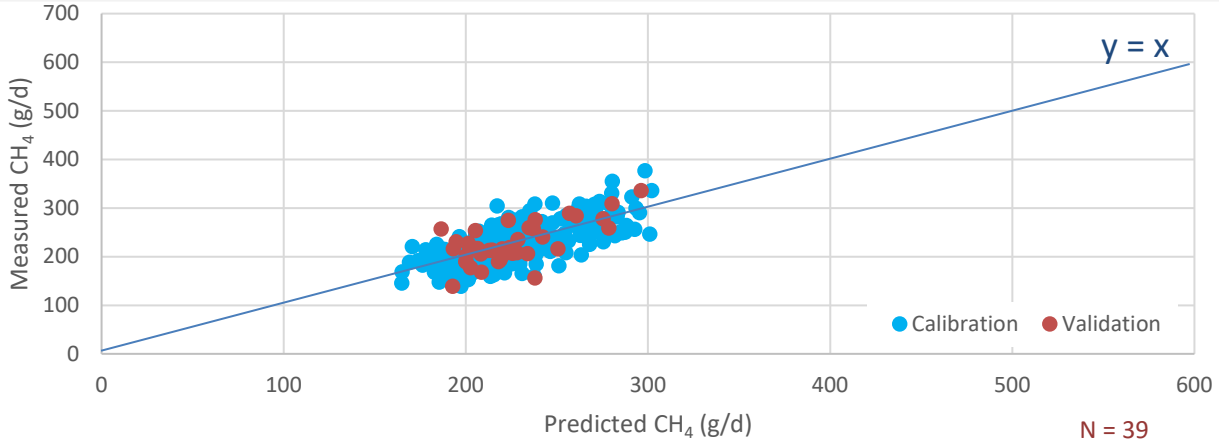
Develop a proxy to estimate CH_4 from feces

Results



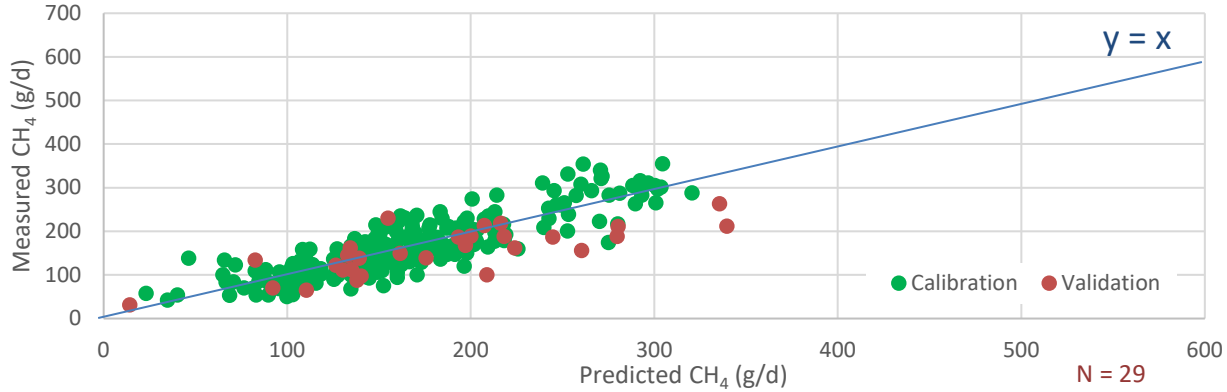
N = 25

Dairy	N	Mean	SD	SEc	R^2c	SEcv	R^2cv	SEp	R^2p
CH_4 (g/d)	230	447	92	67	0.47	68	0.45	77	0.39



N = 39

Beef	N	Mean	SD	SEc	R^2c	SEcv	R^2cv	SEp	R^2p
CH_4 (g/d)	352	222	39	28	0.49	30	0.39	31	0.47

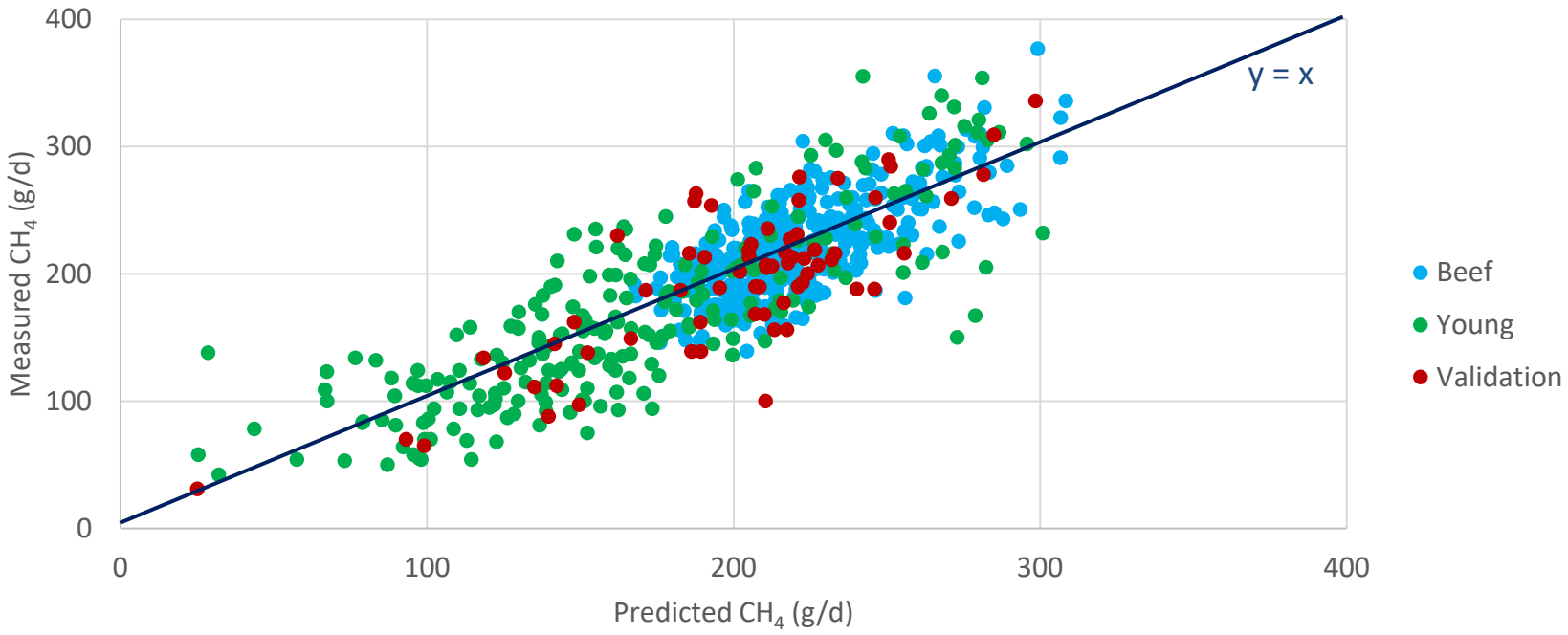


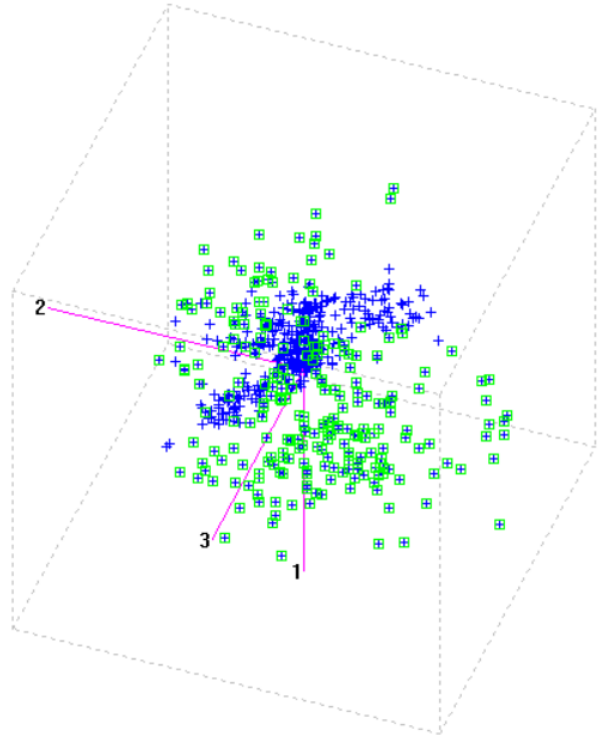
N = 29

Young	N	Mean	SD	SEc	R^2c	SEcv	R^2cv	SEp	R^2p
CH_4 (g/d)	230	176	67	33	0.76	39	0.65	54	0.61

Develop a proxy to estimate CH_4 from feces

Results





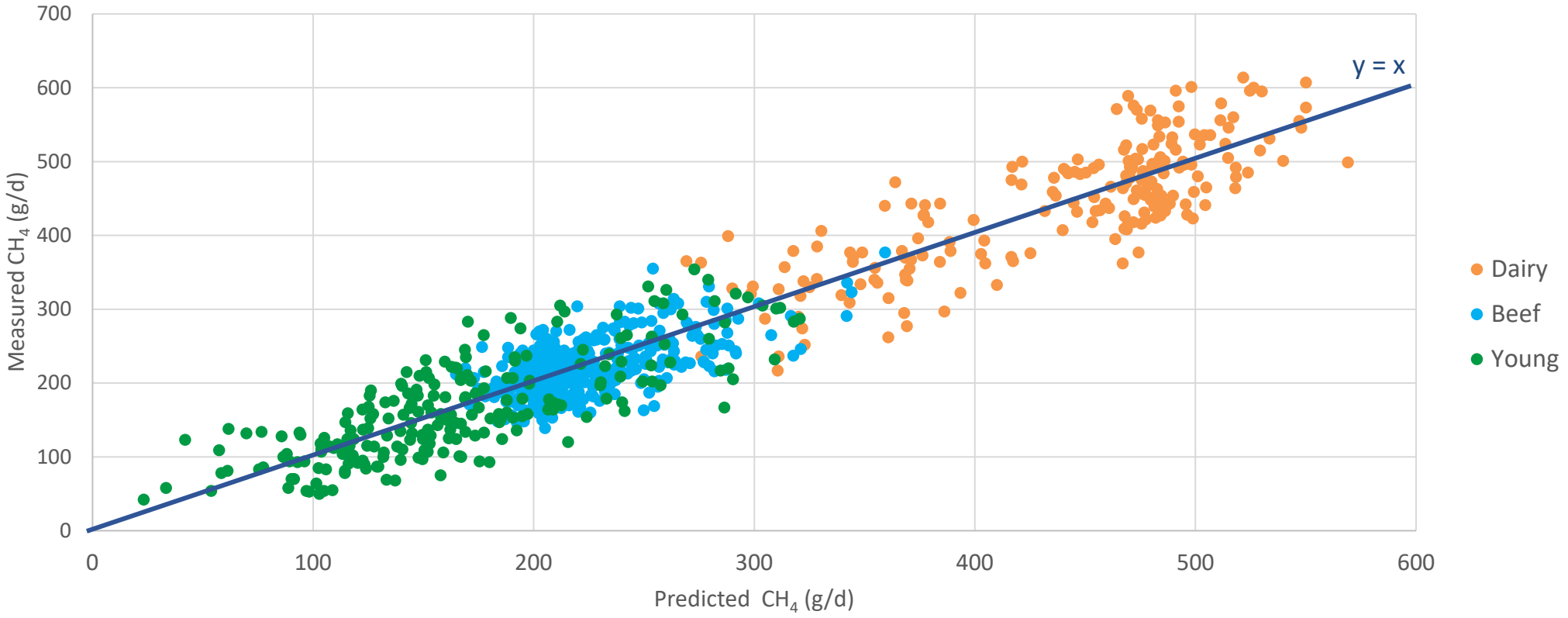
4 outliers removed

N = 68

Beef + Young	N	Mean	SD	SEc	R^2c	SEcv	R^2cv	SEp	R^2p
CH_4 (g/d)	577	200	60	31	0.7	34	0.67	37	0.62

Develop a proxy to estimate CH_4 from feces

Results

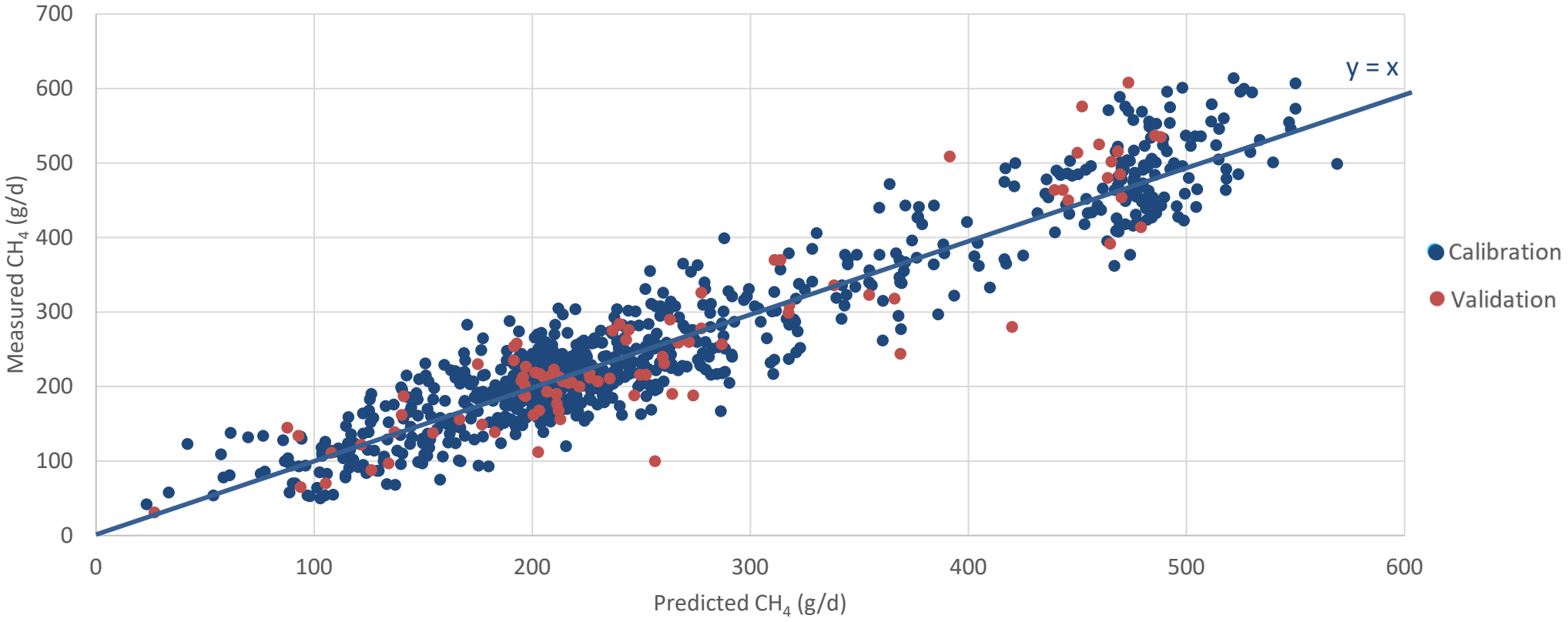


26 outliers removed

All type of animals	N	Mean	SD	SEc	R^2C	SECV	R^2CV
CH_4 (g/d)	785	264	127	41	0.89	44	0.88

Develop a proxy to estimate CH_4 from feces

Results



26 outliers removed

N = 93

All type of animals	N	Mean	SD	SEc	R^2c	SEcv	R^2cv	SEp	R^2p
CH_4 (g/d)	785	264	127	41	0.89	44	0.88	49	0.86

Conclusions & Next Steps

- Promising first models estimating daily CH_4 emissions from fecal NIR spectra
- Model including all type of animals showed better results
- Particularly interesting for non lactating animals
- Fecal NIR spectra can provide several information
  → open the door to large scale studies from one type of sample

- Importance to continue to collect reference data (standardized protocols!)
- Different equation per type of animal/diet/breed?
- Other approaches with consideration of other informative sources

SmartCow

INRAE + Wallonie recherche CRA-W

Consortium for win/win collaborations

Contact us!

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Agroscope

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Thank you for your attention

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