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Validation of national methane MIR prediction equation

Maria Frizzarin, Ben Lahart, and Donagh Berry

Teagasc, Ireland

Maria.frizzarin@teagasc.ie

HOST INSTITUTION

Teagasc

Agriculture and Food Development Authority

PARTNER INSTITUTIONS

DCU, icbf Insight, NUI Galway OE Gaillimh, Tyndall, UCC, Walton, SETU

FUNDED BY:

An Roinn Talmhaíochta, Bia agus Mara, Department of Agriculture, Food and the Marine; Science Foundation Ireland SFI

Objective

- Validation of methane prediction equation
  - Calibration dataset: data from 2020 to 2022
  - Validation dataset: data from 2023
  - No common cows between the datasets

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Predicting methane emissions of individual grazing dairy cows from spectral analyses of their milk samples

Donagh Berry, M. Frizzarin, B. Lahart, M. Kennedy, L. Shalloo, M. Egan, K. Starsmore, S. McParland

Teagasc, Ireland

Donagh.berry@teagasc.ie

HOST INSTITUTION

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PARTNER INSTITUTIONS

DCU icbf Insight NUI Galway OE Gaillimh Tyndall UCD UCC WALTON SETU

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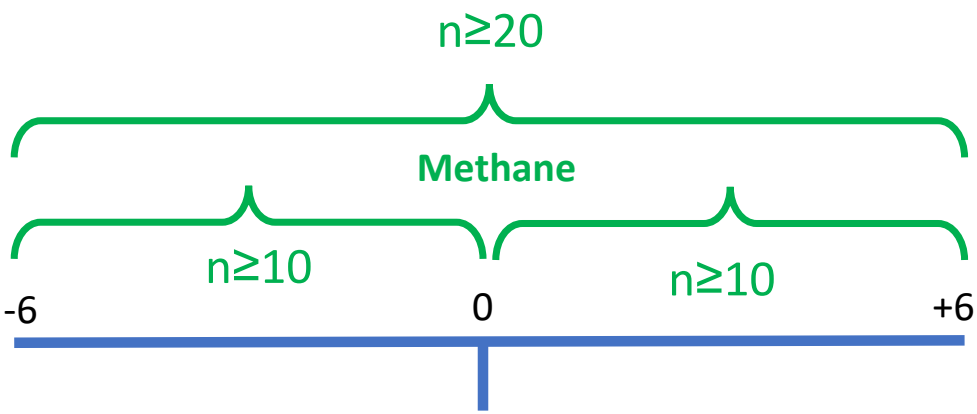
Data

- 93,888 individual methane spot measures (>2 minutes)
  - 384 lactations from 277 dairy cows



AM & PM Milk sample
- Yield & composition
- Spectrum
- Days post calving

AM only
PM only
AM+PM
AM&PM

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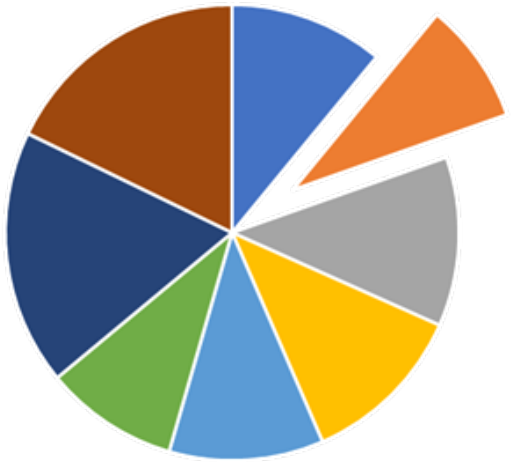
Approach

Four fold cross-validation

One farm out



$$\text{Methane} = \int (\text{spectrum, days in milk, yield, fat\%, protein \%})$$

Partial least squares or neural networks

Results

- μ = 323.4 g/d
- σ = 75.2 g/d
- Average of 30 spot measures to ±6 days
  - 111 minutes
- Repeatability = 28%

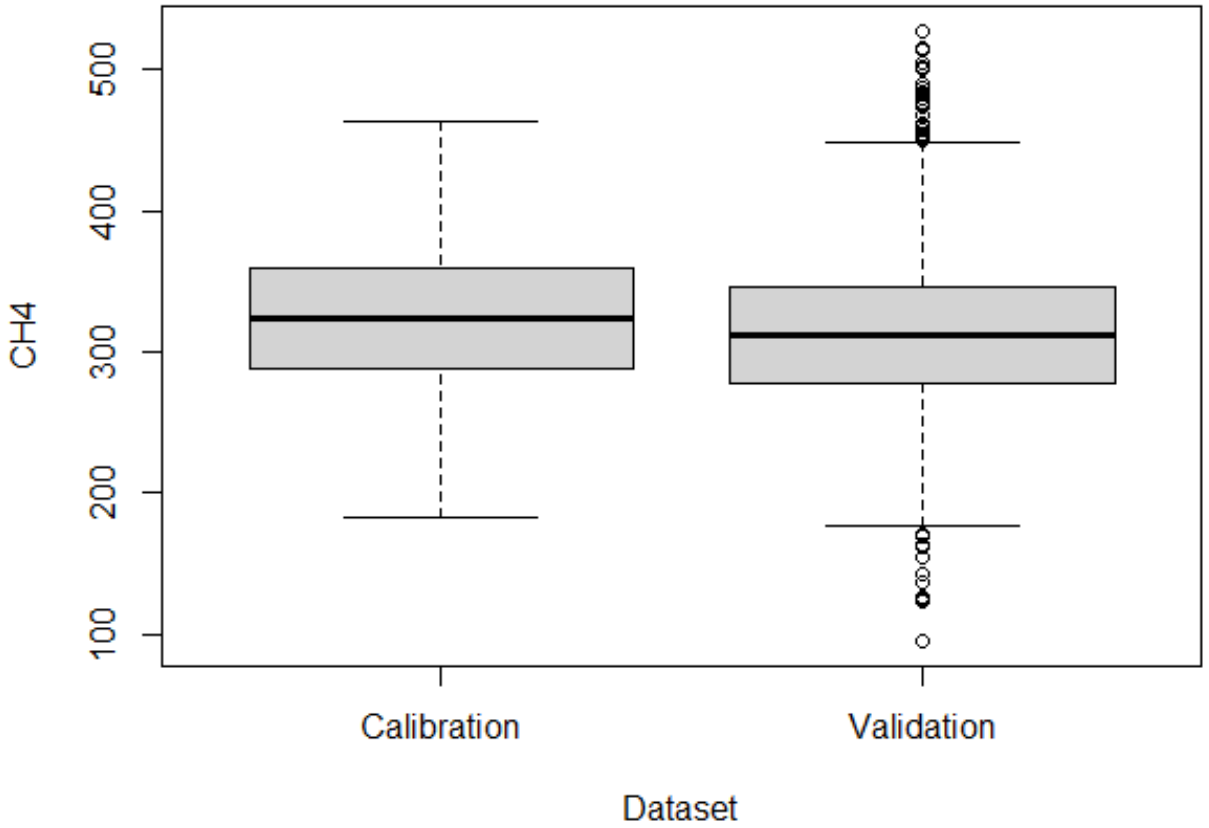
- Little difference
  - AM v PM, neural networks v partial least squares
- Flanking 6 days > previous 6 days > subsequent 6 days

Results

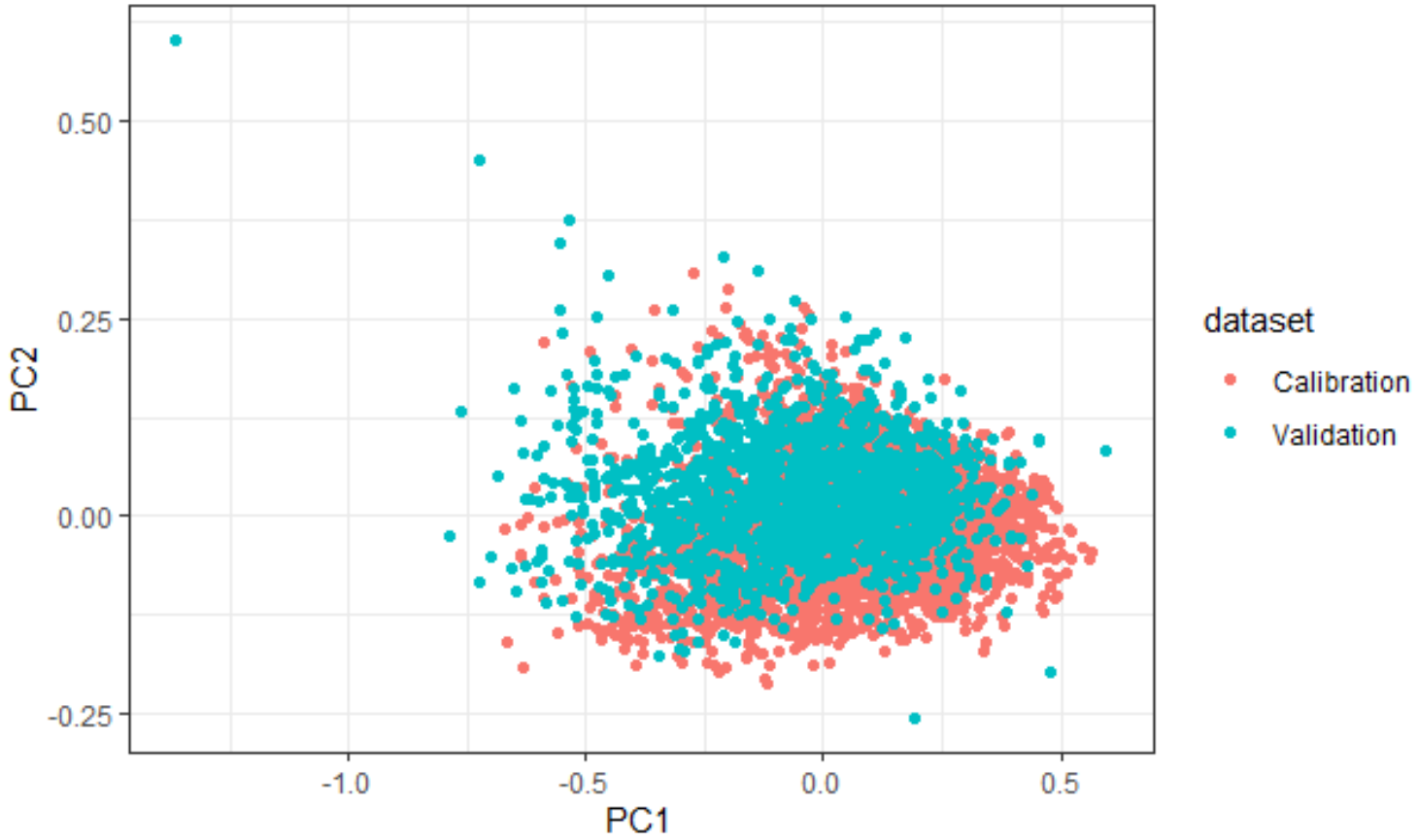
Model	No spectra	With spectra
Spectra		0.55 (0.07)
DIM	0.32 (0.13)	0.55 (0.06)
Yield	0.10 (0.18)	**0.64 (0.05)**
Composition	0.32 (0.13)	0.57 (0.06)
DIM + yield	0.52 (0.10)	0.64 (0.06)
DIM + composition	0.41 (0.10)	0.55 (0.06)
Yield + composition	0.32 (0.07)	0.62 (0.05)
DIM + yield + composition	0.54 (0.09)	0.64 (0.05)

Validation dataset

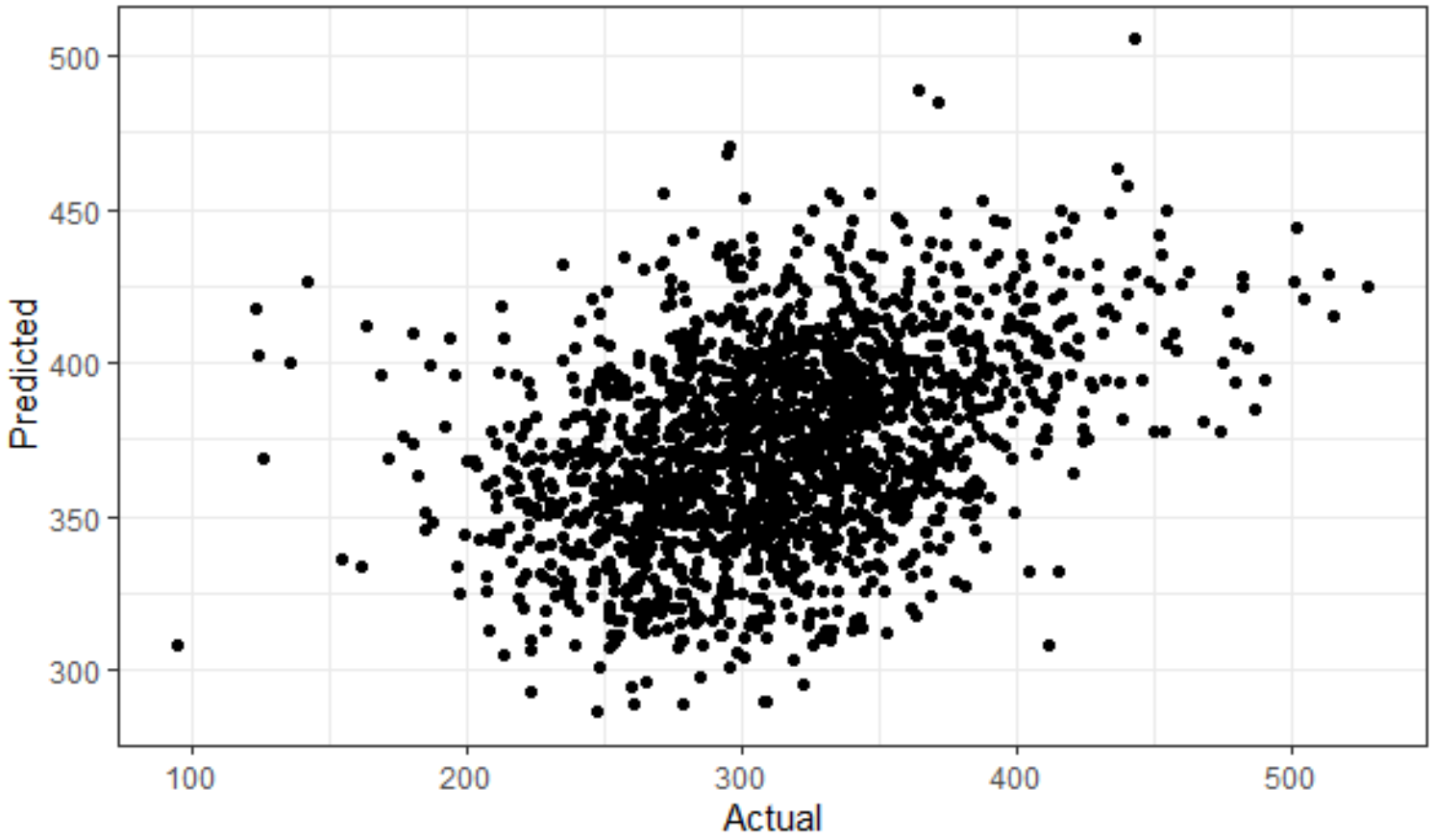
- Calibration
  - N = 3,047
  - From 2020 to 2022
- Validation
  - N = 1,715
  - From 2023



Validation dataset

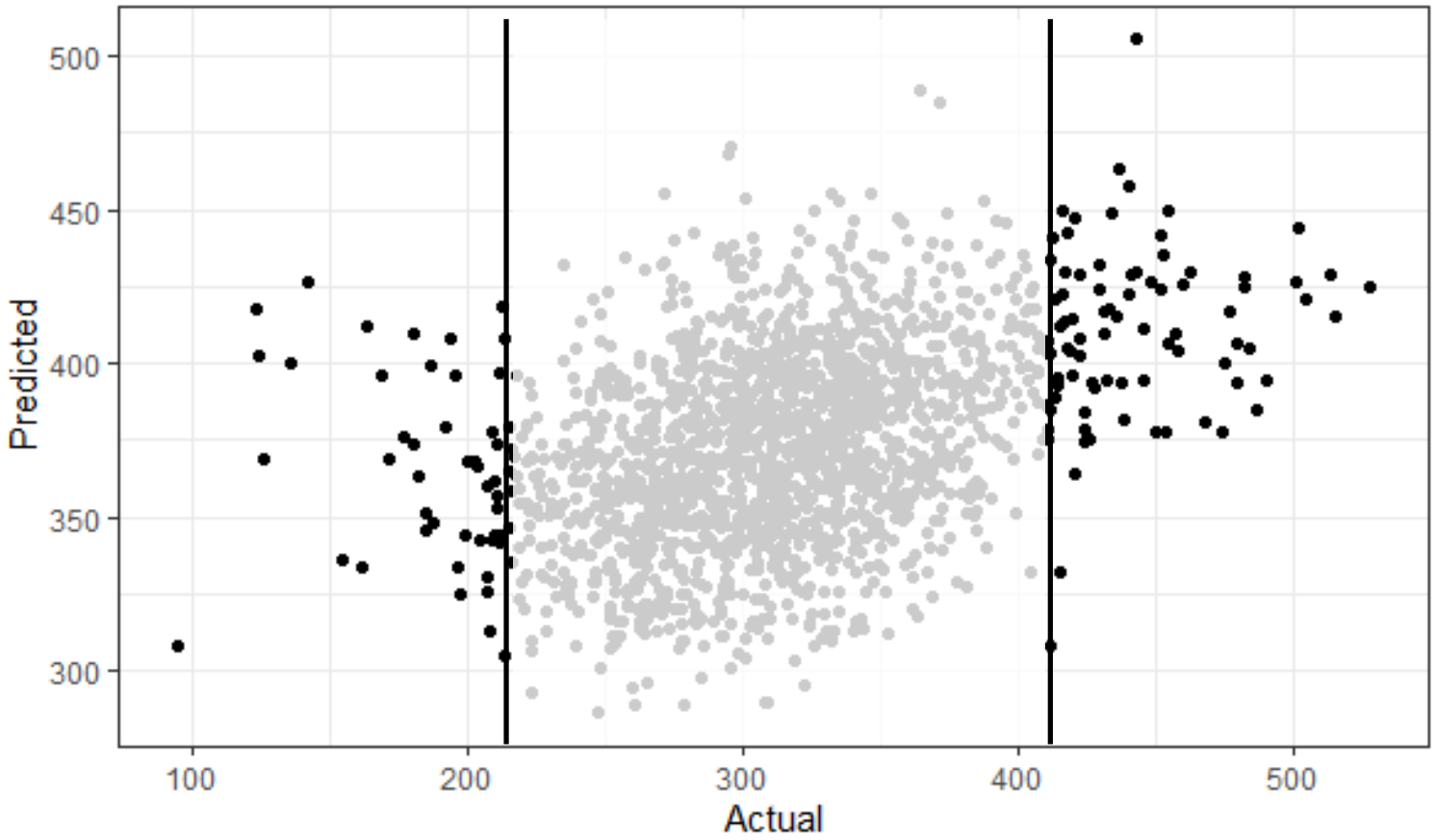


Results



- Correlation between actual and predicted of 0.38
- Root mean square error of 78.76 g/d

Results



- Mean methane predicted high 10% emitting cows = 402.59 g/d
- Mean methane predicted low 10% emitting cows = 358.29 g/d

New models

- AM only + yield
- PM only + yield
- $^1/_2$ AM + $^1/_2$ PM + yield
- $^1/_2$ AM + $^1/_2$ PM + yield + milking time

Results

			Calibration (4-fold)		Validation	
Calibration	**Validation**	**Model**	**Correlation**	**RMSE (g/d)**	**Correlation**	**RMSE (g/d)**
AM	AM	NN	0.68	38.23	0.28	76.68
AM	AM	PLSR	0.68	38.09	0.29	63.17
PM	PM	NN	0.66	39.16	0.43	111.66
PM	PM	PLSR	0.66	39.25	0.40	59.15

Results

Calibration	Validation	Model	Correlation	RMSE (g/d)
$^1/_2$ AM + $^1/_2$ PM	AM	NN	0.36	78.98
$^1/_2$ AM + $^1/_2$ PM	AM	PLSR	0.36	60.05
$^1/_2$ AM + $^1/_2$ PM	PM	NN	0.34	76.22
$^1/_2$ AM + $^1/_2$ PM	PM	PLSR	0.30	60.07

Calibration	Validation	Model	Correlation	RMSE (g/d)
$^1/_2$ AM + $^1/_2$ PM + milking time	AM	NN	0.45	81.47
$^1/_2$ AM + $^1/_2$ PM + milking time	AM	PLSR	0.41	54.56
$^1/_2$ AM + $^1/_2$ PM + milking time	PM	NN	0.40	89.86
$^1/_2$ AM + $^1/_2$ PM + milking time	PM	PLSR	0.33	60.34

Results

Calibration	Validation	Model	Correlation	RMSE (g/d)	Correlation
$^1/_2$ AM + $^1/_2$ PM + milking time	AM	NN	0.45	81.47	0.67
$^1/_2$ AM + $^1/_2$ PM + milking time	AM	PLSR	0.41	54.56	
$^1/_2$ AM + $^1/_2$ PM + milking time	PM	NN	0.40	89.86	0.69
$^1/_2$ AM + $^1/_2$ PM + milking time	PM	PLSR	0.33	60.34	

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Results

Correlation

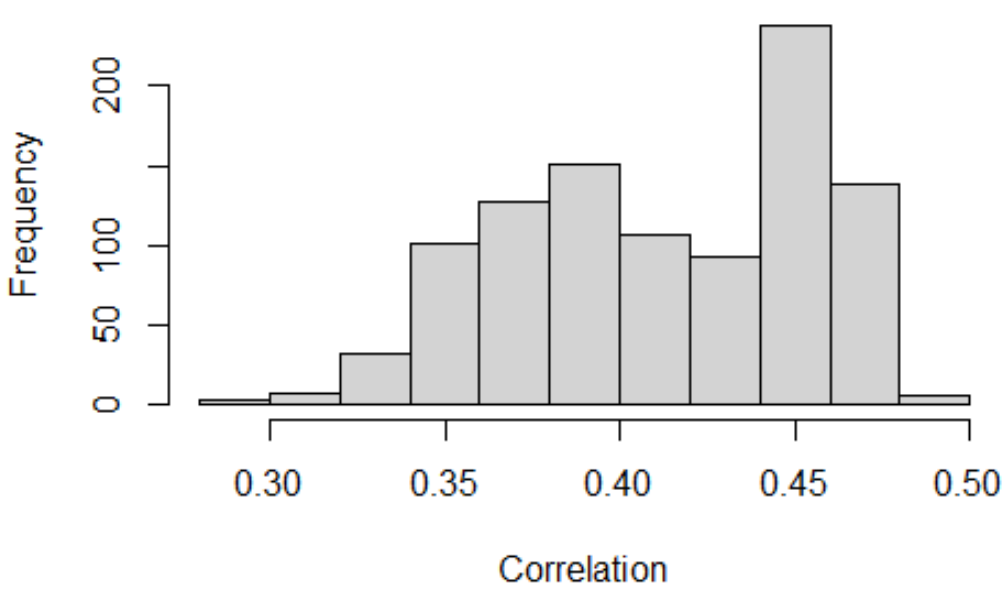
Calibration	Validation	Model	Correlation	RMSE (g/d)
$^1/_2$ AM + $^1/_2$ PM + milking time	AM	NN	0.45	81.47
$^1/_2$ AM + $^1/_2$ PM + milking time	AM	PLSR	0.41	54.56
$^1/_2$ AM + $^1/_2$ PM + milking time	PM	NN	0.40	89.86
$^1/_2$ AM + $^1/_2$ PM + milking time	PM	PLSR	0.33	60.34

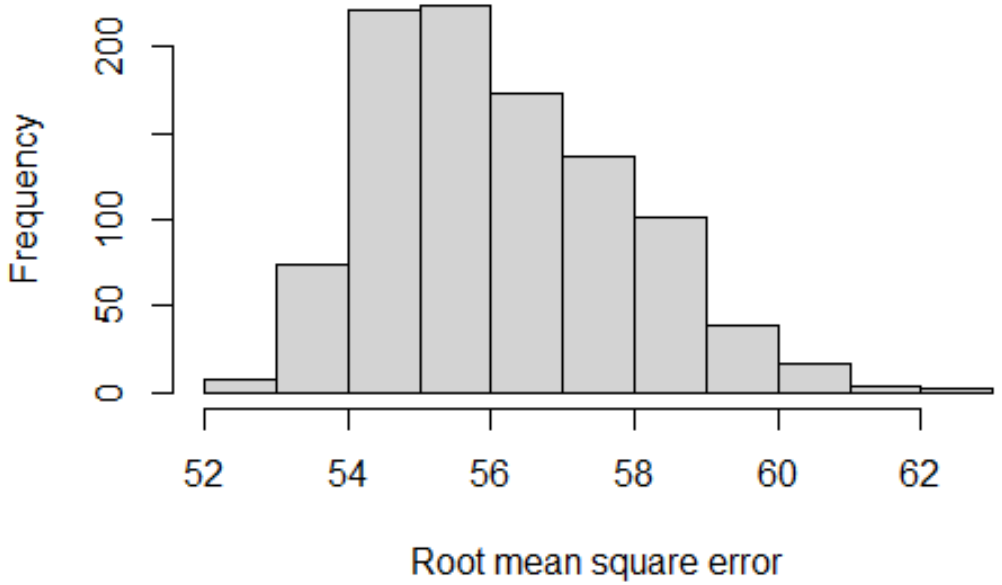
0.73

0.70

Results

After running PLSR 1000 times





Conclusions

- Still need to find the best equation
- How to use the AM and PM?
- More data needed