72ND ANNUAL MEETING OF THE EUROPEAN FEDERATION OF ANIMAL SCIENCE
SCIENTIFIC SOLUTIONS
TO DIFFERENT DEMANDS ON THE LIVESTOCK SECTOR
DAVOS – SWITZERLAND 30 AUGUST – 3 SEPTEMBER 2021
EAAP 2021

LIÈGE université
Gembloux
Agro-Bio Tech

Relationship between proxies of nitrogen use efficiency for dairy cows in early lactation

Y. Chen, C. Grelet, S. Vanderick, N. Gengler

1 Introduction

(1) Protein in the feed is the most expensive raw material

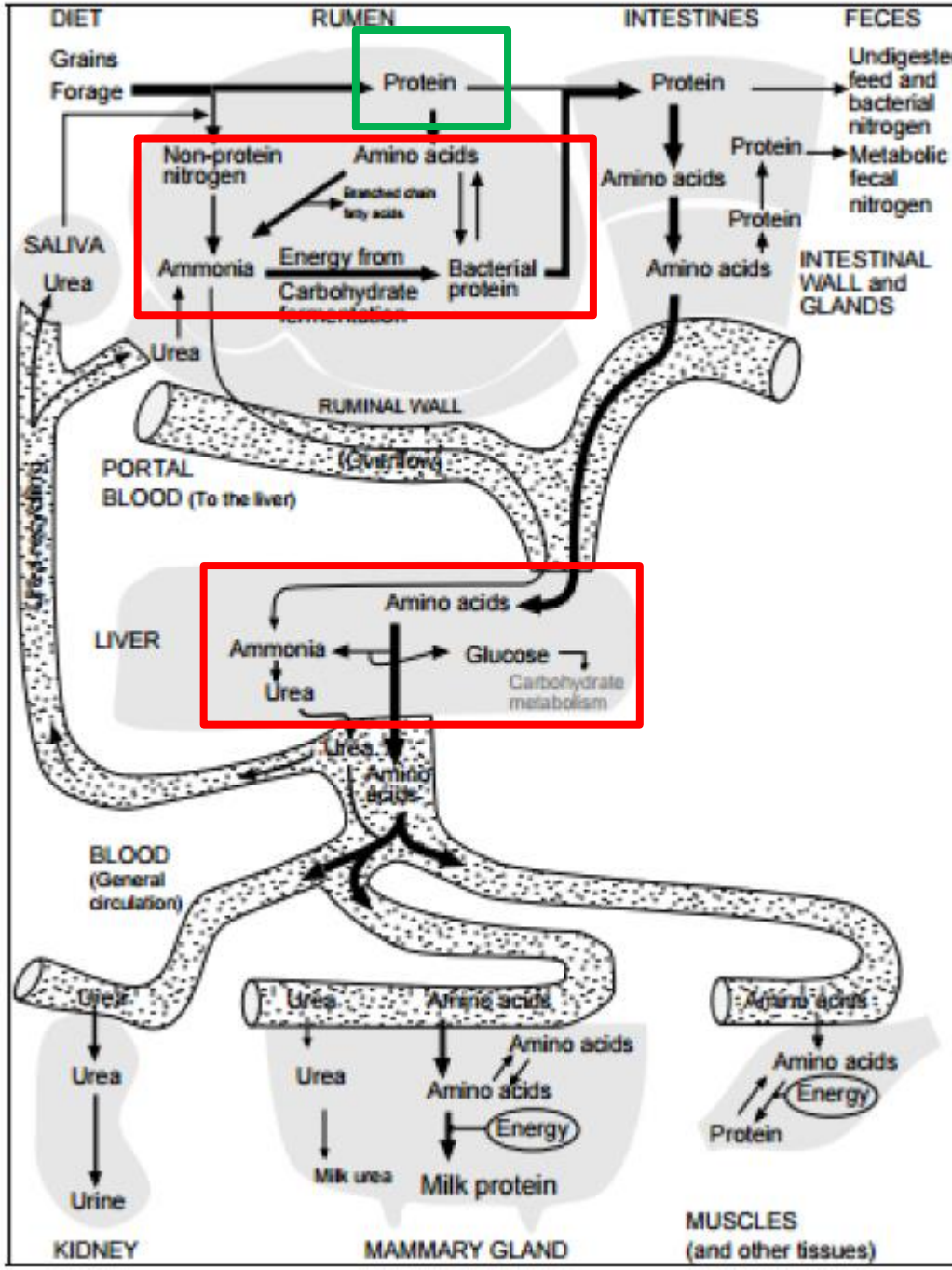
(2) After feed protein enters the cow body,

It is mainly metabolized in different forms of nitrogen (**N**), such as amino acids, ammonia, urea, etc.

(Aguirre-Villegas et al., 2017)

(3) N use efficiency (**NUE**) = $\frac{\text{Milk N}}{\text{N intake}}$ (dairy cow)

(Wattiaux, 2014)



1 Introduction

According to the literature, only from 15% to 45 % of the N intake of cows is converted into milk N

Where did the N intake go?

Publication and study	Animal N[2]	NUE, g/g n	Mean±SD	Min	Max
Cantalapiedra-Hijar *et al.*, 2015					
Study No.1 (ID#1)	Growing beef cattle (36)	34	0.235±0.045	0.152	0.324
Study No.2 (ID#2)	Dairy cows (5)	18	0.320±0.033	0.265	0.392
Cantalapiedra-Hijar *et al.*, 2016					
Study No.3 (ID#3)	Dairy cows (16)	16	0.270±0.032	0.217	0.320
Cabrita *et al.*, 2014					
Study No.4 (ID#4)	Dairy cows (9)	24	0.296±0.042	0.232	0.394
Study No.5 (ID#5)	Dairy cows (9)	25	0.295±0.031	0.239	0.368
Study No.6 (ID#6)	Dairy cows (9)	20	0.341±0.031	0.294	0.397
Cheng *et al.*, 2011					
Study No. 7 (ID#7)	Dairy cows (9)	18*	0.261±0.053	0.177	0.347
Cheng *et al.*, 2013a					
Study No. 8 (ID#8)	Non-lactating sheep (6)	15	0.011±0.147	-0.140	0.175
Cheng *et al.*, 2013b					
Study No. 9 (ID#9)	Dairy cows (15)	15	0.207±0.040	0.149	0.279
Cheng *et al.*, 2014					
Study No. 10 (ID#10)	Dairy cows (16)	16	0.201±0.026	0.159	0.274
Cheng *et al.*, 2016					
Study No. 11 (ID#11)	Dairy goats (8)	16	0.131±0.018	0.102	0.164
Total		217	0.243±0.095	-0.140	0.392

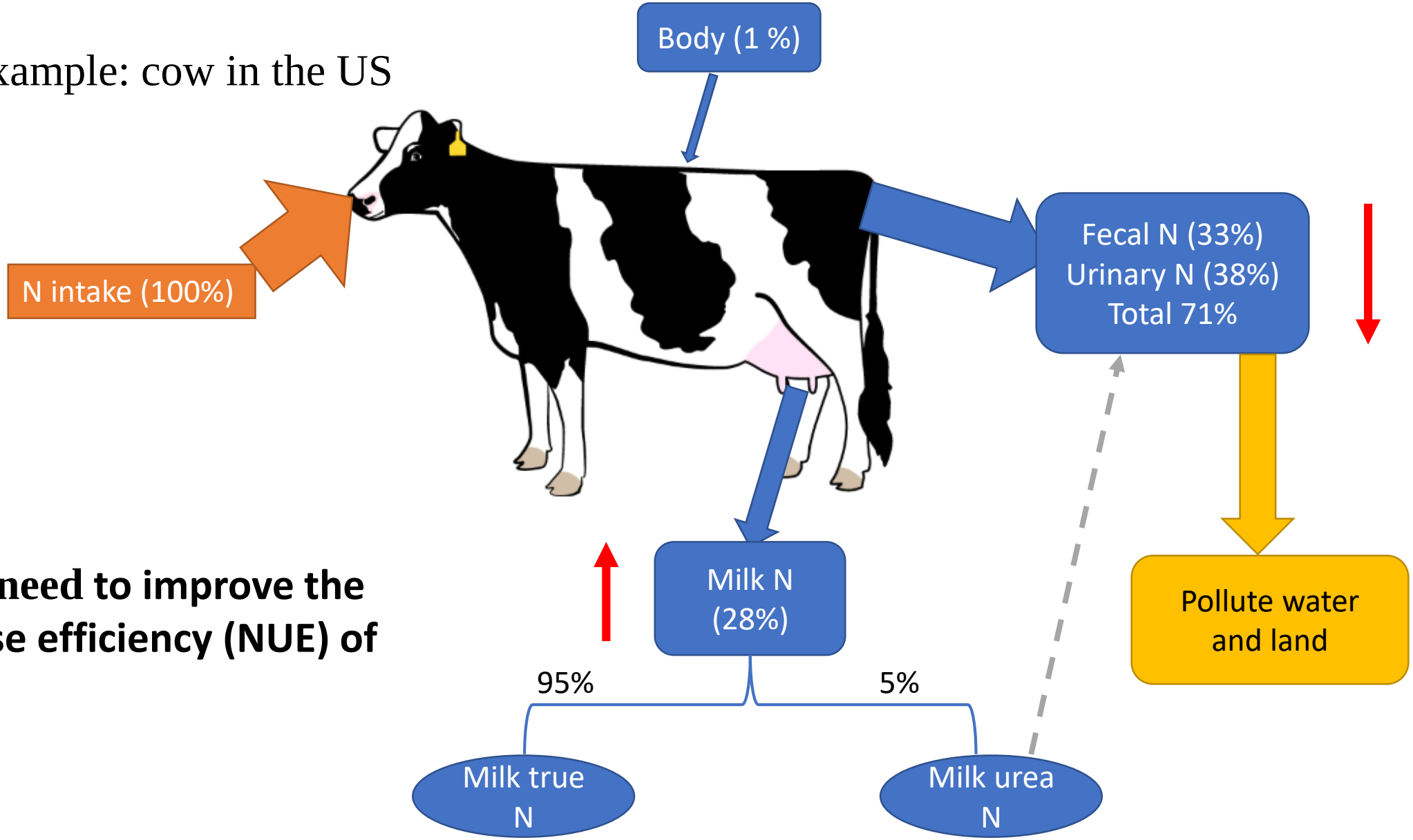
(Cantalapiedra-Hijar et al., 2018)

Diet[1]	NUE[4] (%)
AFBI (UK)	
High C	31
Low C	32
Standard	30
AU (DK)	
High starch	44
High sugar	39
Standard	44
UCD (IE)	
Standard	42

(Grelet et al., 2020)

1 Introduction

A example: cow in the US



We need to improve the N use efficiency (NUE) of cow

(Adapted from Spek et al. 2013)

1 Introduction

However, many proxies may represent the N use efficiency (NUE) of cows

1 Introduction

However, many proxies may represent the N use efficiency (NUE) of cows

We select below four proxies of NUE to do this study:

- **(1) Predicted N use efficiency (PNUE)** $= \frac{\textbf{Milk N}}{\textbf{Predicted N intake}}$
- **(2) Predicted N losses (PNL) = Predicted N intake - Milk N**
- **(3) Predicted N intake (PNintake)**
- **(4) Milk urea concentration (MU)**

2 Objectives

- **(1) explore the curves for four proxies of NUE in the first 50 days in milk**
- **(2) estimate the heritability of four proxies of NUE**
- **(3) analyze the relationship between four proxies of NUE**

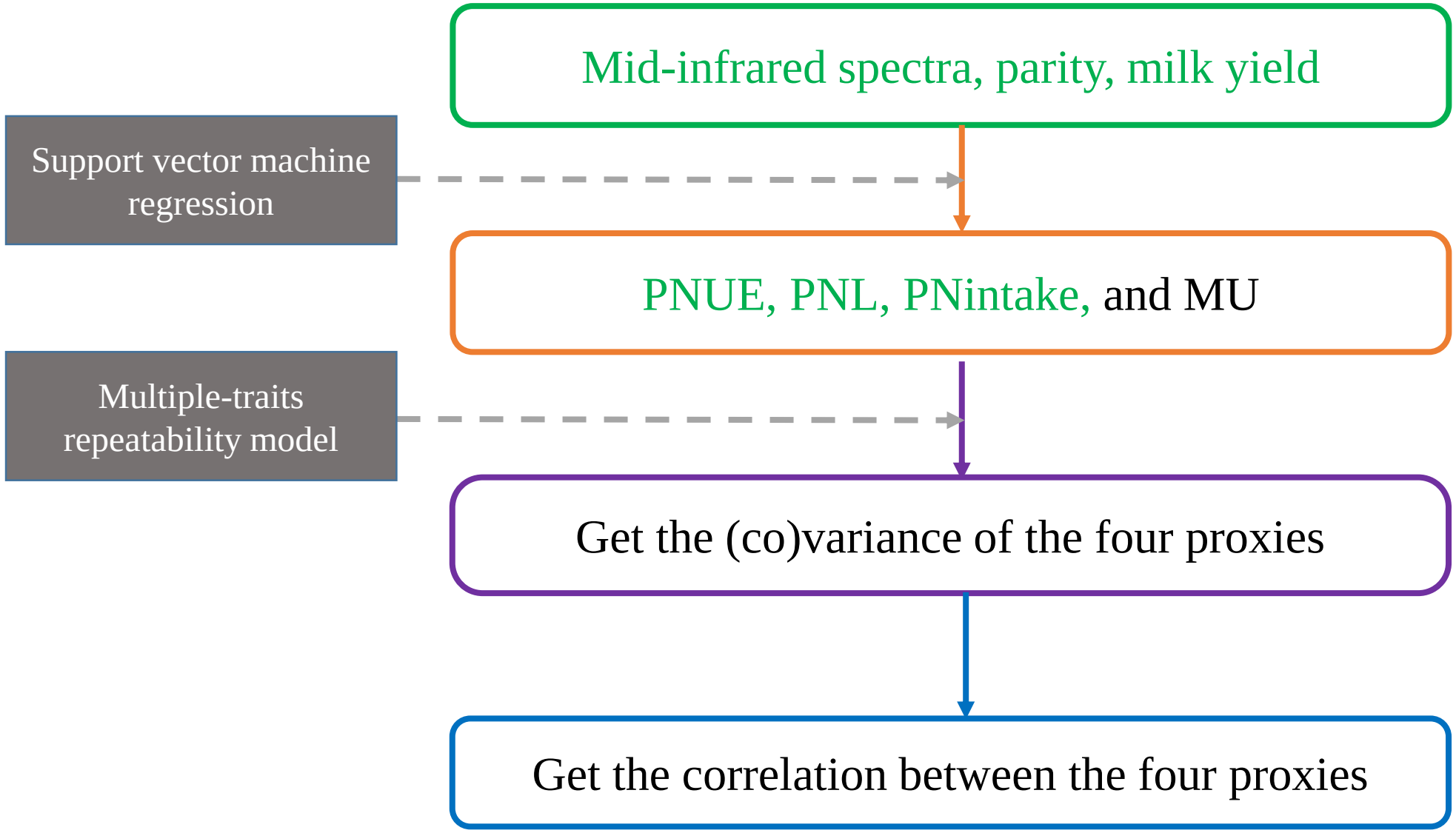
3.1 Material

- Time: from 2012 to 2019
- Place: Walloon Region of Belgium
- DIM : from 5 to 50

Parity_class	1	2 (2 to 5)	Total
Records	44,321	99,274	**143,595**
Cows	35,350	42,468	**53, 660**

The records inclued mid-infrared spactra, parity, milk yield, and milk urea concontration (MU)

3.2 Methods


Mid-infrared spectra, parity, milk yield
Support vector machine regression
PNUE, PNL, PNintake, and MU
Multiple-traits repeatability model
Get the (co)variance of the four proxies
Get the correlation between the four proxies

3.2 Methods

Predicted models of the PNUE, PNL, PNintake

J. Dairy Sci. 103:4435–4445
https://doi.org/10.3168/jds.2019-17910

Potential of milk mid-infrared spectra to predict nitrogen use efficiency of individual dairy cows in early lactation

C. Grelet,[1] E. Froidmont,[1] L. Foldager,[2,3] M. Salavati,[4*] M. Hostens,[5] C. P. Ferris,[6] K. L. Ingvartsen,[2] M. A. Crowe,[7] M. T. Sorensen,[2] J. A. Fernandez Pierna,[1] A. Vanlierde,[1] N. Gengler,[8] GplusE Consortium,† and F. Dehareng[1]‡

Multiple-traits repeatability model

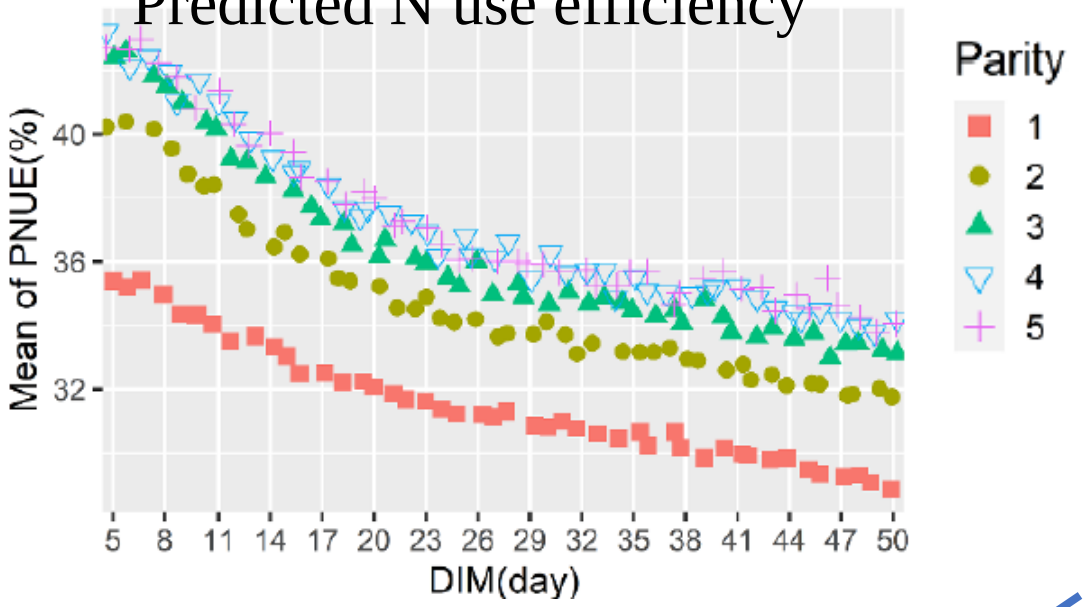
J. Dairy Sci. 104
https://doi.org/10.3168/jds.2020-18849

Estimation of genetic parameters for predicted nitrogen use efficiency and losses in early lactation of Holstein cows

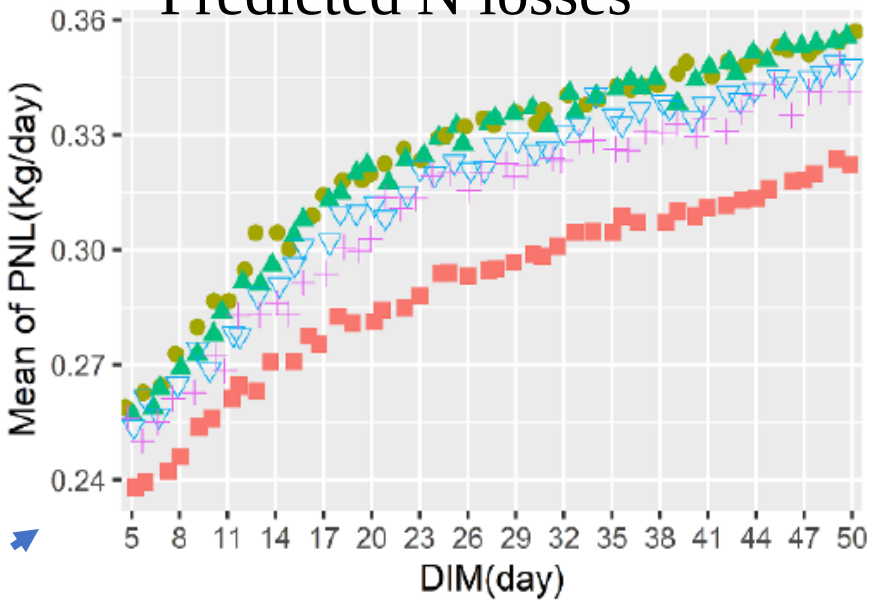
Y. Chen,[1] S. Vanderick,[1] R. R. Mota,[1] C. Grelet,[2] GplusE Consortium,* and N. Gengler[1]†

4.1 Results

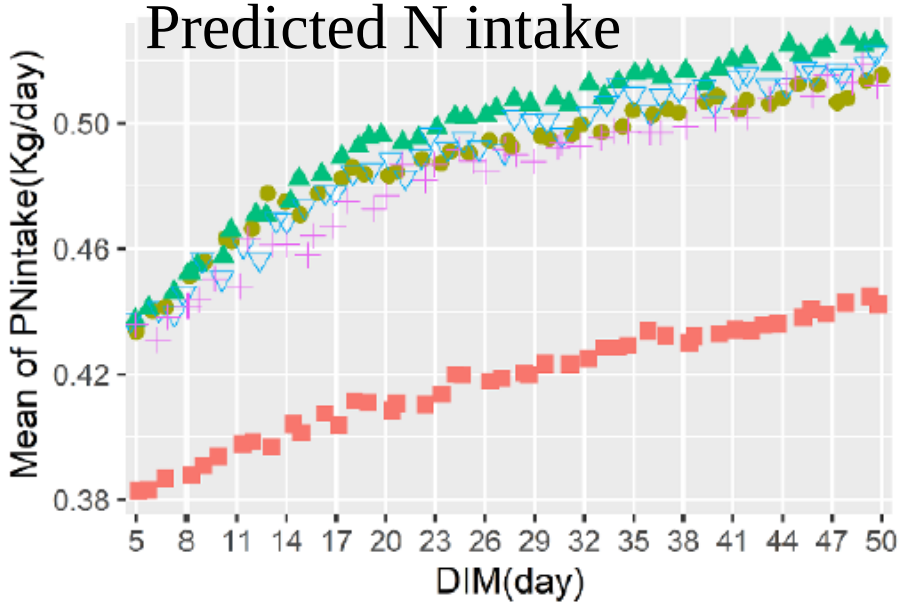
Predicted N use efficiency



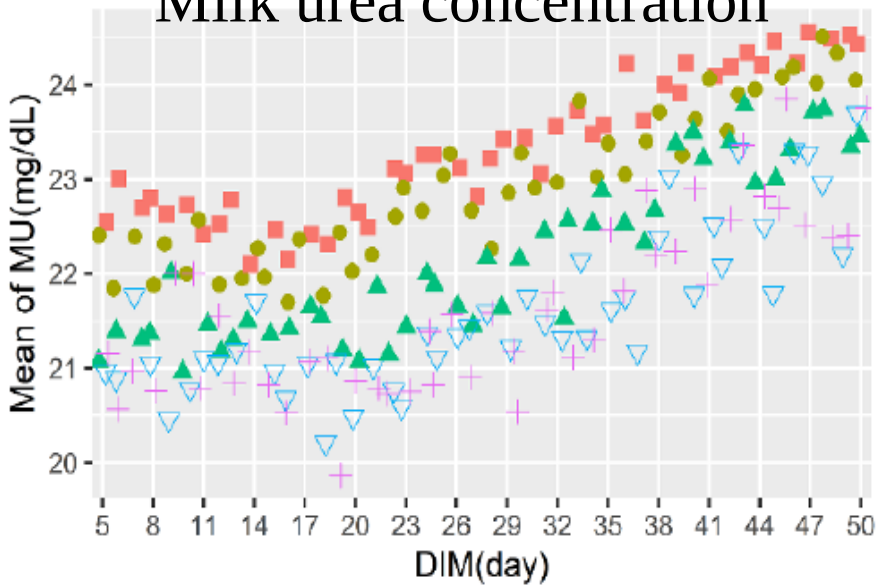
Predicted N losses



Predicted N intake

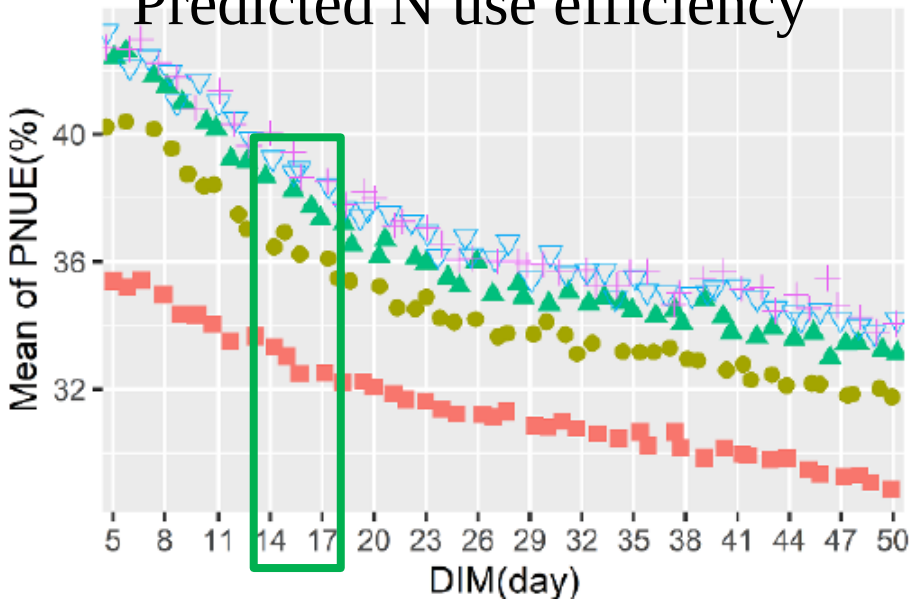


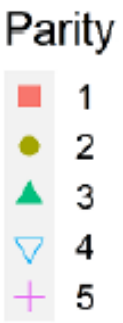
Milk urea concentration



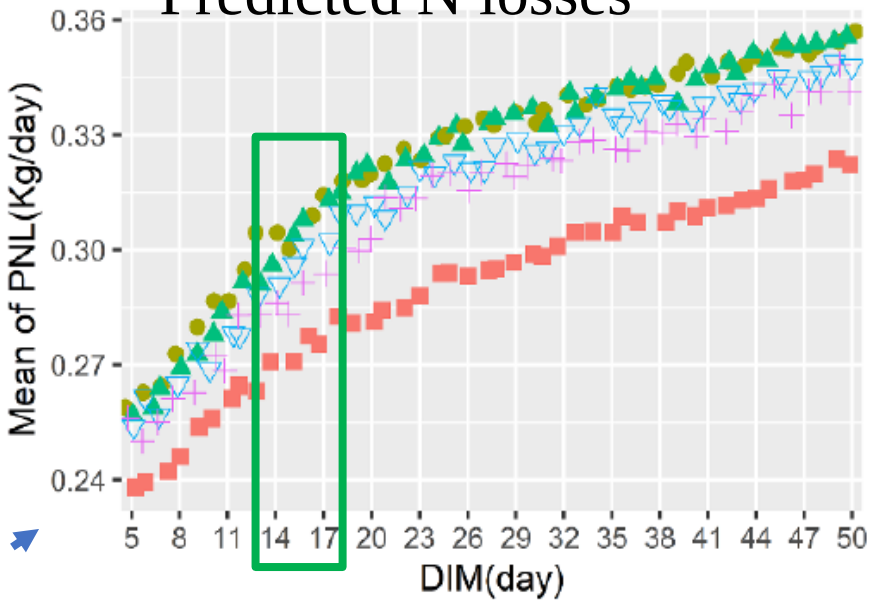
4.1 Results

Predicted N use efficiency

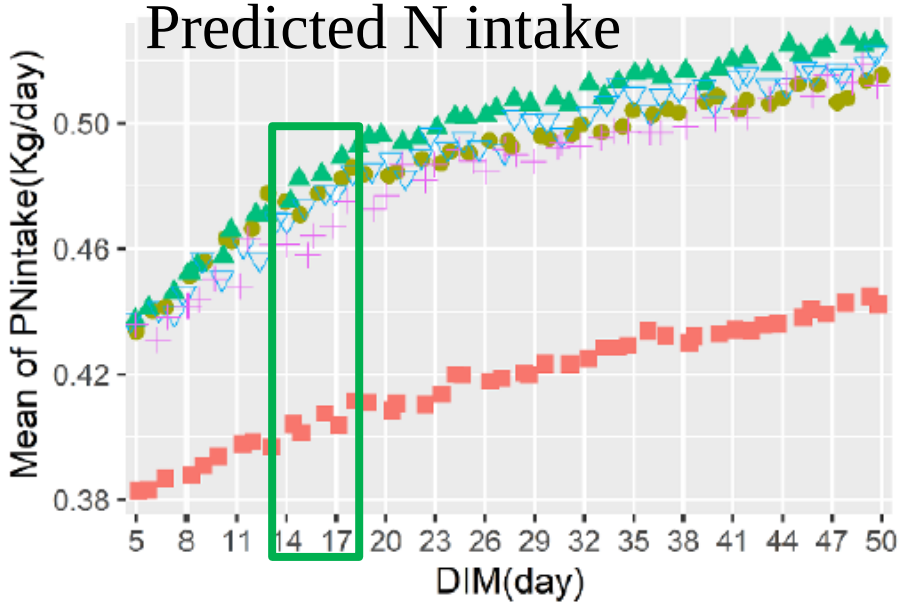




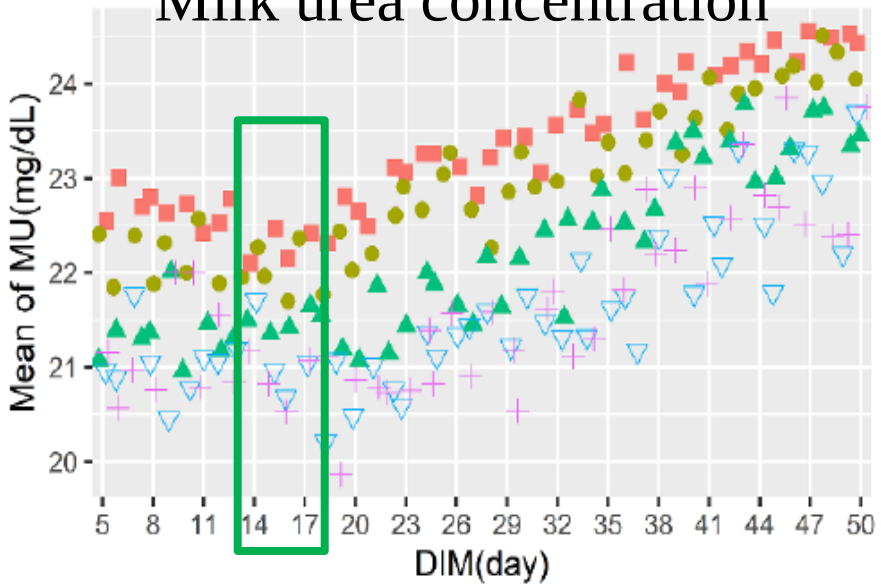
Predicted N losses



Predicted N intake

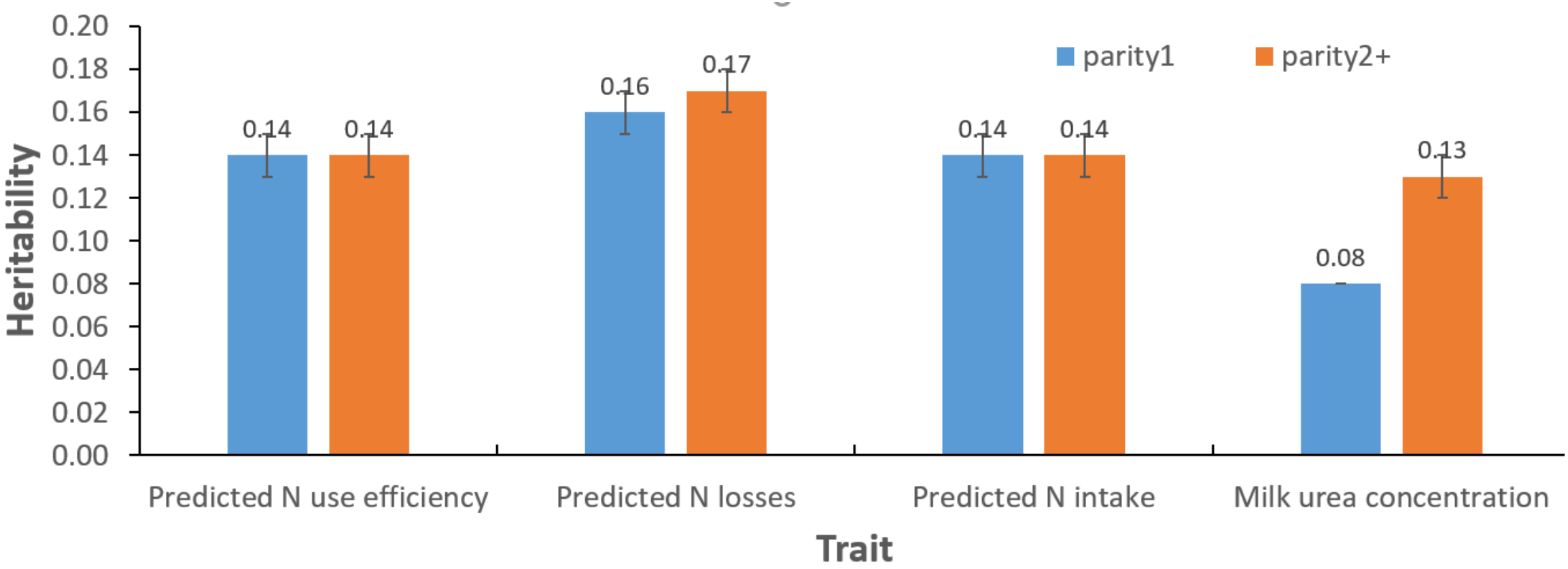


Milk urea concentration



4.2 Results

Heritability of the four proxies are from low to moderate, ranging from 0.08 to 0.17



Note: stand errors for h2 of all are less 0.01

4.2 Results

Range of genetic corrlations between the four proxies is from -0.77 to 0.99

Trait[1]	PNUE1	PNL1	PNintake1	MU1	PNUE2+	PNL2+	PNintake2+	MU2+
PNUE1	[illegible] 0.01 [2]	-0.77 ± 0.03	-0.51 ± 0.05	0.02 ± 0.06	0.73 ± 0.04	-0.61 ± 0.05	-0.38 ± 0.05	-0.02 ± 0.05
PNL1		[illegible] 0.01	0.94 ± 0.07	-0.14 ± 0.06	-0.55 ± 0.04	0.81 ± 0.03	0.80 ± 0.03	-0.09 ± 0.05
PNintake1			[illegible] 0.01	-0.14 ± 0.06	-0.35 ± 0.05	0.76 ± 0.03	0.87 ± 0.04	-0.10 ± 0.05
MU1				[illegible] 0.01	-0.10 ± 0.05	-0.01 ± 0.05	-0.05 ± 0.05	0.99 ± 0.01
PNUE2+					[illegible] 0.01	-0.79 ± 0.03	-0.46 ± 0.04	-0.14 ± 0.04
PNL2+						[illegible] 0.01	0.90 ± 0.05	0.03 ± 0.04
PNintake2+							[illegible] 0.01	-0.02 ± 0.04
MU2+								[illegible] 0.01

[1]Trait: PNUE1 - Predicted N use efficiency in primiparous cows; PNL1 - Predicted N losses in primiparous cows; PNintake1 - Predicted N intake in primiparous cows; MU1 - Milk urea concentration in primiparous cows; PNUE2+ - Predicted N use efficiency in multiparous cows; PNL2+ - Predicted N losses in multiparous cows; PNintake2+ - Predicted N intake in multiparous cows; MU2+ - Milk urea concentration in multiparous cows.

[2]: ± standard error.

4.2 Results

Genetic corrlation between Predicted N use efficiency and Predicted N losses

	PNL1	PNL2+
PNUE1	-0.77 ± 0.03	-0.61 ± 0.05
PNUE2+	-0.55 ± 0.04	-0.79 ± 0.03

Genetic corrlation between Predicted N use efficiency and milk urea concentration

	MU1	MU2+
PNUE1	0.02 ± 0.06	-0.02 ± 0.05
PNUE2+	-0.10 ± 0.05	0.02 ± 0.04

Genetic corrlation between Predicted N losses and Predicted N intake

	PNintake1	PNintake2+
PNL1	0.94 ± 0.07	0.80 ± 0.03
PNL2+	0.76 ± 0.03	0.90 ± 0.05

Genetic corrlation between milk urea concentration

	MU1
MU2	0.99 ± 0.01

4.2 Results

Rang of phenotypic correlations between the four proxies is from -0.43 to 0.63

Trait[1]	PNUE1	PNL1	PNintake1	MU1	PNUE2+	PNL2+	PNintake2+	MU2+
PNUE1								
PNL1	-0.43 ± 0.01							
PNintake1	-0.29 ± 0.01	0.58 ± 0.01						
MU1	0.08 ± 0.01	-0.16 ± 0.01	-0.16 ± 0.01					
PNUE2+	0.19 ± 0.01	-0.11 ± 0.01	-0.04 ± 0.01	0.00 ± 0.01				
PNL2+	-0.11 ± 0.01	0.18 ± 0.01	0.16 ± 0.01	-0.02 ± 0.01	-0.47 ± 0.00			
PNintake2+	-0.03 ± 0.01	0.15 ± 0.01	0.17 ± 0.01	-0.02 ± 0.01	-0.23 ± 0.00	0.63 ± 0.01		
MU2+	0.01 ± 0.01	-0.04 ± 0.01	-0.04 ± 0.01	0.15 ± 0.01	0.06 ± 0.00	-0.10 ± 0.00	-0.09 ± 0.00	

[1]Trait: PNUE1 - Predicted N use efficiency in primiparous cows; PNL1 - Predicted N losses in primiparous cows; PNintake1 - Predicted N intake in primiparous cows; MU1 - Milk urea concentration in primiparous cows; PNUE2+ - Predicted N use efficiency in multiparous cows; PNL2+ - Predicted N losses in multiparous cows; PNintake2+ - Predicted N intake in multiparous cows; MU2+ - Milk urea concentration in multiparous cows.

[2]: ± standard error.

4.2 Results

Phenotypic correlation between Predicted N use efficiency and Predicted N losses

	PNL1	PNL2+
PNUE1	-0.43 ± 0.01	-0.11 ± 0.01
PNUE2+	-0.11 ± 0.01	-0.47 ± 0.00

Phenotypic correlation between Predicted N losses and Predicted N intake

	PNintake1	PNintake2+
PNL1	0.58 ± 0.01	0.16 ± 0.01
PNL2+	0.15 ± 0.01	0.63 ± 0.01

5 Conclusions

- (1) The curves for Predicted N use efficiency (PNUE) ↘, Predicted N losses (PNL) ↗, Predicted N intake (PNintake) ↗, and milk urea concentration (MU) ↘ ↗
- (2) The PNUE, PNL, PNintake, and MU have low or moderate heritability in early lactation
- (3) The correlations between
  - PNUE and PNL are high negative
  - PNUE and MU are low
  - PNinatke and PNL are high positive

6 Advantage and limit

- Advantage
  - Predicted using mid-infrared spectroscopy
  - Cheap
  - Large scale

- Limit
  - Predicted N use efficiency (PNUE), Predicted N losses (PNL), and Predicted N intake(PNintake) are only available for the early lactation

Acknowledgments

Thank you for your attention

yansen.chen@doct.uliege.be