Nitrogen partitioning into faeces, urine and milk according to the feeding strategy of dairy cows

Cutullic E[1], Bannink A[4], Carli J[5], Crompton L[6], Doreau M[2], Edouard N[1], Faverdin P[1]
Jurjanz S[3], Klop A[4], Mills J[6], Moorby J[5], Noziere P[2], Reynolds C[6], Van Vuuren A[4], Peyraud JL[1]

[1] INRA-Agrocampus Ouest UMR1348, Rennes [2] INRA UMRH1213, Theix
[3] Université de Lorraine-INRA, Nancy
[4] Wageningen UR Livestock Research, Lelystad
[5] IBERS, Aberystwyth [6] University of Reading, Earley Gate

EAAP 2013 64th ANNUAL MEETING OF THE EUROPEAN FEDERATION OF ANIMAL SCIENCE
AUGUST 26TH - 30TH, 2013 NANTES, FRANCE

Why to predict nitrogen partitioning ?

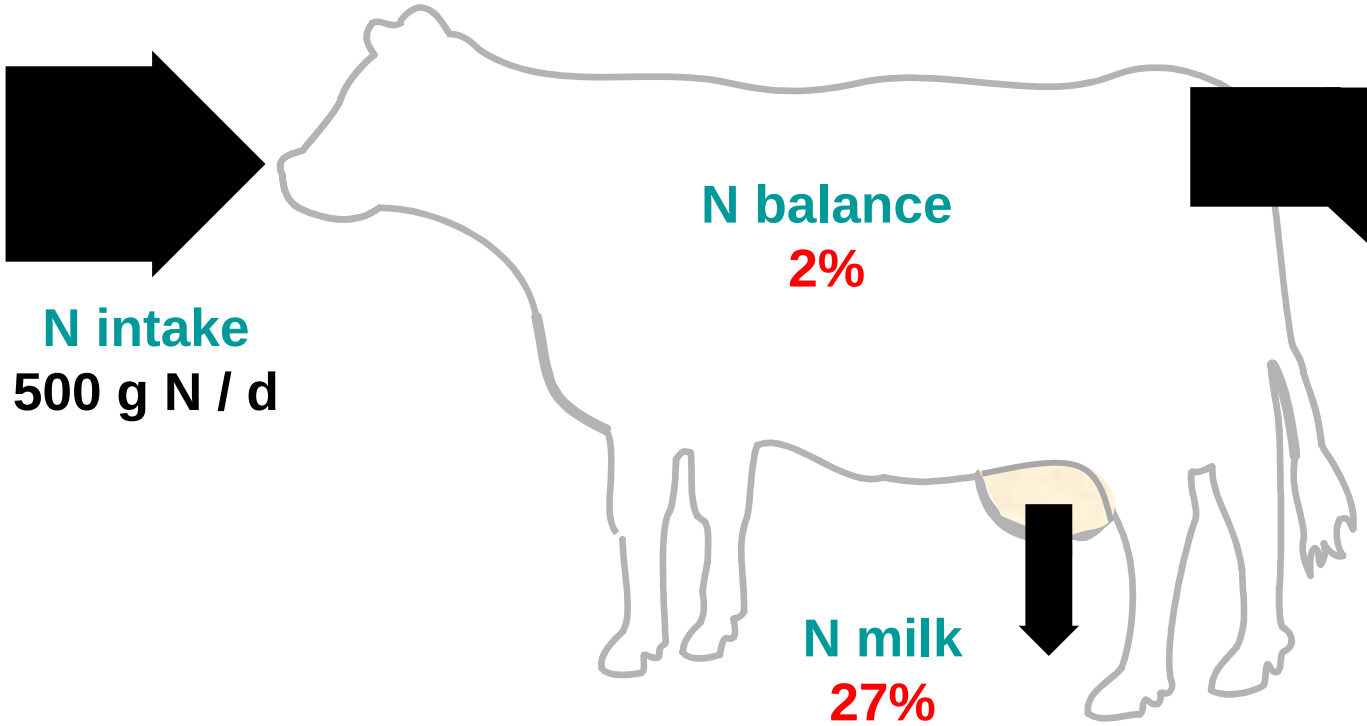
- **faecal** N is mainly organic
  → slow mineralisation rate

- **urinary** N is mainly urea-N
  → rapid volatilisation potential (NH_3, N_2O)

reviews Peyraud et al. 1995, Dijkstra et al. 2011

N flows at the animal scale

Cow producing 26kg milk, with 19 kg DMI at 16% CP



N intake
500 g N / d

N balance
2%

N faeces
33%

- microbial
- endogenous
- undigested feed

N urine
38%

- urea
- purine derivatives
- hippuric acid
- creatine, creatinine

N milk
27%

Spek et al. 2013 meta-analysis (>68 treat. EU trials)
Dijkstra et al. 2013
Diagram adapted from Lemosquet 2013

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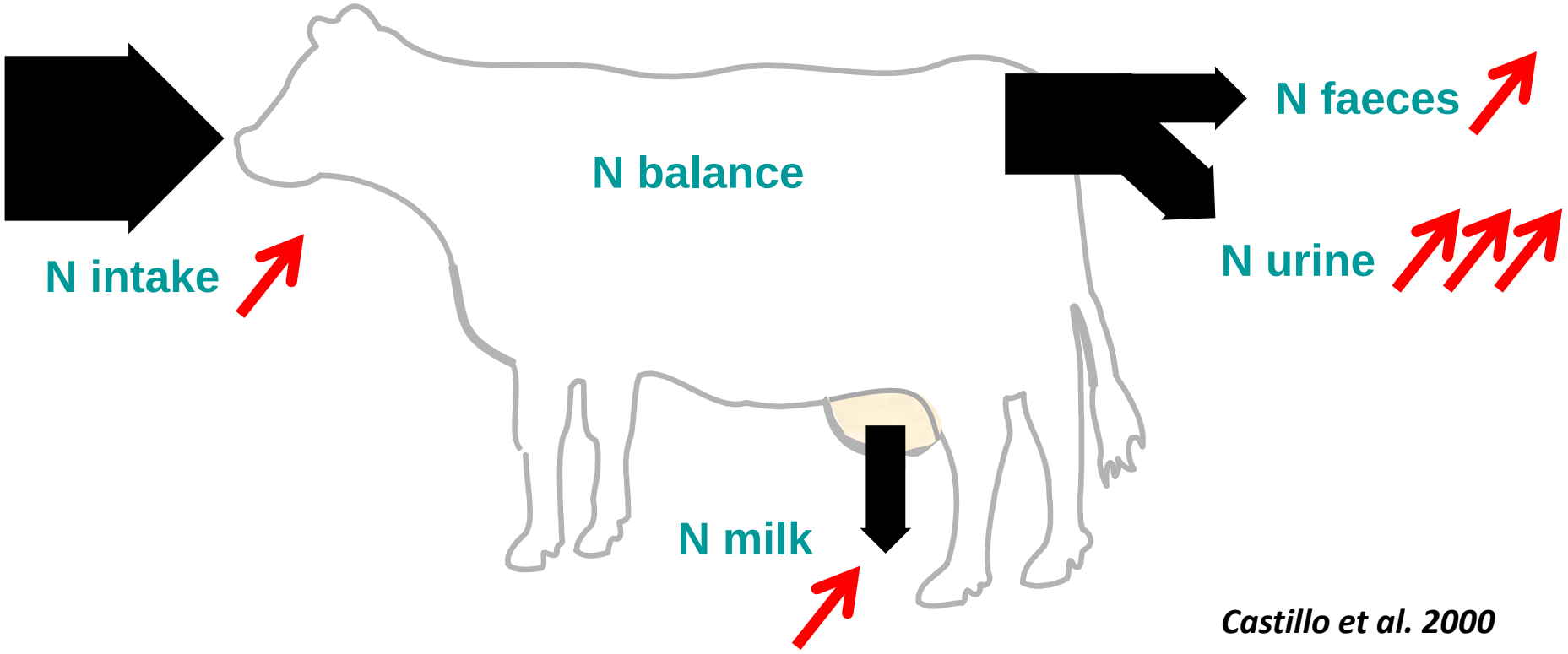
Main drivers of N flows are well known

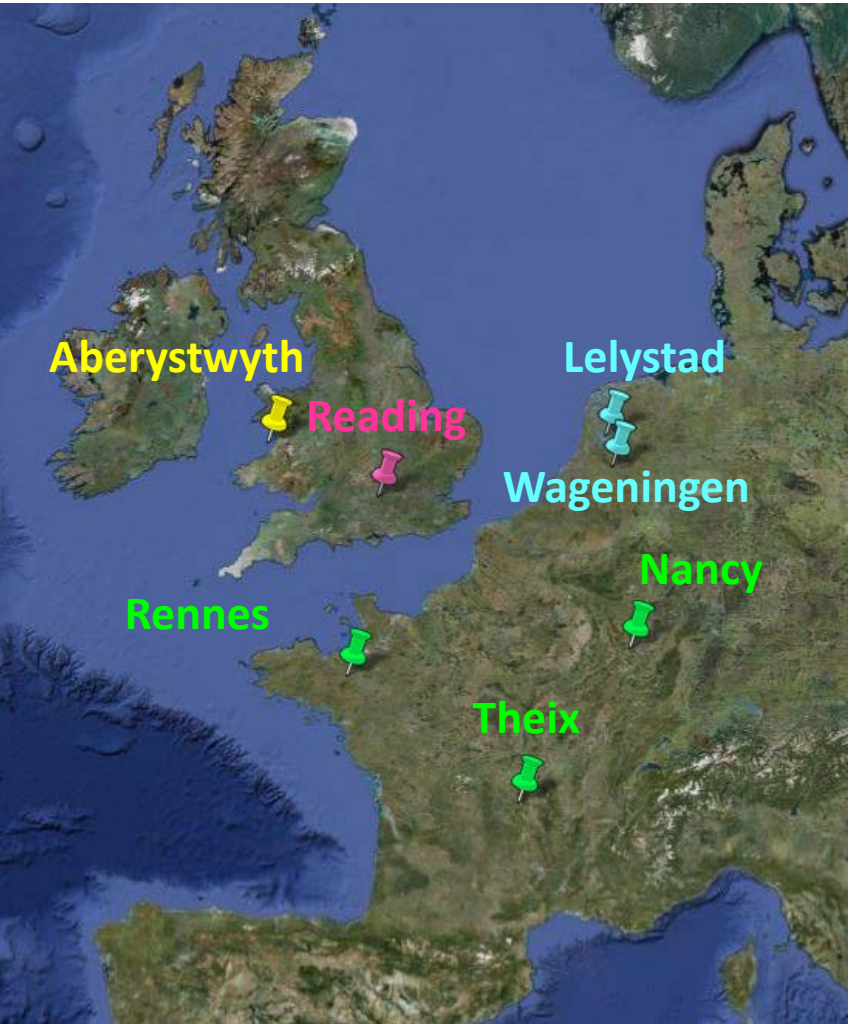


Castillo et al. 2000

But how much are these increases sensitive to the underlying diet type ?

A large data set across 7 teams with various diet types

109 trials, 511 cows, 1737 complete N balances (intake, faeces, urine, milk)



→ 1151 with known diet type

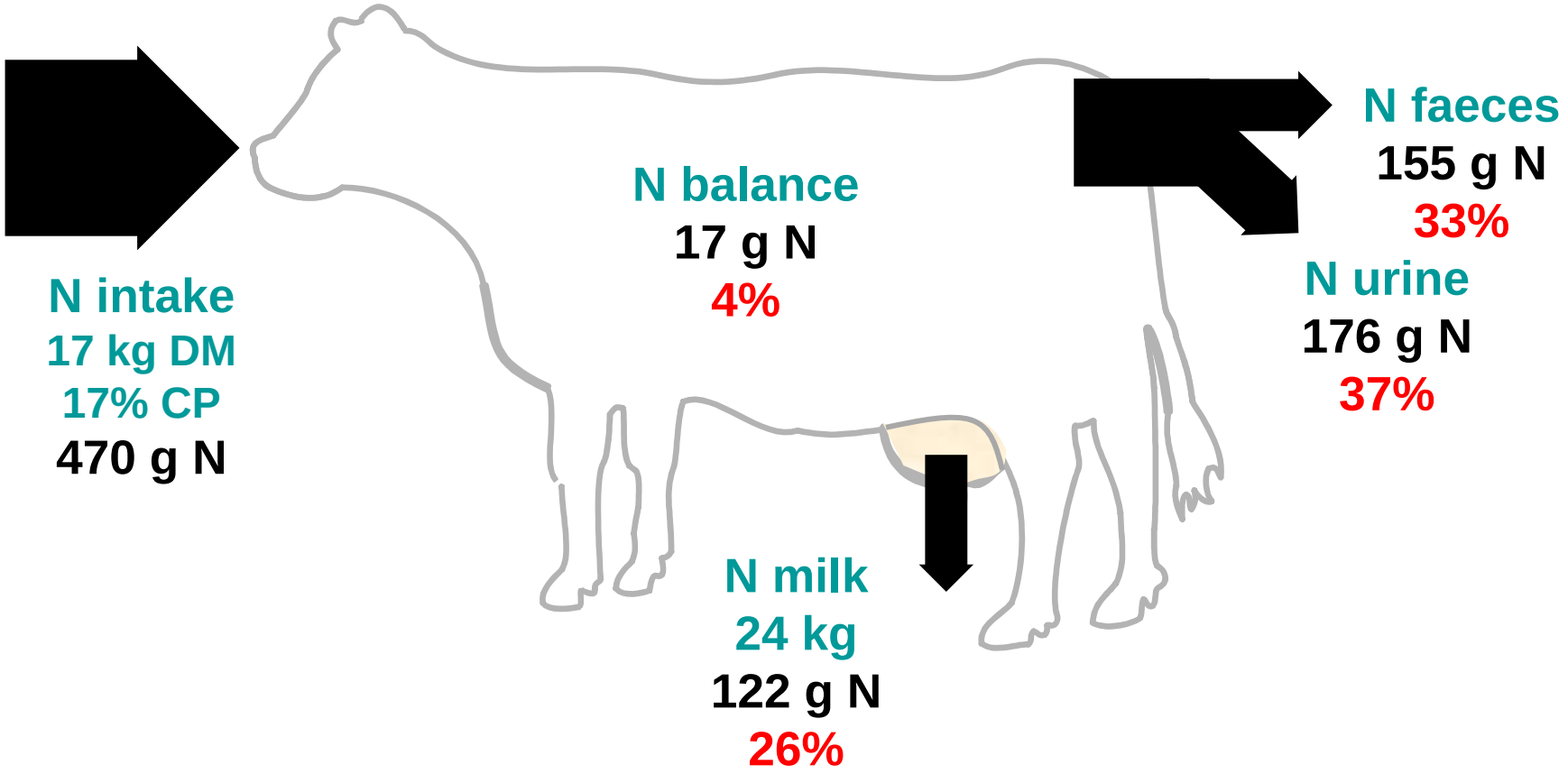
G	fresh grass	n = 206
GS	grass silage	n = 298
MS	maize silage	n = 319

... others

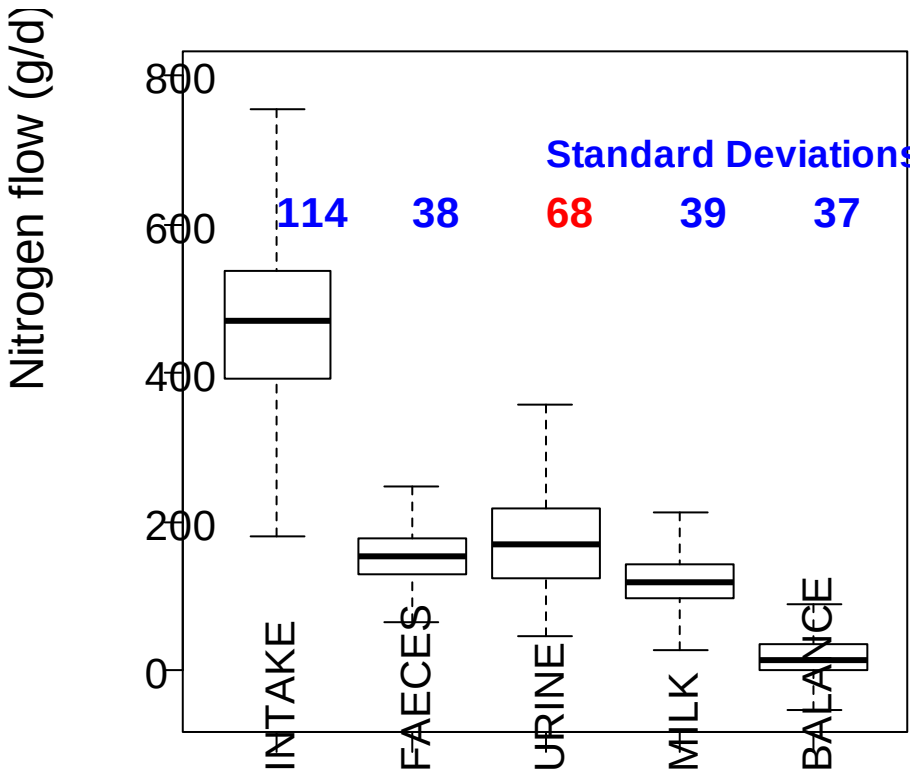
→ 701 with known diet composition

% of each type of feed
degradable CP content
...

Average daily N flows were consistent with previous studies

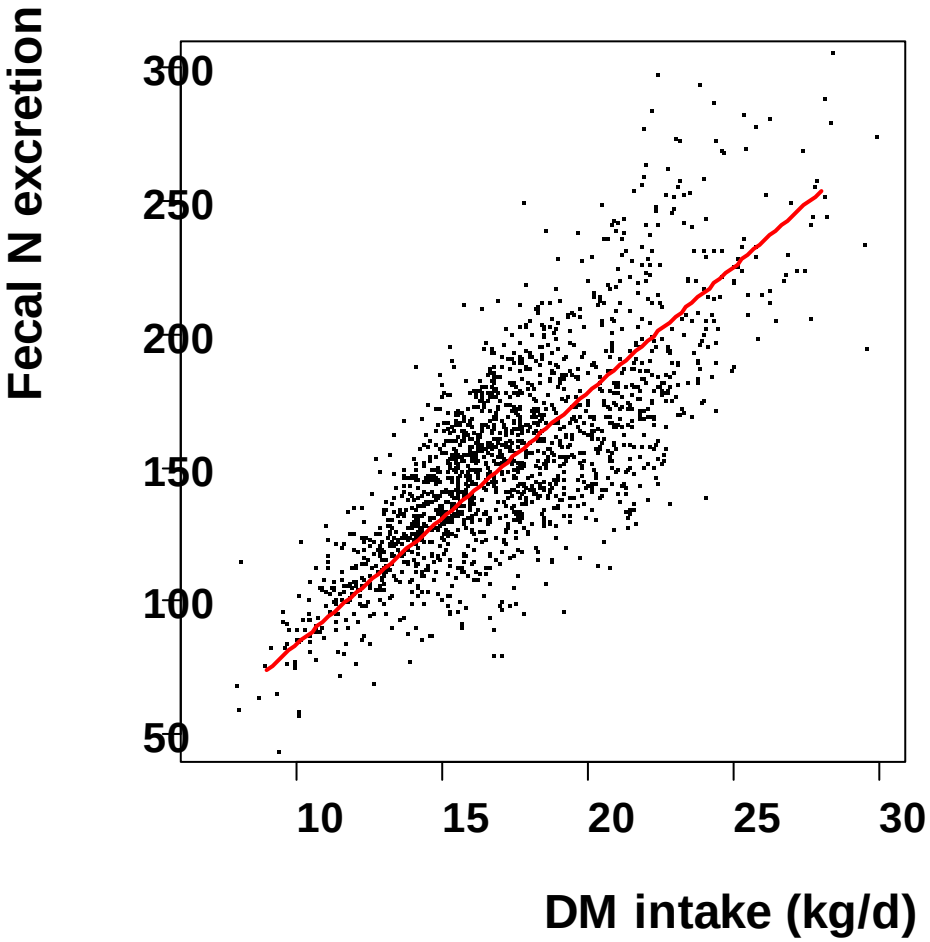


A large variability



Urine N excretion has a twice greater variability, urine N can represent from 20 to 55% of N intake

The faecal N excretion mainly depends on DM intake



+ 9 gN / kg DMI
(corrected for team effect)
partial R^2_{DMI} = 52%
n = 1737

in the average of reported values +7 to +10 gN / kg DMI

Peyraud et al. 1995, Spek et al. 2013,

Huhtanen et al. 2008

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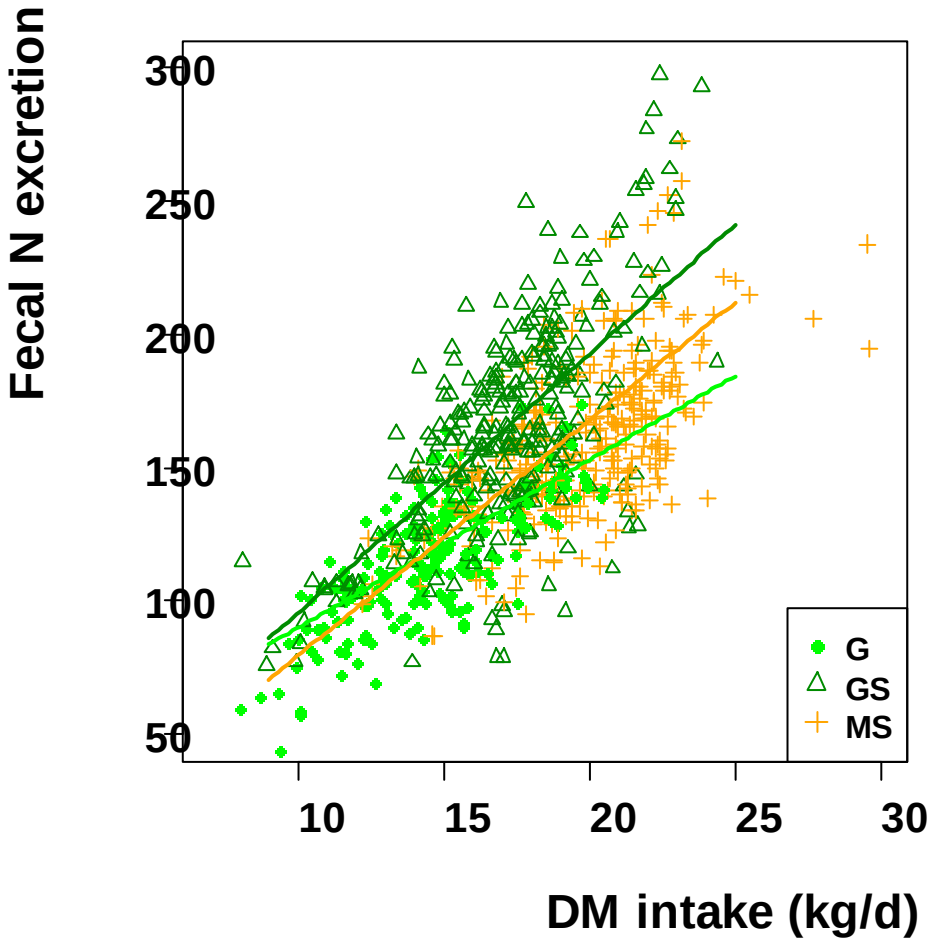
The faecal N excretion also depends on the type of diet



Diet x DMI interaction ***

G + 6 gN / kg DMI

GS + 10

MS + 9

(corr. for team effect, n = 823)

also included more concentrate

The faecal N excretion depends on DMI of main diet components

The DMI effect can be expressed as the sum of each feed DMI effect

Faecal N (g/d) = -8

+ 8 x DMI of fresh grass

Huhtanen et al. 2008 ← + 11 x DMI of grass silage → *Peyraud et al. 1995*

+ 8 x DMI of maize silage

+ 12 x DMI of dehydrated grass or lucerne

+ 3 x DMI of straw

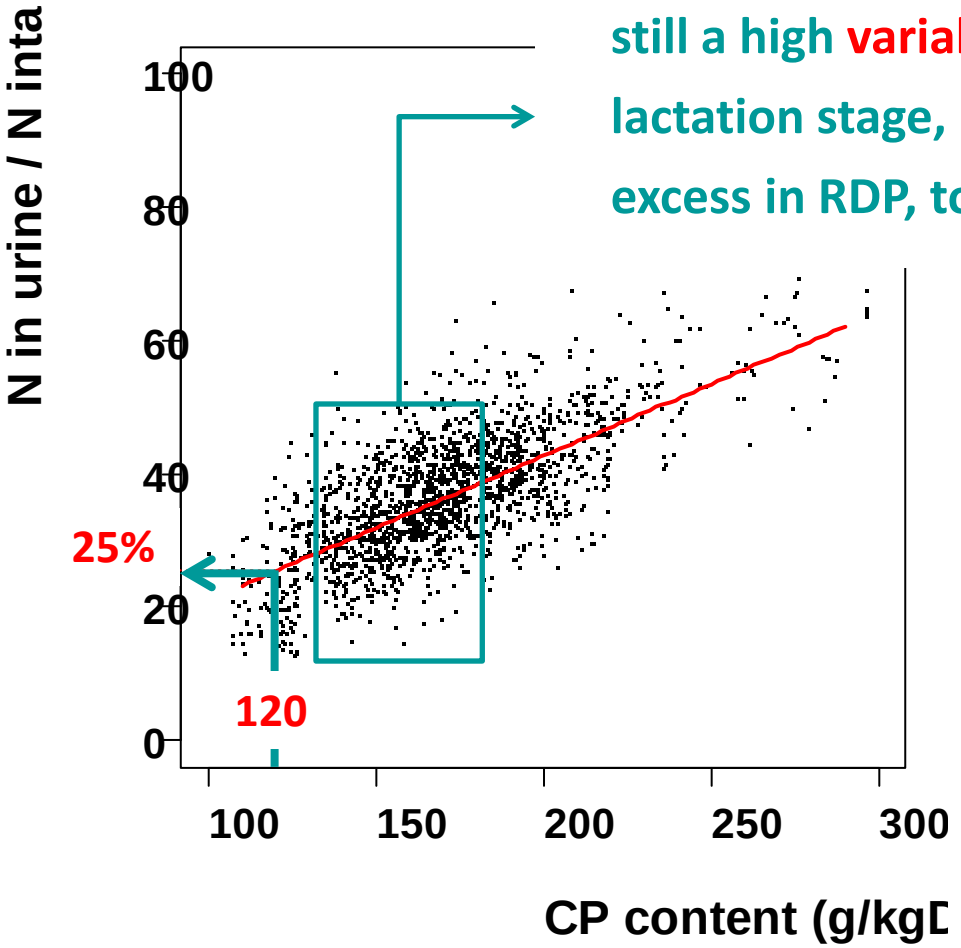
+ 10 x DMI of other forages

+ 9 x DMI of concentrates

with DMI in kg/d

(corrected for team effect, n=1118, R^2= 75%, r.s.e. = 19)

The urine N excretion mainly depends on feed CP content



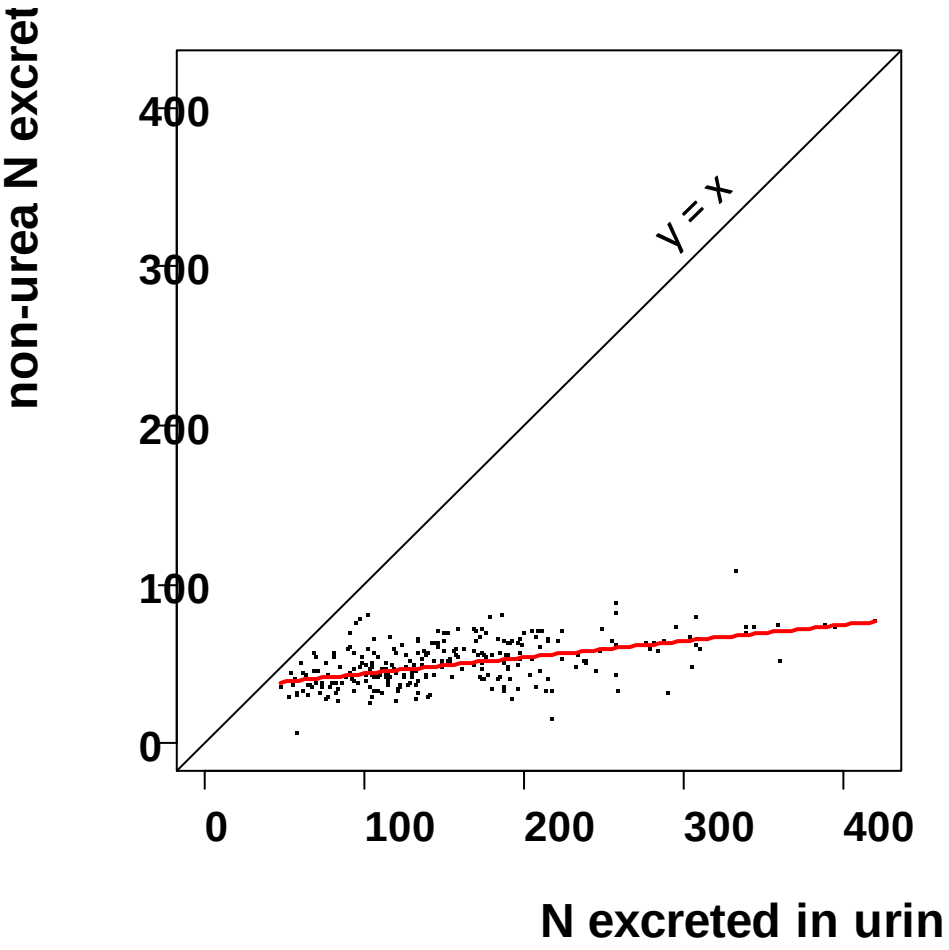
still a high **variability** influenced by:

lactation stage, milk yield

excess in RDP, too high MP / ME ratio

+ 2 % per +10 g CP content
(corrected for team effect)
partial R^2_{CP} = 43%
n = 1737

Urine N composition also matters



non-urea N fraction (purine deriv., hippuric acid, creatine, creatinine) **has a slower decomposition rate than urea and will less contribute to gaseous losses**

reviewed by Dijkstra et al. 2013

non-urea N slightly increases with total urinary N excretion

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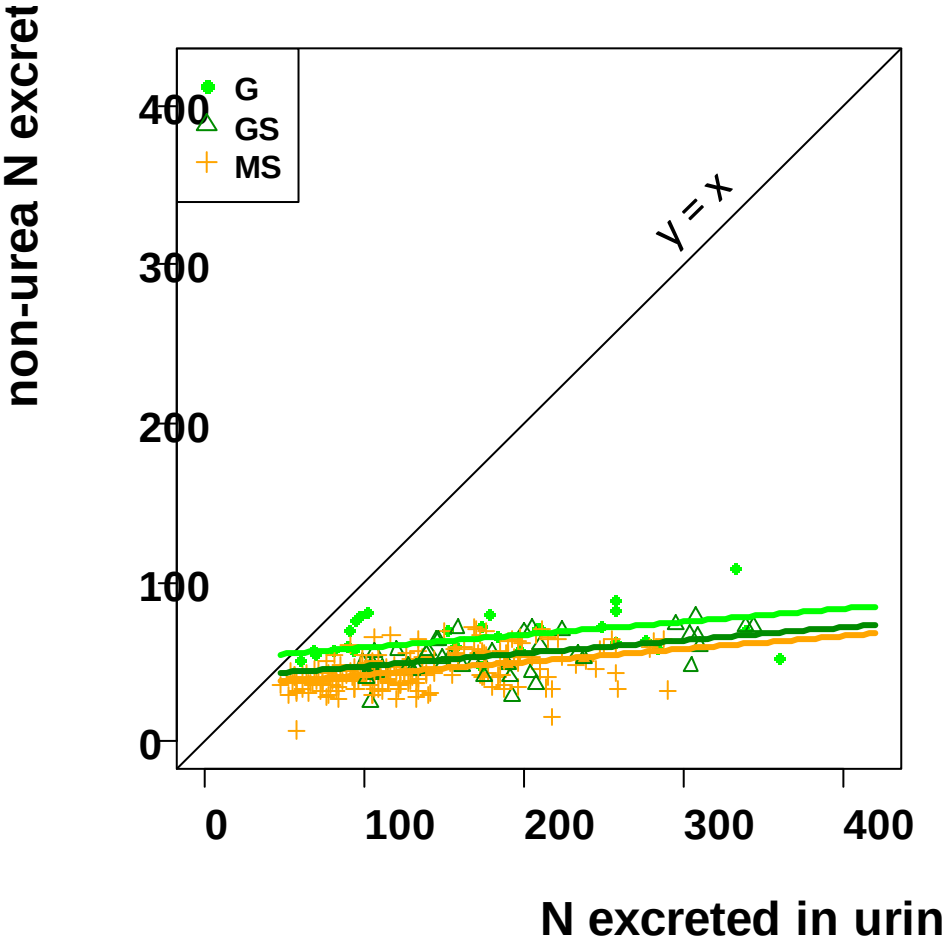
Urine N composition also matters



non-urea N depends on diet type and is higher for fresh grass diets

G adj. mean 63 g non-urea N / day
GS adj. mean 52
MS adj. mean 46

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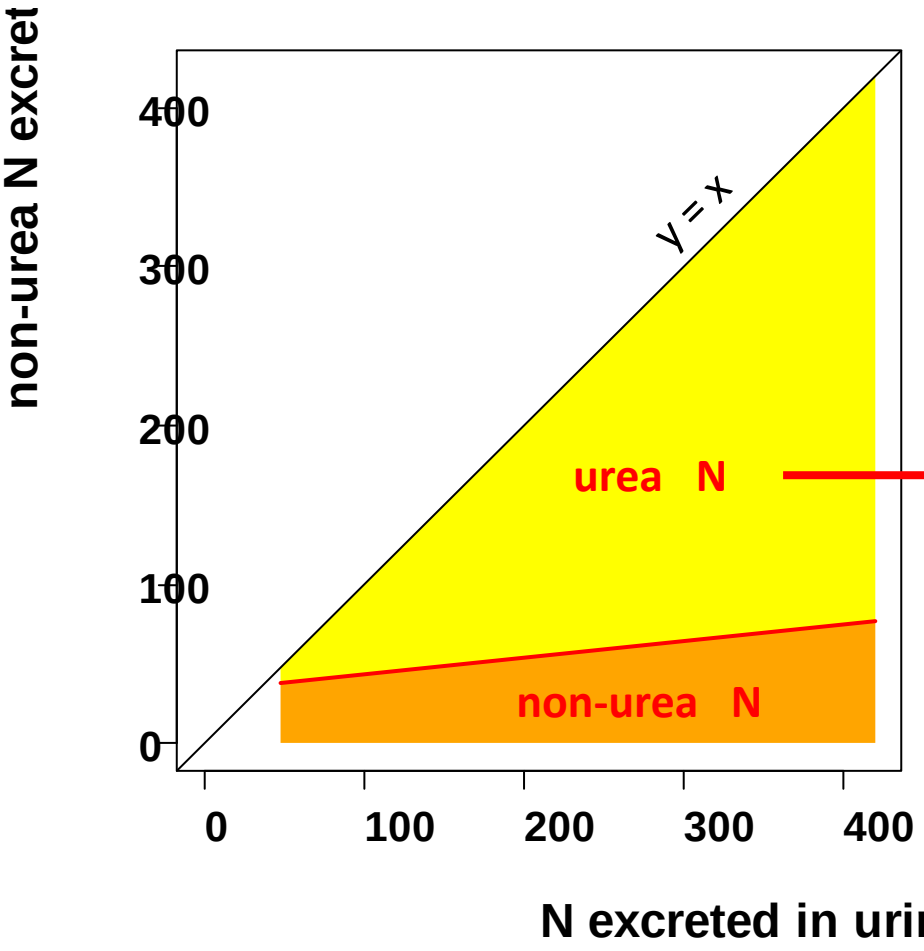
Urine N composition also matters



urea N can represent from 15% to 90% of total urinary N

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Is it worth to complicate?

- classical relationships held *Castillo et al. 2000, Spek et al. 2013*
- the faecal N on DM intake ratio depends on diet type
- the urine N composition differs across diet types
- further work is required to investigate the consequences of diet type on the various N fractions both in urine and in faeces, and thus to predict the consequences on decomposition rates

Never forget the scale and time !

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Acknowledgements

to all the people who shared their data for this collective work

AND to all the people who « help data to survive »,
by filling in and managing databases,
by keeping floppy disks, lotus files, old reports and paper sheets...

ROBUST HARD DISK DRIVE

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This presentation has been carried out with financial support from the Commission of the European Communities, FP7, KBB-2007-1.

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It does not necessarily reflect its view and in no way anticipates the Commission's future policy in this area.

SEVENTH FRAMEWORK PROGRAMME

Innovative and practical management approaches to reduce nitrogen excretion by ruminants