Characterization of grazing Holstein-Friesian dairy cows based on a combination of nitrogen use efficiency and nitrogen balance

Elia Tavernier
donagh.berry@teagasc.ie
Supervisor : Donagh Berry and Claire Gormley

A World Leading SFI Research Centre

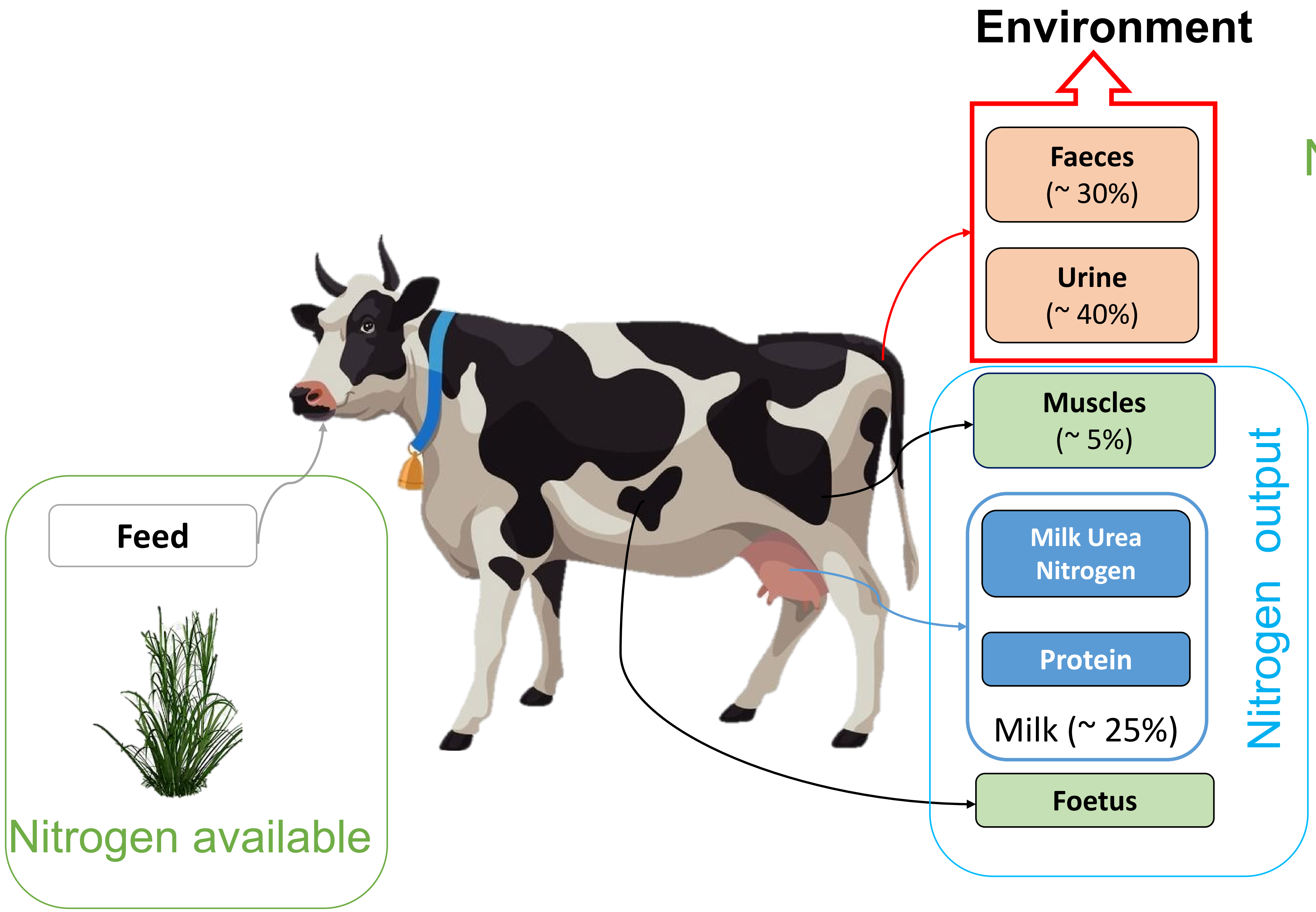
HOST INSTITUTION

PARTNER INSTITUTIONS

FUNDED BY:

Nitrogen in Ireland

Materials and methods



Nitrogen available = Nitrogen output + e

error
urine
faeces

Nitrogen balance = Nitrogen available - Nitrogen output

$$\text{Nitrogen Use Efficiency} = \frac{\text{Nitrogen output}}{\text{Nitrogen available}}$$

Materials and methods

Grass

Feed supplementation (concentrate)

Nmob or Nres = f(Energy balance) (INRAE,2018)

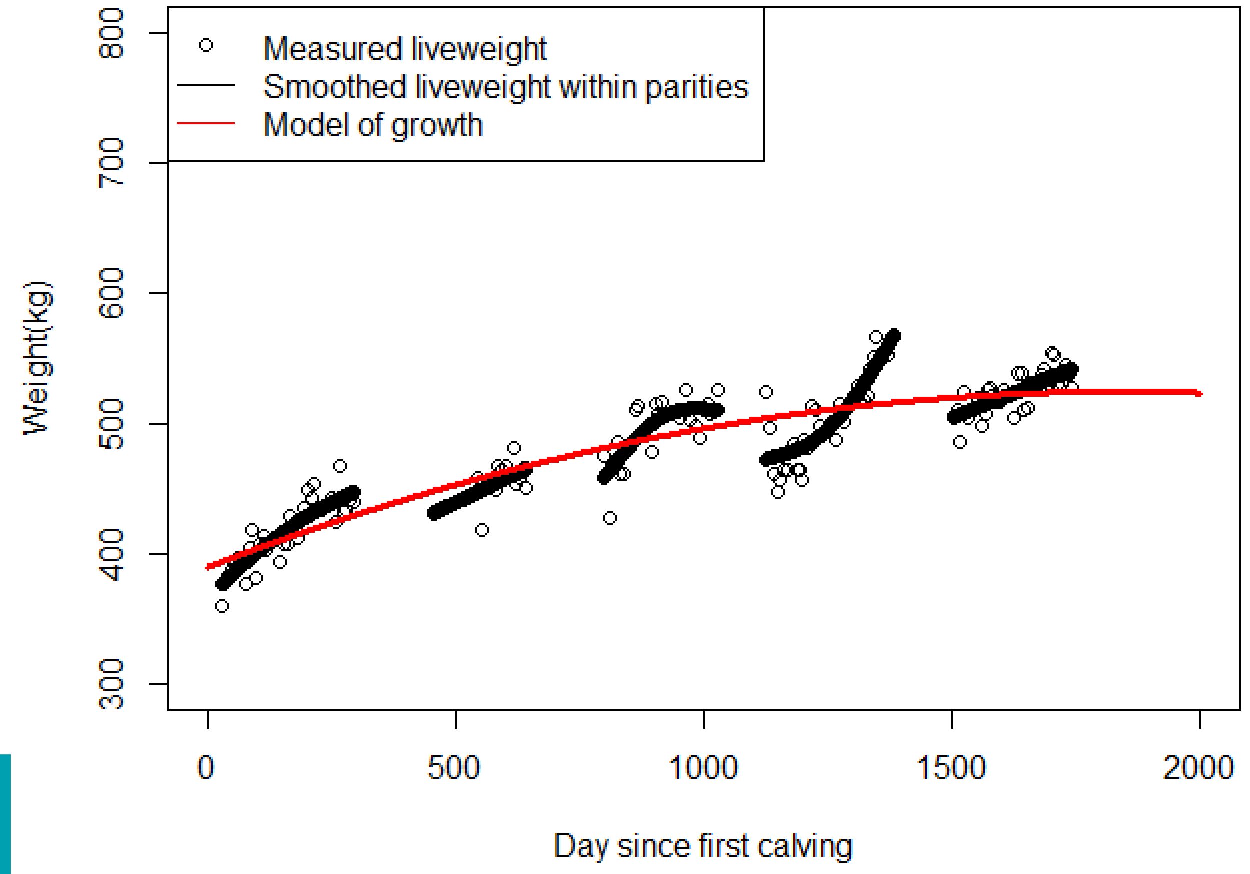
Nitrogen Balance = Nitrogen in food + Nitrogen mobilised - (Nitrogen in milk+ Nitrogen in Foetus + Nitrogen in Growth + Nitrogen in reserve)

Ngrowth = Nmuscles x f(days after the first calving)

Protein
Urea

Nfoetus = f (days of gestation, calf weight at birth) (INRAE,2018)

Evolution of a random cow's liveweight throughout its lifespan



Data set

Data :

- Holstein Friesian
- 1 measure in 1 and 1 measure in 2 or more parity

$$\text{Nitrogen Use Efficiency} = \frac{\text{Nitrogen output}}{\text{Nitrogen available}}$$

$$\text{Nitrogen balance} = \text{Nitrogen available} - \text{Nitrogen output}$$

1,472 nitrogen efficiency phenotypes computed

Problematic

$NUE = \frac{N_{out}}{N_{available}}$

$Nbal = N_{available} - N_{out}$

Correlation between nitrogen efficiency and excretion is between **-0.45 to -0.40**

Correlation between NUE and Nbal = -0.46

→ standard deviation of Nbal conditional on NUE = 86 g

Model to compute individual nitrogen utilization metrics

$$Y_{ijkl} = \mu + Het + Rec + Stage_j \,|\, Parity_k + animal_i + Parity_k(animal_i) + CG_l + e_{ijkl},$$

Fixed effect

Het : Heterosis of the cow i

Rec : Recombination loss of the cow i

$Stage_j | Parity_k$: stage j (1 to 9) and parity k (1,2+) and their interaction

Random effect

$animal_i$: the cow i

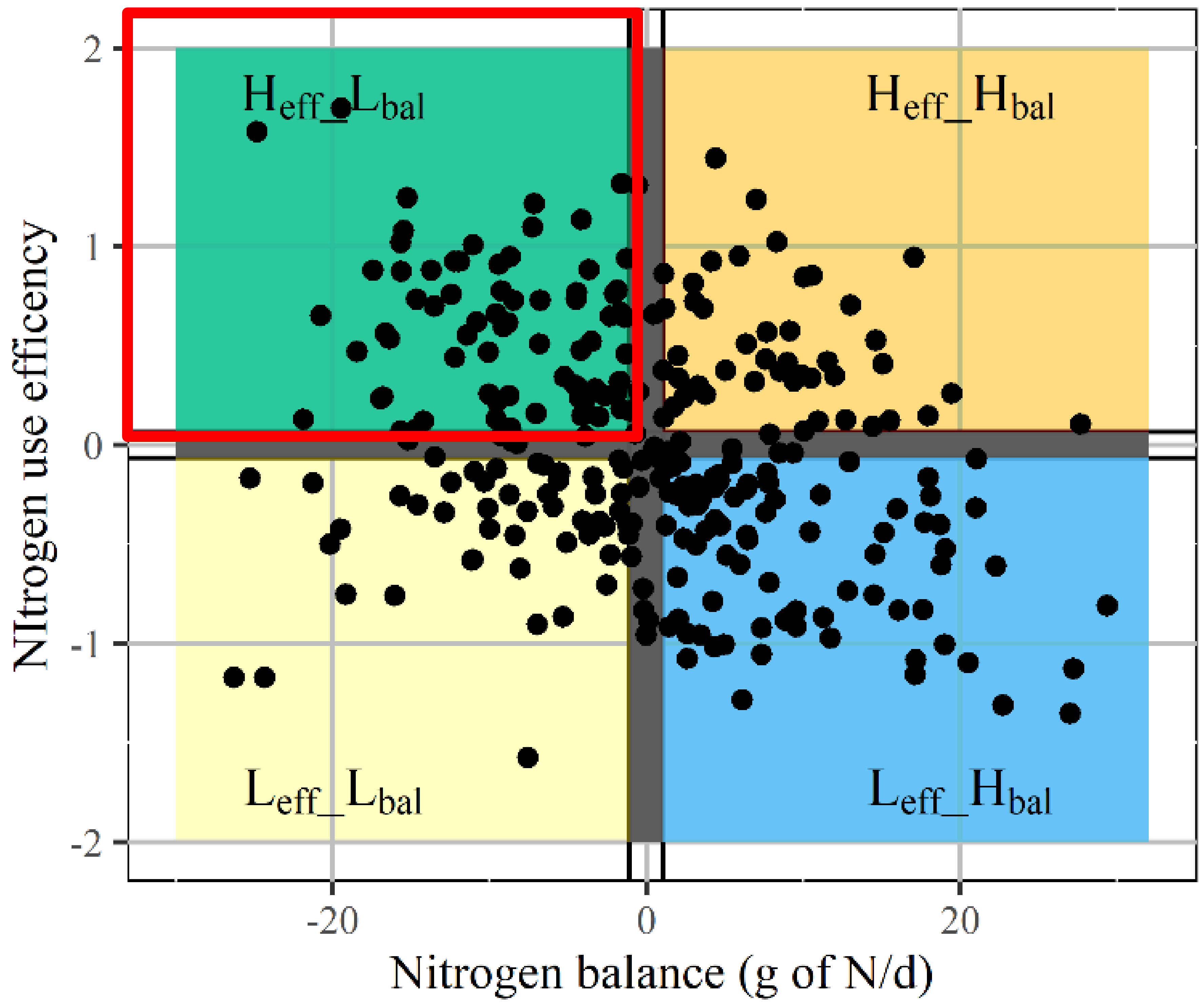
$Parity_k(animal_i)$: the parity k nested in the cows i

CG_l : the contemporary group l (treatment, date of sample)

Creation of nitrogen utilization strata

$$NUE = \frac{N_{out}}{N_{available}}$$

$$Nbal = N_{available} - N_{out}$$



248 cows left once categories are done

$H_{eff}\_H_{bal}$: cows with high NUE and high Nbal

$H_{eff}\_L_{bal}$: cows with high NUE and low Nbal

$L_{eff}\_H_{bal}$: cows with low NUE and high Nbal

$L_{eff}\_L_{bal}$: cows with low NUE and low Nbal

VistaMilk

Model for the comparison between strata

$$Y_{ijklmn} = \mu + Het + Rec + Stage_j \mid Parity_k + Stratum_l + Stratum_l \times Stage_j + Parity_k(animal_i) + CG_m + e_{ijklmn,}$$

Fixed effect

Het : Heterosis of the cow i

Rec : Recombination loss of the cow I

$Stage_j|Parity_k$: stage j (1 to 9) and parity k (1,2+) and their interaction

$Stratum_l$: Stratum l

$Stratum_l$ x $Stage_j$: Interaction of the stratum l and the stage of lactation j

Random effect

$Parity_k(animal_i)$: the parity k nested in the cows i

CG_m : the contemporary group l (treatment, date of sample)

Strata comparison

	$H_{eff}\_H_{bal}$	$H_{eff}\_L_{bal}$	$L_{eff}\_H_{bal}$	$L_{eff}\_L_{bal}$
Nbal (g/d)	419^{b} (12)	369^{a} (11)	420^{b} (11)	370^{a} (13)
NUE	22.2^{b} (0.56)	21.3^{b} (0.50)	18.8^{a} (0.49)	19.3^{a} (0.58)
Liveweight (kg)	490^{c} (6)	456^{a} (5)	478^{b} (5)	446^{a} (6)
Body condition score	2.82^{ab} (0.03)	2.79^{a} (0.02)	2.85^{b} (0.02)	2.85^{b} (0.03)
Total DMI (kg/d)	15.7^{c} (0.38)	13.6^{a} (0.34)	14.8^{b} (0.33)	13.2^{a} (0.39)
Energy balance (UFL/d)	-1.8^{a} (0.33)	-2.0^{a} (0.29)	-0.8^{b} (0.29)	-1.5^{ab} (0.35)
Milk yield (kg/d)	19.5^{c} (0.33)	17.0^{b} (0.30)	16.8^{b} (0.30)	15.1^{a} (0.34)
Milk urea N (mg/dl)	16.5^{ab} (0.42)	16.3^{a} (0.38)	17.0^{b} (0.37)	16.3^{a} (0.42)
Milk solids per kg of liveweight (g/kg)	2.76^{b} (0.05)	2.69^{b} (0.05)	2.57^{a} (0.05)	2.53^{a} (0.05)
Feed conversion ratio	9.41^{b} (0.29)	9.26^{b} (0.26)	8.33^{a} (0.25)	8.75^{ab} (0.30)

$$NUE = \frac{N_{out}}{N_{available}}$$

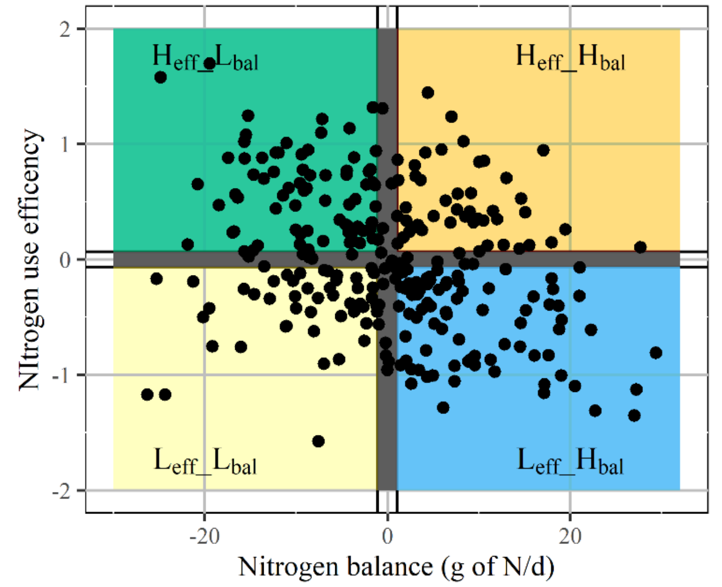
$$Nbal = N_{available} - N_{out}$$

$H_{eff}\_H_{bal}$: cows with high NUE and high Nbal

$H_{eff}\_L_{bal}$: cows with high NUE and low Nbal

$L_{eff}\_H_{bal}$: cows with low NUE and high Nbal

$L_{eff}\_L_{bal}$: cows with low NUE and low Nbal



Take away

$NUE = \frac{N_{out}}{N_{available}}$

$Nbal = N_{available} - N_{out}$

$H_{eff}\_L_{bal}$ = most nitrogen efficient cows

$H_{eff}\_L_{bal}$ **VS** $H_{eff}\_H_{bal}$

same NUE

50 g of nitrogen less per day

$H_{eff}\_H_{bal}$: cows with high NUE and high Nbal

$H_{eff}\_L_{bal}$: cows with high NUE and low Nbal

→ Lower energy balance and body condition score

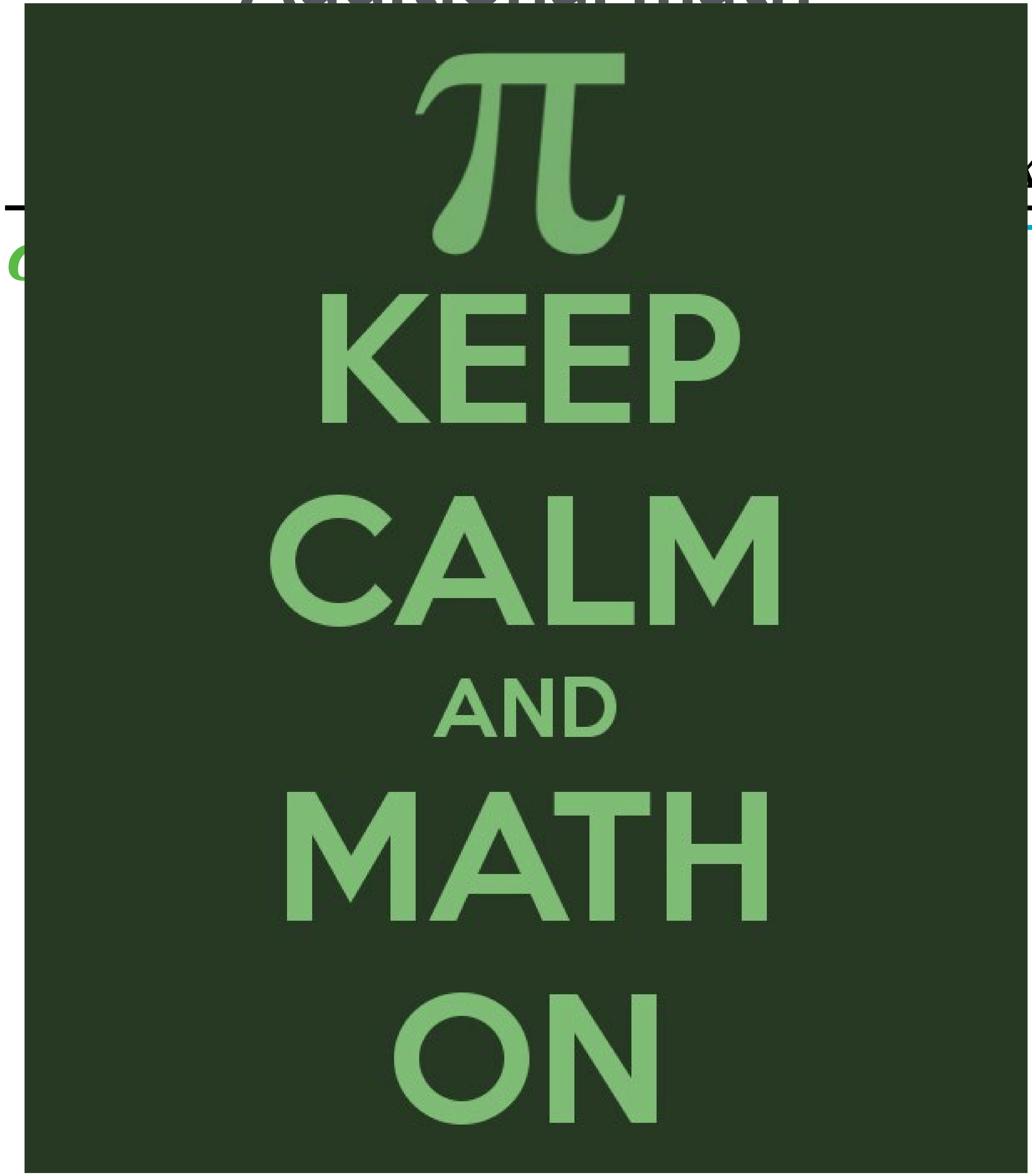
NUE at the exploitation level ?

Contact

e-mail : elia.dufosse@teagasc.ie

Additional math

$r_{X-Y,\frac{X}{Y}} = $ … $+ \sigma_Y c_Y)$ … c_Y



Additional math

Only by the fact they have the same component, they will be correlated

Additional math

$$r_{Nbal,NUE} = \frac{sd_{Nout}}{sd_{Nbal}} \times f\left(r_{Navail,Nout}, k, M\right)$$

sd_i= Standard deviation of I

$r_{i,j}$ = Correlation between i and j

$k = \frac{cv_{Navail}}{cv_{Nout}}$ = Comparison of the coefficient of variation of the components

$M = \frac{mean_{Navail}}{mean_{Nout}}$ = Comparison of the mean of the components