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Feeding Systems, Feeding strategies and the use of supplements

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Feeding Systems, Feeding strategy and supplements

S. Lemosquet

M.N. Haque - A. Boudon - J. Guinard Flament

(16th May 2013)



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Plane

- Context : Why improving N efficiency of utilization economy, protein autonomy, environment
- Introduction : Nitrogen balance in dairy cows (animal level)
- Concepts of feeding systems (Protein Part)
 - ex: PDI and AADI system
- Diet formulation
- Conclusions

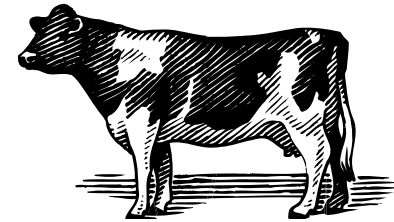
Efficiency of N use is an important stake for agricultural sector

N Loss

Economic



e.g. Protein cost

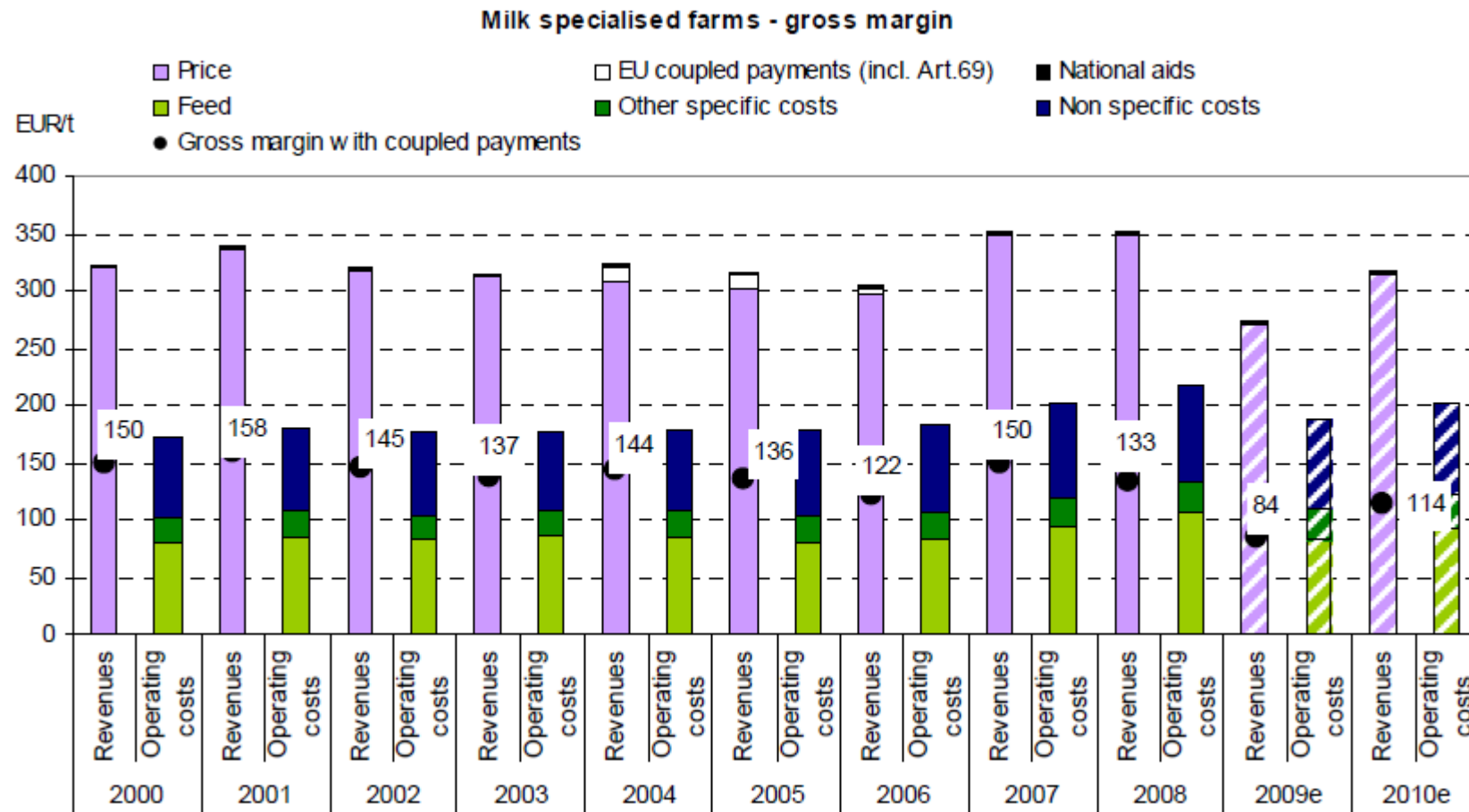


Animal Level

- In milk specialised farm of EU 27 (2000 – 2010)
 - Feeding cost representing = 50% of operating cost
 - Also in Roumania and Bulgaria (2008)
- EU imports a lot of Soybean Meal
 - 22 Millions of t. (2013) – 9 Millions produced
 - Roumania : 15% of Soybean seed in EU (EU: 1 million/t.)

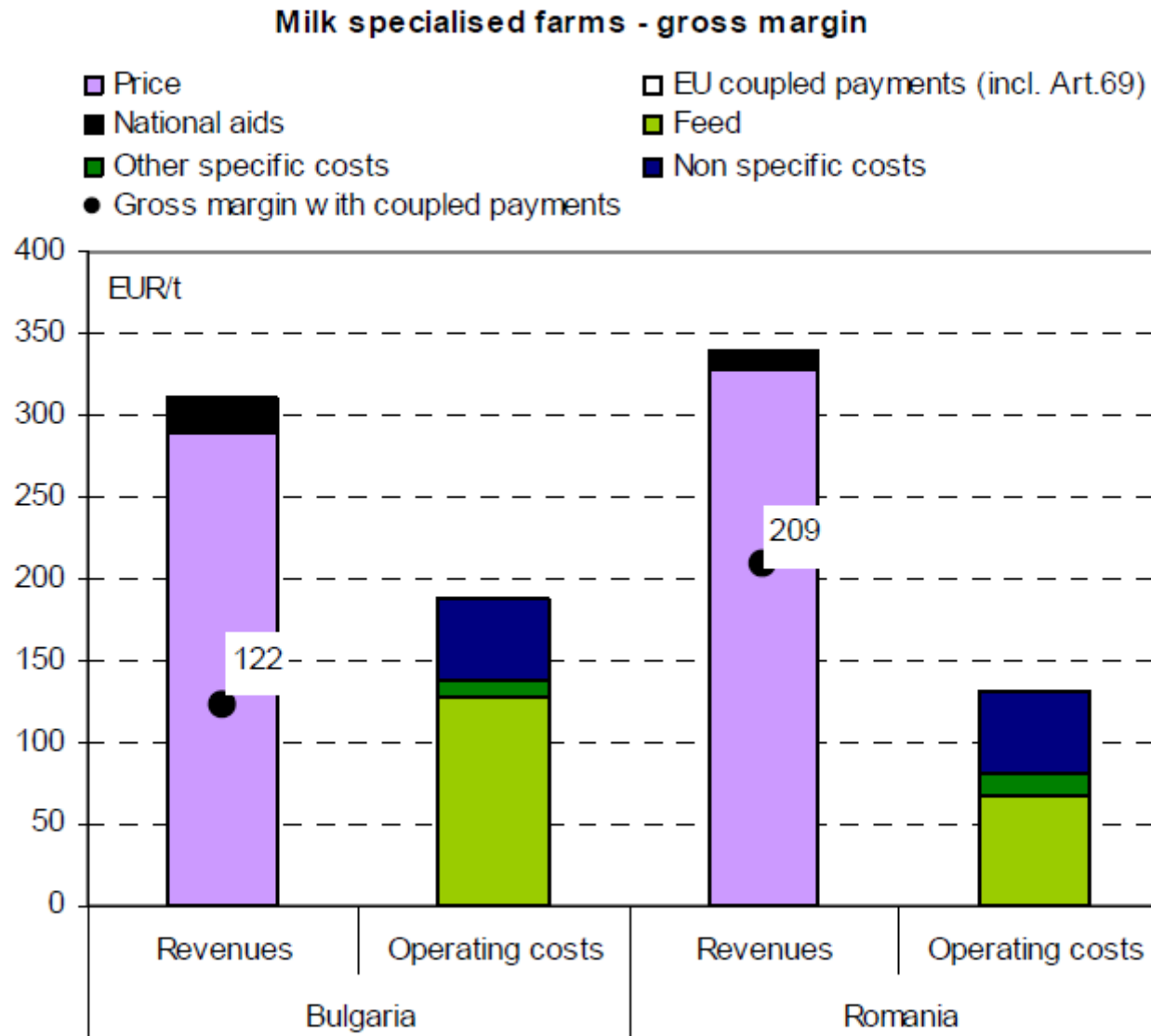
Context

In milk specialised farm of EU 27 feeding cost = a half of operating cost



EU Dairy Farm Report 2011 (based on FADN data)

Feeding cost = a half of operating cost

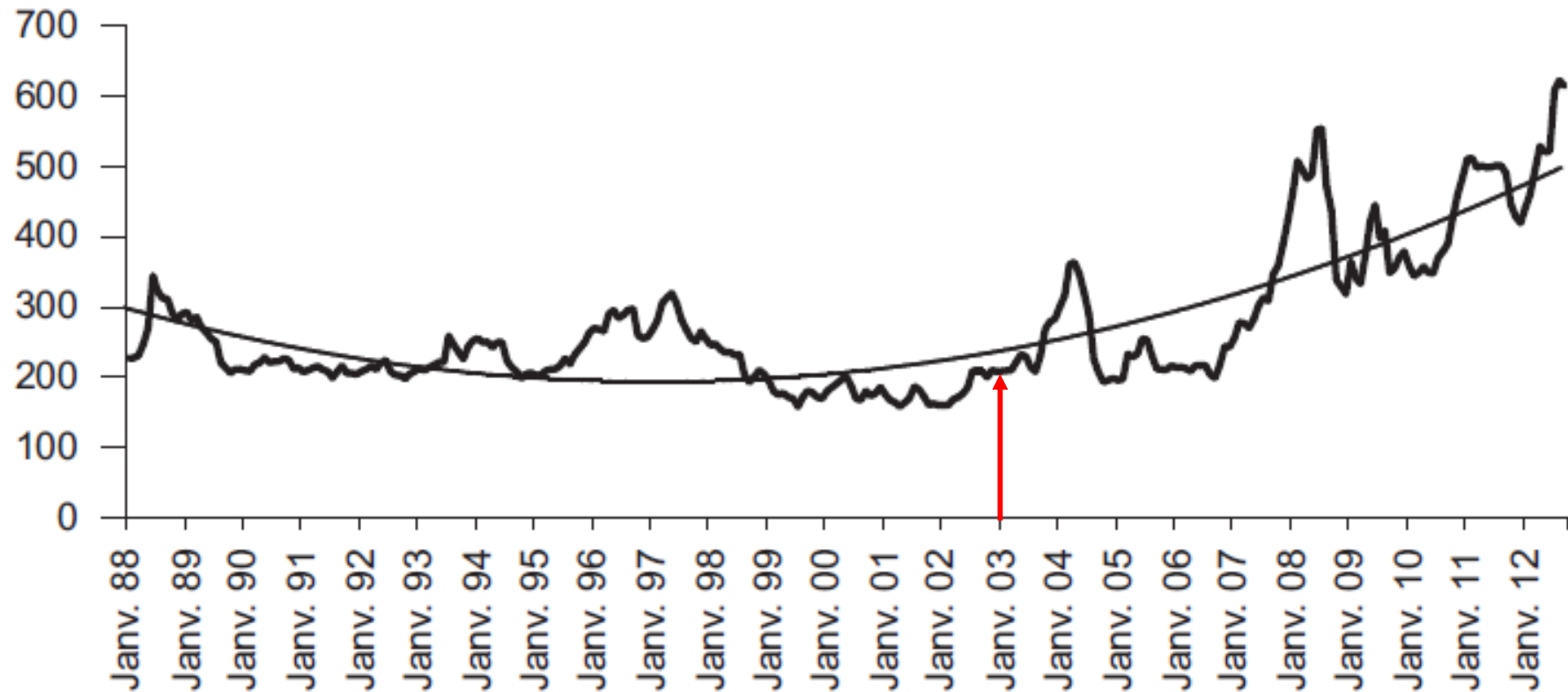


EU Dairy Farm Report 2011 (based on FADN data)

Context

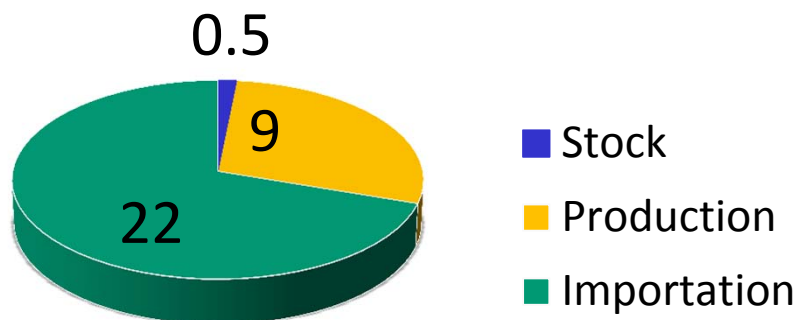
Increase in Soybean price until 2003

Soybean cost
At Chicago(\$/t)

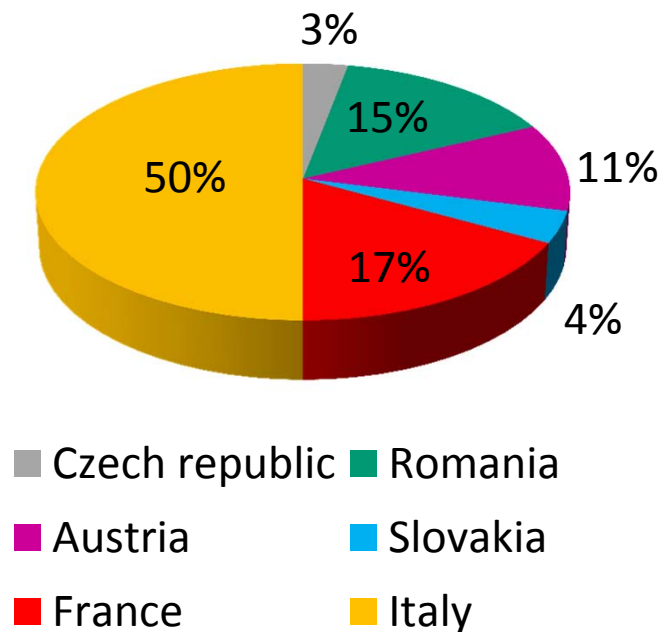


The EU highly dependent of soybean meal imports

EU Soybean Meal Forecast for 2013 in millions of tons

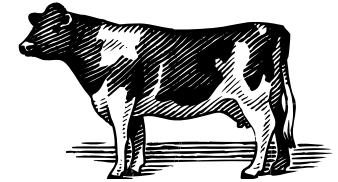
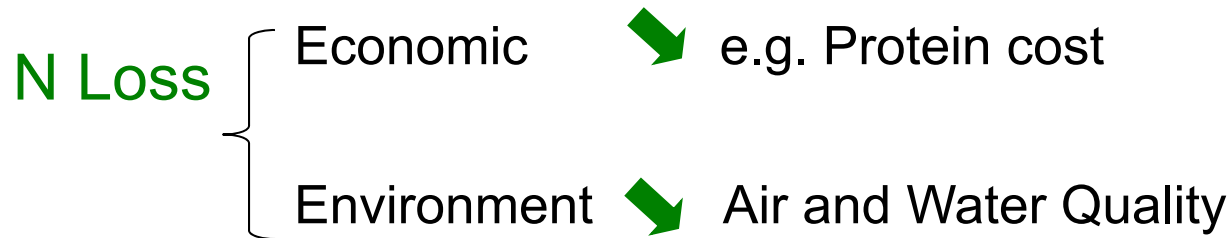


EU Soybean seed Productions (1 millions tons/year)



Context

Efficiency of N use is an important stake
for agricultural sector



Animal Level



Farm Level

Nitrogen Emission by Agriculture

Total “N” Emission due to Agriculture in France
1933 k ton/year (63% by Livestock Sector)

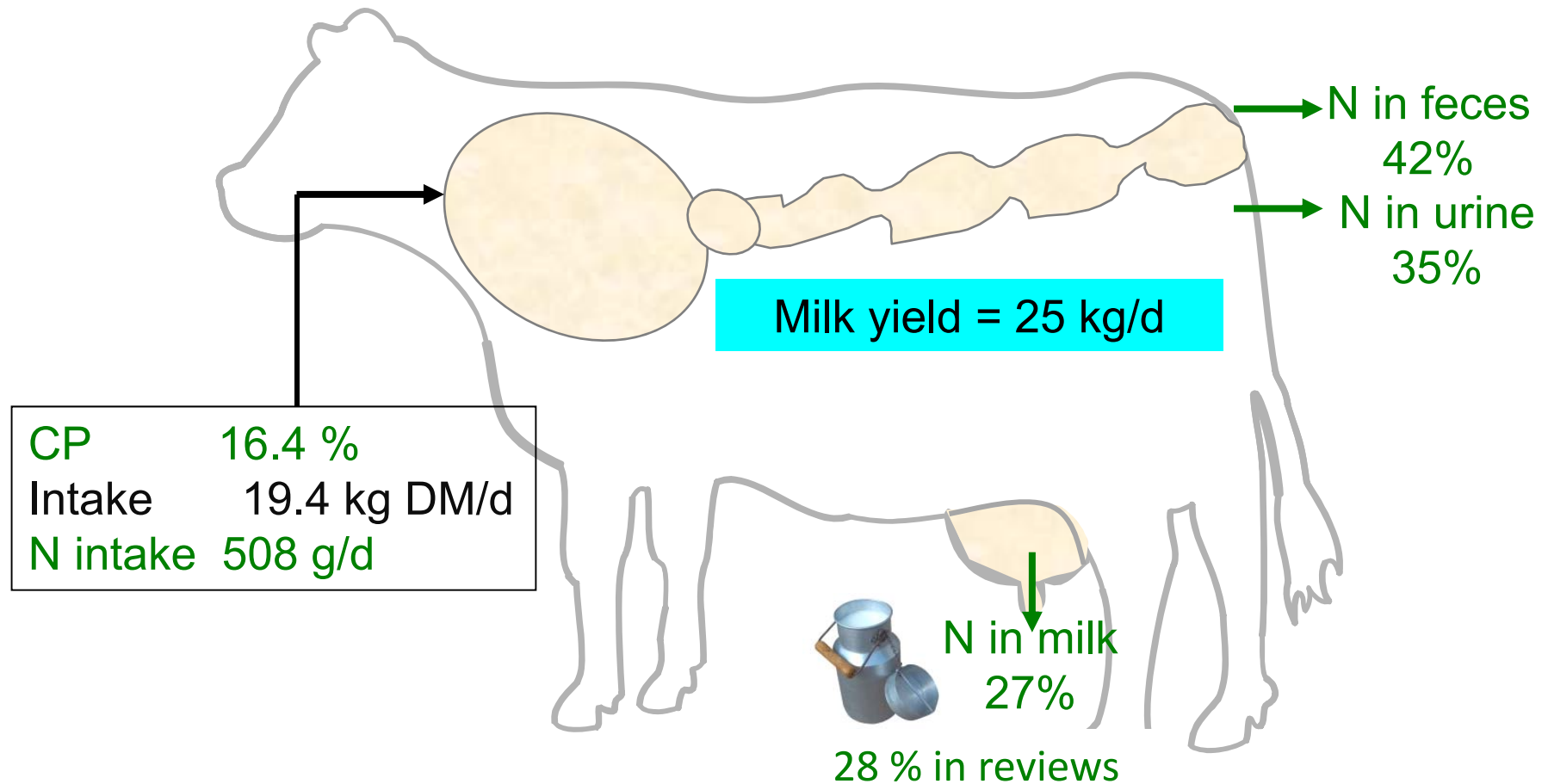


NH₃ Emission 31% of total N emission



Bovines 41% of NH₃ emission

Nitrogen Balance in Dairy Cows

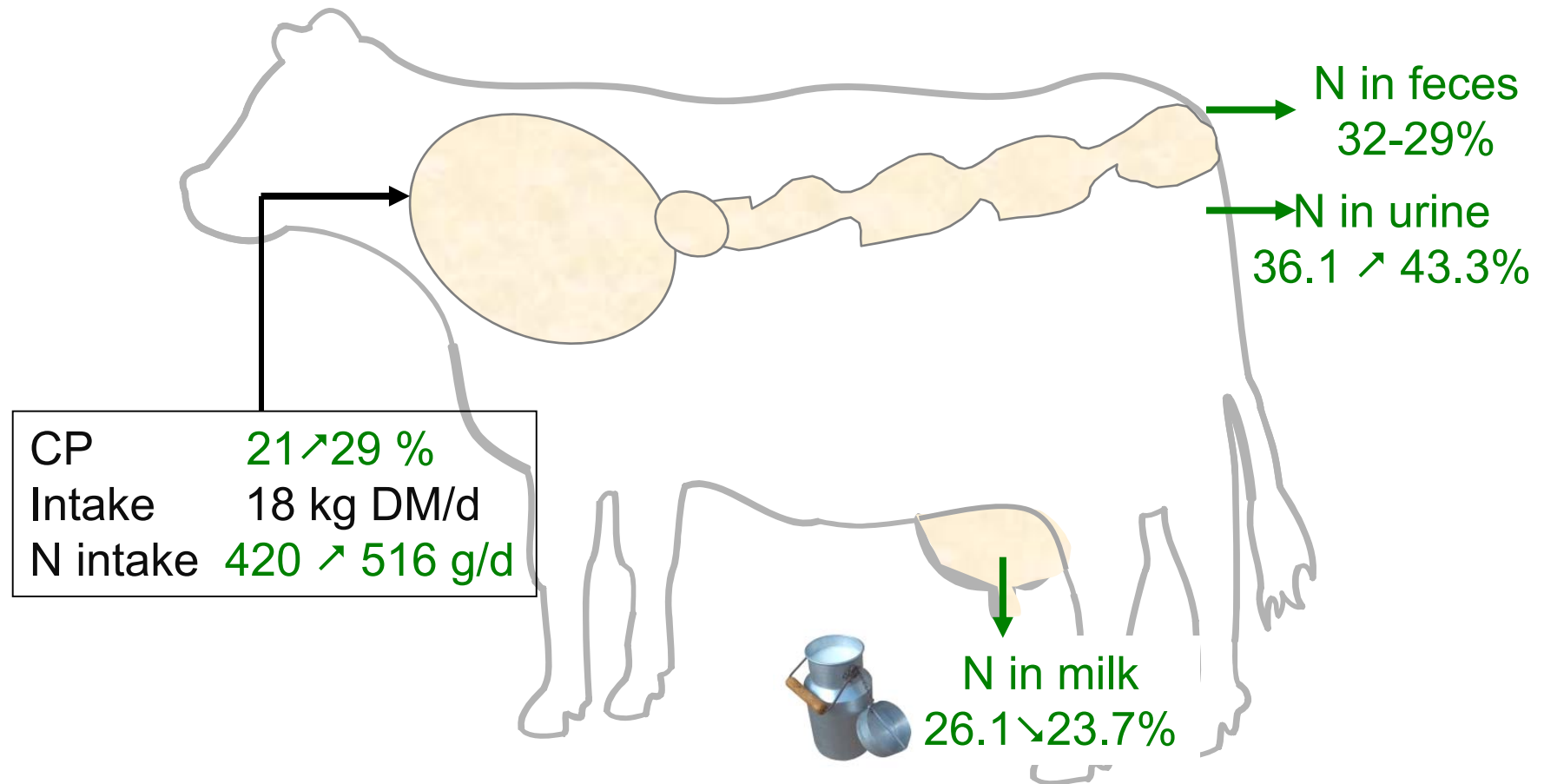


Bannink and Van Vuhren, 1999

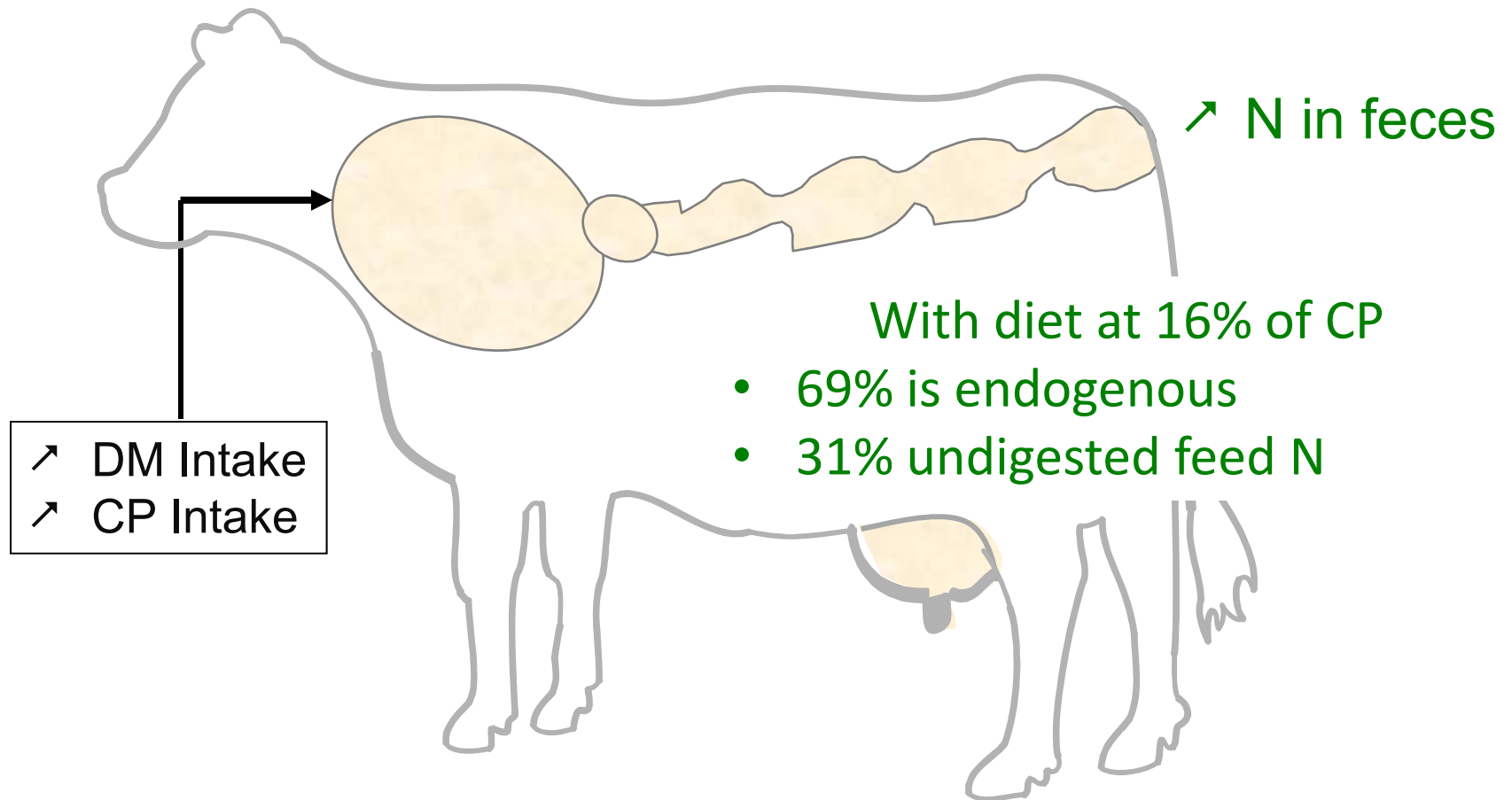
Hutanen et al., 2008 & 2009

Weiss et al., 2009

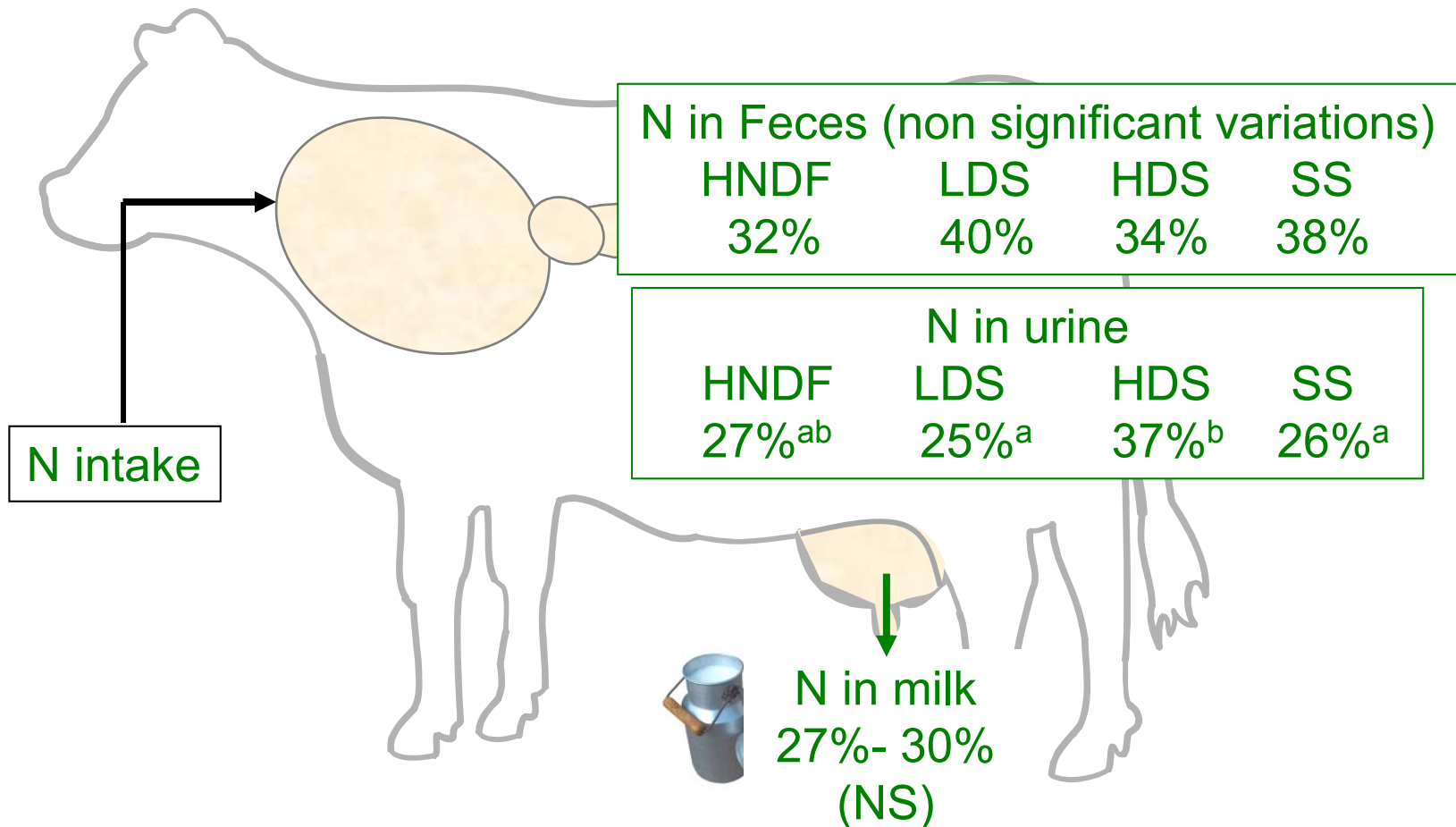
Nitrogen Balance variations at High CP



Nitrogen in feces: depends on DM and CP intakes

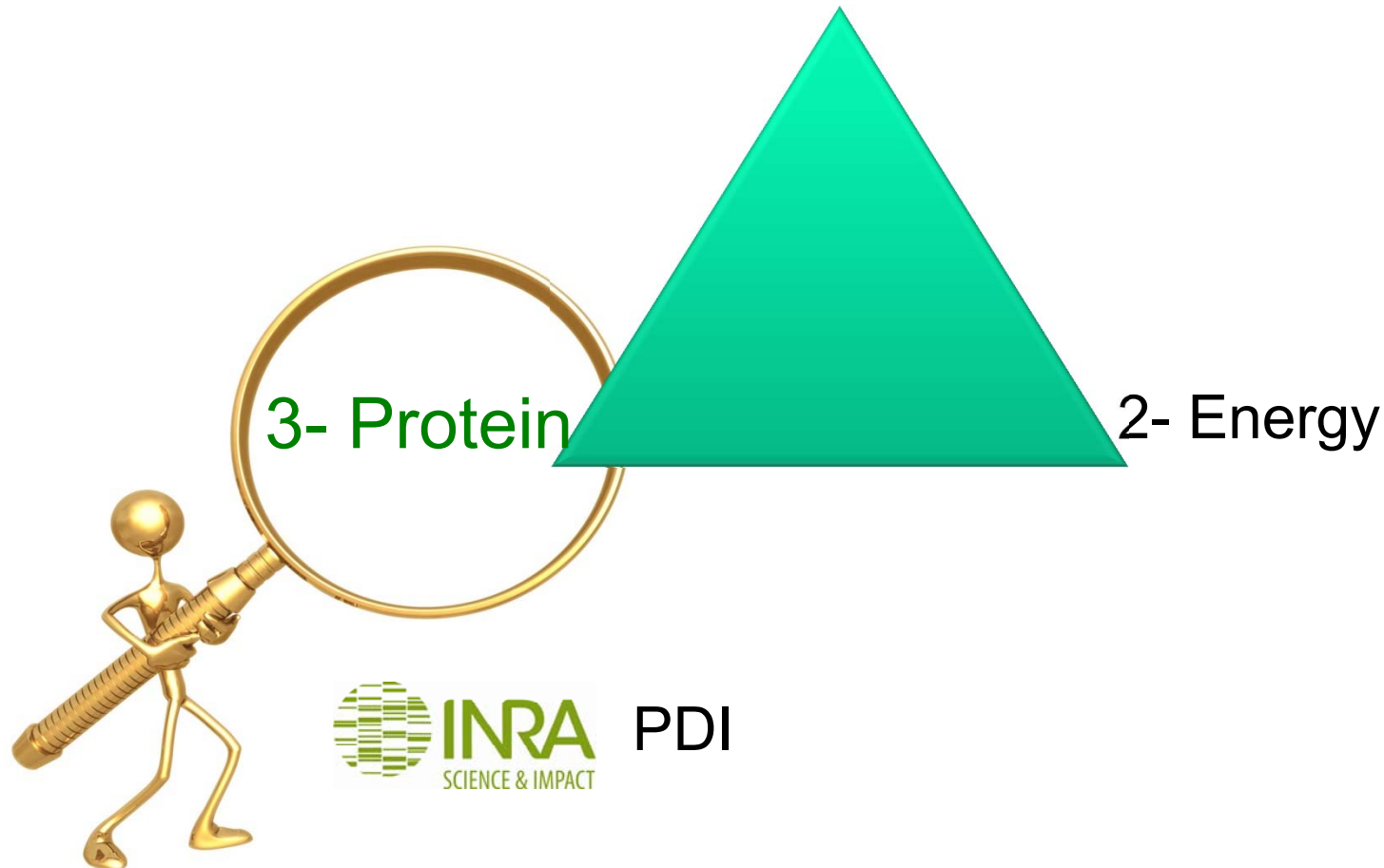


Nitrogen in urine and feces could vary with different energy supplements ?

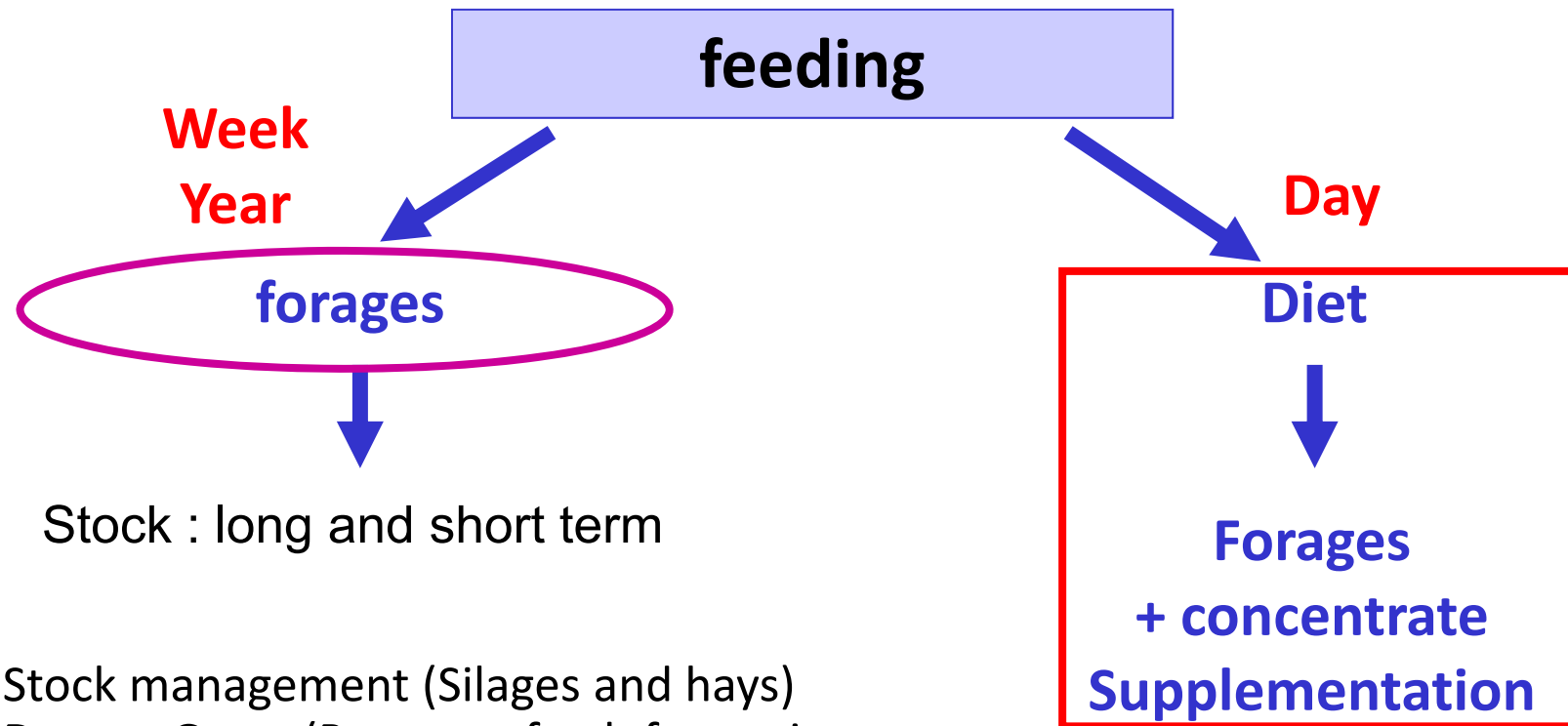


Basis of Feeding Systems

1- Intake (ad libitum)



Feeding strategy and plane in ruminants (forages +/- concentrates)



- Stock management (Silages and hays)
- Days to Graze (Pastures: fresh forage in the field):

→ depends on available surface, climates, environments
breeder choices



Protein evaluation systems

- PDI – INRA, France
- DVE – CVB, the Netherlands (1994 / 2010)
- FiM – UK
- NorFor – Scandinavia
- nXP – DLG Germany

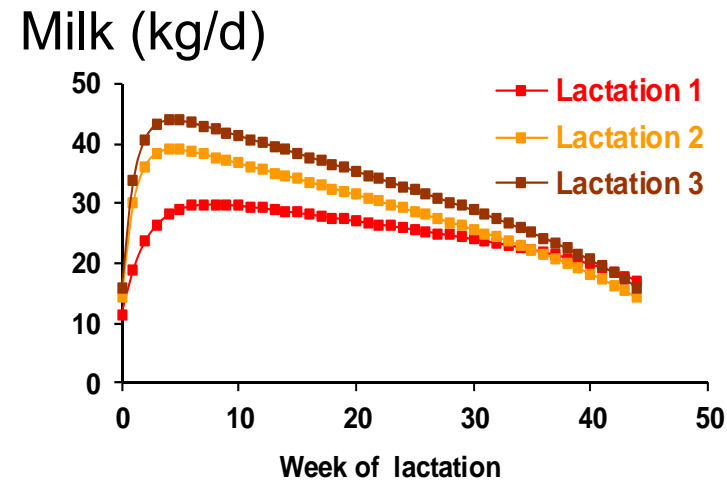
- NRC, USA
- CNCPS, USA
- CPM Dairy, USA



Van Vuhren, 2013

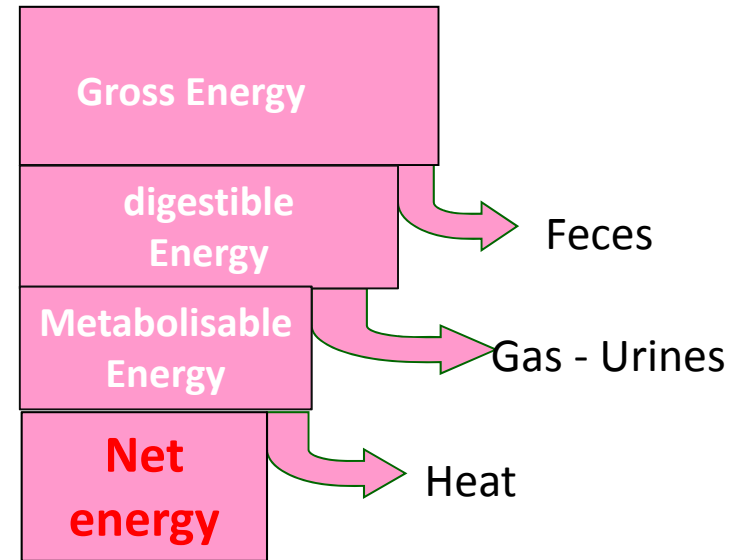
INRA 2007 Feed Intake : fill unit

- Cow : Intake capacity
 - Age
 - Physiological status
 - Milk potential
 - Body Condition Score



- Diet : Fill Unit (F.U. and in French U.E.L.)
 - For forages F.U. = 1 for a good forage ad libitum (fresh grass)
 - For concentrate : a substitution of concentrate for forages

INRA Net Energy



- **Cow Net Energy requirement**

- Energy retained or produced in milk
- In INRA - UFL: 1 UFL = 1.7 Mcal of NE_L
- Requirements for **maintenance**, **milk production** and **gestation**

$$[(0,041 \times BW^{0,75}) \times I_{act}] + (0,44 \times Milk_{4\%}) + (0,00072 \times BW_{veal} \times E^{0,116 \times weekG})$$

I_{act} = 1 hampered stall; 1.1 free in stall and 1.2 walking in pasture

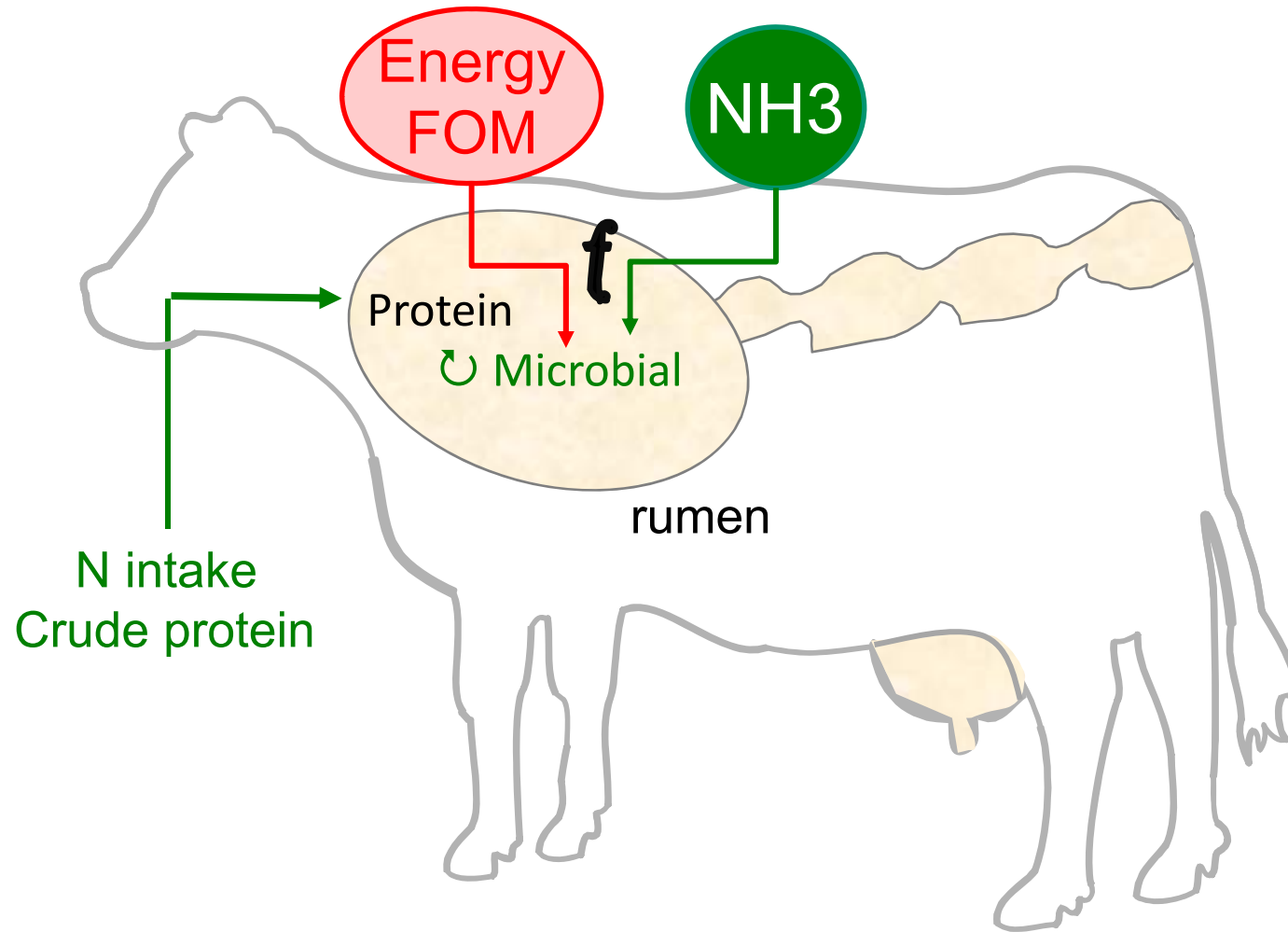
- **Diet Net Energy Supply : UFL diet = Σ UFL feed - E**

- Digestive interactions (in the rumen):

$$E = (0,00063 \times \%Concentrate^2) + (0,002 \times UFL_{ing}^2) - (0,017 \times UFL_{ing})$$

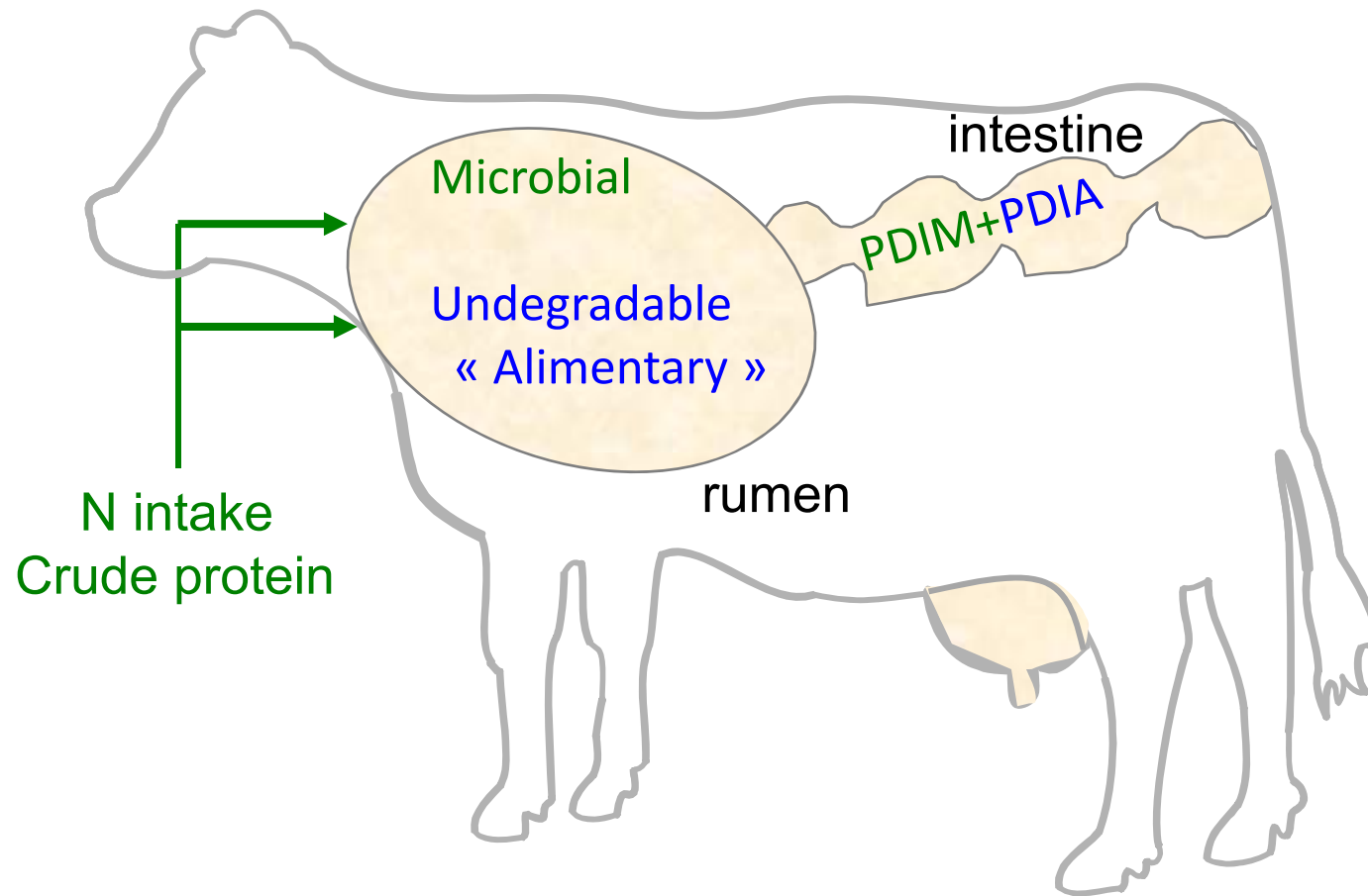
UFL_{ing} = Sum of UFL of Feed

Nitrogen Metabolism in Dairy Cows

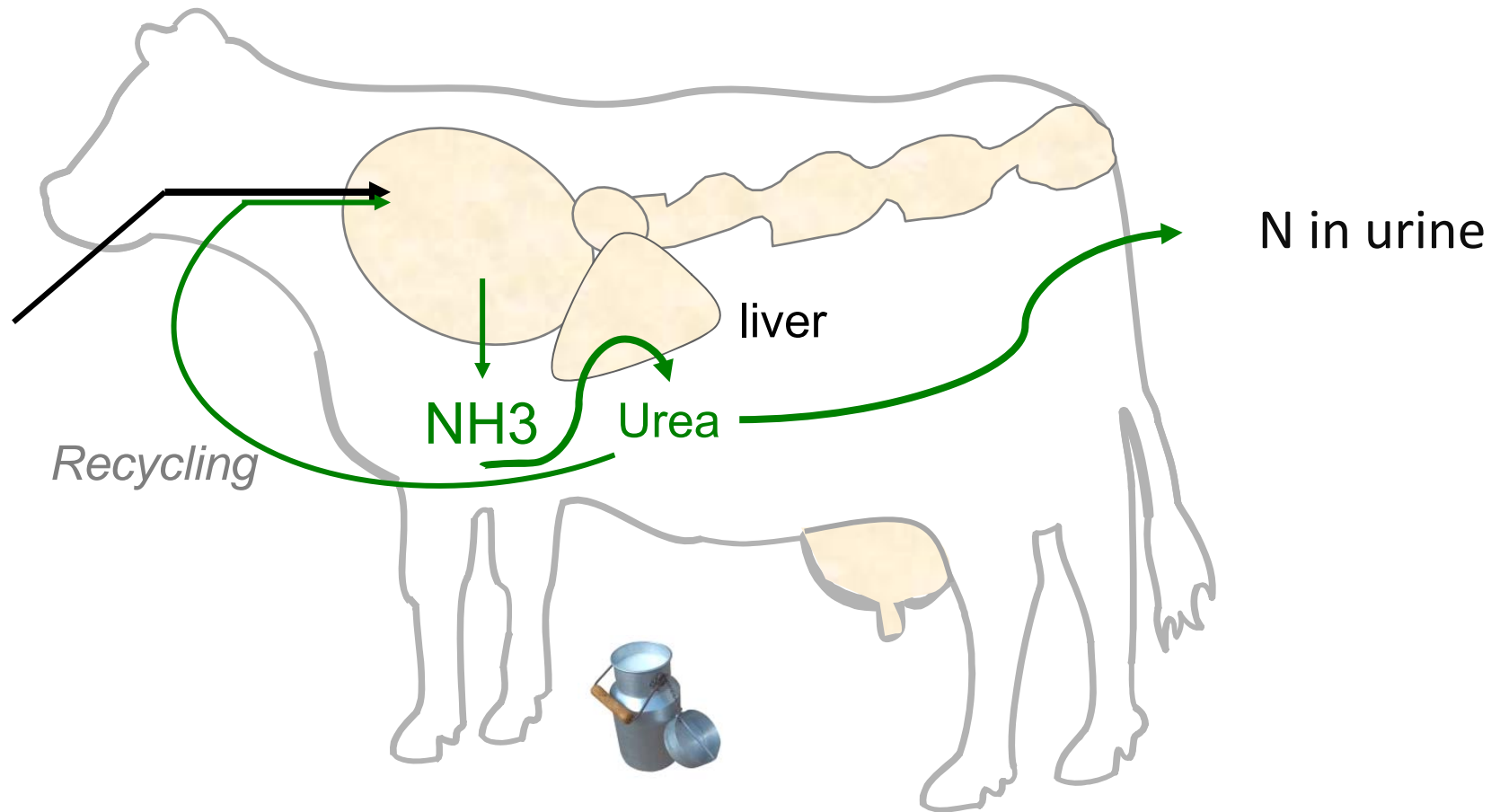


Nitrogen Metabolism in Dairy Cows

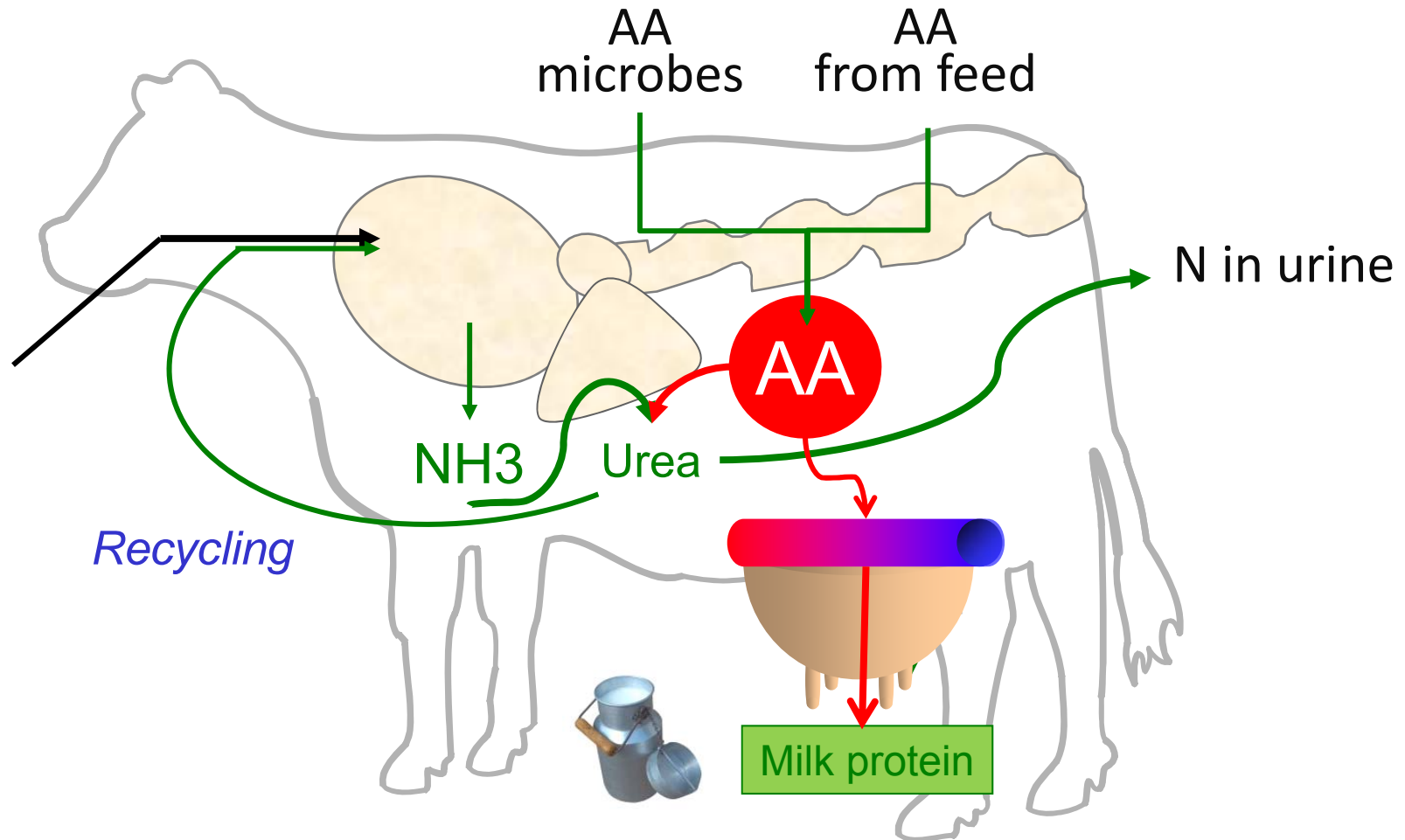
Protein truly digestible in the intestine



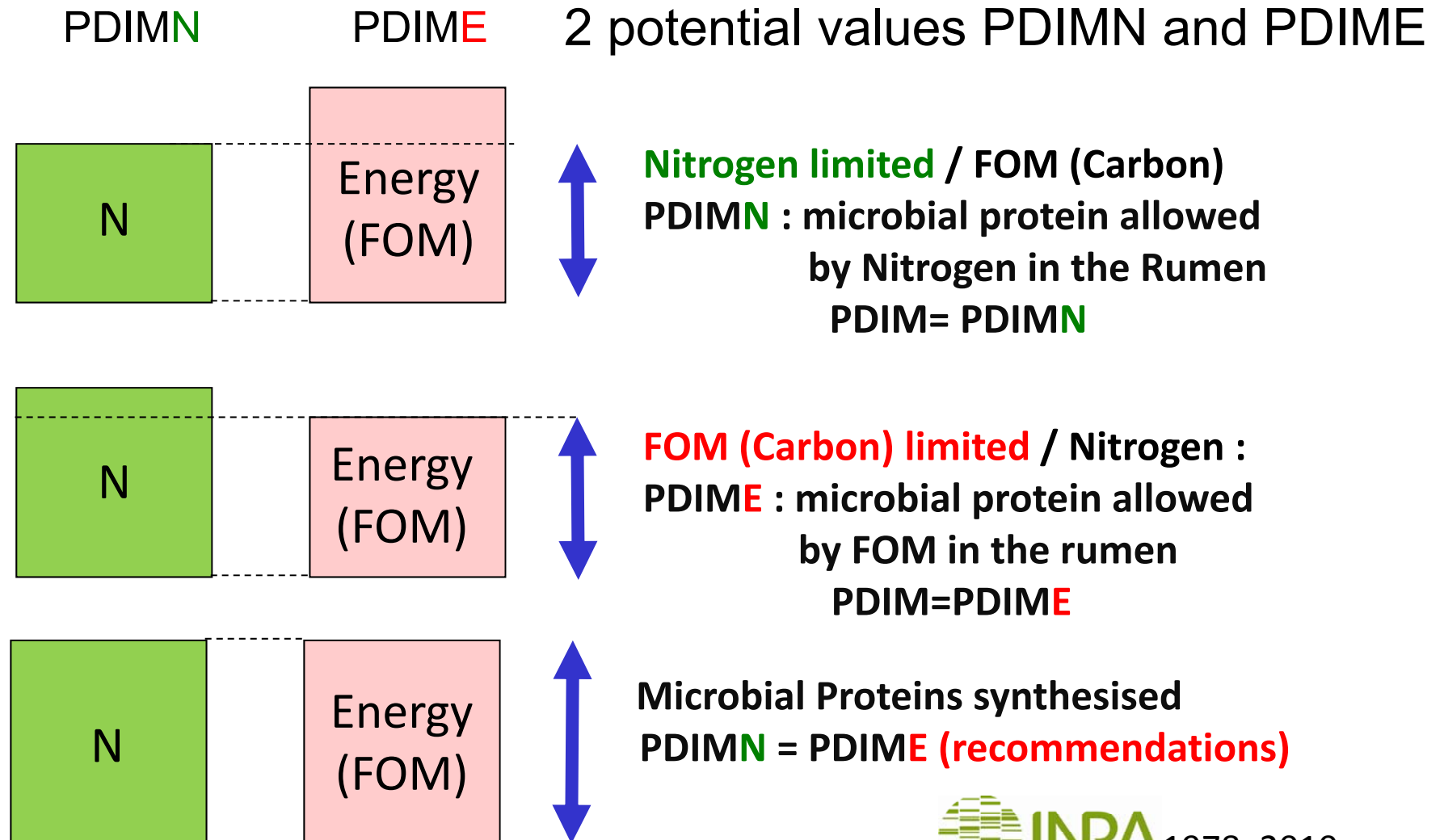
Nitrogen Metabolism in Dairy Cows:



Nitrogen Metabolism in Dairy Cows



INRA PDI Protein truly Digested in the Intestine PDIM for Microbial fraction

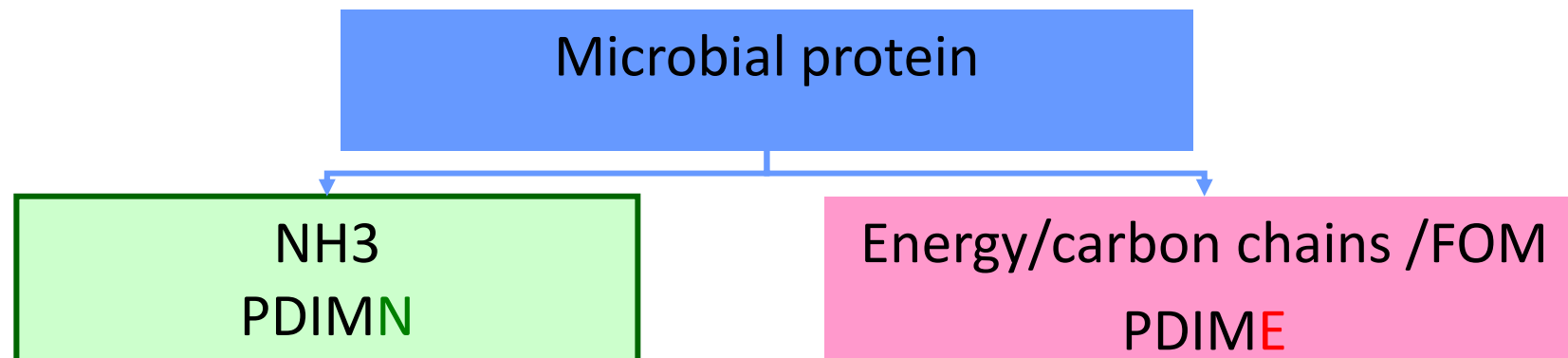


INRA PDI definition

PDI = Proteins truly digested in the Small Intestine

- A = Alimentary (rumen undegraded but digested in the intestine)
- M = Microbial

$$\text{PDI} = \text{PDIA} + \text{PDIM}$$



$$\text{PDIN} = \text{PDIA} + \text{PDIMN}$$

$$\text{PDIE} = \text{PDIA} + \text{PDIME}$$

INRA PDI values of a Diet

Each feedstuff

2 potential values

PDIN

PDIE

- Food A	Xa	Ya
- Food B	Xb	Yb

Diet value

Sums

 $Xa + Xb$

 $Ya + Yb$

DIET PDI Values
the smaller between the 2 sums

INRA PDI (Metabolizable Protein) requirement in dairy cows

- Sum of requirements for maintenance, for milk protein (fixed efficiency) and for gestation:

$$\text{PDIreq} = (3.25 \times \text{BW}^{0.75}) + \frac{(\text{Milk Protein})}{0.64} + (0.07 \times \text{BW}_{\text{veal}} \times e^{0,111 \times \text{Gestation Week}})$$

- Marginal efficiency: recommendations that limit N wastage
 - PDIN-PDIE (rumen)
 - PDIE/UFL (animal)
 - AADI system (%PDIE)

PDIN-PDIE supply influence N efficiency

N urine (g/d) / N lait (g/d)

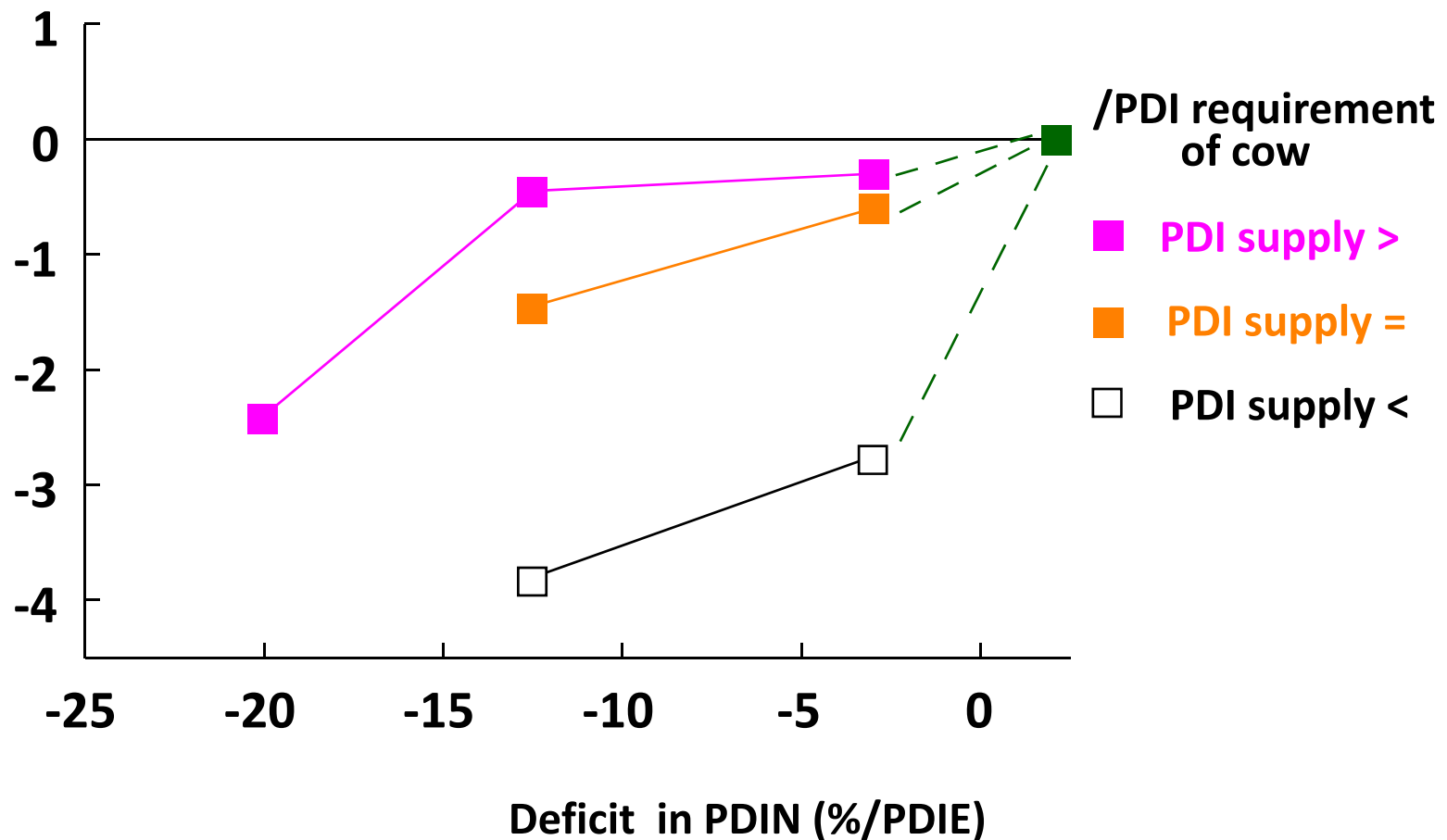
	PDIE (g/kg DM)	
	94	108
PDIN (g/ kg MS)		
94	1.3	
108	1.5*	1.6**

*N urine increased with NH₃
ruminal

Vérité et Delaby, 1998 & 2000

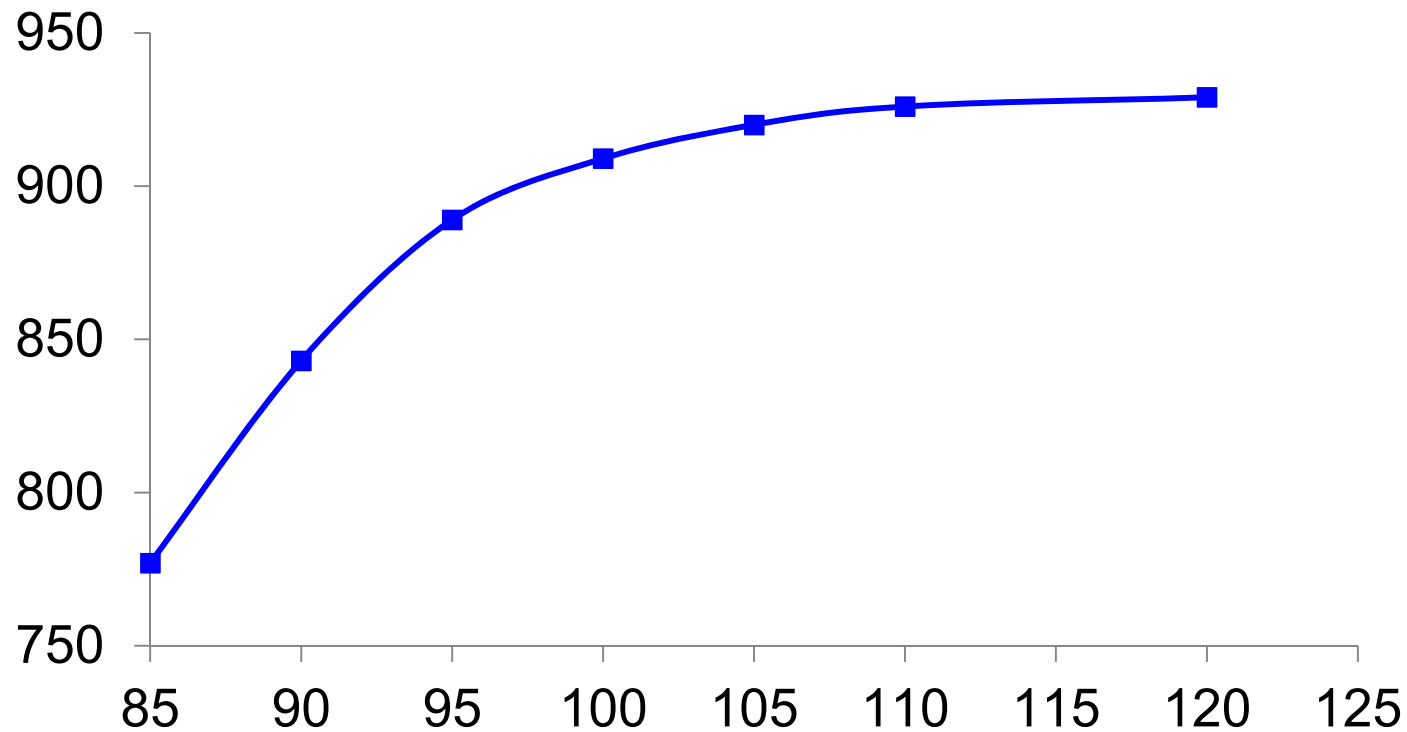
Slight deficit in rumen degradable N does not affect milk yield response (recycling Nitrogen) i.e. $PDIN \leq PDIE$

Milk Yield (kg/d)



PDIE/UFL: Metabolizable Protein to Net energy supply equilibrium

Protein Yield g/d



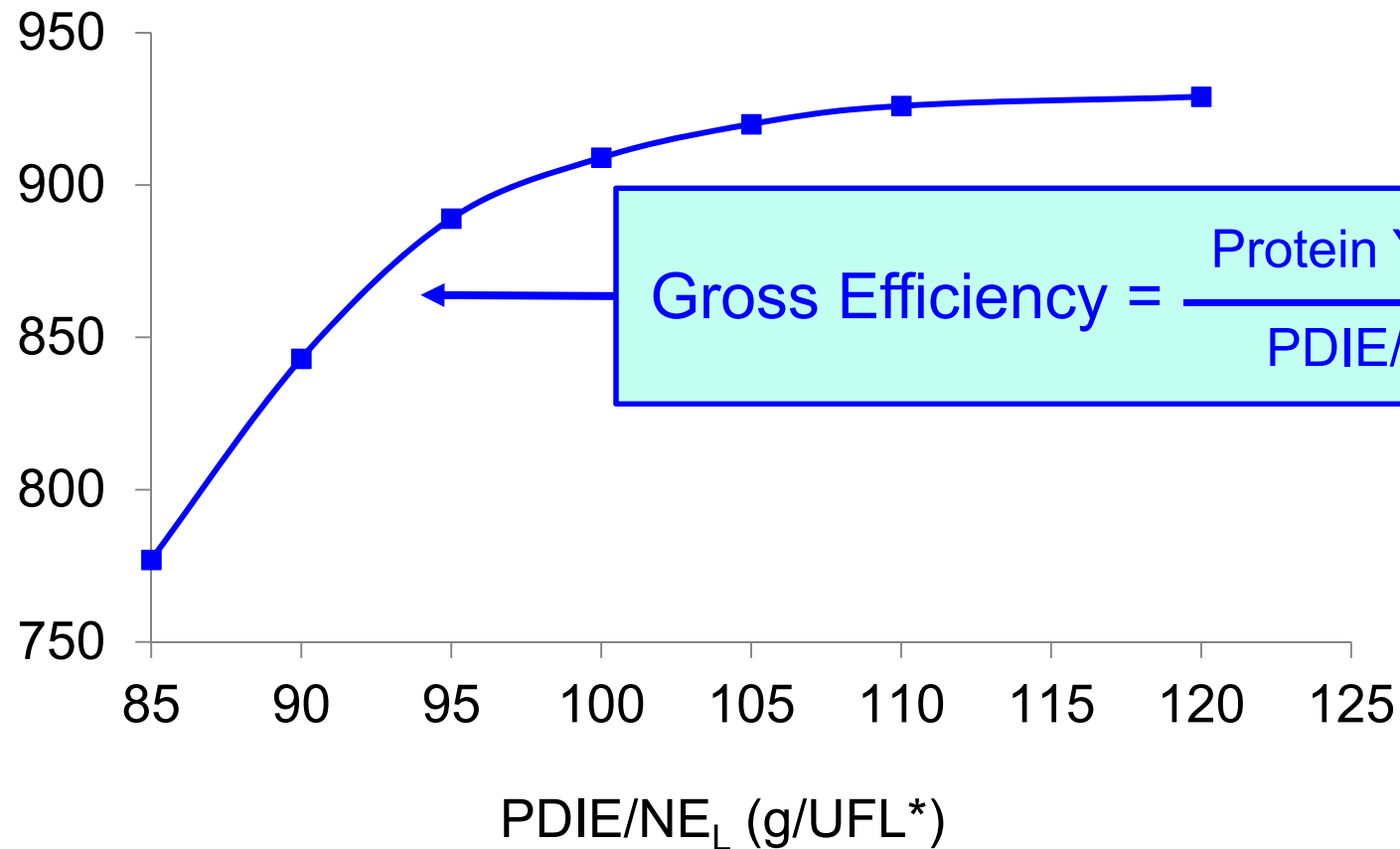
PDIE/NE_L (g/UFL*)

(Vérité Delaby, 1998 & 2000)

* 1 UFL = 1.7 Mcal of NE_L

PDIE/UFL: Metabolizable Protein to Net energy supply equilibrium

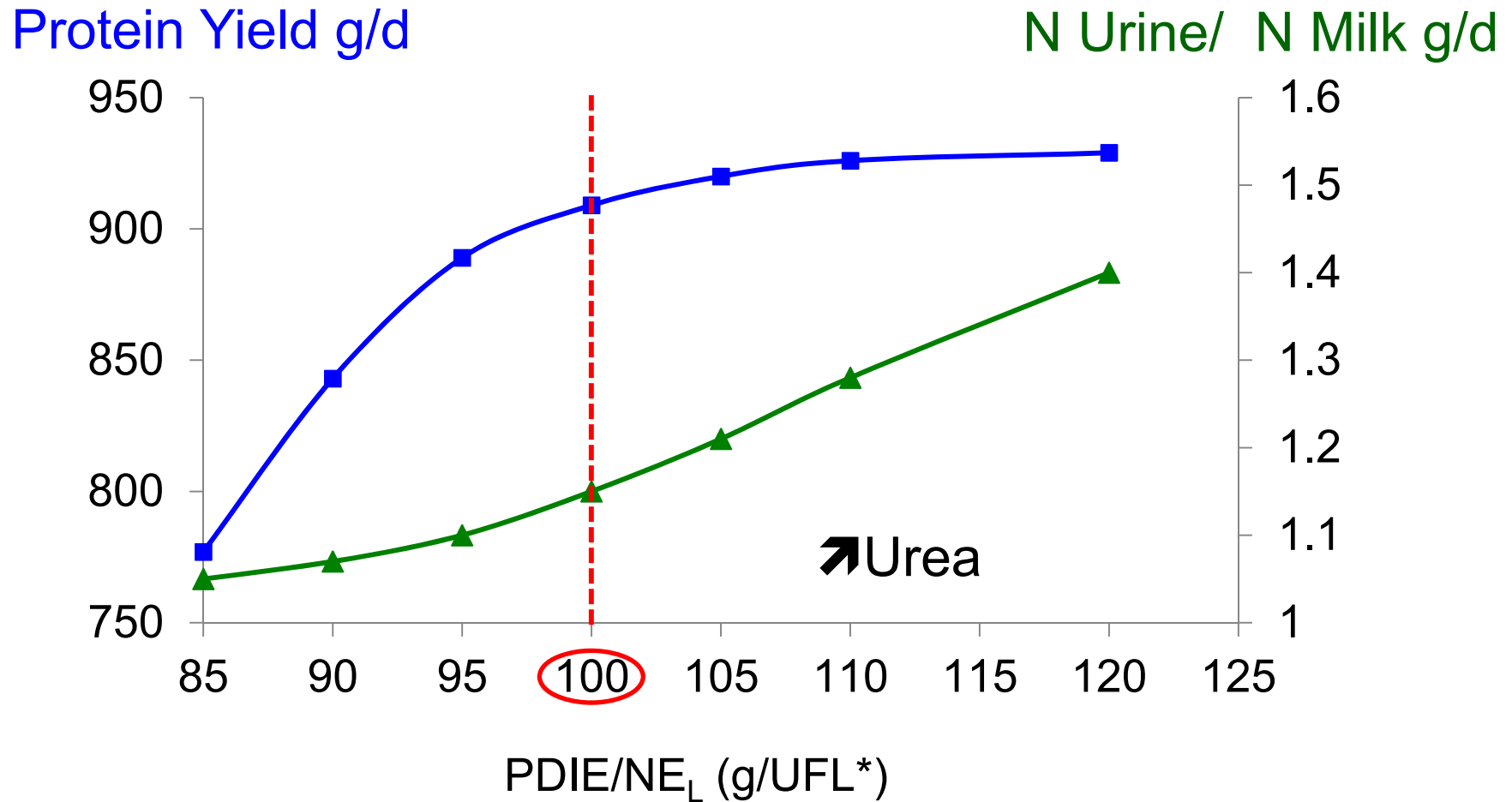
Protein Yield g/d



* 1 UFL = 1.7 Mcal of NE_L

(Vérité Delaby, 1998 & 2000)

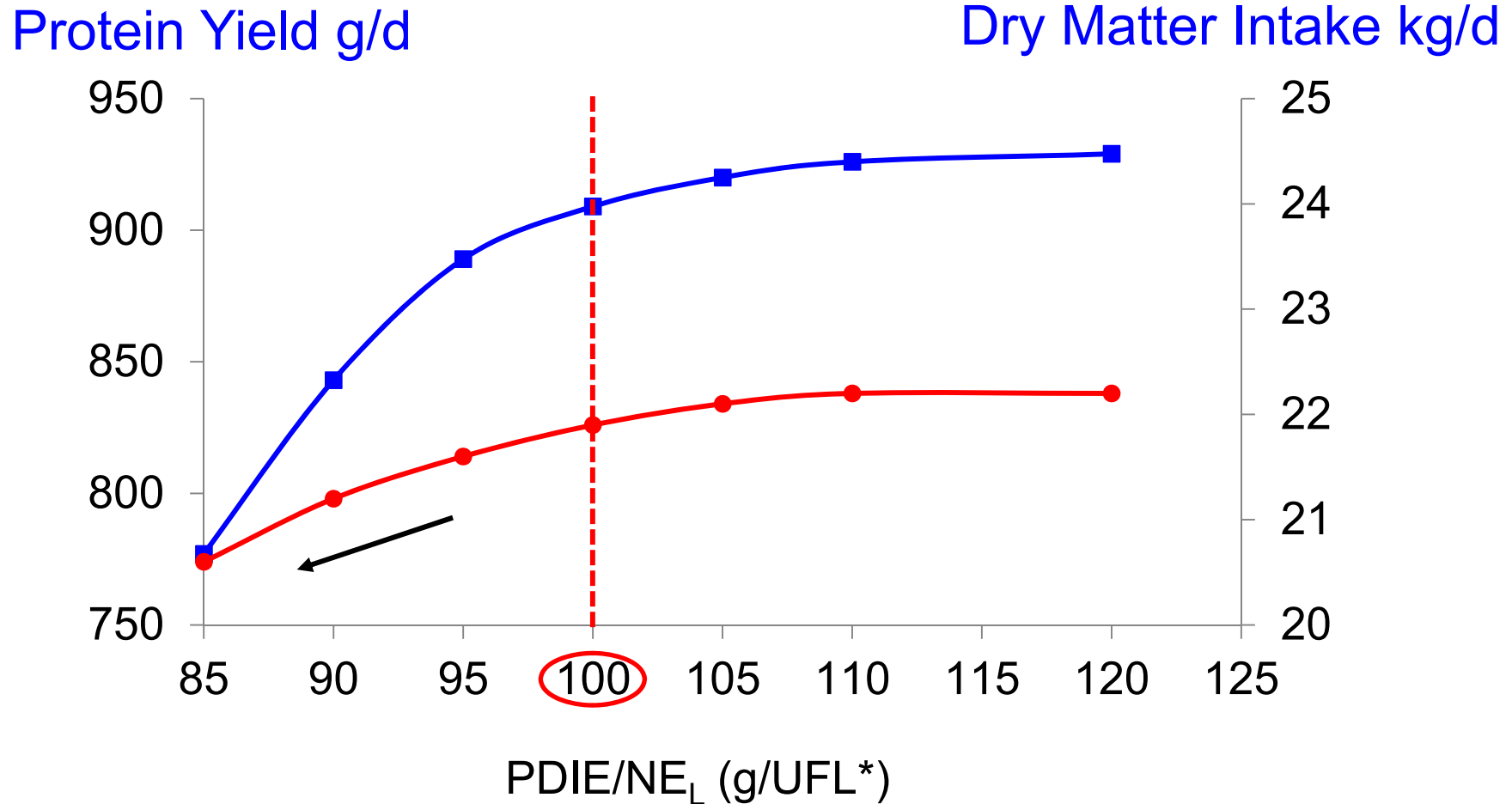
PDIE/UFL: Metabolizable Protein to Net energy supply equilibrium



* 1 UFL = 1.7 Mcal of NE_L

(Vérité Delaby, 1998 & 2000)

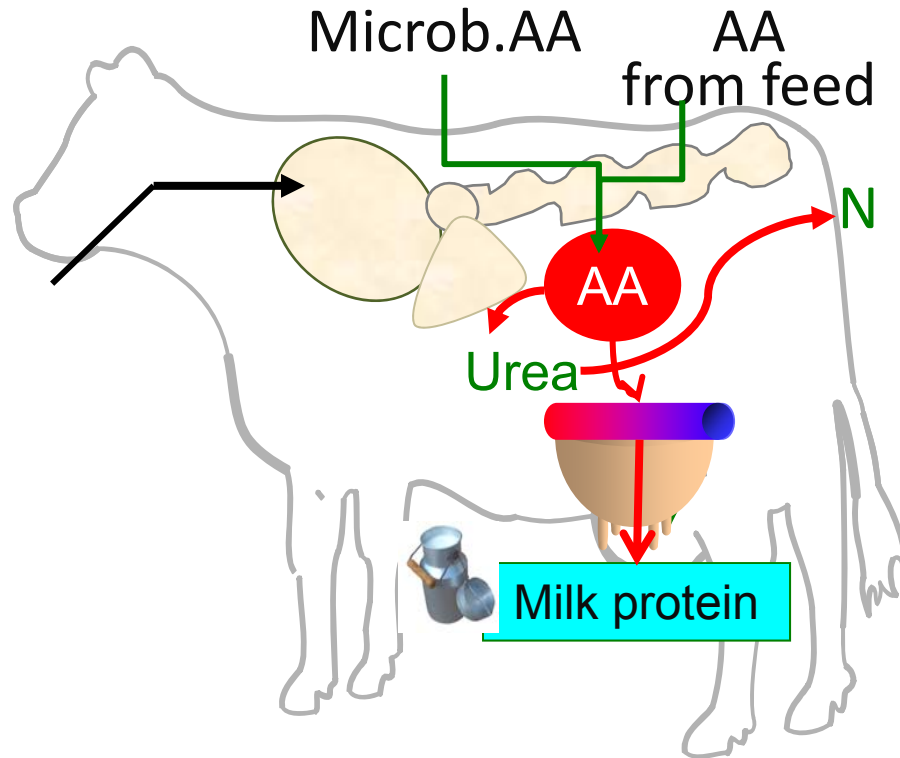
At too low PDI supply DMI decrease which decrease Protein yield and increase PDI efficiency



* 1 UFL = 1.7 Mcal of NE_L

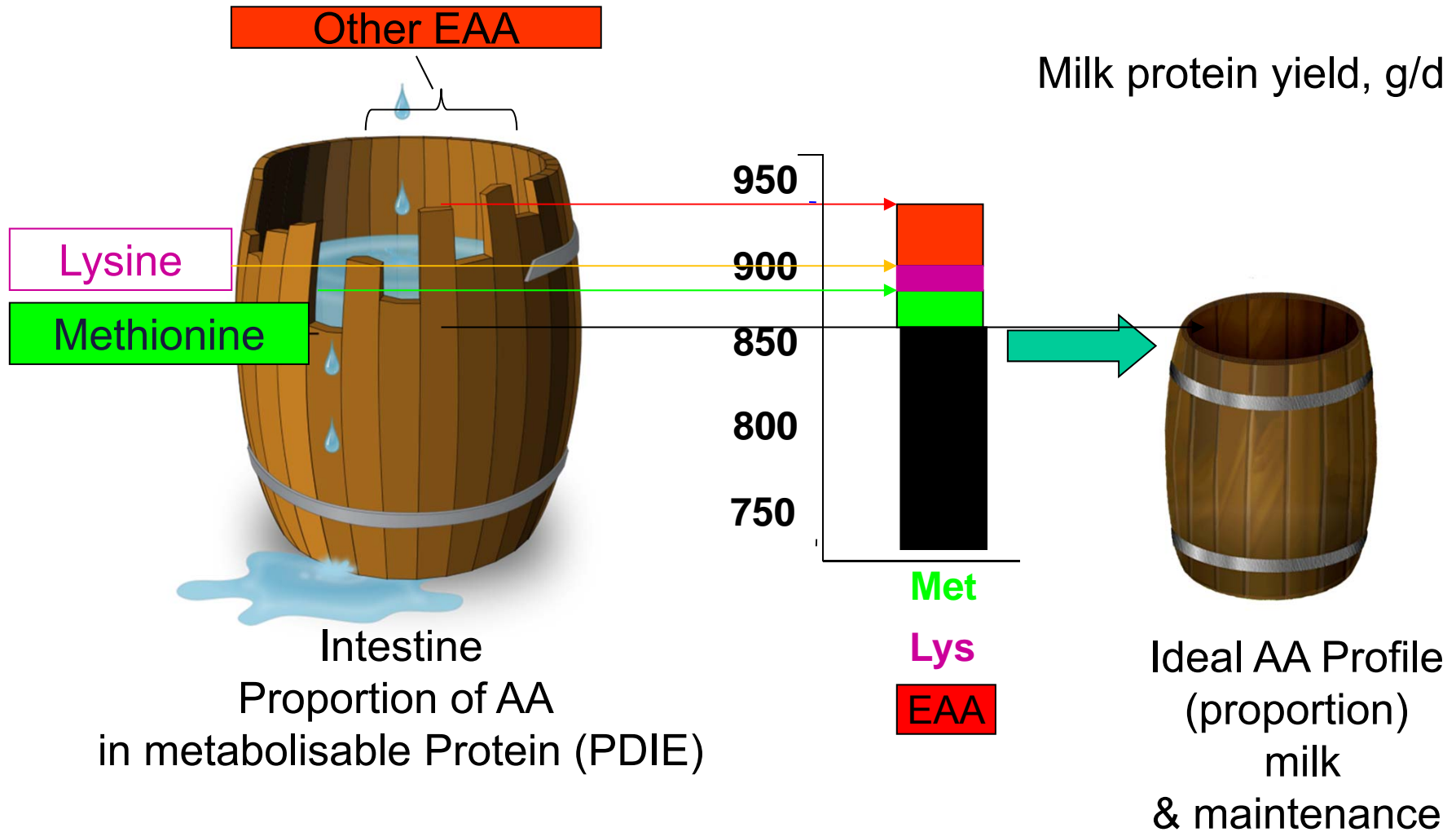
(Vérité Delaby, 1998 & 2000)
Faverdin et al. , 2002 & 2003

Milk Protein AA profiles



- **Composition of milk proteins :**
 - Holstein : 80% casein
 - Depends on Genetic
 - Varied a few with diets
- **Composition of AA in each protein genetically determined**

Ideal intestinal essential AA profil for Cow: the Barrel concept



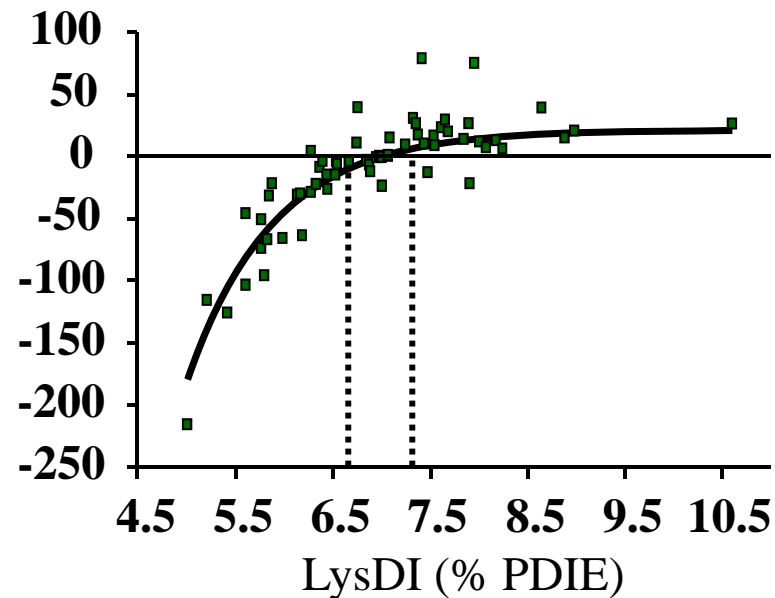
Different Ideal Essential amino acid profile expressed in % of metabolizable protein

AAs	Fraser	Rohr	Doepel	Rulquin	Microbial
	(1991) % MP	(1991) % MP	(2004) % MP	(2007) % PDIE	Rulquin (1998) Meta-analysis % tot AA
Lys	7.3	7.3	7.2	7.3	8.0
Met	2.7	2.3	2.5	2.5	2.5
His ?	2.6	2.4	2.4	3.0	1.8
Leu ?	8.0	9.0	9.4	8.9	7.7
Ileu ??	4.5	5.2	5.3	4.5	5.9
Val ??	5.3	5.9	6.1	5.3	6.2
Phe ??	4.5	5.5	5.2	4.6	5.3
Thr ??	3.5	5.5	5.1	4.0	5.8
Trp ??	1.1				3.0
Arg ??	3.1	4.6	4.8	3.1	4.9

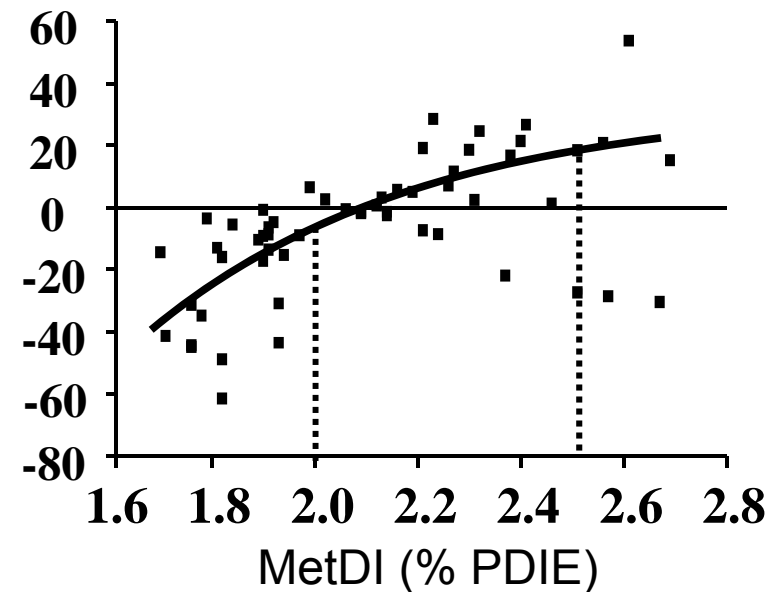
Lysine and Methionine increase PDIE Efficiency

110 g of PDIE/UFL

Milk protein yield (g/d)



Milk protein yield (g/d)

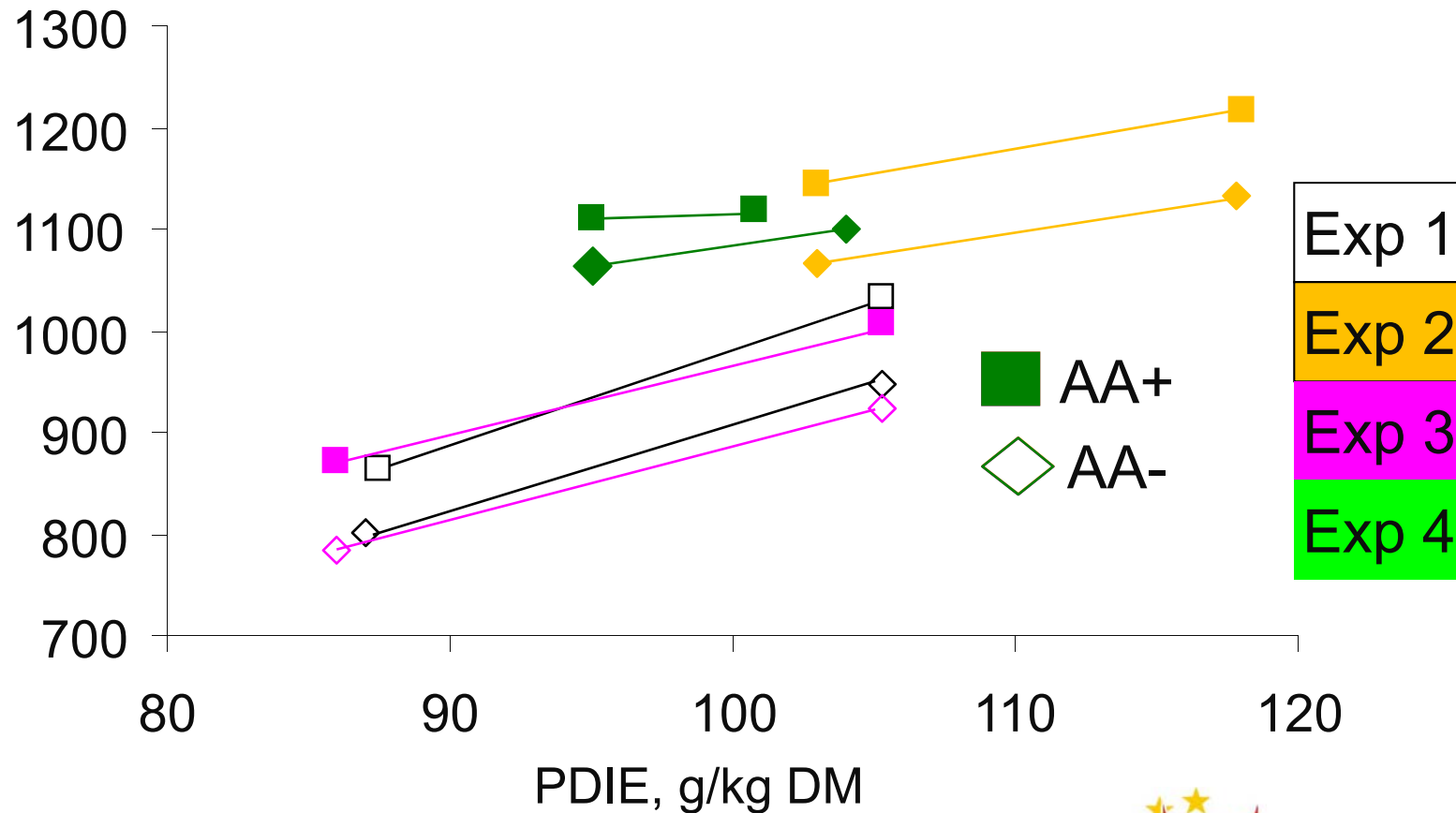


$$\text{PDIE Efficiency} = \frac{\text{Milk protein yield}}{\text{PDIE intake}}$$

PDI & AADI Rulquin et al., 1993 .
NRC: Schwab, 2001

REDNEX Results: PDIE × AA = Lactation Responses

Milk protein yield, g/d



Haque et al. 2012: EAAP. Bratislava, SLOVAKIA



INRA recommendations integrates fixed and marginal efficiencies of PDI utilization

- Fixed efficiency of protein utilization for requirements: 0.64
- Marginal efficiency/ limiting N wastage (animal)

- $(PDIN-PDIE)/UFL = -4$ g for cow : 25 kg to 35 kg of milk

- PDIE/UFL

PDIE/UFL	80	90	100	110	120
Δ DMI (kg DM/d)	-2.2	-0.7	0	+0.2	+0.3
Δ Milk (kg /d)	-5.0	-1.7	0	+0.9	+1.3
Δ Protein (g/Kg)	-1.8	-0.6	0	+0.3	+0.5

- AADI System :

LysineDI : 7.3% of PDIE ; MethionineDI : 2.5%

LeucineDI : 8.9% ; HistidineDI : 2.4-2.8%

Diets Formulation : Forages (+) concentrate

1. What forage covers – cow requirement?



Intake capacity (cow)
Forage/Fresh grass availability (diet)

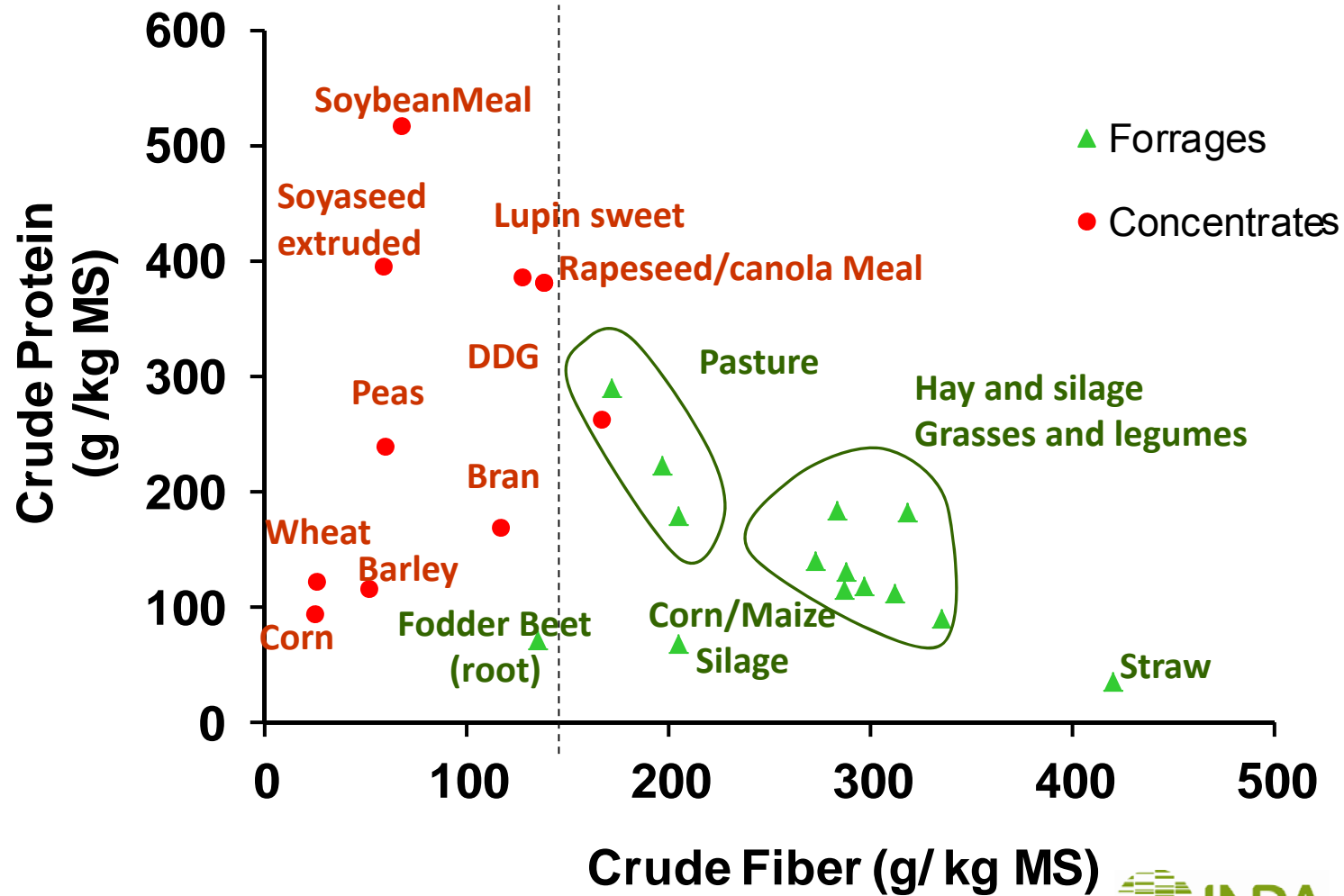
2. Metabolism Protein and Net Energy Supply
/ « cow » requirement:

PDI/UFL in regards to energy density (UFL/FU)

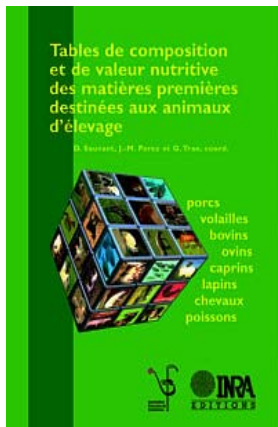
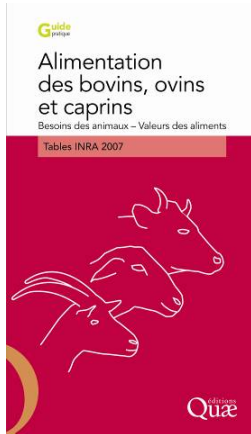
3. Nitrogen Efficiency

- PDI/UFL & PDIN \approx or \leq PDIE (rumen)
- LysDI (6,8 -7,3% des PDIE) et MetDI (2,1 à 2,5% des PDIE)

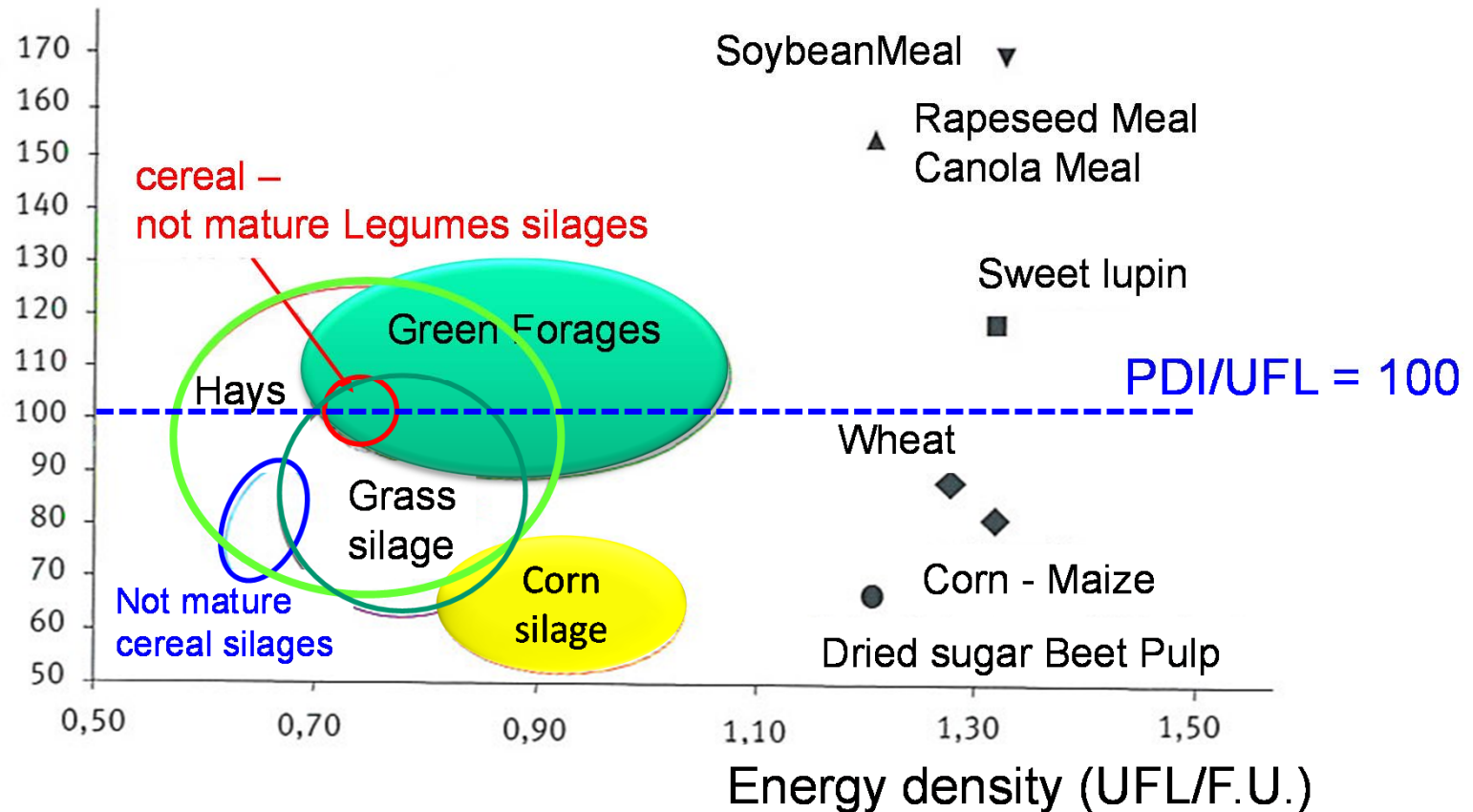
Forages and Concentrates Crude Fiber/Crude Protein Content



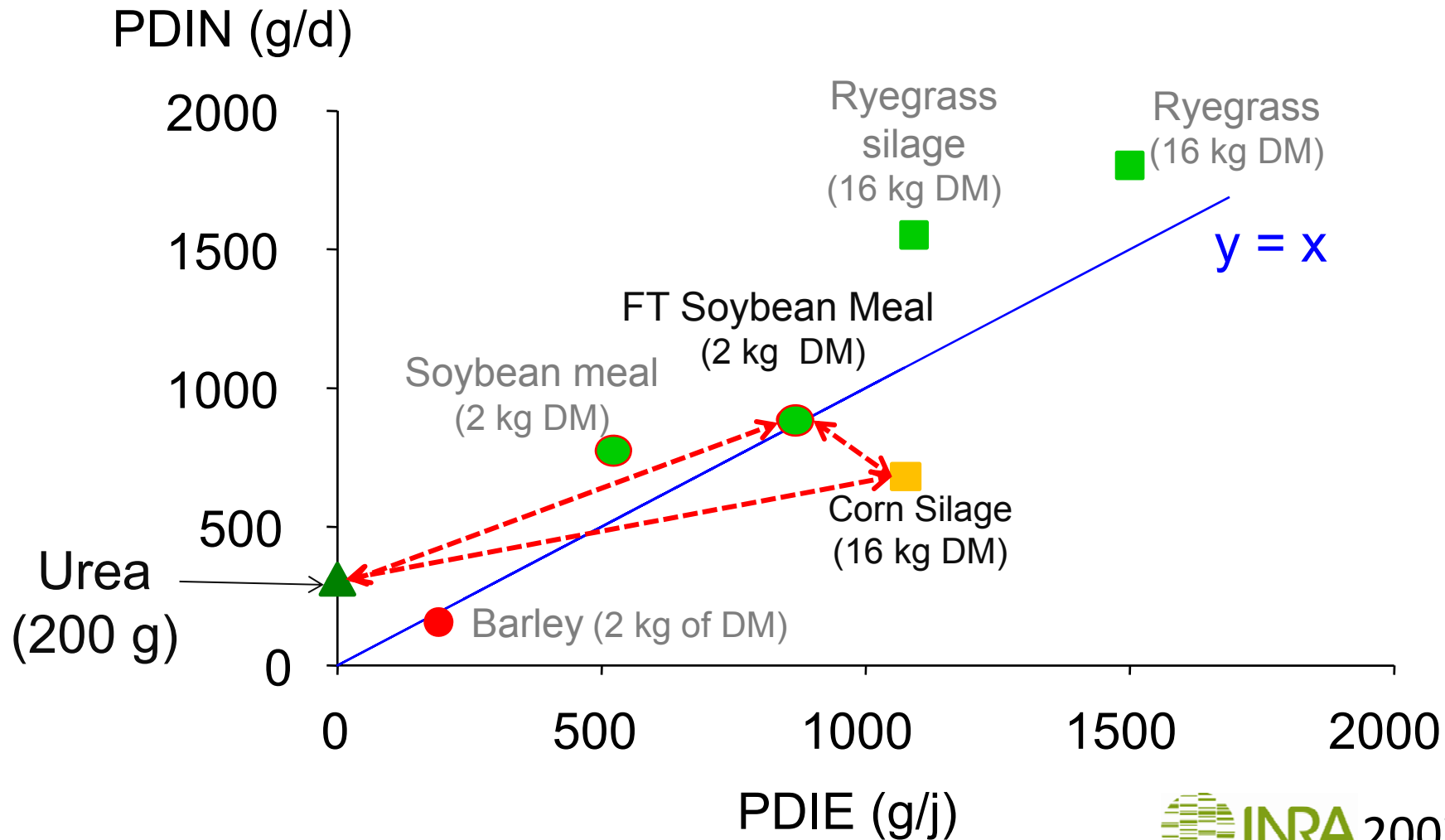
Choose the concentrate in function of forage balancing PDI/NE_L (UFL) and energy density (F.U.)



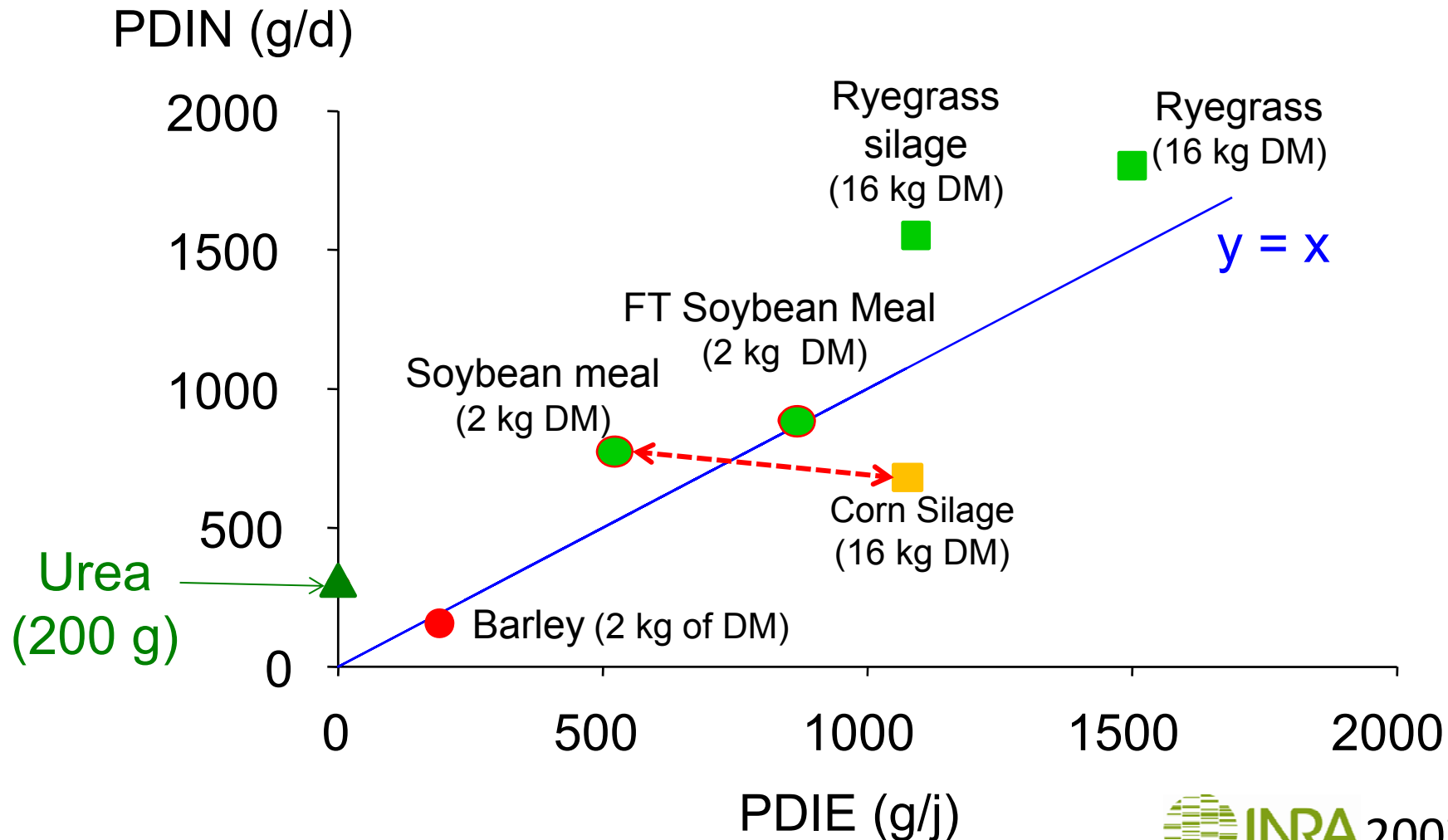
PDI/NE_L (g/UFL)



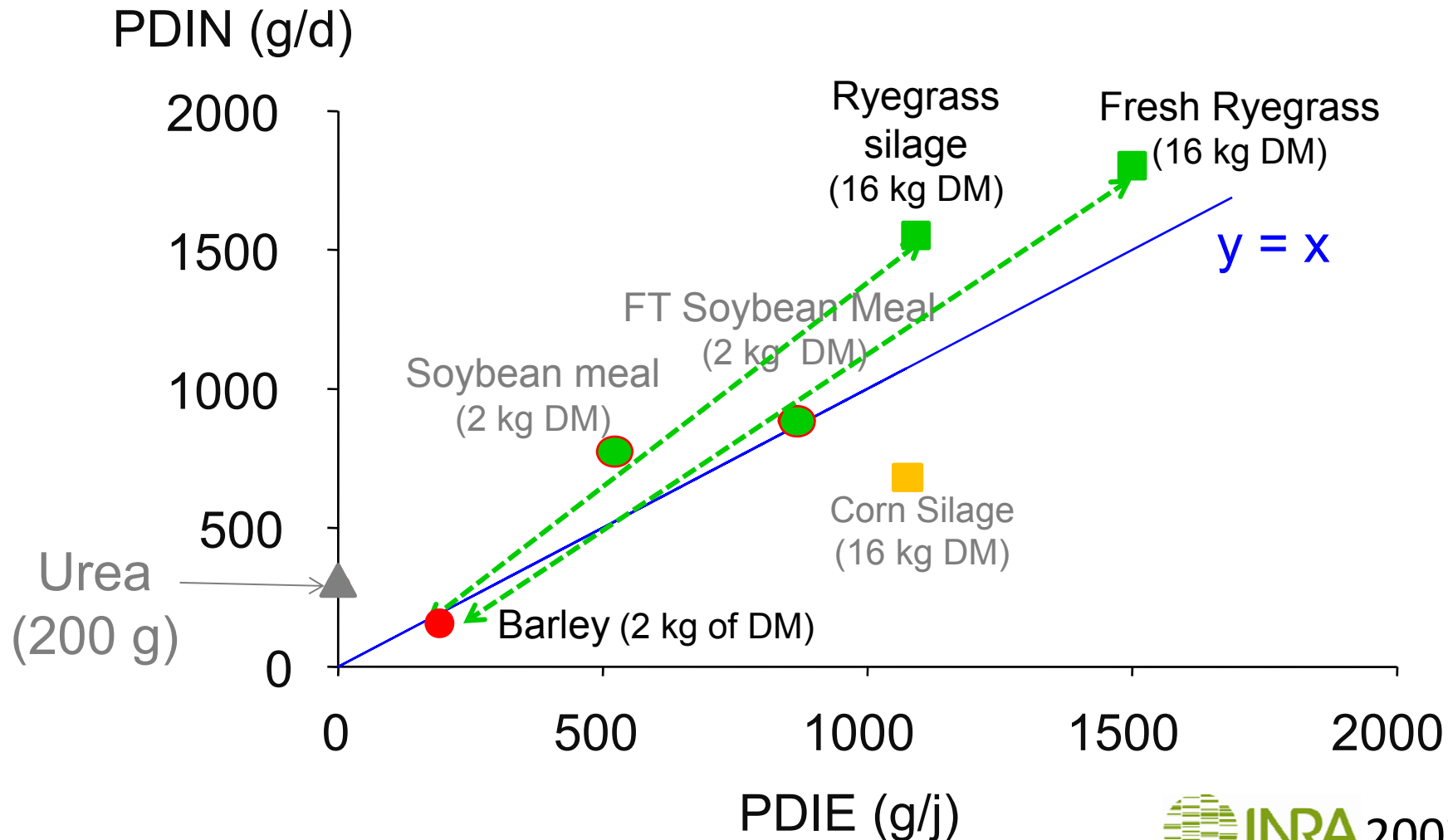
Choose the concentrate to equilibrate diet in PDIN = PDIE



Choose the concentrate to equilibrate diet in PDIN = PDIE

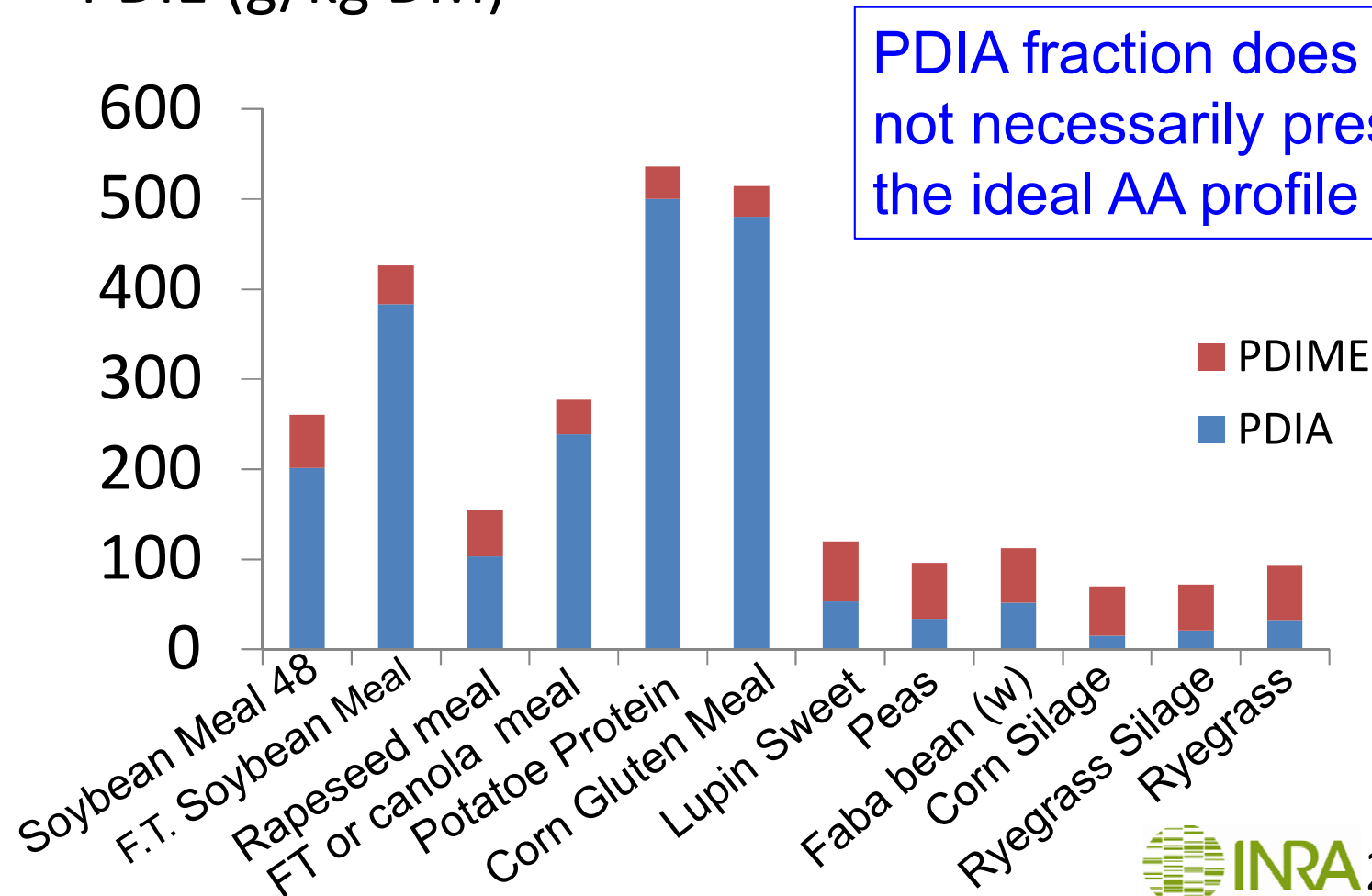


Choose the concentrate to equilibrate diet in PDIN = PDIE



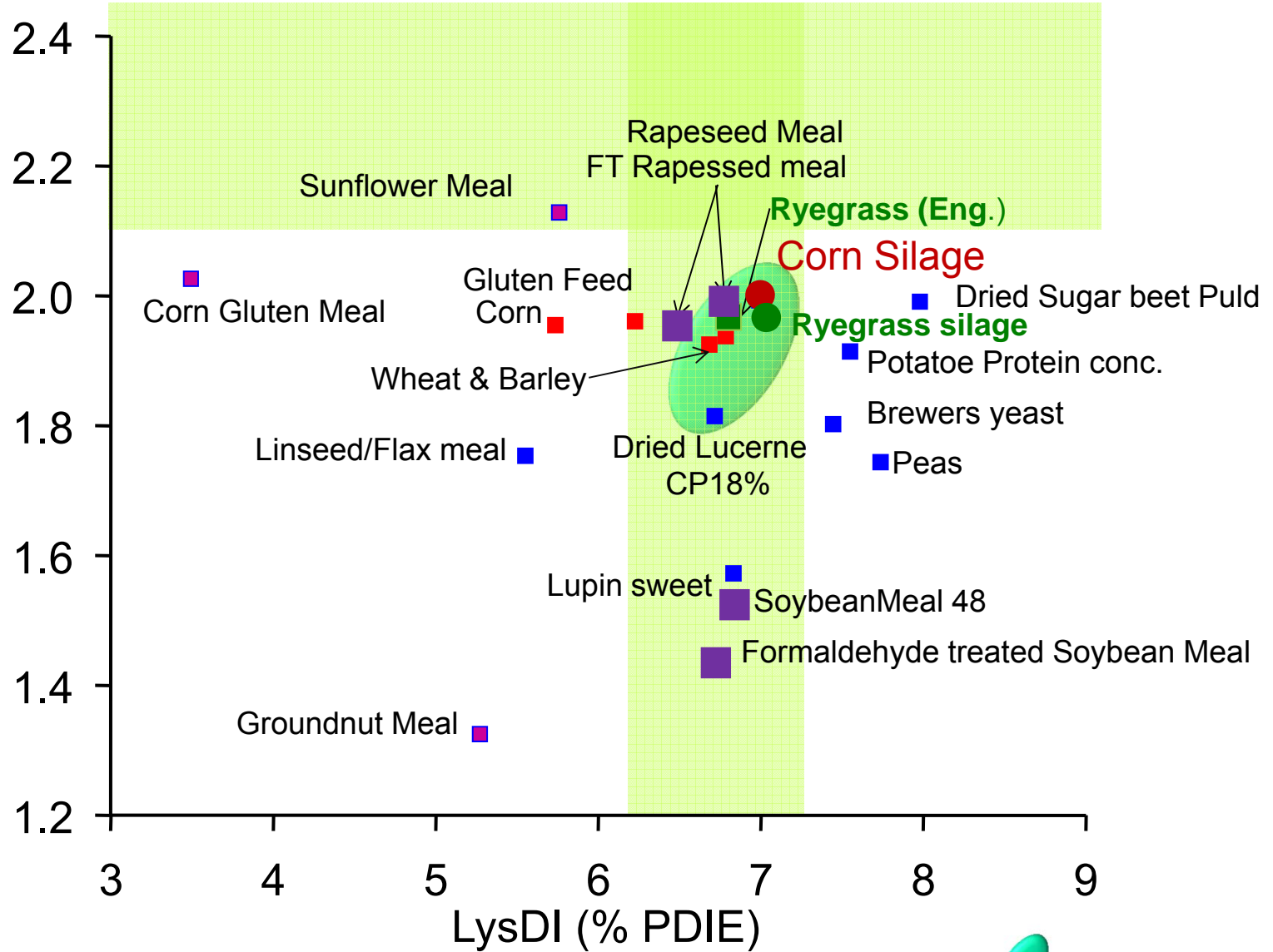
Concentrate with high protein content = High PDIA fraction (rumen undegradable protein)

PDIE (g/kg DM)



Take care of the AADI concentration of diet

MetDI (% PDIE)



 Alarm and recommendations thresholds for a diet

 Forages

Protein Feeding Strategy

To respect several criteria for diet

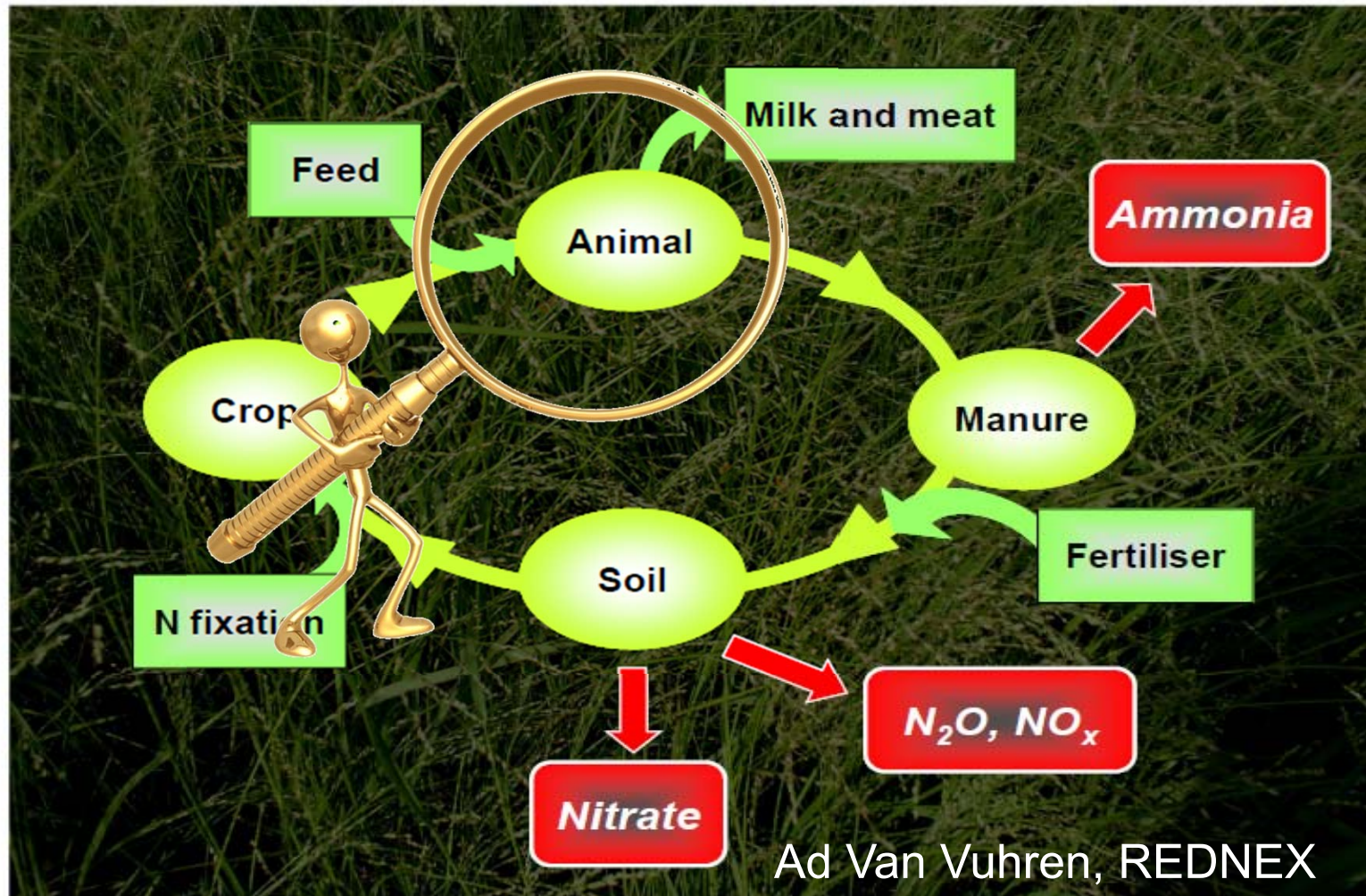
- Milk production objectives (requirements)
- Nitrogen efficiency (cost, protein autonomy, climate, environment)

In diet formulation, take into account to Equilibrium

- Rumen N – FOM [PDIN \approx PDIE (rumen)]
- Metabolizable Protein/Net Energy [PDI/UFL* -UFL/FU)]
- Lysine and Methionine concentration in Metabolizable Protein
LysDI (6.8 -7.3% of PDIE) and MetDI (2.1 à 2.5% of PDIE)

* Unit of Net energy of Lactation (1 UFL= 1.7 Mcal)

However don't forget Nitrogen efficiency/Loss in environment does not only depend of Animal N efficiency





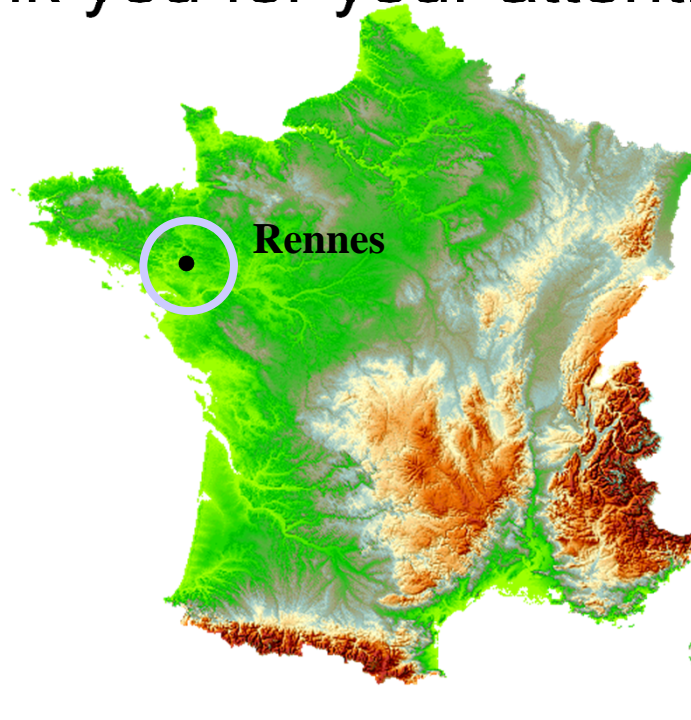
Vă mulțumesc pentru atenție
Thank you for your attention



Dr S. Lemosquet,
INRA



Dr M.N.
Haque,



Dr A. Boudon
INRA



Dr J. Guinard-
Flament
Agrocampus
Ouest

