The PDI system

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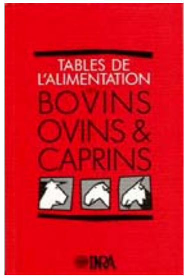
A brief history

1978: first version of the PDI system
80's: utilisation increased (feed manufacturers, technicians, farmers)

1988: new version of the PDI system



1999: software to calculate feed value

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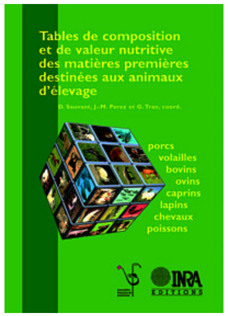
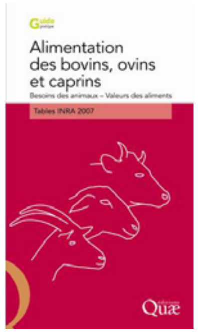
2002: revised feed values
2007: revised forage values
revised FU system





Presentation of the system

PDI value of feedstuffs

Undegraded feed protein

Microbial proteins

PDIA

+

PDIMN ↓ Degraded feed N — **PDIN**

PDIME ↓ Availabe energy — **PDIE**

Microbial nutrition

Animal nutrition

Each feedstuff : 2 values : PDIN et PDIE
Actual value = the smallest
Potential value = the highest
Objective : diet PDIN = diet PDIE

Animal requirements

Maintenance: **3.25 g PDI / kg $LW^{0.75}$**

≅ From 500 to 700 kg : 95 + 0,5 LW

≅ 395 g PDI / day (600 kg)

Yield: **protein yield / 0.64**

= 0.56 x MY x protein content

≅ 48 g PDI / kg milk (31 g/kg protein)

Pregancy: **0.07 x Birth LW x exp $^{(0.111 \times \text{week pregnancy})}$**

from 75 g to 205 g PDI / day

Growth: 250 to 350 g PDI / kg LWG

One dairy cow (600 kg – 25 kg milk) **= 1600 g PDI / day**

How to formulate a diet for a dairy cow ?

	Feed (g/kg DM)		Diet (g/d)	
	PDIN	PDIE	PDIN	PDIE
15 kg Maize Sil	51	71	765	1065
2.5 kg Barley	79	101	198	253
3.0 kg SBM	377	261	1131	783
			2094	2101

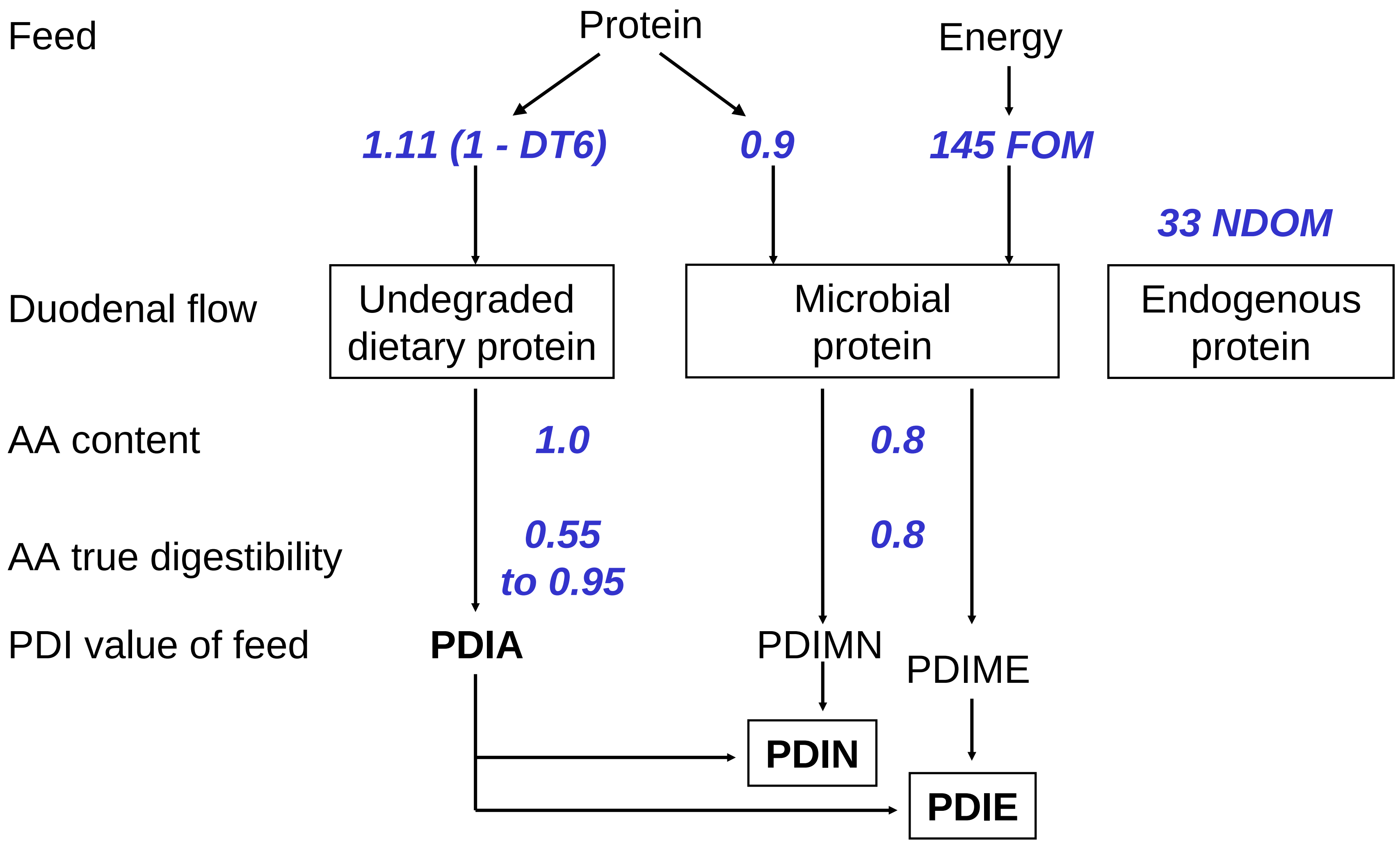
Net energy supply = 35 kg milk

Expected milk : (2100 – 395) / 48 = 35.5 kg

Expected N excretion : NI – N_{milk} = 9.5 g/kg milk

Origin of the coefficients and tables of feed values

Evaluation of the PDI value of feed



Theoritical degradability (DT6) of feed protein

Disappearance of N from Nylon bag method

The method was strictly and carrefully standardized (4 labs)

- Conditions : animal, diets, bag procedures
- Calculations
- Reduction of variability and biais between animals, labs, series of measurments : one reference sample

Particles outflow rate : 6%/h

- do not affect the ranking of feed

DT6 is not an exact estimate of actual *in vivo* degradation and need to be calibrated

By pass protein and efficiency of microbial synthesis

Duod Flow = Undegraded Prot + Microbial Prot + endogeneous Prot

↓ a x bag undeg CP ↓ b x FOM ↓ c x NDOM

FOM : DOm – non deg protein – fermentation products - fat

Data basis

405 diets (20 teams, 142 sheep, 101 beef, 162 dairy cows)

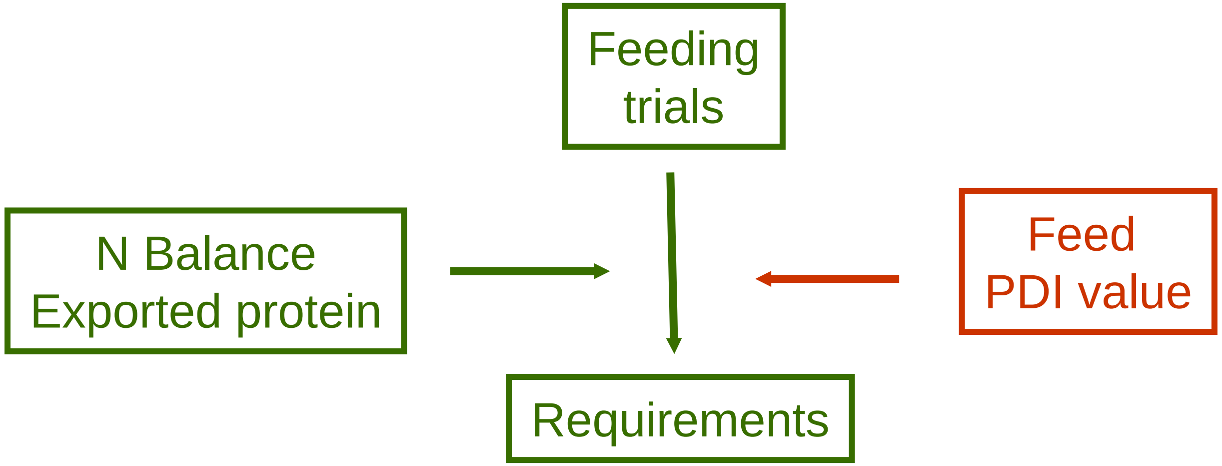
Cover a large range of of feeding situations

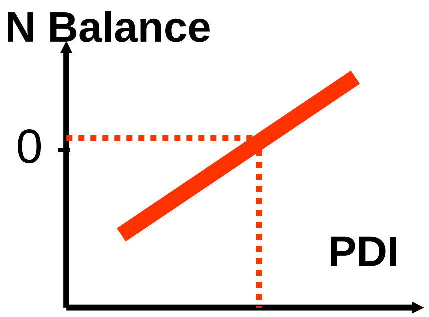
Duod flow = 1,11 bag undeg Prot **+ 145** FOM **+** 33 NDOM

Evaluation of Proteins requirements

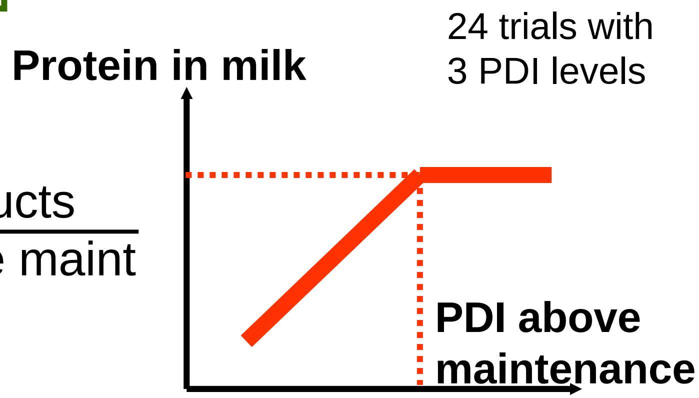
Based on production trials with a large range of PDI supply

Calculated to be coherent with feed values

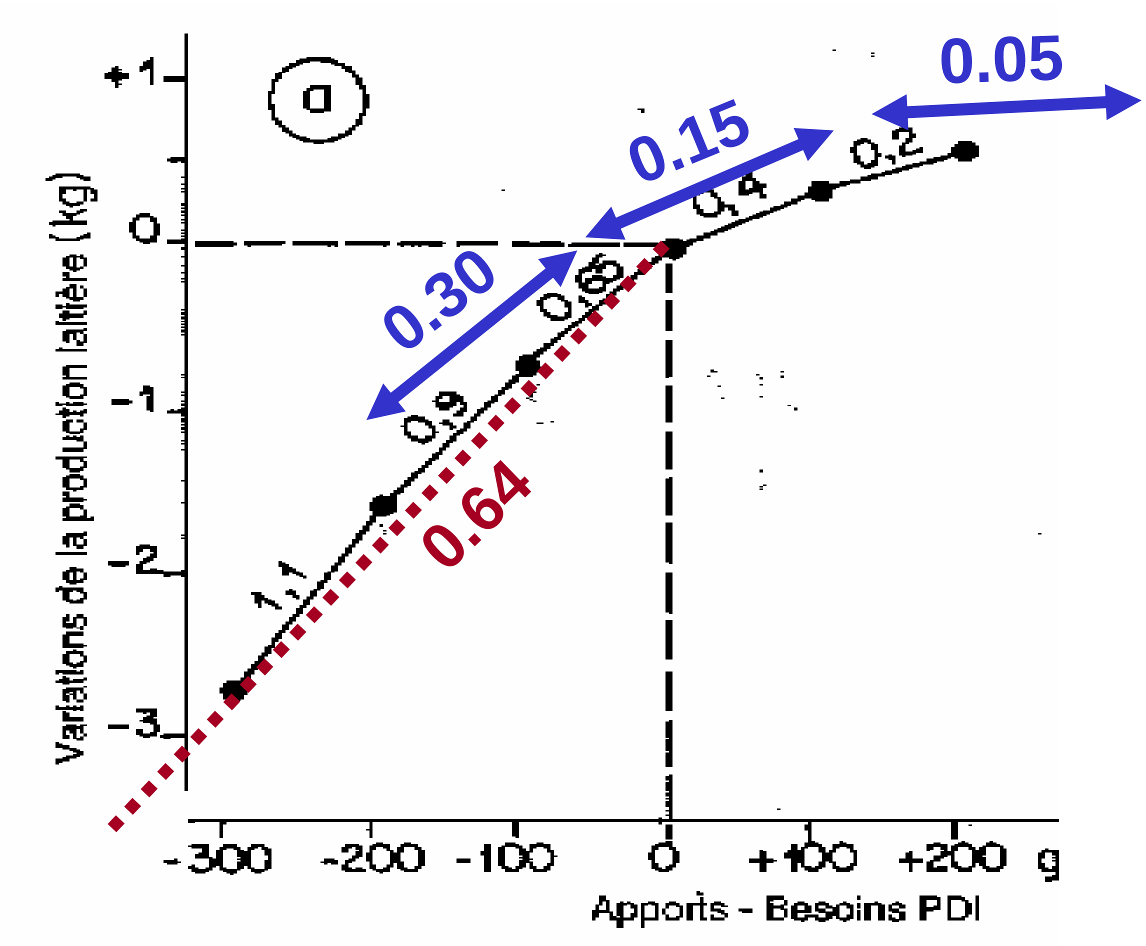




$$\text{Metabolic efficiency} = \frac{\text{Protein in products}}{\text{PDI supply above maint}}$$



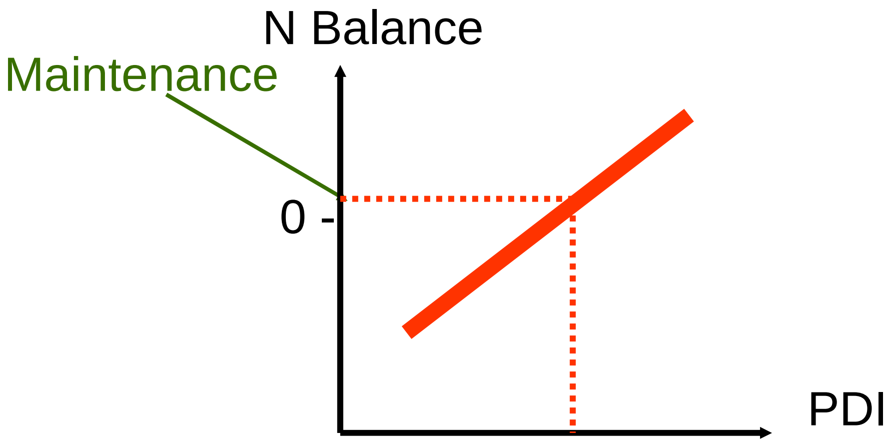
Global and marginal efficiency



Estimation of requirements

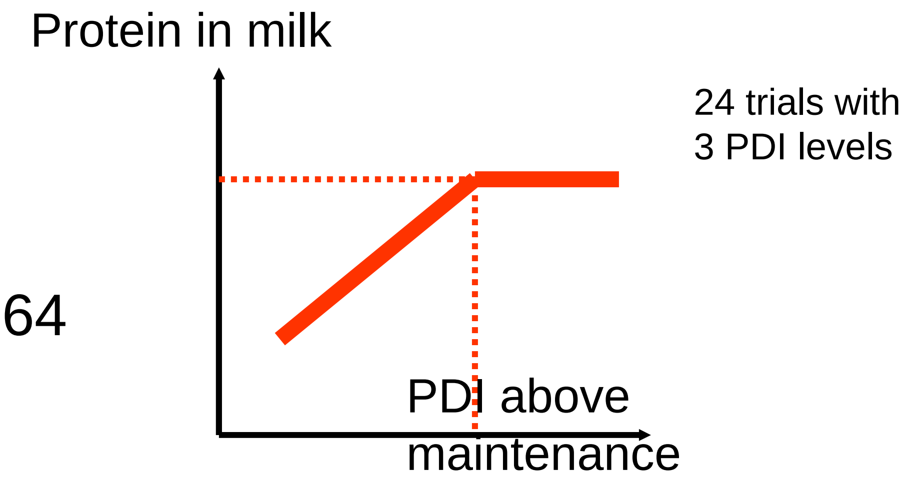
Maintenance

3.25 g / kg $P^{0,75}$



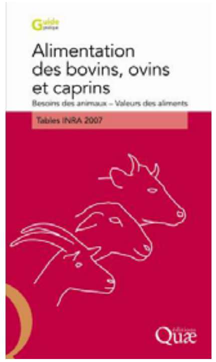
Lactation

Metabolic efficiency = 0.64
Requirement = Prot Yield / 0.64



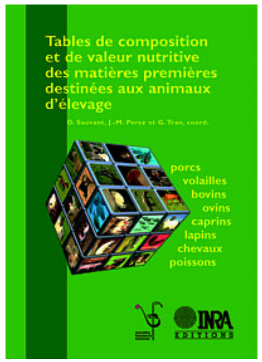
Tables of nutritional value of feeds

294 fresh forages, 185 silages, 148 hays
27 straws, tubercules

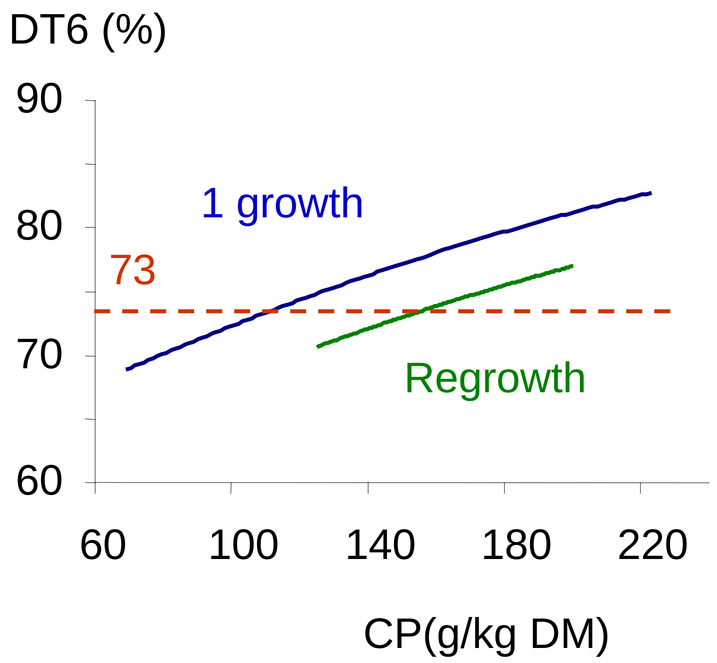


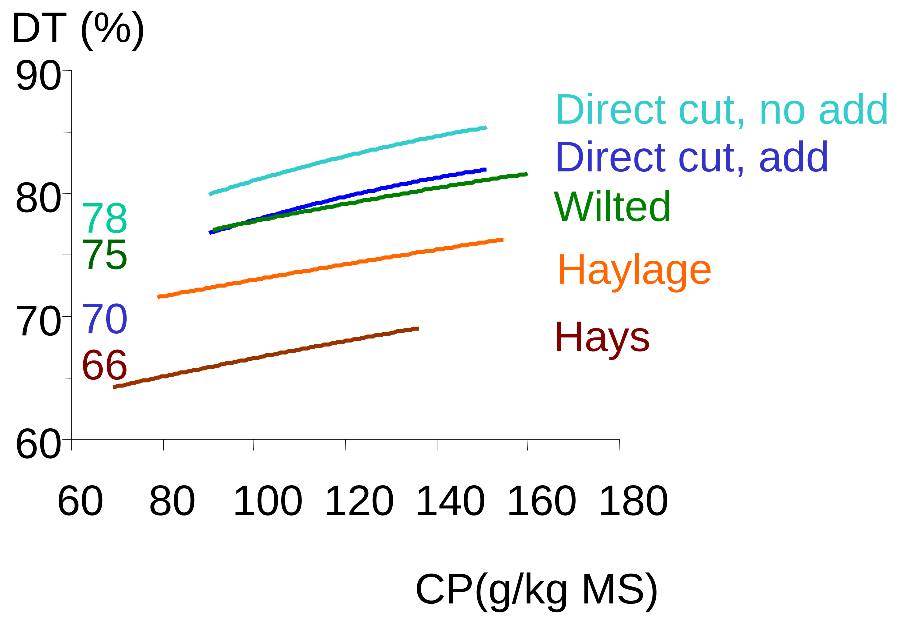
132 feeds (42 different botanical origins) :

- cereals and by products, seeds, cakes, dehydrated, milk by products,
- take account of technological treatments



Forages : prediction of DT6 and dsi





dsi: Estimated from the residue of « mobile bag »

	1988	2007
Fresh forage	75	75 - 85
Silage + Cons	65	65 - 70
Wilted silage	60	65 - 75
Hays	70	70 - 80

Feeds materials: prediction of DT6 and dsi (2007)

DT6:

- Large data set : 584 french data (4 labs)
  + 1305 litterature data (172 feeds, 139 publications)

dsi:

- Large data set from mobile bag residues
  388 samples, 15 labs, 72 feedstuffs
- Bag residue ≅ truly indigestible by pass protein
- dsi = 88.3 + 0.371 CP – 0.0037 CP^2 - 1.07 ADL – 0.3130NDOM

PDI value of an unknown feed

❑ From the feed tables

Code INRA	ENSILAGE	% MS	Énergie (b) UF/kg UFL	UFV	Azote g/kg PDIA	PDIN	PDIE	% PDIE LysDI	MetDI
PRAIRIE PERMANENTE, PLAINE (NORMANDIE)									
Mi-fané									
FE0580	1er cycle (a) 25/05, début épiaison ST=470°C	**55,0**	**0,82** 0,45	**0,75** 0,41	**32** 18	**86** 47	**83** 46	**7,03**	**1,94**
FE0590	1er cycle (a) 10/06, épiaison ST=685°C	**55,0**	**0,73** 0,40	**0,65** 0,36	**27** 15	**71** 39	**75** 41	**7,08**	**1,95**
FE0600	1er cycle (a) 25/06, floraison ST=903°C	**55,0**	**0,65** 0,36	**0,56** 0,31	**23** 13	**61** 33	**67** 37	**7,11**	**1,95**
FE0630	2e cycle après déprimage Repousses à tiges de 7 semaines	**55,0**	**0,76** 0,42	**0,68** 0,37	**29** 16	**71** 39	**77** 42	**7,06**	**1,95**
FE0660	2e cycle après coupe épiaison Repousses feuillues de 7 semaines	**55,0**	**0,82** 0,45	**0,75** 0,41	**39** 22	**100** 55	**89** 49	**6,94**	**1,92**

Code INRA	Encombrement (b) UE/kg UEM	UEL	UEB	Constituants organiques g/kg / % MO dMO	MAT dMA	CB dCB	NDF dNDF	ADF dADF	Minéraux g/kg P P*abs*	Ca Ca*abs*	Énergie kcal/kg / % EB dE	EM
FE0580	**1,38**	**1,07**	**1,11**	**912** 69	**134** 65	**301** 69	**562** 66	**326** 67	**3,2** **1,9**	**6,3** **2,2**	**4437** 65	**2359**
FE0590	**1,56**	**1,16**	**1,29**	**919** 64	**112** 62	**332** 65	**588** 60	**352** 61	**3,1** **1,9**	**5,7** **2,0**	**4427** 60	**2154**
FE0600	**1,67**	**1,21**	**1,40**	**919** 58	**96** 58	**349** 60	**603** 53	**366** 54	**3,1** **1,9**	**5,2** **1,8**	**4400** 55	**1948**
FE0630	**1,51**	**1,14**	**1,24**	**919** 65	**113** 62	**336** 68	**592** 63	**355** 64	**3,1** **1,9**	**6,3** **2,2**	**4429** 62	**2220**
FE0660	**1,37**	**1,06**	**1,10**	**910** 69	**155** 67	**301** 69	**562** 66	**326** 67	**3,2** **1,9**	**8,0** **2,8**	**4470** 65	**2363**

❑ From analysis

- CP analysis + Prediction of DOM (FOM), DT6, dsi
- Equations are published to predict

  DOM from « pcd digestibility »

  DT6 from dE1 « Enzymatic degradability »

  dsi from proximal analysis

- software for automation / standardisation

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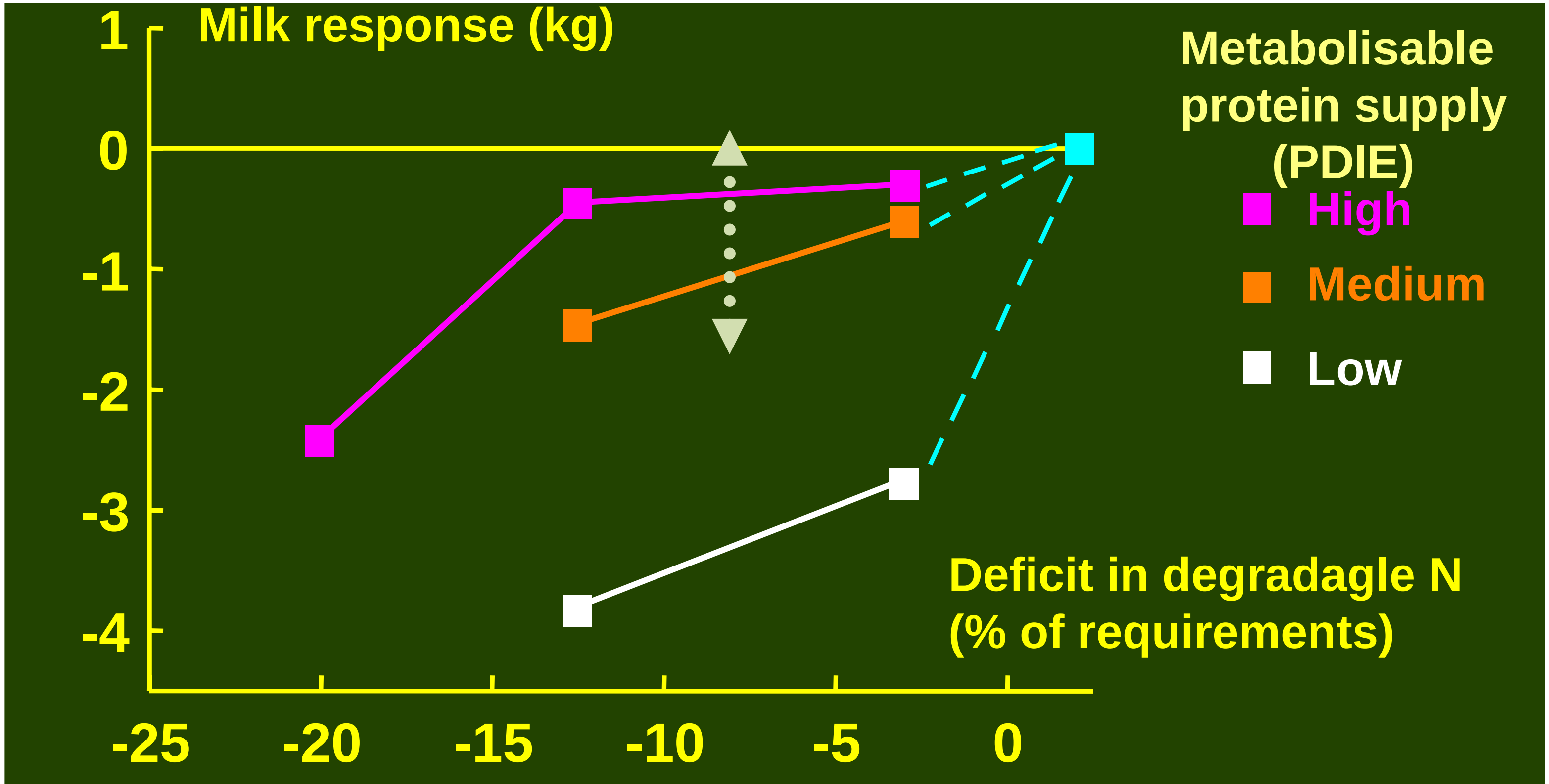
Practical animal feeding

The PDI system allows to rationalize the supply of ruminally degradable N (1)



A deficit of up to 8% do not affect cow performances when the supply of PDIE is correct and will reduce N excreted

The PDI system allows to rationalize the supply of ruminally degradable N (2)

Diet 1 : 15 kg MS + 2.5 kg Barley + 3.0 kg SBM
Diet 2 : 15 kg MS + 3.6 kg Barley + 1.9 kg pSBM + 260 g urea
Diet 3 : 15 kg MS + 3.6 kg Barley + 1.9 kg pSBM + 100 g urea

	Diet 1	Diet 2	Diet 3
PDIE (g/d)	**2101**	**2095**	**2095**
PDIN (g/d)	**2094**	**2101**	**1905**
Expected MY (kg)[1]	**35.5**	**35.5**	**35.5**
Expected N excretion (g/kg milk)[2]	**10.0**	**10.2**	**8.8**

all diets provide enough NE to produce 33 kg milk

[1] : (PDIE – 395)/48
[2] : N intake – N milk

… and to detect diets having an excess of degradable N

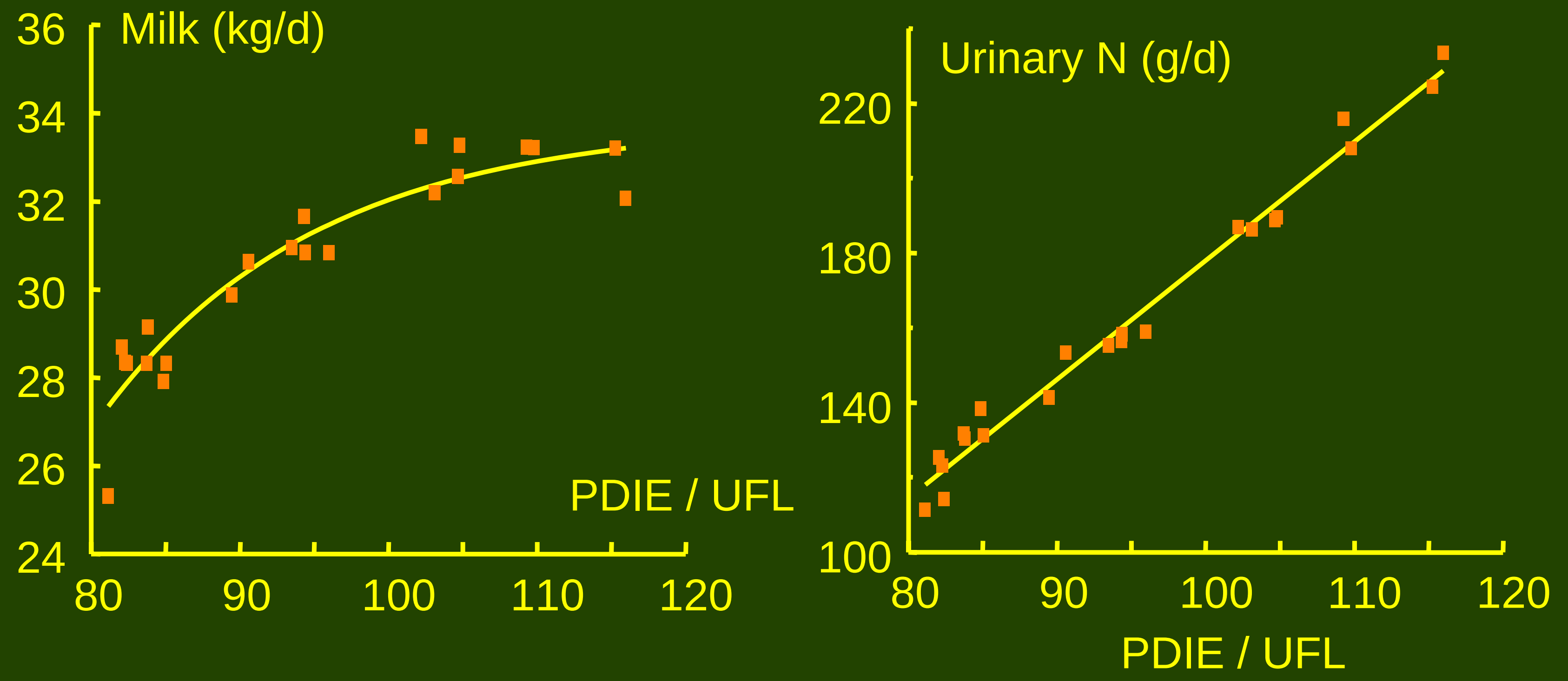
Diet 1 : 15 kg MS + 2.5 kg Barley + 3.0 kg SBM
Diet 2 : 15 kg MS + 1.6 kg Pea + 0.9 kg wheat bran + 3.0 kg SBM
Diet 3 : 13 kg GS + 1.0 kg barley + 5.0 kg maize + 2.0 kg SBM

	Diet 1	Diet 2	Diet 3
PDIE (g/d)	**2101**	**2085**	**1992**
PDIN (g/d)	**2094**	**2233**	**2204**
Expected MY (kg)	**35.5**	**35.0**	**33.3**
Expected N excretion (g/kg milk)	**9.6**	**10.0**	**13.1**

No milk response to an extra supply of PDIN (above PDIE) but urinary N output increased.

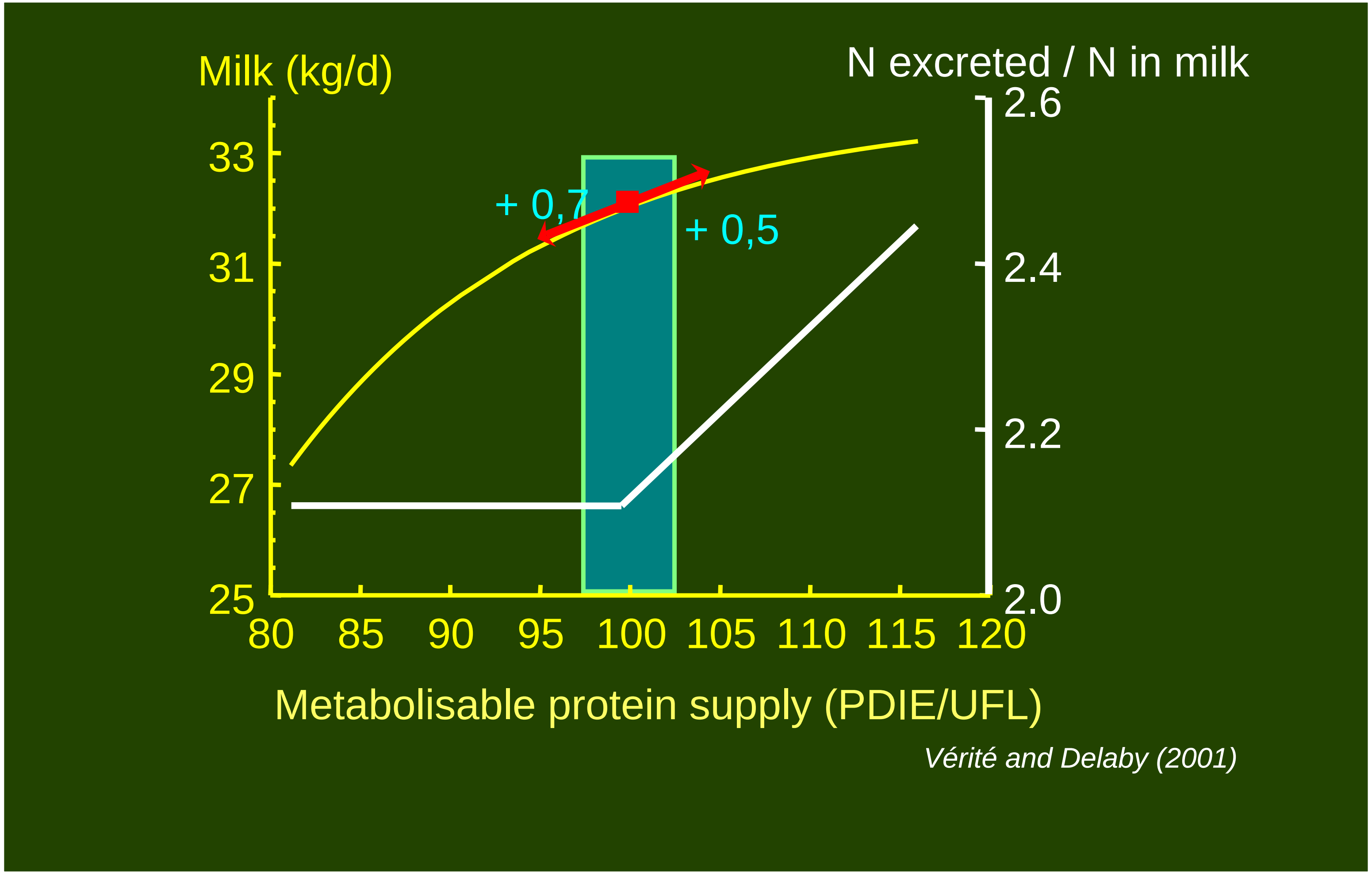
No effect of the origin of degradable N on cow performances on normal feeding conditions

Response of milk yield and urinary N losses to PDIE supply



The supply of MP can not be reduced to a large extent without an adverse effect of milk yield (and DMI)

An optimum supply of PDIE can be defined



Using the PDI system to predict urinary N

Urinary N = 48

+ 0.28 rumen balance *(PDIN – PDIE)*

+ 0.16 animal balance *(PDI supply – PDI requirements)*

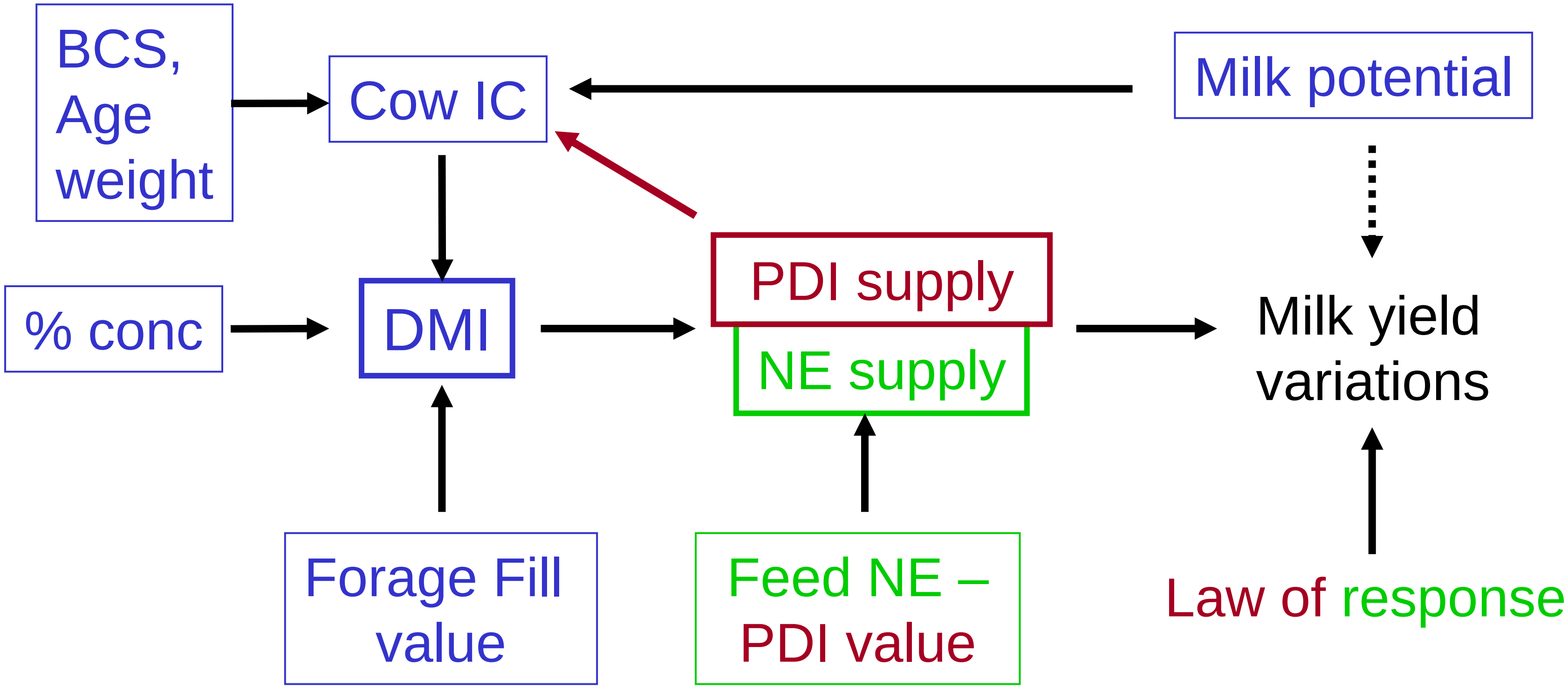
+ 3.8 milk yield

$r^2 = 0.92$

Main strengths of the PDI system to optimize milk yield / N excretion

Based on a large diversity of feeding situations	Soundness
Coherence between animal requirements and feed value	Allow to rationalise degradable N and MP supply / animal demand
Very rich feed tables	Offer a range of solutions
Description of the responses curves	Optimise supply considering Milk yield and N excretion responses
Predictive methods to calculate value of unknown feeds	On farm evaluation of feeding practices
Used since 80’s and regularly upgraded	Take account of returns from on farm evaluation
Linked with Fill unit system	Prediction of cows performances

PDI sytem:
part of the french feeding systems



Fill Unit system
PDI system
NE system

Main shortcomings of the PDI system to increase feeding efficiency

Effect of high level of feed intake

- FOM, by pass protein, microbial efficiency, dsi ?
- Shift between faecal and urinary N excretion ?

Tolerable deficit in degradable N

- to (re)consider according to the diet (forage) and cows

Variations of metabolic efficiency

- Effect of the profile of absorbed AA (beyond Lys and Met)