Influence of rumen degradable protein balance and precision protein feeding on nitrogen efficiency

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Introduction

- High producing Dairy Cows are more and more fed indoors with maize based diet, but with a development of precision livestock farming
- More NH3 emissions from manure storage
  - → More environmental impacts or…
  - → More investment in technologies to manage manure
- Maize silage is a high energy but low protein content forage
  - → A high dependency in protein supplement (cost, competition on protein sources)
  - → An opportunity to reject less N ?
- **Could it be possible to find a cost-benefit strategy to maximize N and protein efficiencies?**

N nutrition: Feed the microbes and feed the cow

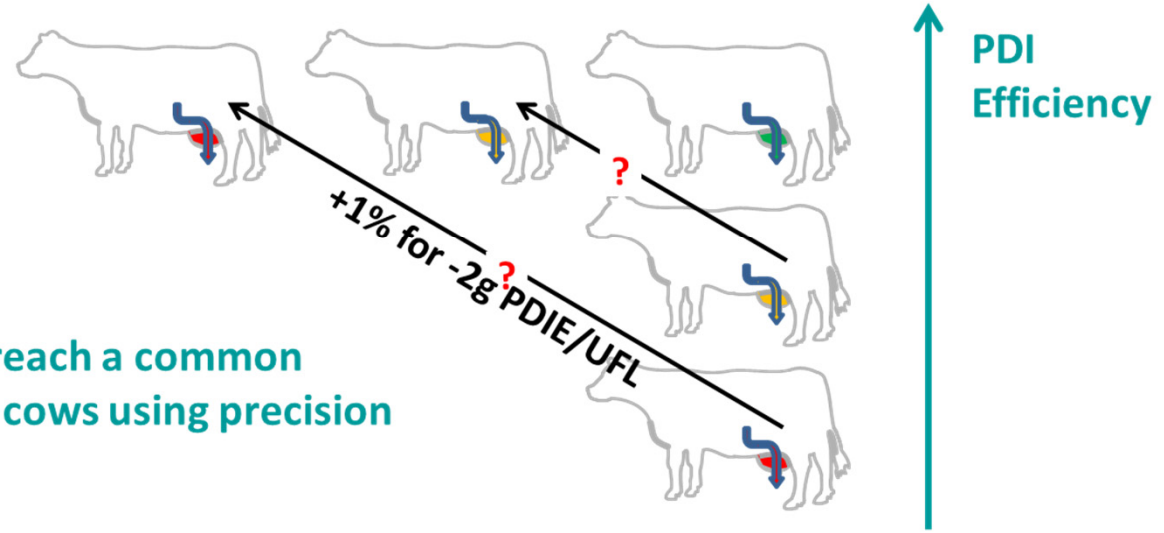
- INRA Feeding systems propose recommendations
  - - to provide sufficient level of degradable N for microbial protein synthesis in the rumen PDIN=PDIE
  - - to supply sufficient amount of metabolizable protein to the cow
- In practice, a complete maize based diet well balance in degradable N and in metabolizable protein corresponds to an average CP content of 14.5%.
- Law of response around recommendations could be explored to improve efficiency

Objective

* To improve the nitrogen and protein efficiencies combining
    - a decrease in degradable nitrogen and
    - an individual protein supplementation according to animal response
* To test a possible interaction between the two strategies

Precision feeding : supplement of protein according to observed protein efficiency

PDI efficiency = 64 % (reference PDI system) *INRA 2010*



The aim was to reach a common efficiency for all cows using precision feeding

85 g 95 g 105 g PDIE/UFL

Experimental design (1/2)

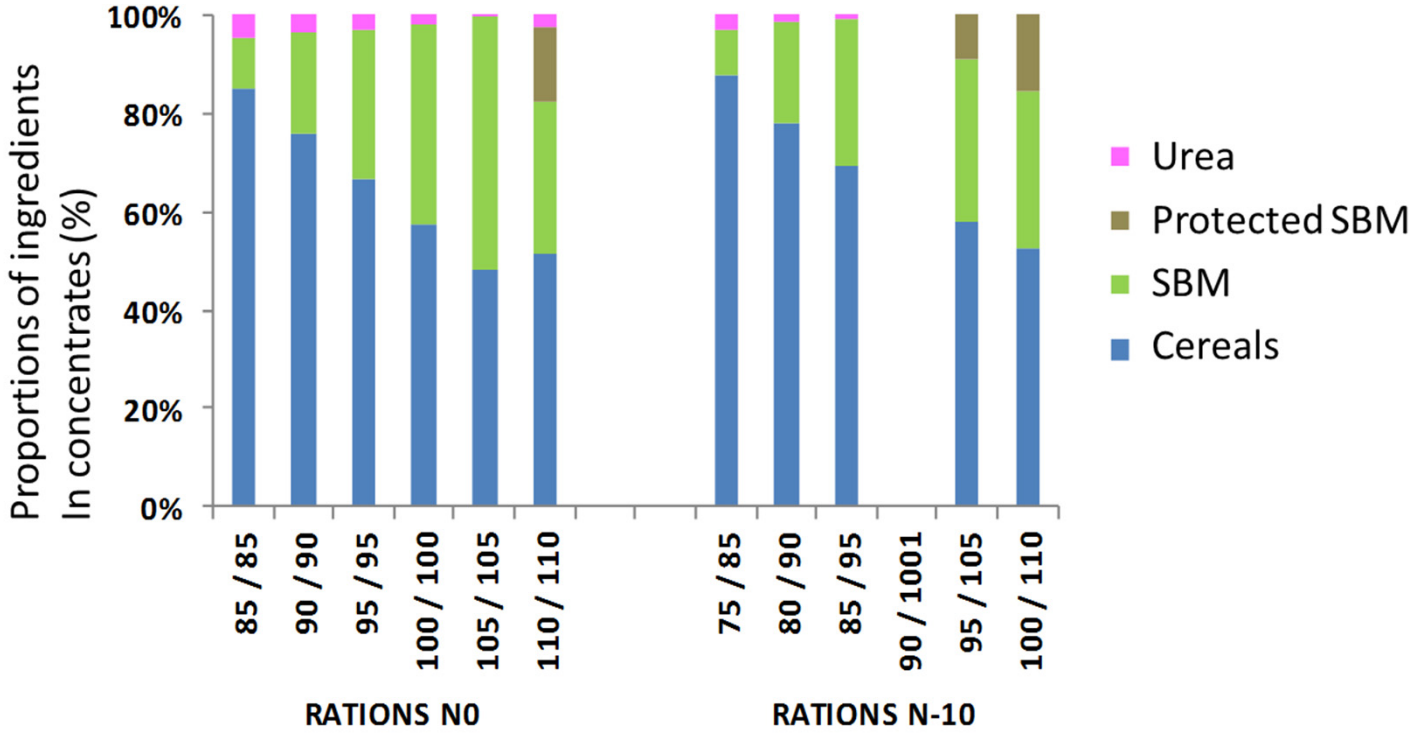
Factorial Design2 x 2

Metabolisable Protein	Degradable Protein: N0 (PDIN = PDIE)	Degradable Protein: N-10 ((PDIN-PDIE)/UFL= -10)
EC (PDIE/UFL Constant 105)	N = 11	N = 11
EV (PDIE/UFL Variable 85-90-95-100-105-110)	N = 11	N = 11

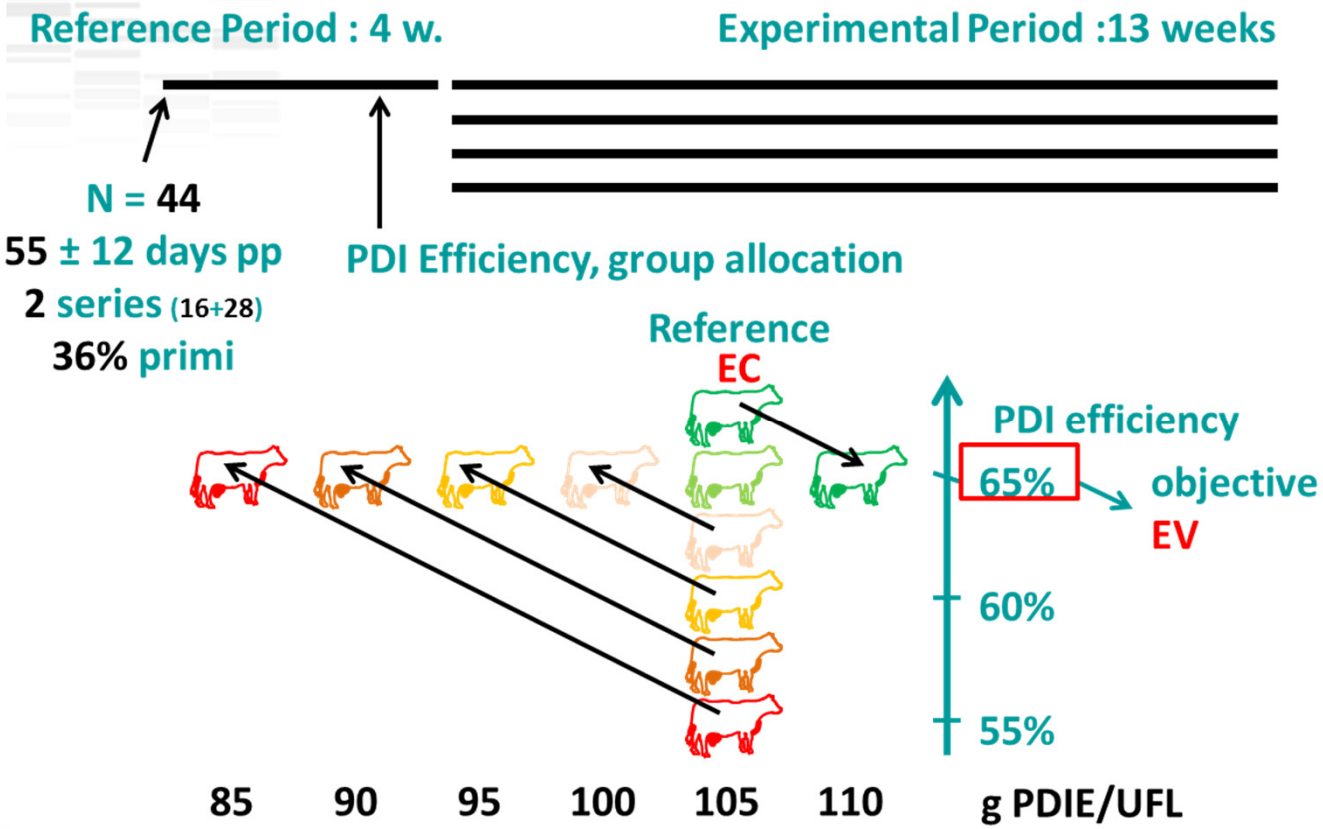
→ 12 complete mixed diets fed ad libitum

- Maize Silage 70%
- Concentrate 30% (composition according cow and treatment)

Concentrate composition of the diets



Experimental design (2/2)



Reduction of rumen degradable nitrogen

No interaction between the two strategies

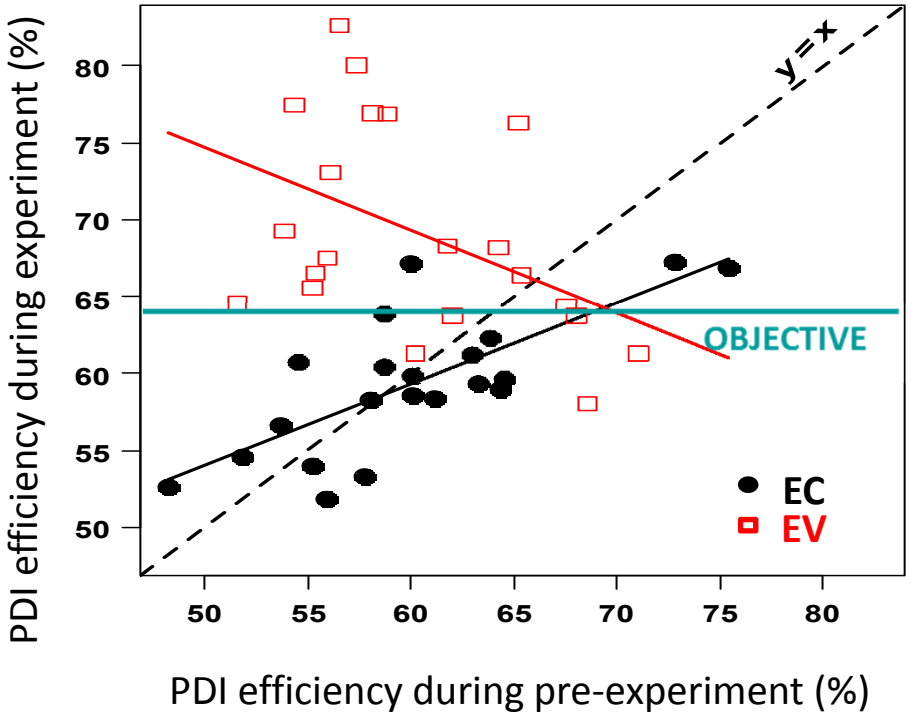
	Degradable Protein		
	N0	N-10	*P*
CP Content (g/ kg DM)	146	128	
Milk Production (kg/d)	31,8	31,2	NS
Protein Content (g/kg)	30,8	30,4	NS
Intake (kg DM/d)	21,3	21,1	NS
PDI Efficiency (%)	64,4	64,0	NS
N Efficiency (%)	32,2	35,7	***

*** P < 0.001 ; ** P < 0.01 ; * P < 0.05 ; + P < 0.10 ; NS P > 0.10

Response to individual protein supplementation

- Variation between cows in protein efficiency are stable in time without change in diet composition (EC)

- Change of protein content correct low efficient cows (EV) (more than expected)



Effect of protein precision feeding

	MP supply		
	EC	EV	*P*
g PDIE / UFL	102	93	
CP content (g/kg DM)	140	133	
Milk Production(kg/d)	32,4	30,7	*
Protein Content (g/kg)	31,1	30,2	*
Protein Production (g/d)	1000	924	**
Intake (kg MS/j)	21,8	20,7	**
PDI Efficiency (%)	59,3	69,1	***
N Efficiency (%)	33,6	34,4	NS
DM Efficiency (kg Milk/kg DMI)	1.48	1.49	NS

*** P < 0.001 ; ** P < 0.01 ; * P < 0.05 ; + P < 0.10 ; NS P > 0.10

An important reduction in urea excretion

	Degradable Protein		Metabolisable Protein		*P*	
	N0	N-10	EC	EV	N	E
Plasma Urea (mg/L)	277	161	247	190	***	***

Using RedNex equation for N partition *Cutullic et al. 2013*

N-10_EV *vs* N0_EC = -58% N urea excreted in urine (133 g vs 58 g)

Conclusion

- Degradability of nitrogen modifies N efficiency, whereas PDIE content changes metabolizable protein efficiency
- With maize based diet, moderate deficiency in degradable protein supply reduces largely urinary N urea losses without decreasing production.
- precision feeding to fit protein supplementation according protein efficiency :
  - decreases the use of protein supplement (- 43% kg SBM/kg milk protein)
  - has limited impacts on dairy production
  - contributes to decrease N urea losses
  - doesn't change the energy efficiency (kg Milk/kg DMI)

Perspectives

- It seems possible to replace expensive manure treatment with low N feeding practices to reduce NH3 emissions
- It is important to consider efforts on protein feeding strategies in the regulation on N organic (estimation of N rejected per cow)…
- … but it requires good indicators of efficient practices
- The precision feeding perspectives are promising to fed individually dairy cows considering their own response to feeding and decrease the use of expensive or limited resources (protein supplement)
- It is essential to be able to use sources of proteins highly protected from the rumen degradation

Thank you for your attention

We would sincerely thank the team of UMR PEGASE…

… especially technicians in animal facilities who participate to this complex trial…

… and the cows of course!