A tool to assess nitrogen efficiency, autonomy and excretion at dairy herd level: CowNex

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Context

- Competition on protein resources
  - Increase in cost
  - Interest to produce more protein on farm (Farm self-sufficiency)
- Nreactive (Nitrogen cascade, Galloway 2004) has always many environmental impacts (climate change, eutophication, acidification, health with small particles), and livestock is an important step in its transformation
  - 77% of ammonia emissions come from animal N excretion

-> Farmers have a double interest in controlling protein use

Background and objective

- At cow level, on a daily basis:
  - N efficiency in dairy cows depends of the rumen balance of nitrogen and the efficiency of metabolizable protein (MP)
  - MP efficiency if a function of MP/NE of the diet, energy balance, essential AA content and milk yield.
- However, what are the main factors of N efficiency at herd scale according the type of dairy system and annual feeding management ?

→ CowNex, a simple tool to estimate N efficiency of a dairy herd

CowNex: a model predicting N excretion for a dairy herd over the year

- Calculating N excretion from a dairy herd according to the number of animals and the diets on a daily basis.
- Merging animal sub-model and a herd demography structure (number of heifers, dry cows and productive cows across the year and the feeding strategies for each category of animals).
- The animal sub-model predicts N intake and urinary and faecal N output on a daily basis using on farm available data.
- N intake and N partition is predicted daily using the intake model developed during the GRAZEMORE project and other results of the RedNex project.

www.cownex-record.inra.fr

Using the INRA modeling Record Platform

With the VLE modeling language

And the informatic skills of ULCO

This site is optimized for Mozila Firefox and Google Chrome

Use of CowNex: different steps

- Describe the main characteristics of the herd : Herd
- Select the feedstuffs used to fed the herd during the year : Feed
- Define the main groups of cattle gathering several classes of animal fed with the same diet during the year : Feeding Groups
- Indicate for each feeding group the different diets offered during the year : Diet Plan
- Run the simulation to get results : Simulation

Simulation of model farms with CowNex: feeding calendar

Feeds offered in fixed amounts (kg DM/d)

Feeds offered ad lib (%)

Cows-Vaches

	Diet 1 (75 Day) Begin : 9/1/2012 End : 11/15/2012 (mm/jj/aaa)		Diet 2 (60 Day) Begin : 11/16/2012 End : 1/15/2013 (mm/jj/aaa)		Diet 3 (88 Day) Begin : 1/16/2013 End : 4/14/2013 (mm/jj/aaa)		Diet 4 (76 Day) Begin : 4/15/2013 End : 6/30/2013 (mm/jj/aaa)		Diet 5 (62 Day) Begin : 7/1/2013 End : 8/31/2013 (mm/jj/aaa)	
	DM (kg/day)	%	DM (kg/day)	%	DM (kg/day)	%	DM (kg/day)	%	DM (kg/day)	%
FreshGrass		100						100		100
MilkP-LaitP										
MaizeS-EMais			7			65				
Straw-Paille										
SMB-Tt_Soja			1			10				
Barley-Orge	4					20	4		4	
Grass Silage										
BRE										
Foin				100		5				
Total	4	100	8	100	0	100	4	100	4	100
Time outdoors (h)		20		0		0		20		20

Simulation of feeding management of different model farms using survey data

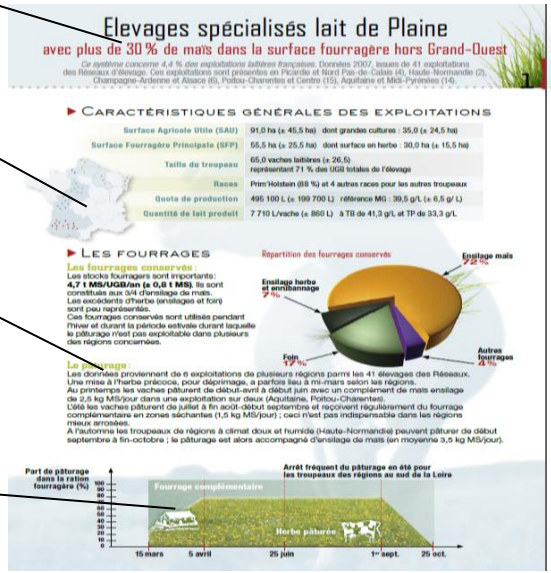
15 diets of different model farms in different parts of France

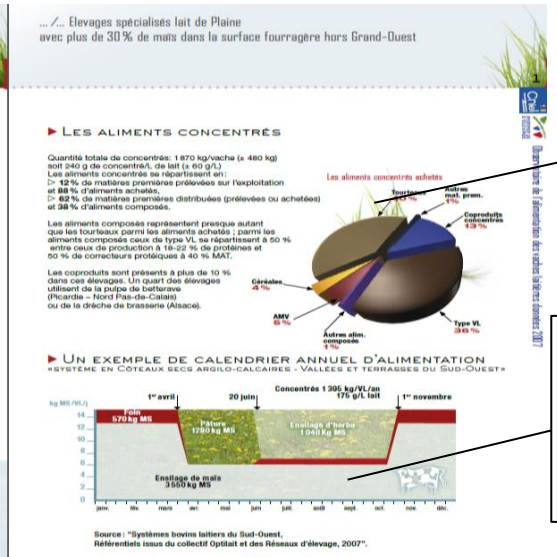
Type of farm

General description

Characteristics of forage used

Heifers: Example of feeding calendar





Cows:Types and amount of concentrates used

Cows : example of feeding calendar

Example of one model farm description (Institut de l'Elevage, 2011)

Comparison of specialised dairy systems in lowland

	Autres régions			Grand Ouest		
Annual results	Maïs>30%	10<Maïs<30	Maïs<10	Maïs>30%	10<Maïs<30	Maïs<10
DM intake (kg/cow/y)	7047	6756	6108	6791	6327	5732
N intake (kg/cow/y)	187	181	152	165	163	142
N excreted (kg/cow/y)	142	141	119	122	125	110
Milk (kg/cow/y)	8169	7500	6334	7827	6786	5608
DM Self-sufficency	76%	82%	89%	87%	88%	94%
N Self-sufficency	49%	57%	78%	67%	73%	79%
N Efficiency	23.6%	22.4%	21.4%	25.7%	23.1%	21.4%
NH3 (kg N/T Milk)	4.9	4.0	1.8	2.2	3.4	1.7

Impact of protein supplementation on emissions

- Comparaison of different protein supplementations in dairy systems using large amont of soyabean meal (dairy specialized and crop-dairy systems). Calcul on dairy cows only.
  - 14% CP
  - 15% CP
  - 16% CP
- Collection of CowNex output to calculate NH_3 and N_2O emission using the EMEP/EEA european reference method and national database to describe housing and manure management systems

	A	B	C	D
1	equations/lots	Cows-Vaches	Heifers-GÃ©nisses	Calves-Veaux
14	MaizeS-EMais N	17.9361614	0	1.208880048
15	Straw-Paille N	0	1.884728099	0
16	SMB-Tt_Soja N	20.29854541	6.946569279	0
17	Barley-Orge N	23.6938453	0	4.064640162
18	Grass Silage N	0	7.538912283	0
19	BRE N	0	0	0
20	Foin N	10.00888089	0	0
21	Total Diet MS(input)	7510.849093	3339.256725	547.5000218
22	Total Diet N(input)	181.8897581	91.28261772	13.78824055
23	CP	151.3558553	170.8513025	157.4
24				
25	N intake(dm)	757036.8075	446261.8916	6956.097832
26	N intake(n)	18333.11255	12199.10807	175.1823678
27	N produced(dm)	732255.5584	435017.3779	4173.658699
28	N produced(n)	16287.17263	11270.76101	67.00113432
29	N imported(dm)	24781.24906	11244.51375	2782.439133
30	N imported(dm)	24781.24906	11244.51375	2782.439133
31	Self efficiency(dm)	96.72654634	97.48028815	60
32	Self efficiency(n)	88.8401933	92.39004155	38.24650572
33				
34	N Milk	45.29550802	0	0
35	N Meat	5.51291129	3.936631399	0.629798532
36	N Feaces	67.68911106	25.50556371	3.854400153
37	N Urine	67.34937134	61.42919758	2.921911558
38	Total Diet N (output)	181.8897581	91.28261772	13.78824055
39	N Efficiency	27.93363399	4.312575052	4.567649725
40				
41	totalExcretion	13610.85815	11618.05582	86.09440244
42	Collectable feaces	2572.289909	866.2873052	48.97092874
43	Collectable urine	1597.906984	1249.659492	37.1234737
44	Collectable total	4170.196893	2115.946797	86.09440244
45	Uncollectable feaces	4250.260765	2542.303901	0
46	Uncollectable urine	5190.400494	6959.80512	0
47	Uncollectable total	9440.66126	9502.109021	0
48	% Controlable	30.63875067	18.21257214	100
49				

simulation

Prêt

N-Efficiency, N-self-sufficiency and N emissions

Dairy Systems
(maize in %
of forage area)

Specialised

Plain

1 nW Maize>30%

2 W Maize>30%

3 nW Maize10-30%

4 W Maize10-30%

Montain

7 Maize

Crop dairy

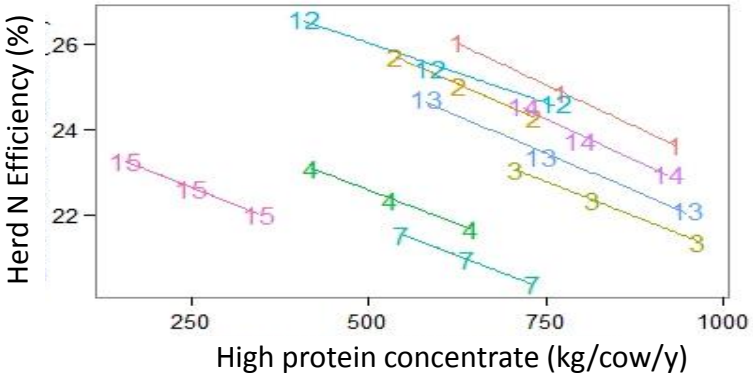
12 Maizes>30%

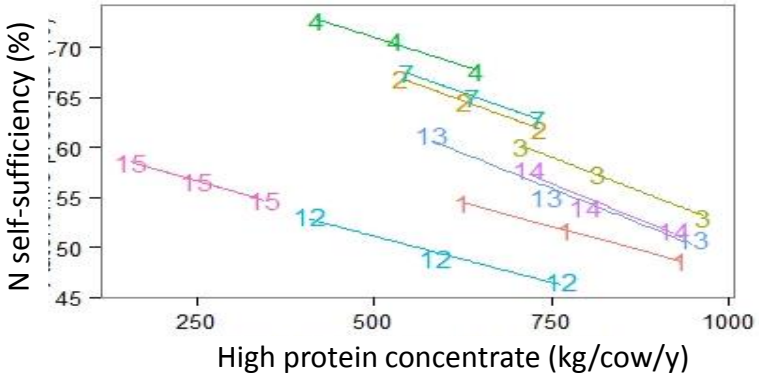
Mixed Dairy

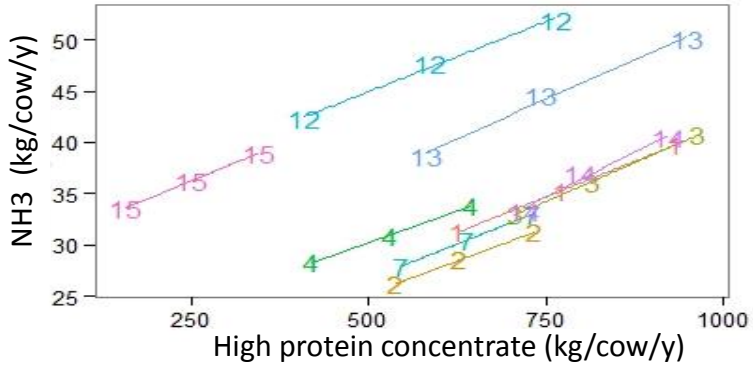
13 Maize>30%

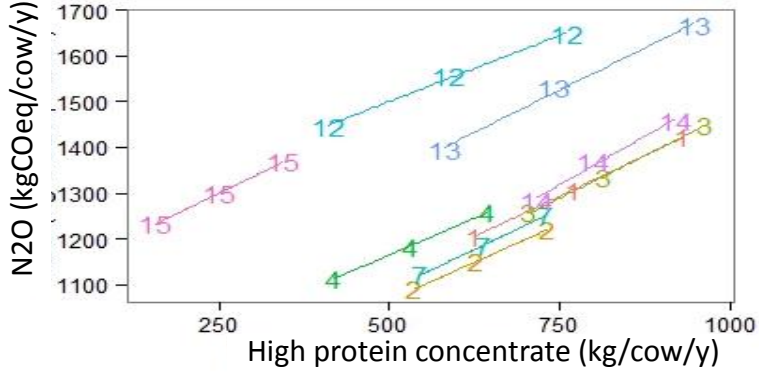
14 Maize10-30%

15 Maizes<10%









Conclusions

- CowNex is a simple tool to assess quickly the efficiency of N use at herd level
- If maize systems could theoritically better balance protein supplementation, it is not always observed in pratice and they are less protein self-sufficient
- Protein supplementation is an important lever to control protein selfsufficiency, nitrogen excretion and environmental impacts of dairy farming system
- Time spent indoor increases the risks of ammonia emissions
- In many systems, there are economic and environmental benefits to pay attention to the protein supplementation

Thank you for your attention

and welcome to CowNex…

A product of RedNex project
EU, FP7, KBB-2007-1
Caution: Do not confuse with