Assesment of N flows in Livestock Farming Systems:

Main issues and proposed options

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A request from Ministry of Agriculture and Ministry of the Environment

- A synthesis of updated knowledge on N flows in livestock farming systems, from the animal to the regional scale, with a specific focus on farm level
- All forms of N (nitrate, ammonia, nitrous oxide, others) and the link with impact had to be considered
- Identify possible actions to improve livestock farming systems sustainability (e.g. techniques, management, re-design of systems, economic and policy incentives

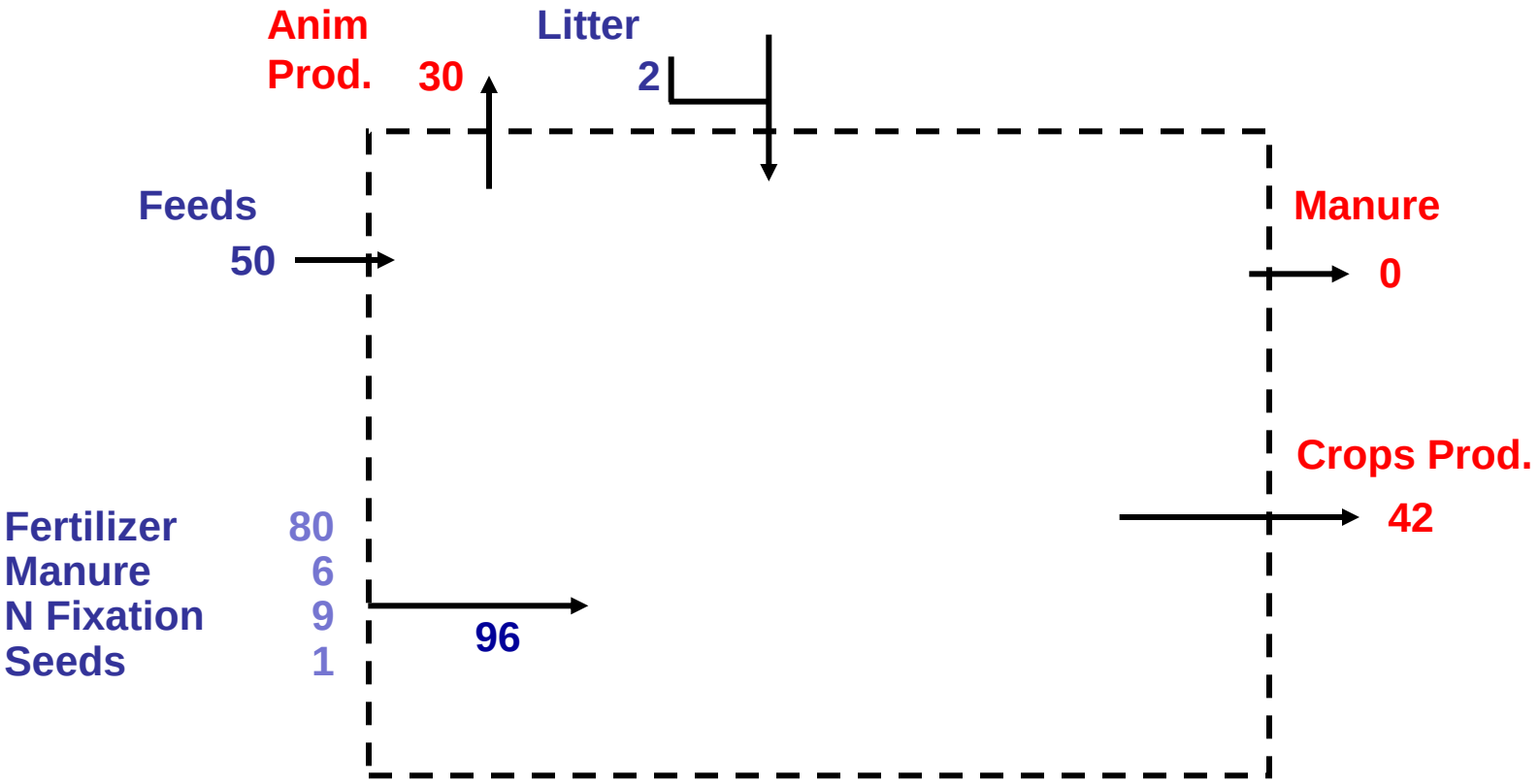
A collective expert assessment was conducted in 2011

Plan

- N flows in livestock farming systems
- Options to improve N efficiency and to reduce environmental impacts
- Indicators
- Conclusions

Numerous and interdependant N flows:
A variety of inputs and output to/from the farm

Adapted from Jarvis et al (2011) with data from typical french farms

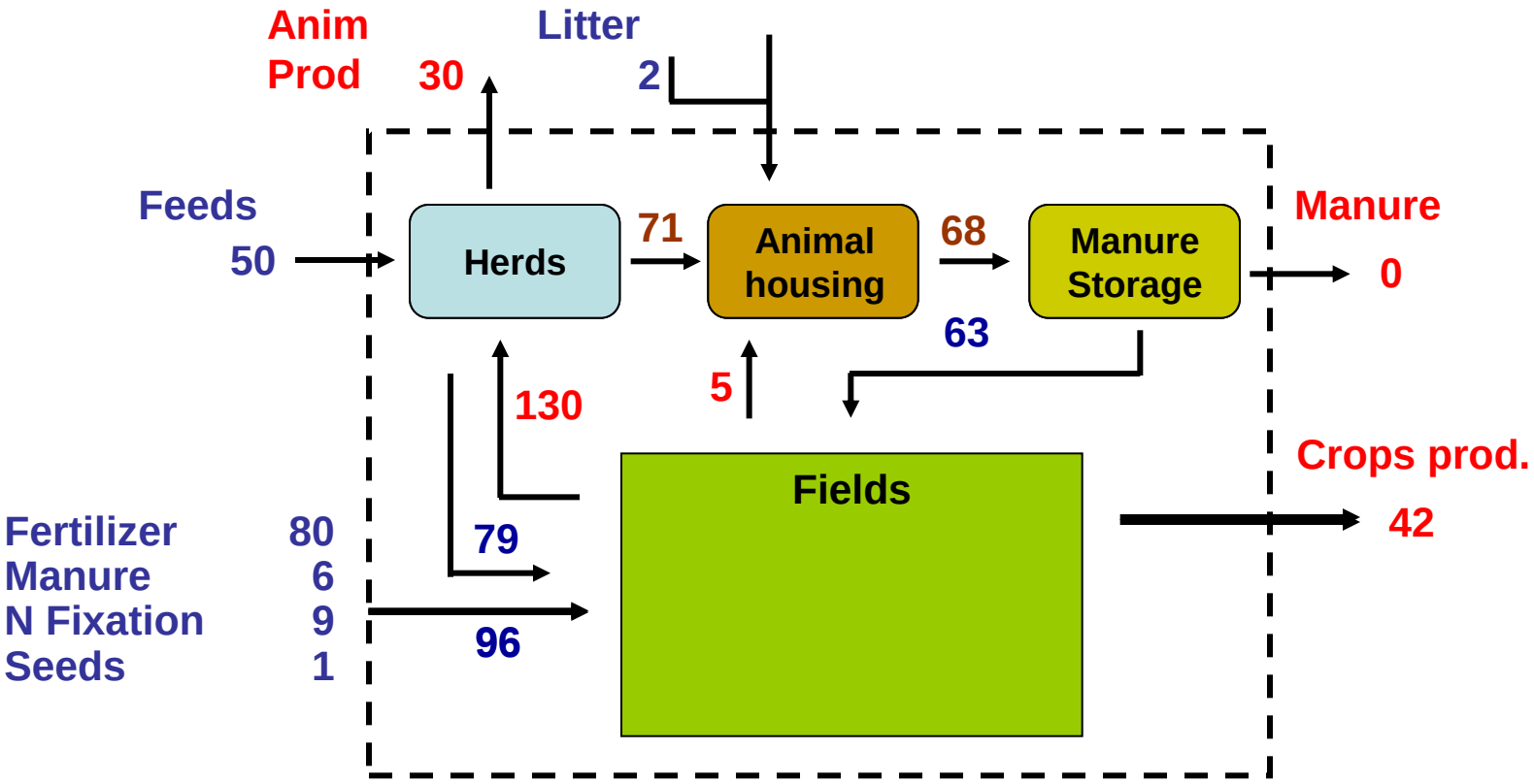


Dairy and crops

80 ha, 82 LU, 25 ha cereals

Numerous and interdependant N flows:
Lots of internal fluxes to consider

Adapted from Jarvis et al (2011) with data from typical french farms



Dairy and crops

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Numerous and interdependant N flows:
A variety of N fluxes to the environment

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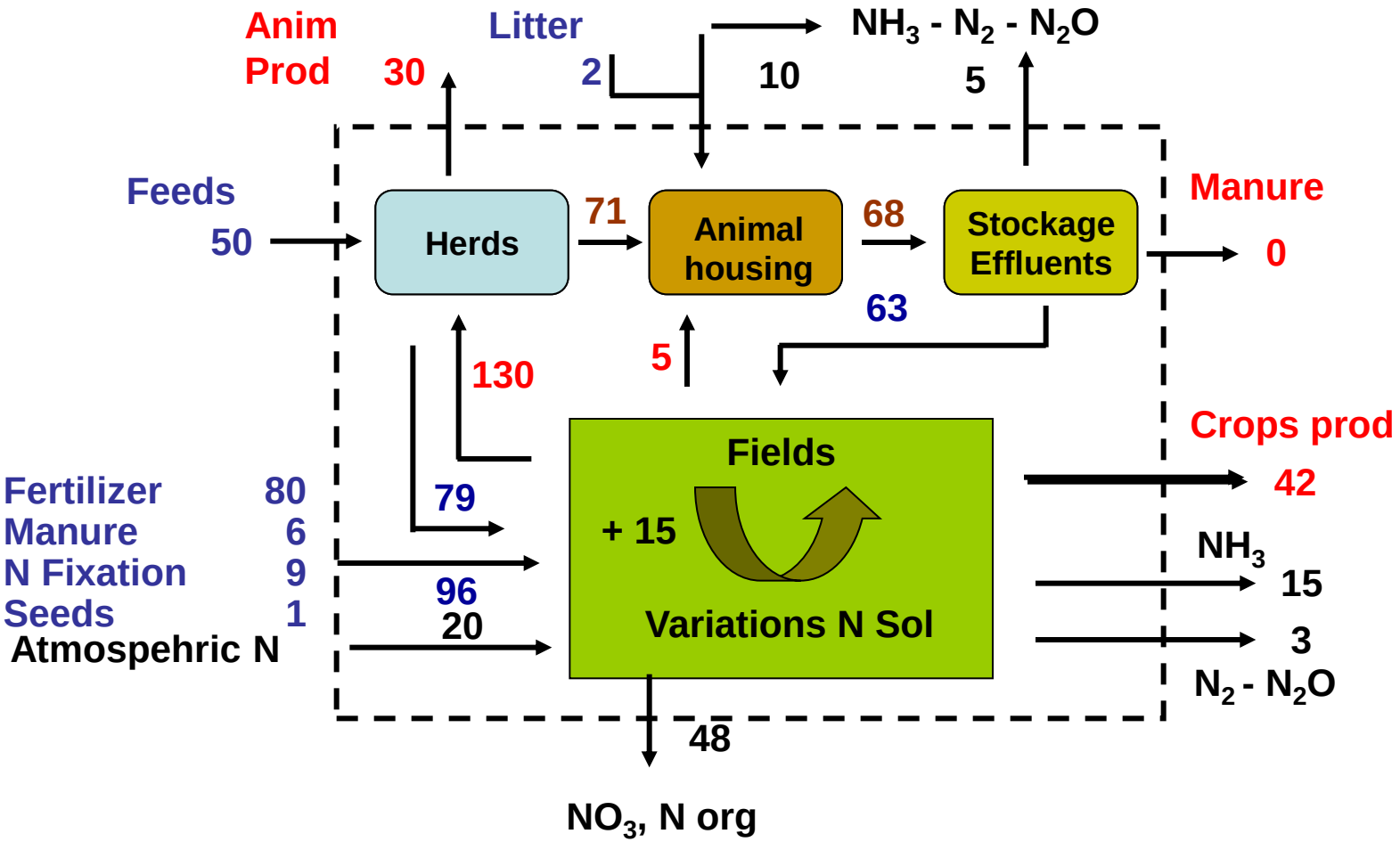
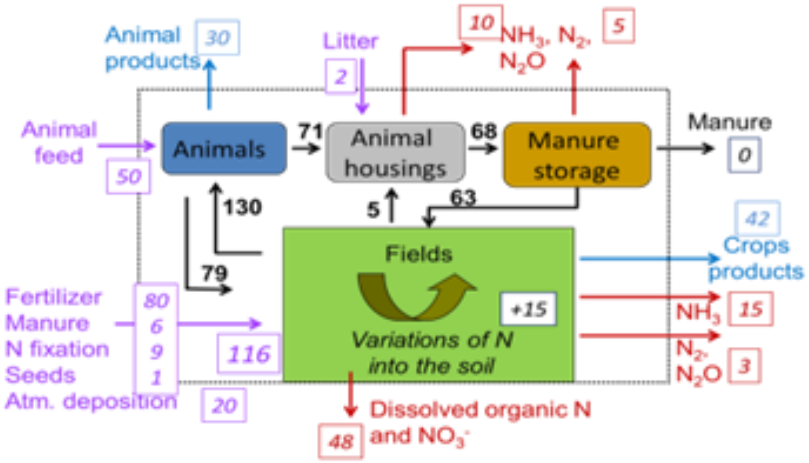


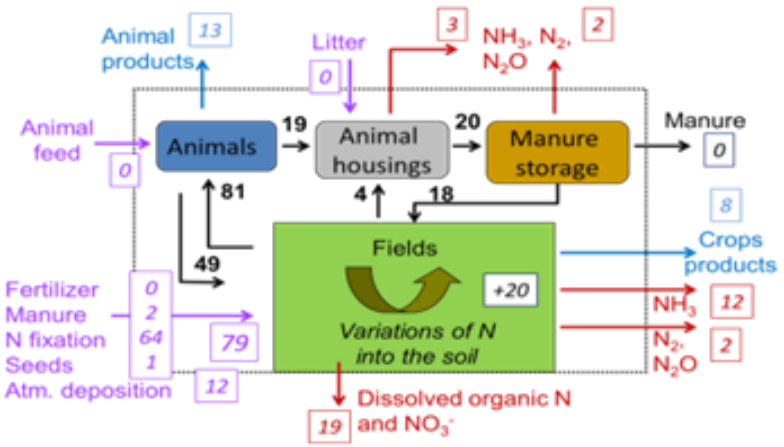
***N efficiency results from complex interactions**, one improvement can be cancelled by a bad management at a previous or next stage*

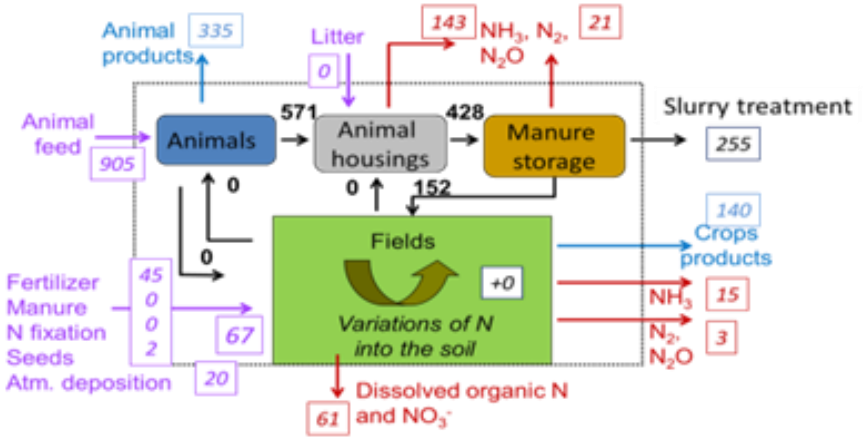
Numerous and interdependant N flows:
A huge variability depending of the system

Dairy and cereals
80 ha, 82 LU, 25 ha cereals



Organic dairy
160 ha, 107 LU, 65 ha cereals





Pigs and cereals
84 ha, 400 sows

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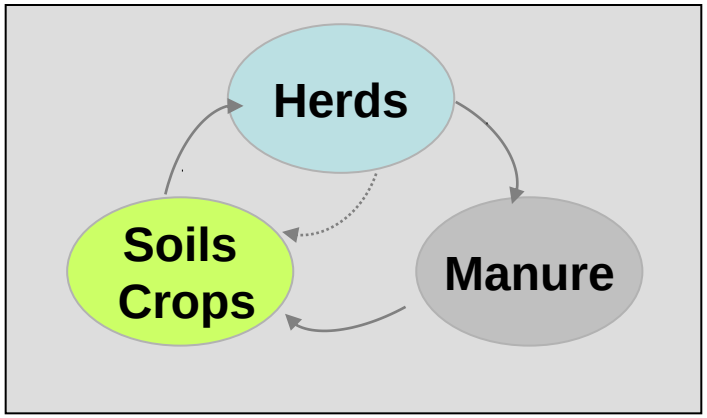
Options to increase N efficiency at farm level

Efficiency	Drivers	Knowledge
<10 à 40%	Genetic merit (↑ eff) Feeding practices	++

Margins of progress +/-



Take into account all N flows related to the farm to screen every source of waste and every way to progress

Effect of diet composition and genetic merit on N excretion

Diet composition

- Pig :

  "Multi phases" feeding + AA balance : - 30% N excreted
  reduced N rejected / feeding cost

- Dairy cows :

  Major effect of forage N content (grass > maize silage)

  MS+GS 6 months + 6 months grazing = 121 kg N excreted

  MS 12 months = 91 kg N excreted /year

Genetic merit

+ 1000 kg/lactation = - 5% N excreted /t milk

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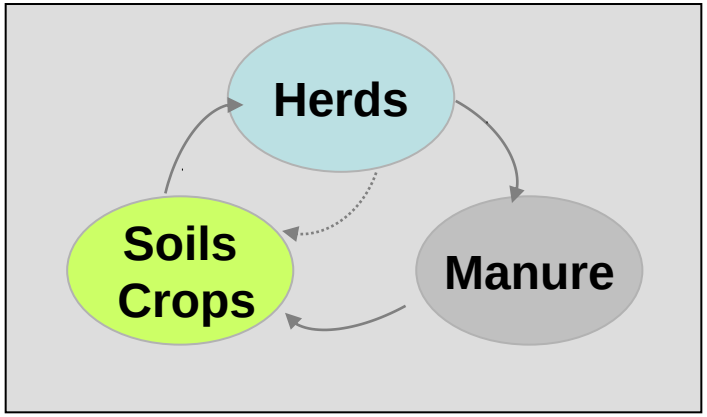


Losses	Drivers	Knowledge
20 to 80% NH_3 25-55%	Housing > grazing Housing>spreading >storage Treatments	Large uncertainty (emission)

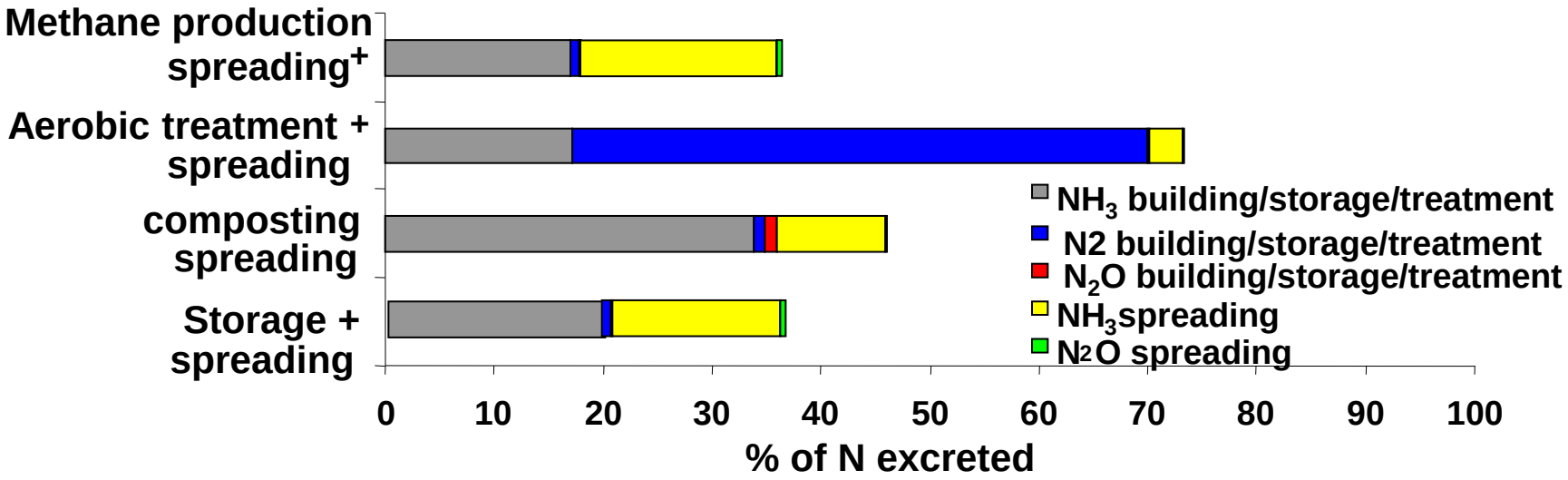
Margins of progress ++

Take into account all N flows related to the farm to screen every source of waste and every way to progress

Effect of livestock manure management on N emissions

Large effects of liquid manure management on N losses

Animals x housing engineering x practices



Lower NH3 emission at grazing

< 10% vs 25% for housed ruminants

Risk of pollution swapping

Reduced emission during storage / increase during spreading

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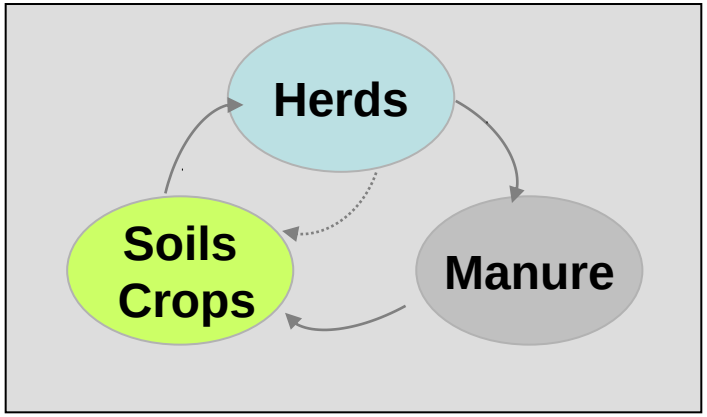


Losses	Drivers	Knowledge
20 to 80% NH_3 25-55%	Housing > grazing Housing>spreading >storage Treatments	Large uncertainty (emission)

Margins of progress ++

Efficiency	Drivers	Knowledge
Medium (> 40%)	High inputs (↓ eff) Grassland, legumes, crop rotation	+

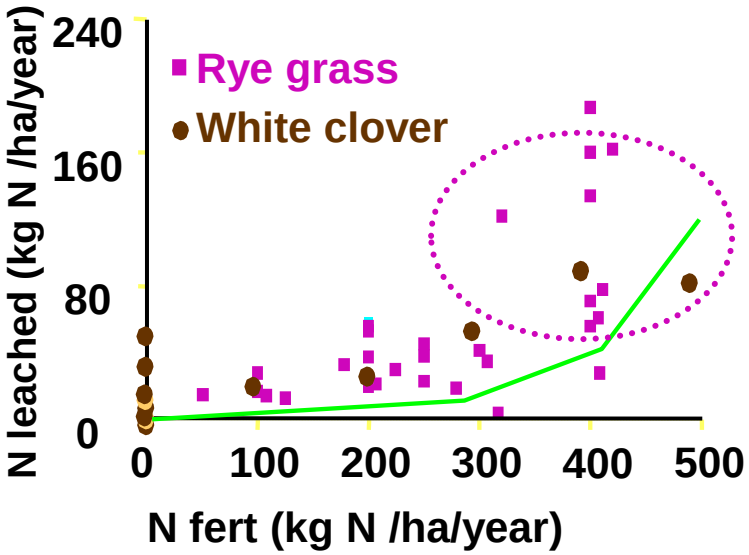
Margins of progress ++

Take into account all N flows related to the farm to screen every source of waste and every way to progress

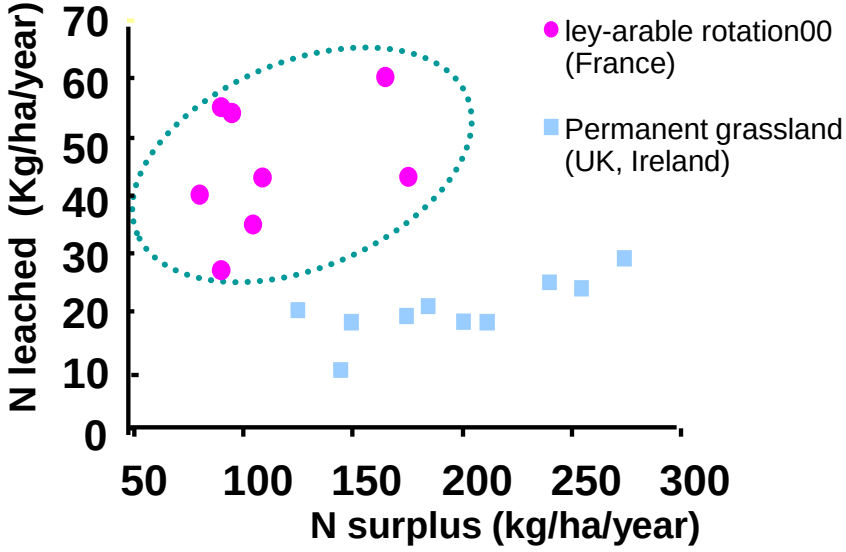
Grassland contributes to regulate N flows … provided good practices are adopted

Fate of N excreted	Urine	Dung
Volatilisation	10-15	5-10
Leaching	25-30	10-15
$N_2O + N_2$	< 5	-
Plant growth	25-30	60-70
Soil OM	30-35	10-20

Although large amounts of N are excreted, large amounts of N can be recycled under well managed grasslands



(Vertes et al., 2010)



(Raison et al., 2008), Projet Greendairy

Conclusion can be different according to the investigated scale

40 cows, 7500 kg milk per lactation

Maize silage Grazing	12 months	6 months 6 months
N intake (kg)	5.3	6.4
from concentrate (kg)	*2.5*	*1.3*
N excreted (kg)	3.7	4.8
spreadable N[1] (kg)	2.7	4.2
N in forage (% spreadable N)	99 %	121 %

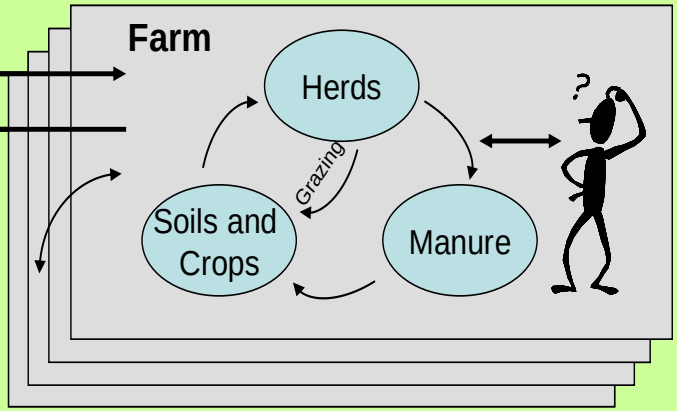
[1] 0.75 N excreted in barn + N at grazing

(from Peyraud et al., 1995 and Vérité and Delaby, 2000)

On grassland based systems, N excretion by dairy herd is high but grazing allows to recapture a high proportion of N and to increase protein (and energy) autonomy at farm level

Options to better use N at landscape level

Looking forward synergies between farms



Changing local farming systems

Improving landscape management
(wetlands, grasslands, edges, small forests…)
(N use, denitrification, NH3 recapture)

Relocating animals

Collective manure management for exporting

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Indicators for assessment and management

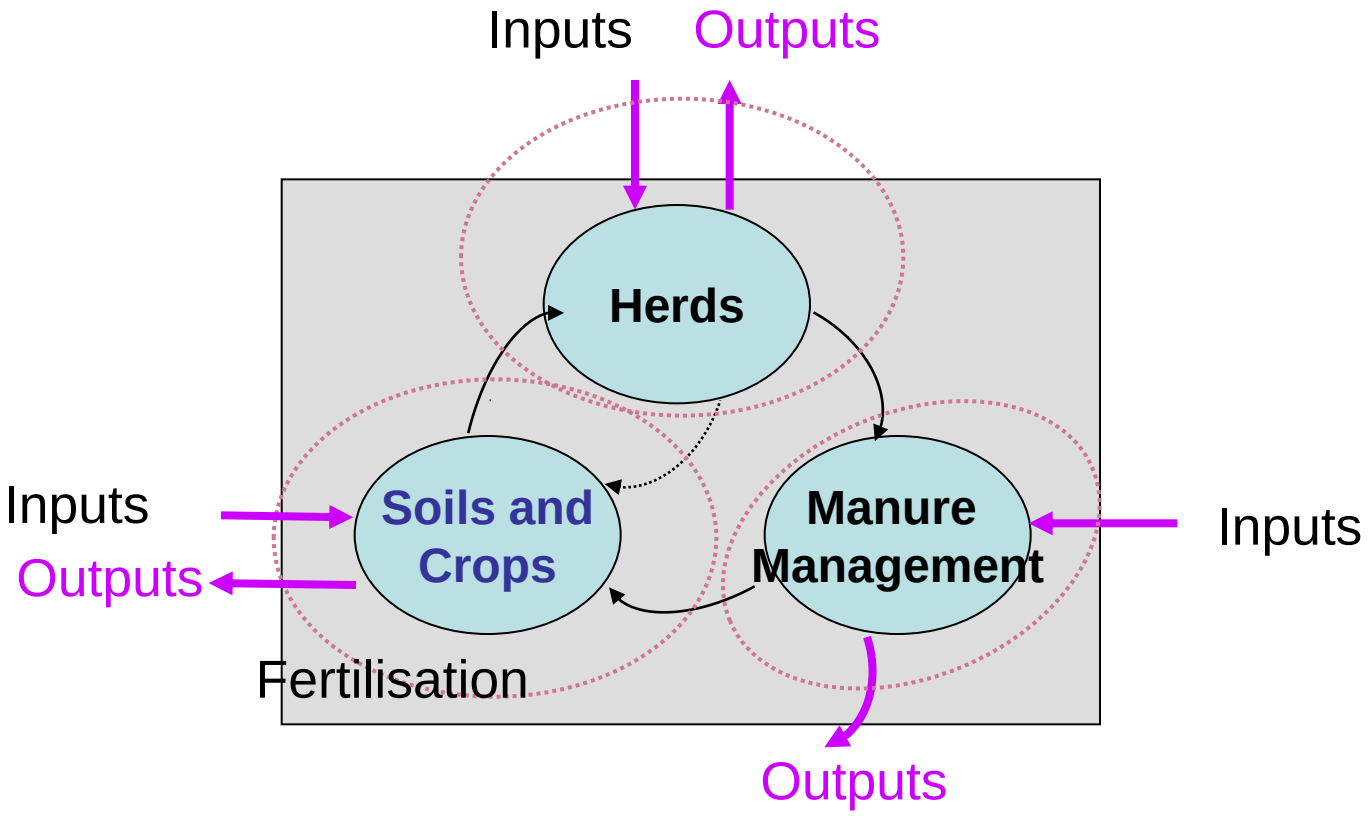
Type of indicators

Practices	Emissions	Status / Impacts
% fertilised area	Soil N conc.	NO_3 conc/water
Inputs…	Emission factors	Particles conc.
N Balances ⟷	Models ↕	LCA
N management Poor predictors of impacts	Effects of the practices	Diagnostic Comparison of systems

Difficulties and uncertainties

- Data availability - cost for collecting valuable information
- Difficulties for implementing numerous indicators
- Threshold values, lack of knowledge, scaling up (farm to regional scale)

N Balance to assess environmental performances



Farm gate N balance + N balance of sub systems
+ simulation of N emissions

Adapted from Aarts

“Soil N surplus” and “farm N budget” produce different figures

Pigs + Cereals (84 ha)
Same cereal crops - Same N fertilisation (152 N org + 67 N min)

150 sows + fattening
(no manure aerobic treatment)

	Farm gate
Inputs	**386**
Outputs*	**265**
Surplus	**121**

Soil
199
140
59

400 sows + fattening
(60% treatment)

Farm gate
952
730
222

* 140 crops + 125 carcasses

* 140 crops + 335 carcasses
+ 255 N_2

Associated effects to adopted solution for increasing N efficiency

	Pollution transfer (water/air)	P efficiency	GHG reduction	Energy consumption	Income	Productivity (/ha)
Feeding	0 or +					
Manure Management	0 or +	+			+ or -	
Soil and crops	0	+			variable (innovations)	
Landscape designing	+ or -	+	+ or -	0		

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Options were identified

Farm level

Reducing farm N surplus (manure > fields > herds)

- Animal feeding, animal genetics, precision livestock feeding
- Reduce NH_3 losses but interdependant steps, risk of pollutions transfer,
- Cropland and grassland management

Indicators to better manage the system : N balances,….

Landscape level

Need to take better account of local territorial vulnerability

but … this will need strong will from policy makers

- Documents on the web

  http://www.inra.fr/l_institut/expertise/expertises_realisees/expertise_flux_d_azote_lies_aux_elevages

  - Summary : 8 pages
  - Extended summary : 67 pages
  - Full report : 528 pages