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Assessment on nitrogen flows in livestock farming system in France. Main issues and options.

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1. Background : Livestock consumes large amounts of agricultural products and is a major source of reactive nitrogen. Moreover different economic and societal factors contributed to a concentration of livestock in the West of France, leading to an increased pressure on the environment. The surplus of N causes pollution especially in the atmosphere, water ressources and coastal ecosystems.

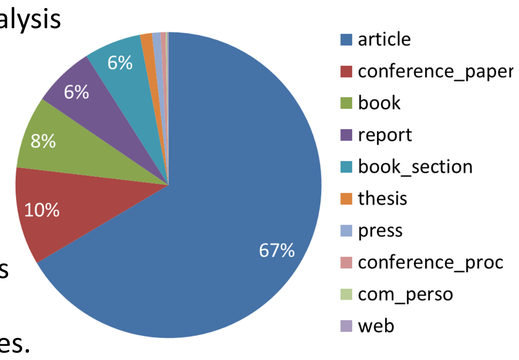
2. Objectives : A collective expert assessment (Esco) was conducted whose objectives were to

- make a synthesis of updated knowledge on N flows in livestock farming activities on, from the animal to the regional scale with a specific focus on the farming system. All forms of nitrogen (nitrate, ammonia, nitrous oxide, others) were considered as well as the link with impact.
- make a comparison between different livestock systems.
- identify several possible actions in livestock breeding systems, e.g. improved techniques and management, change in the system, territorial and economic incentives.

3. Methods

The cross-disciplinary assessment was based on an analysis of the literature by a panel of 22 scientists from a wide range of disciplines: animal sciences, agronomy, social sciences, biogeochemistry, etc.

- 1332 references were analyzed from 272 scientific journals; 82% after 1998.
- 3/4 of the references were on biophysical processes (of which half on N fluxes in livestock farming systems and approx. 20% on indicators), and ¼ in social sciences.
- The references were also analyzed according to the journal which they were originating from, the origin of the authors and the main topics of the assessment.



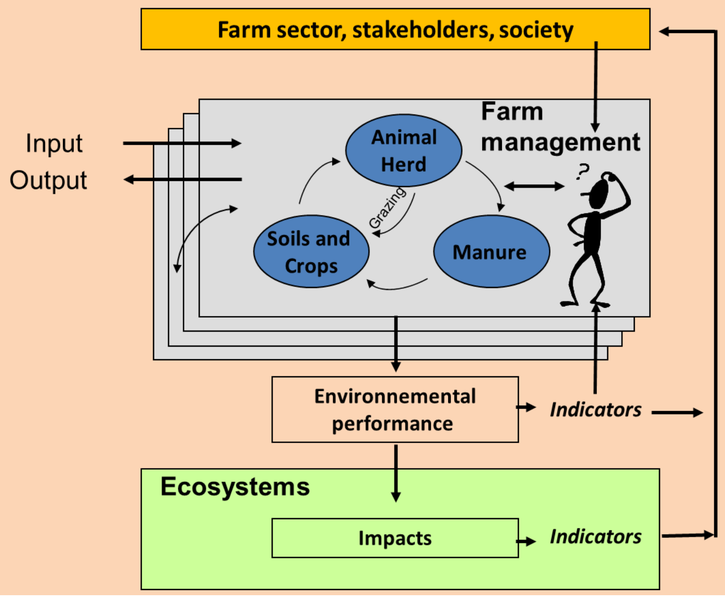
4 Results

This section makes a synthesis of the main findings.

A framework to analyse livestock farming system

Choices in N management are taken by farmers. But they involve:

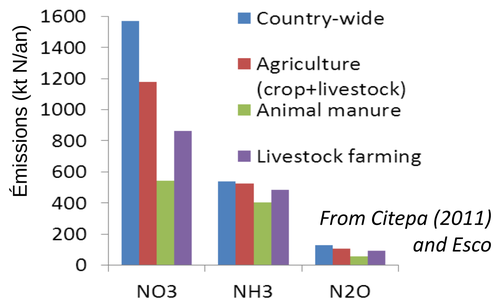
(i) Herd unit, manure management , soils & growing crops.
(ii) Groups of farms or local organisations where deals may open new opportunity for N flows control.
(iii) Environmental issues linked to farming activity
(iv) Stakeholders with their policies and social debate.



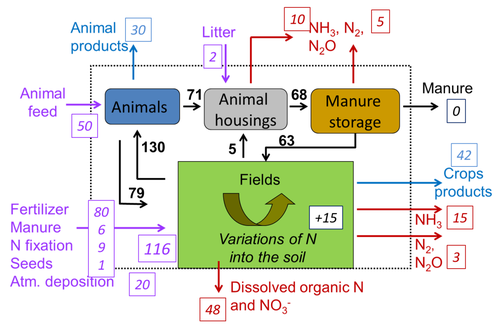
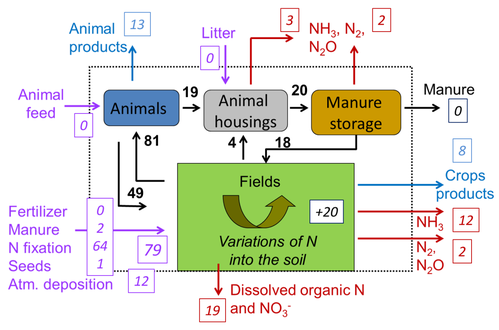
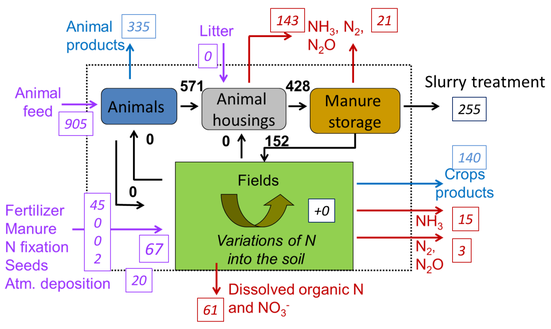
➢ **Livestock farming provides major part of N flows.**
In France for very long, nitrogen issues in livestock farming have only been considered from the point of view of water contamination by nitrate. However, livestock farming has a prominent place in the whole N cycle: it is the main provider of atmospheric ammonia (90%) and N_2O (>70%) and accounts for more than 50% of nitrate.

➢ **Specialisation and concentration amplify problems.**
From the 50th , the agricultural system moved from mixed farming to specialized systems and increased concentration in animal husbandry due to economic rationality and agroindustry pressure. West of France presently concentrates half of hogs and poultry and 20% of cattle on only 6% of farmland. Consequently, livestock farming has no longer sufficient land for providing feed and spreading manure. Scientific literature emphasizes that this technical and economic logic locks the system because firms and farmers are strictly connected in their activities.

➢ **A complicated legal frame did not allow to achieve the objectives.**
The French N regulations framework is characterized by a overabundance of plans that make it difficult to find a compromise between agreeing with the European directives, maintaining the production and reaching environmental aims.
The problem of pollutions progressively entered into the public debate in the 90th , thereby questioning the livestock farming practices and making the farmers more difficult in some cases.



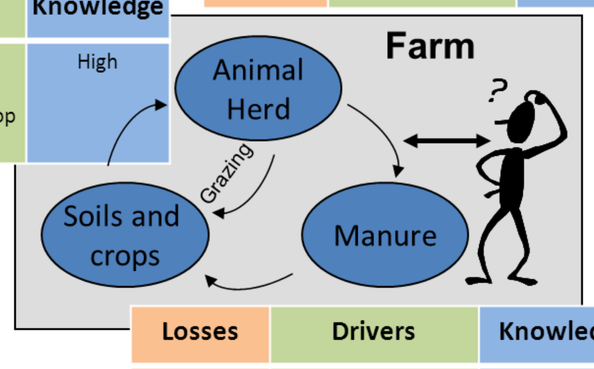
➢ **N farm budgets are convenient methods for improving nitrogen management.** The budget has to take into acount all the flows related to the farm in order to screen every source of waste and identify a range of progress.

Average N flows	Farming system		Budget (kg N/ha) Farm-gate	Budget (kg N/ha) Soil system
	**Dairy farm + crops** 80 ha UAA 82 LU Crops = 25 ha West of France	Input	148	238
		Output	72	177
		Balance	76	61
	**Organic dairy farm + crops** 160 ha UAA 107 LU Crops = 65 ha East of France	Input	67	134
		Output	21	93
		Balance	46	41
	**Pig farm + crops** 84 ha UAA 400 sows Breeding and fattening Slurry treatment (60%) West of France	Input	952	199
		Output	730	140
		Balance	222	59

➢ **N efficiency per animal is low but it increases at the farm scale thanks to internal recycling**
A minority of N input is exported in products: eggs, milk or meat. Limited progress can still be made with feed recommendations. Margins are higher for farms. The N balance results from complex interactions and thus an improvement at one stage can be cancelled by a bad management at a previous or next stage. Grazing reduces N emissions because there is no storage and grass absorbs N directlyfrom excreta. Globally, N efficiency in livestock farming is around 40-50%. It decreases when N input increases. Low input and organic farming show the highest N efficiency.

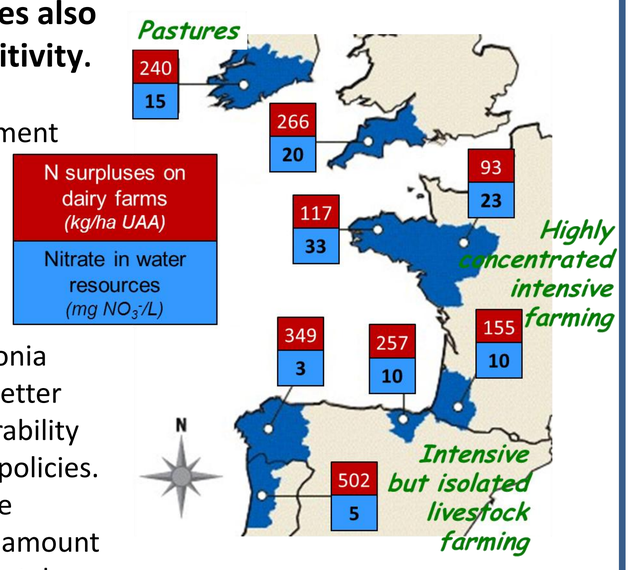
Efficiency	Drivers	Knowledge
Medium (40%)	Production intensity Farming system: grassland, legumes, crop rotation	High

Efficiency	Drivers	Knowledge
Low (10-40%)	Production yields Feeding practices	++



Losses	Drivers	Knowledge
Very variable (20-80%) NH_3: 25-55%	Housing > grazing Housing> spreading > storage Manure treatments	± Large uncertainty on emissions

➢ **The impact of nitrogen losses also depends on landscape sensitivity.**
That is the capacity of the agroecosystem and the environment (surrounding ecosystems, soils) to use or to transform the excess N.
Animal density, fraction of farmlands and grassland in the area influence nitrate and ammonia losses. This shows the need to better account for the territorial vulnerability when setting up environmental policies. Then a critical load of N might be allowed for a given area ,whose amount depends on the local environmental sensitivity.



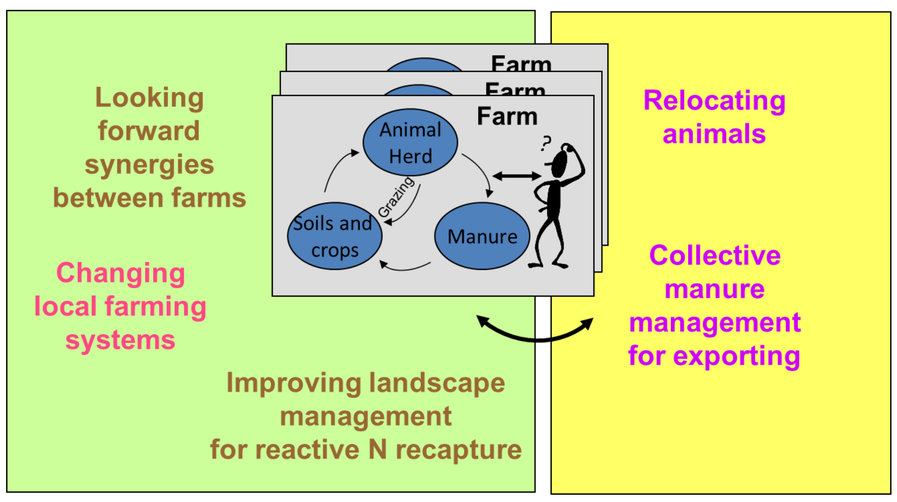
From the Green Dairy project (2006) (Inquiry on >200 farms)

A range of options for reducing the impact of excess nitrogen in livestock farming has been defined:

- Applying more extensively measures for decreasing ammonia emissions, which has not been considered very thoroughly in France up to now.
- Manure treatment for exporting them to remote places with fewer nitrogen issues.
- Improving nitrogen balance on farm instead only in fields, considering thus all the flows and losses of nitrogen in the system. Yet it is difficult to implement due to the lack of data to estimate llocal flows.
- Relocating a fraction of livestock farms, or mixing crop and livestock systems could be envisaged on a case by case basis, between regions or between adjacent areas with different nitrogen loads. Inside critical areas, this might require reorganizing the farming system dramatically. This can only be done with cooperation between local partners.
- Environmental policies face with the problem of the mostly diffuse sources of nitrogen sources and with the difficulty to give a precise value to most N-related damages. Penalties based on estimating nitrogen surplus seems to be the best compromise.

These options must consider interactions with other environmental issues (energy budget, phosphorus, pollution swapping) and economic issues (farmers income, global production).

➢ **Territorial options and deals between areas**



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