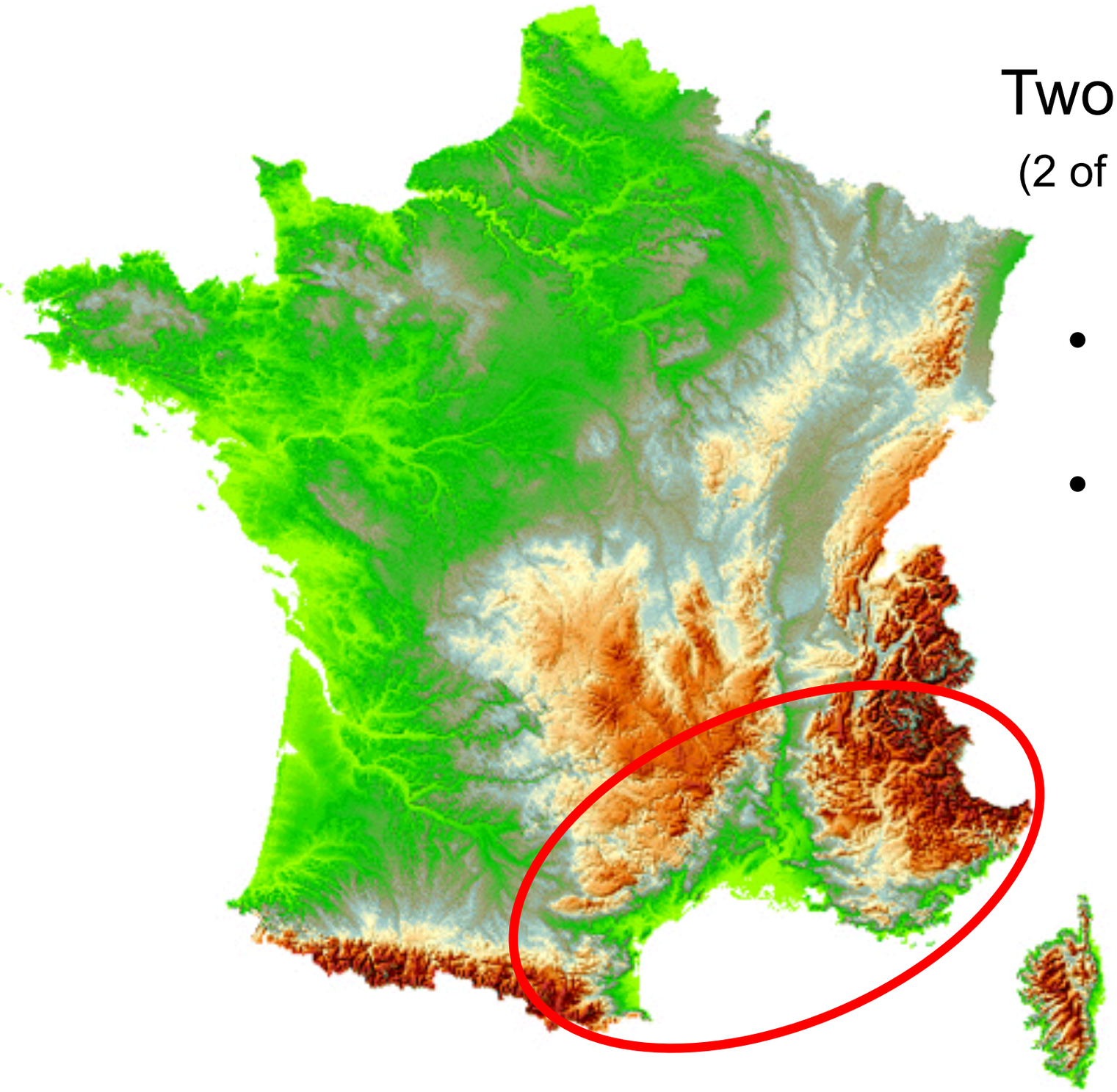
CLIMED

The future of Mediterranean Livestock Farming Systems: opportunity and efficiency of Crop–Livestock Integration

Mid-term meeting, Rabat
20-21 April, 2013

Midterm achievements of the project in France
and plan activities for 2015



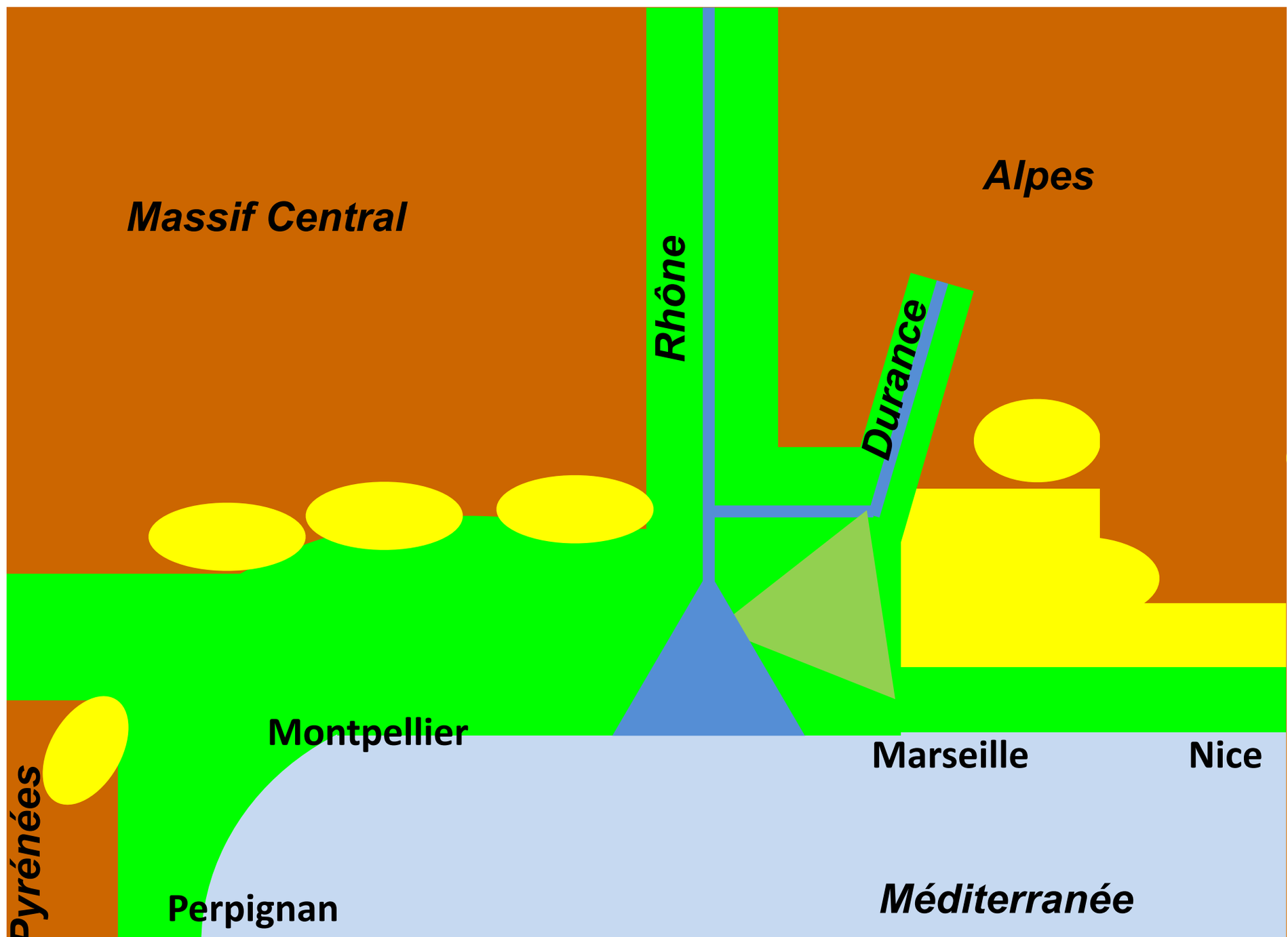
Two administrative region

(2 of the 22 region in France)

- Provence Alpes Côte d'Azur (**PACA**)
- Languedoc-Roussillon (**LR**)

Four areas, with different dynamics of crops and livestock

1. Mountains or altitude plateaus
2. Piedmont, hills, small valleys
3. Large valleys and littoral plains
4. Deltas



Dynamics of crop-livestock integration in mediterranean areas in south of France

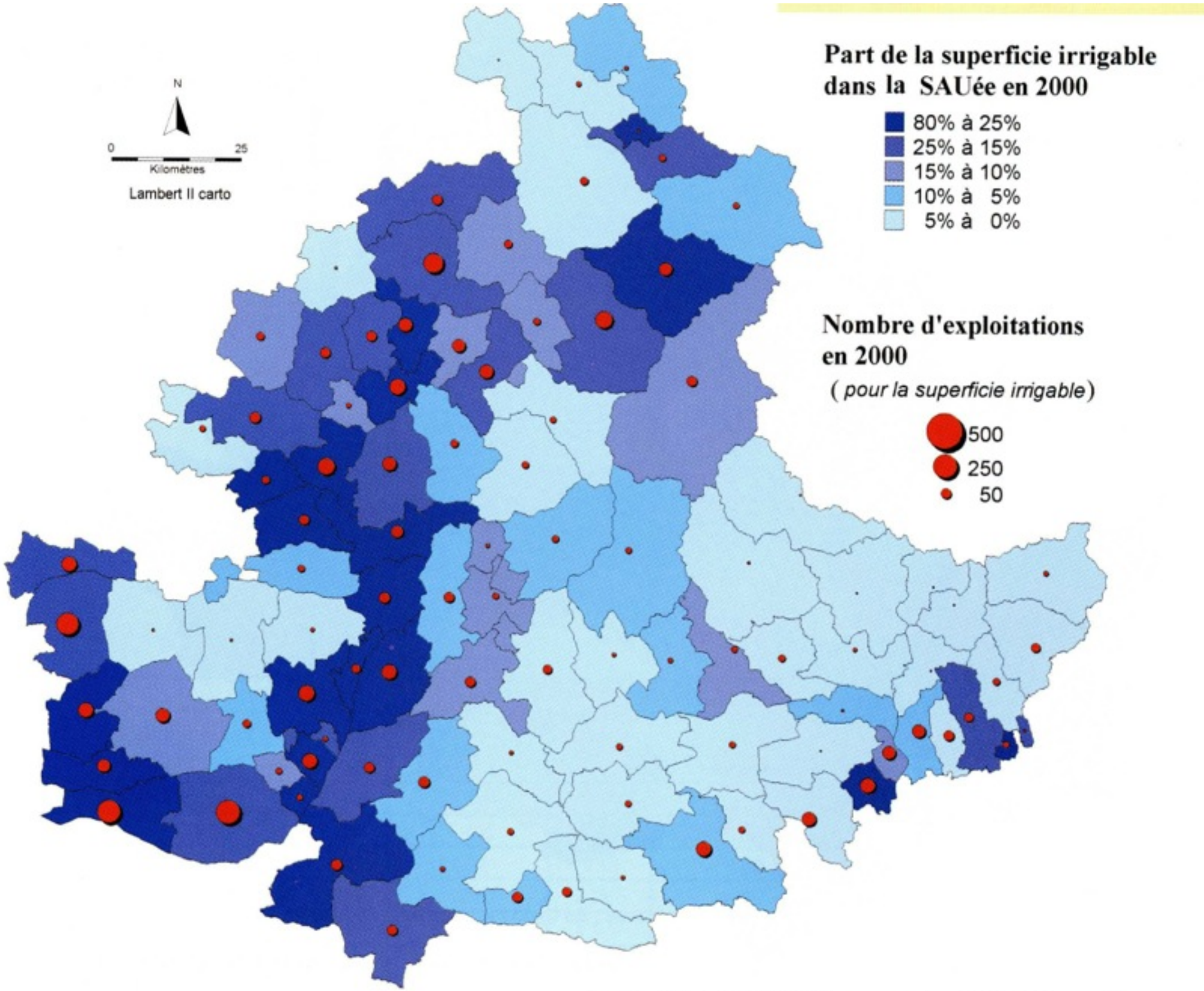
At farm and territory scales

- **Spatial analysis of recent dynamics :**
  from statistics of agriculture (census of 2000 and 2010)

  Land use – number of animals – Livestock densities - proportion of farm categories (combination of crop and livestock activities)…

  - Complete analysis for 2015
  - Integration of new informations in the database (data on the parcels of each farm, used for CAP declaration)

Irrigated lands in PACA



Source : Bd Carto PACA©, Recensement agricole 2000

Dynamics of crop-livestock integration in mediterranean areas in south of France

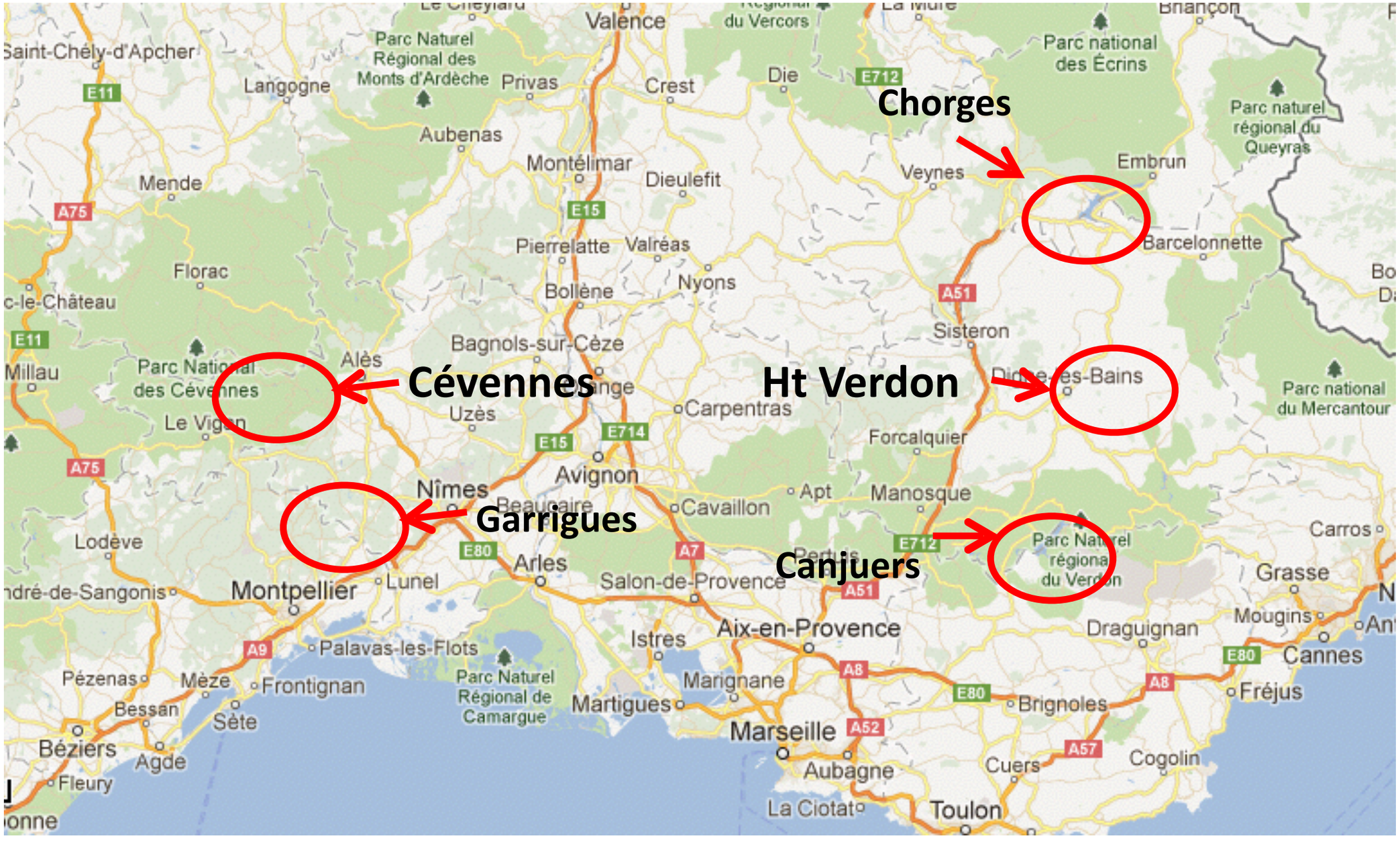
At farm and territory scales

- **Trajectory of livestock and farming systems in local territories** (from agrarian diagnosis)

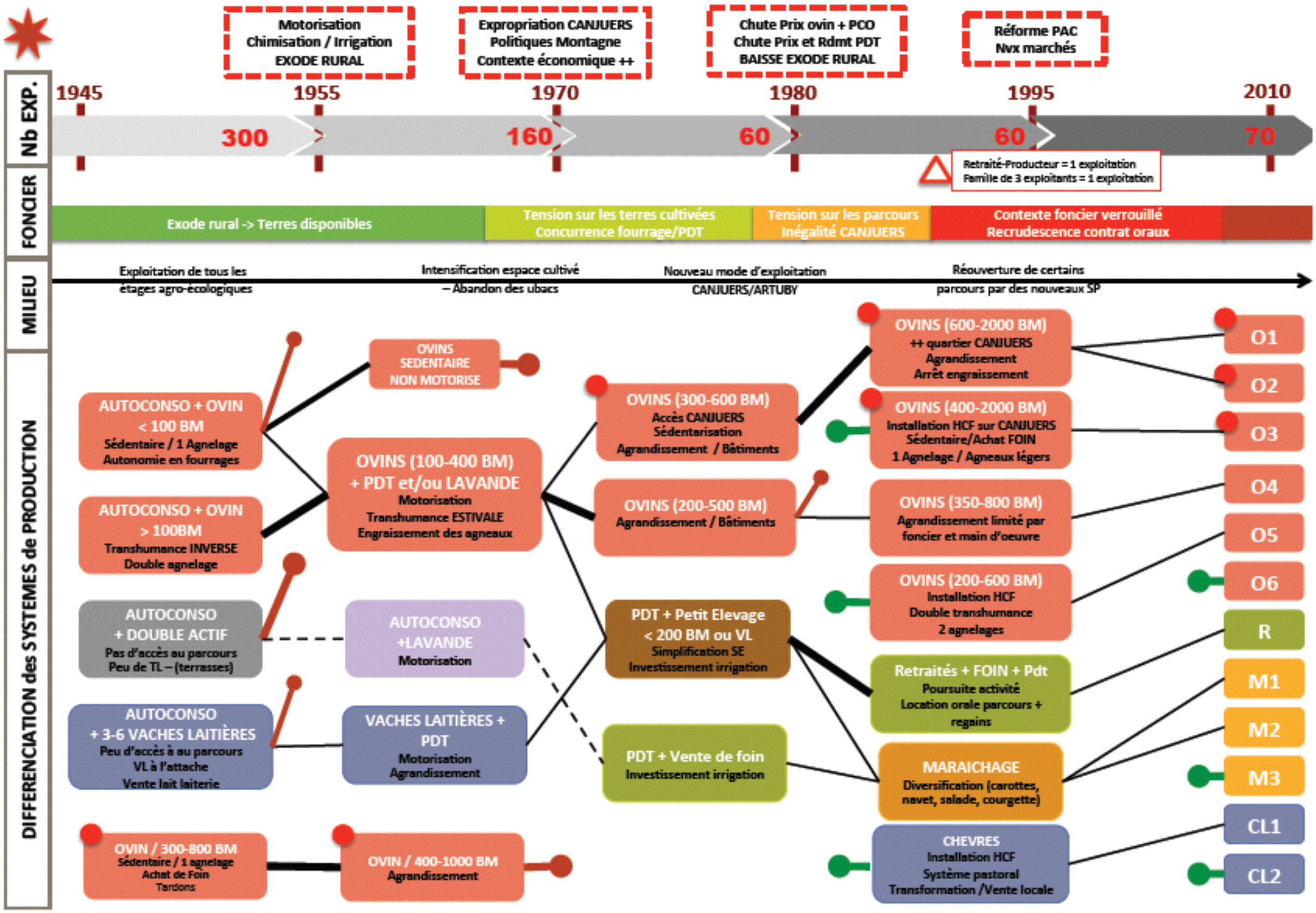
Farm typologies and changes since mid 20th century
(4 diagnosis already availables (2011-2012)

2014 - Agrarian diagnosis in large valley situation
(M2 student from AgroParisTech)

Localization of case studies



Changes in farming systems



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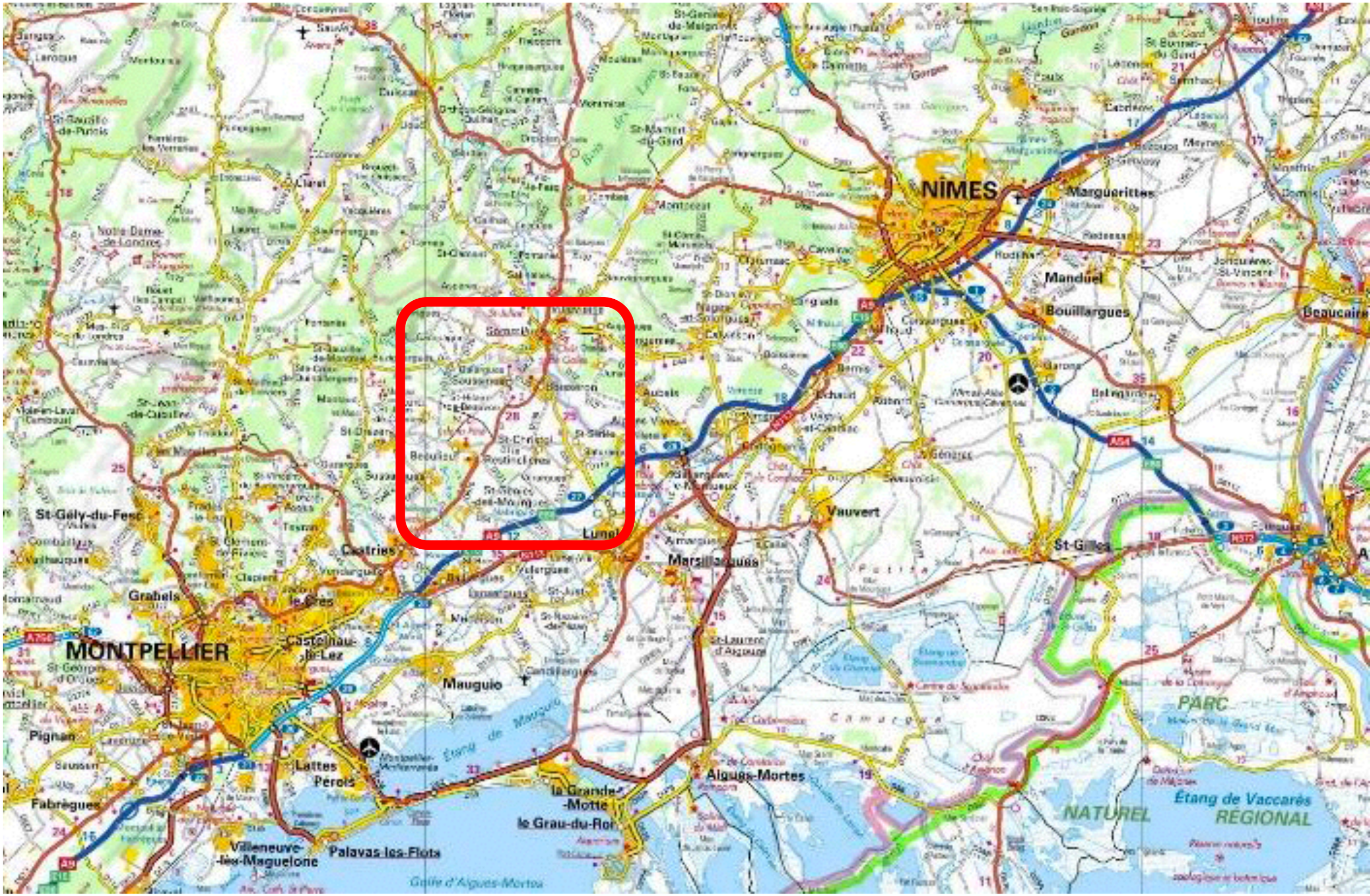
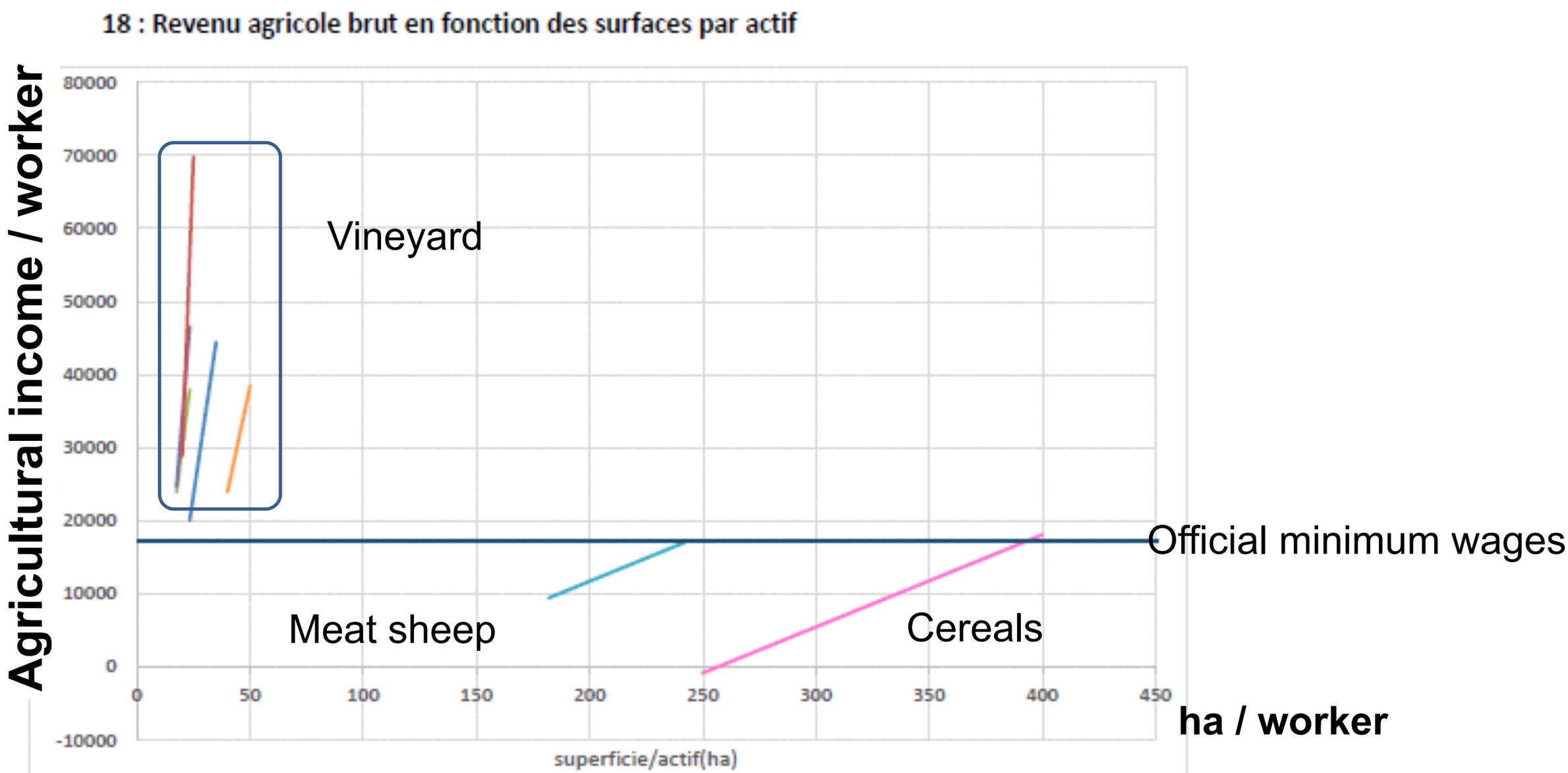


Competitive cash crops (vineyards) on arable land / majority of the farms

Interstitial spaces

- Rangelands ("garrigues") : meat sheep system
- Small parcels of arable land (ancient vineyards) : cereal systems



Unbalance between crop (vineyards) and livestock activities

Opportunities Crop-livestock relations but few development

- Use of manure in vineyards
- sheep grazing in vineyards during winter (with grass between the rows of vines)

Hay production in some vineyard systems : small haystack for horses (leisure / urban dvelopment) (concurrence for providing sheep systems)

Stakes :

Installation of livestock farms in plains, for use of interstitial rangelands (protection against fire, landscape….)

Projects supported by local collectivities, but many constraints (tenure, economic…)

Use of rangelands by flocks from mountain areas (« transhumance inverse »)

- **Trajectory of livestock and farming systems in local territories** (from agrarian diagnosis)

Plan for 2015

- Synthesis of the 5 agrarian diagnosis, according to the issues of crop-livestock integration

- Explore the conditions of integration of transhumant shepherds in lowlands in order to access resources for the flocks *(study by a group of students of SupAgro, 6 weeks in february-march)*

- **Efficiency / adaptation assessment at farm scale**

From existing farm models (2 meat sheep / 2 dairy sheep farms)

Methodological work with :

LCA =Life Cycle Analysis
ENA = Ecological Network Analysis

Post-Doc Ludivine Pradeleix

CLIMED Project

Characterizing crop livestock integration with Network Analysis
Assessing eco-efficiency with Life Cycle Analysis

Ludivine Pradeleix, Post doc researcher
INRA SELMET Joint research Unit, France
pradeleix@hotmail.com

Outline

1. Objectives
2. Material and method
3. Results
4. Discussion

Objectives & rationale

- Difficult to characterize crop livestock integration in a quantitative way ===> **Network Analysis** : transferred from ecological systems to agro-ecological ones (Rufino, 2009)

- **Life Cycle Analysis** : a standardized (ISO 14040) and widespread method to assess eco-efficiency : ratio « environmental impacts/unit of service provided »

- **Large amounts of data** are required to design the network of flows characterizing each system and to specify flow's nature : e.g. fertilizers and pesticides specifications => different impacts…

Material & Methods

Material

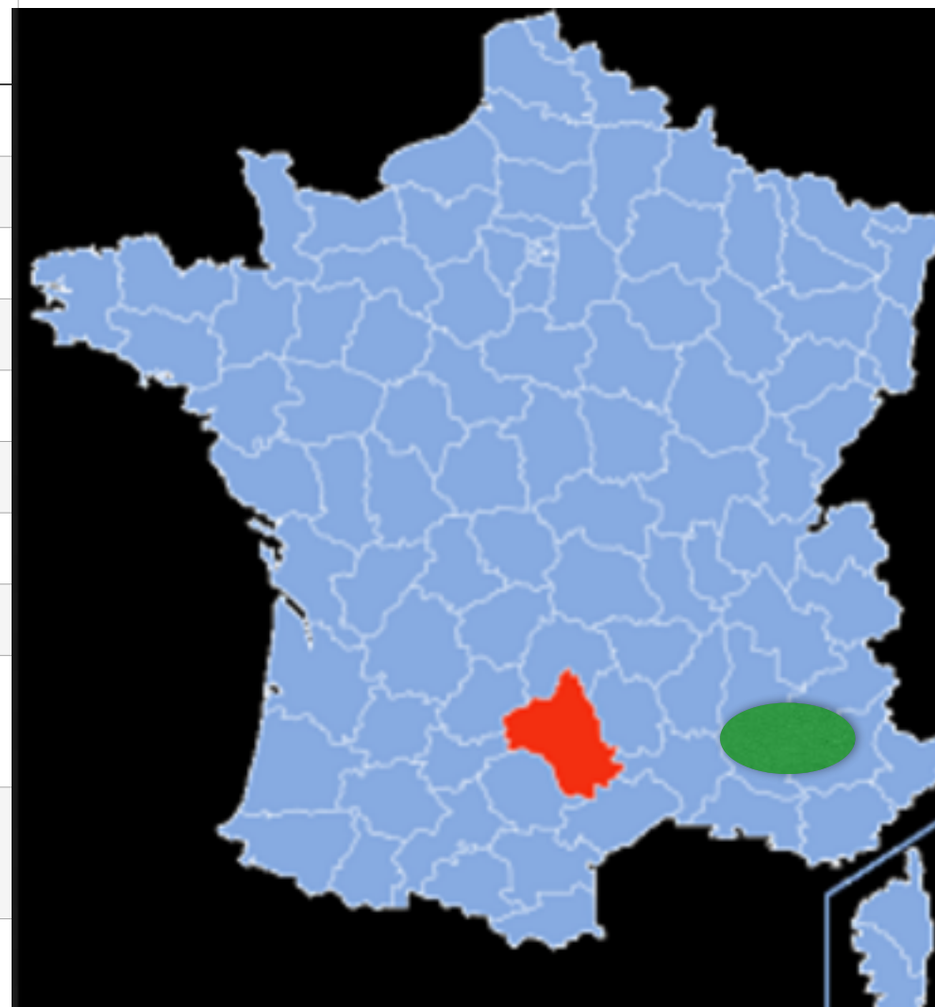
- **FOUR** Farm archetypes from the Livestock French Institute (Idele) for dairy sheep farms

- « Meat » sheep farms are designed after Agrarian System Diagnosis

- Data required :Cropping plan, sequence of **farm operations** (which fertilizer, amount/ha…) of every cropping and forage system, **diet** details and **feeding calenda**r

Main features of farm types

	Meat input intensive	Meat extens.	Dairy input intensive	Dairy extensive
	GASSEND	SEI2	ROQ2	ROQ3
	Hay Irrigated meadow + aromatic plants	Drylands Rangeland	Favorable area, Maïze and grass silage, hay	Dry hill lands Hay and Rangeland
Breeding ewes	220	450	314	340
Ewe lambs	20	70	100	110
Nb lambs solds	256	363	440	340
Milk sold nb	0	0	91238	85140
Workforce	1	1	2	2
SAU/owned land	55,1	43	57	96
SFP/Forage area	55,1	32	39	68
Crop area	0	11	18	28
Rangeland	0	395	0	300
Added gross value euro	NA	7632	63098	57547



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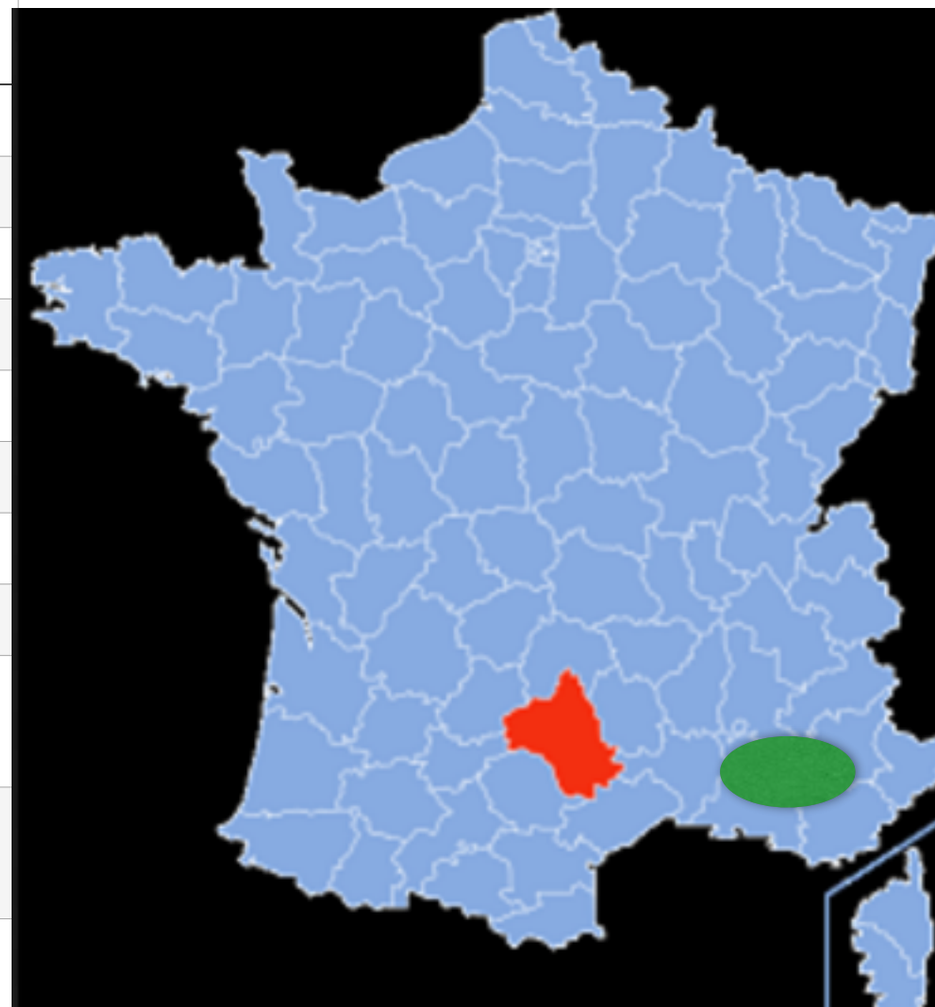


Dairy input intensive

ROQ2

Favorable area, Maïze and grass silage, hay

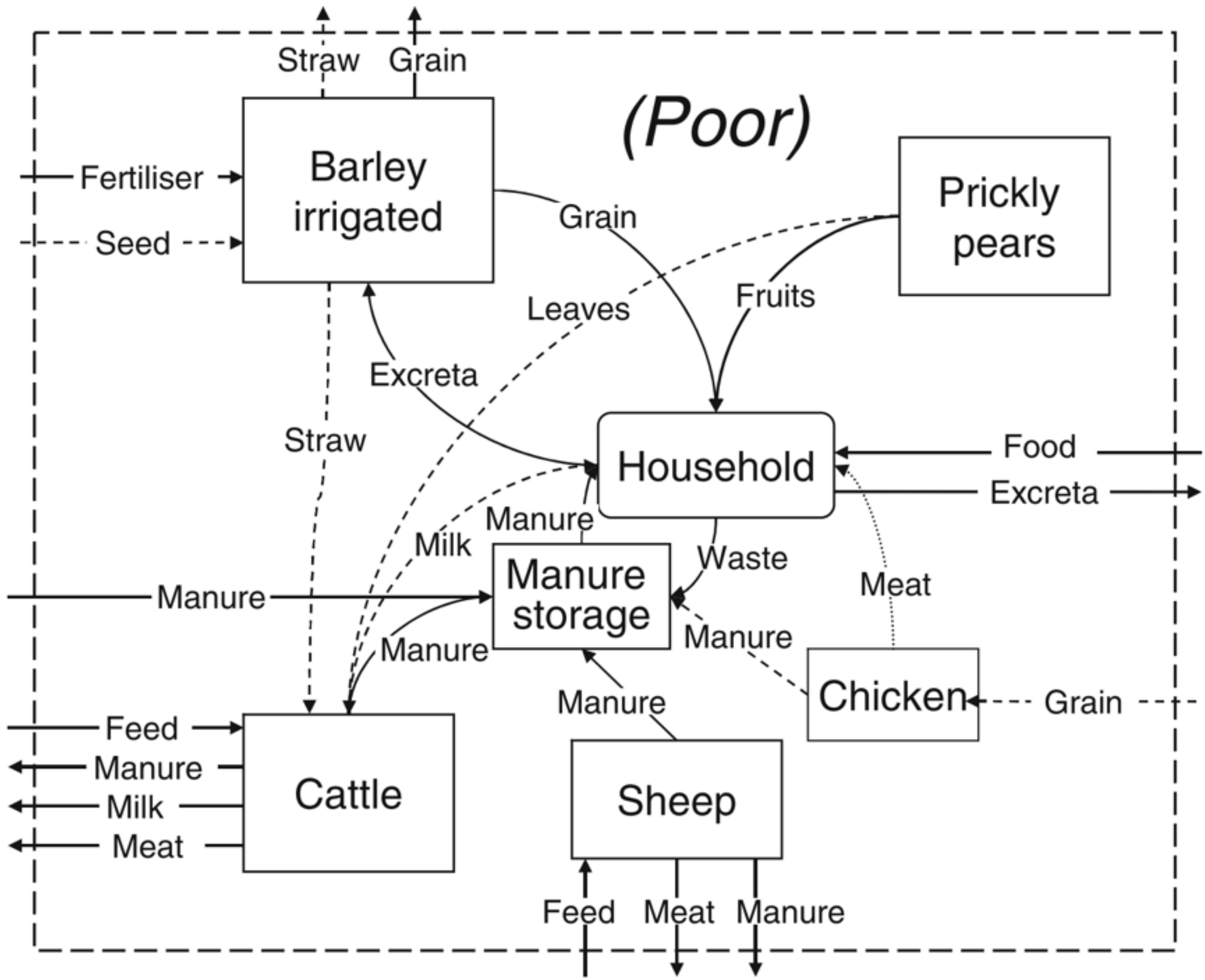
Dairy extensive

ROQ3

Dry hill lands Hay and Rangeland

The Network Analysis Method

==> quantitative indicators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Seed
Barley irrigated
Grain
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Leaves
Fruits
Excreta
Straw
Household
Food
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Manure
Milk
Manure storage
Waste
Meat
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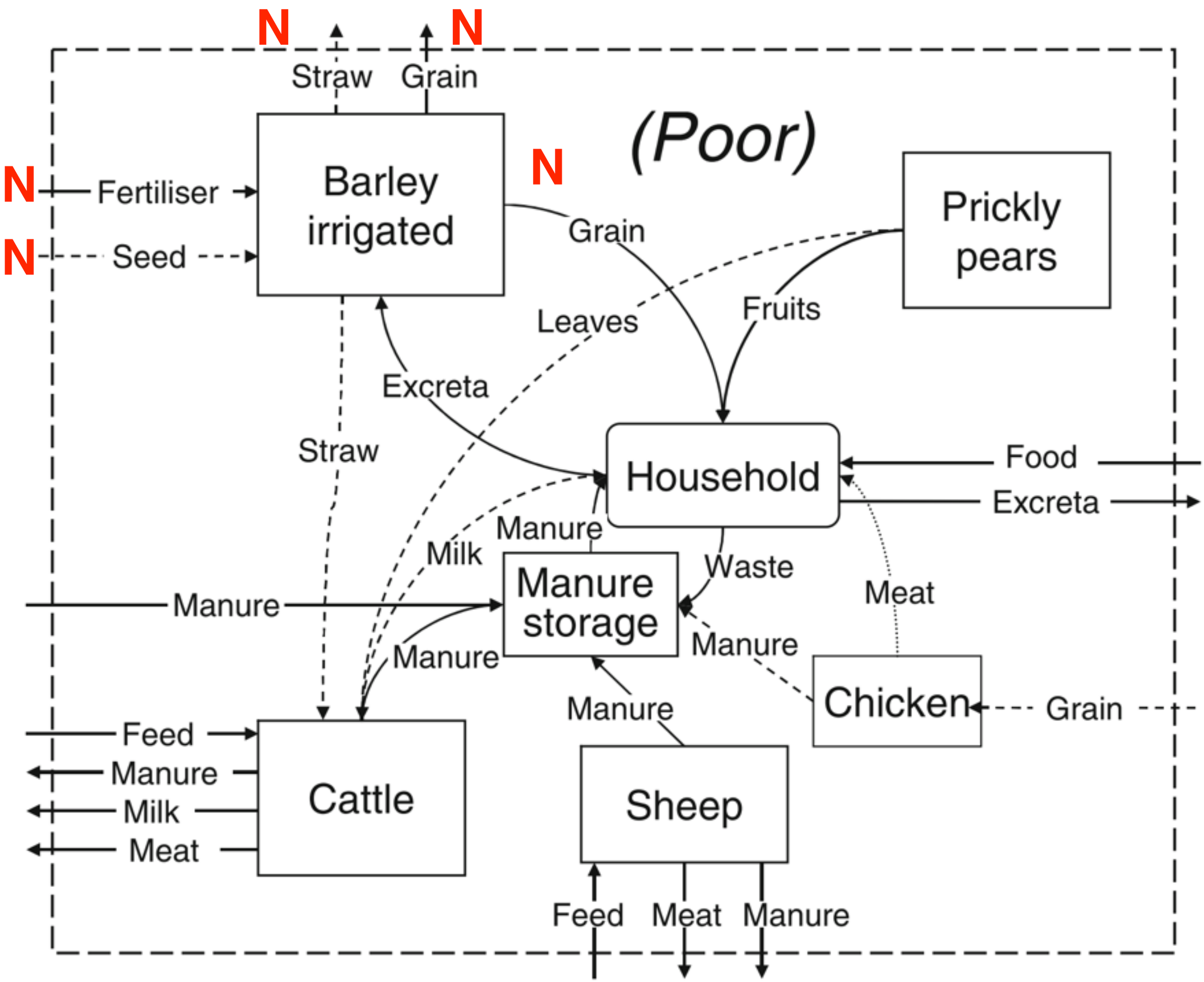
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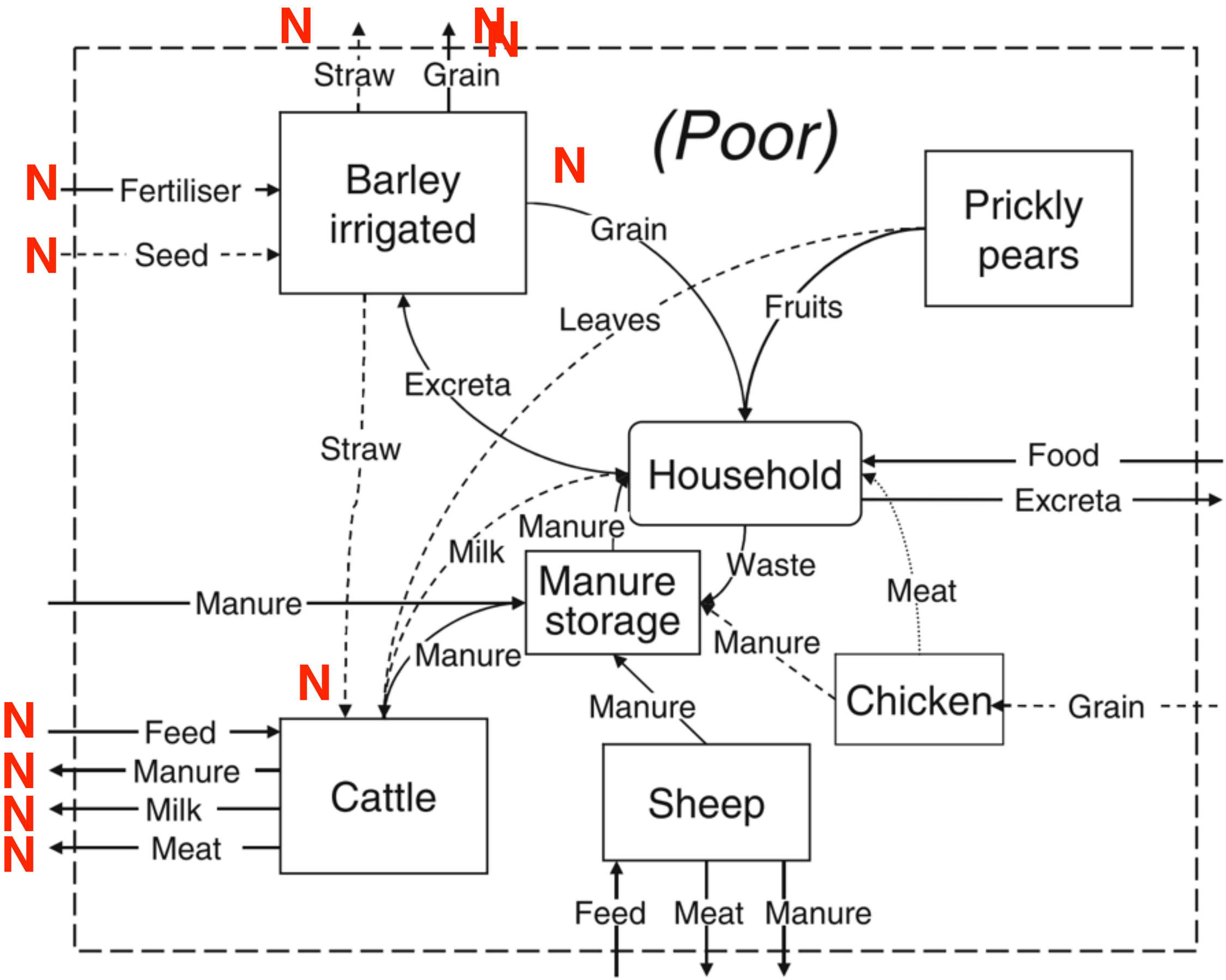
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Milk
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Matrix of Nitrogen Flows

	j (From) -->	H0	H1	H2	H3	H4	H5
i (To)		Import	Brebis	Fourrages	Cultures mixtes	Stock aliments	Stock fumier
H1	Brebis	0	134	1 005	0	9 725	0
H2	Fourrages	5 689	0	0	0	0	1 061
H3	Cultures mixtes	0	0	0	0	0	0
H4	Stock aliments	67	0	5 744	0	0	0
H5	Stock fumier	0	1 307	0	0	34	0
N+1	Usable exports	0	88	0	0	525	246
N+2	Unusable exports	0	27	1 322	0	0	510

Focus on Diversity/ specialization/resilience

- AMI and Hr : information theory = Organization of the network, diversification of pathways used by Nitrogen flows

- AMI is a « **measure of the information we have regarding the exchange of material within the system**».

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- **Specialization : the more specialized, use the most effective pathway for N, small number of pathways. AMI is high**

- **Diversified systems are prone to adapt to changes : AMI is smaller, AMI/Hr is poor : « room for manoeuvre »**

Indicators of dependancy and recycling

- Dependency to inputs -IN : IN/TST ↗️
- Internal recycling : FCI ↗️

The Network Analysis Method

==> **RESULTS**

Network Analysis

	Dependency to external	Internal Recycling index	AMI	Hr	AMI/Hr
SEI2	5 %	12 %	1,1	2	55 %
Gassend	20 %	10 %	1,5	2	77 %
ROQ3	9 %	9 %	1,4	2,4	57 %
ROQ2	16 %	15 %	1,3	2,4	55 %

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Rangelands

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Internal Recycling

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Indicates Specialization

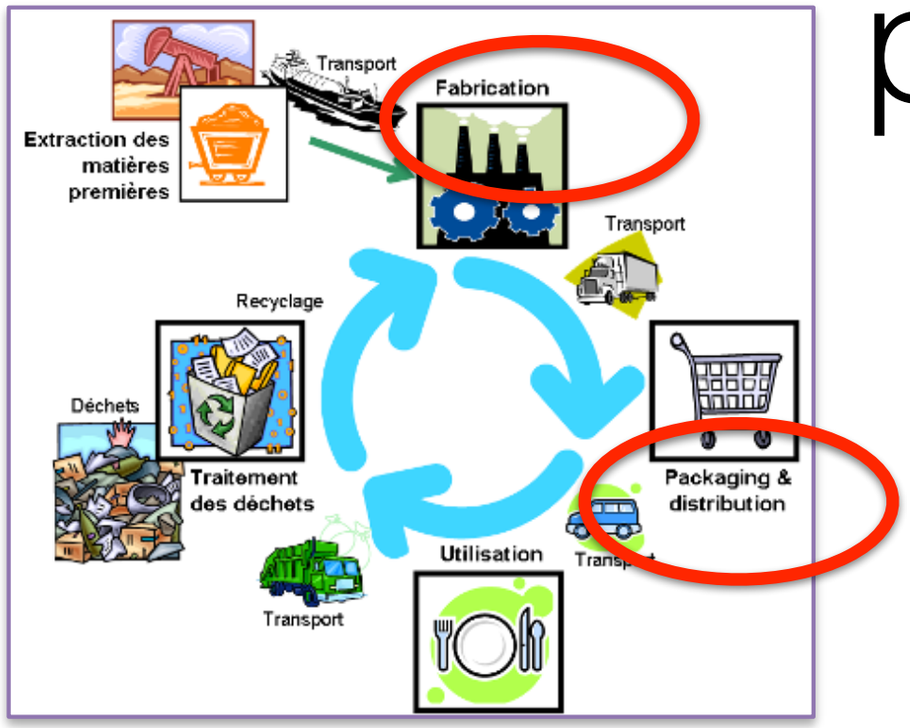
The Life Cycle Analysis : **Method**

impacts/  <u>or</u> impacts/  <u>or</u> impacts/ 

Life Cycle Analysis : 3 principles

1. Assess impact at field scale AND input manufacture /transportation

Life Cycle Analysis : 3 principles



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Life Cycle Analysis : 3 principles

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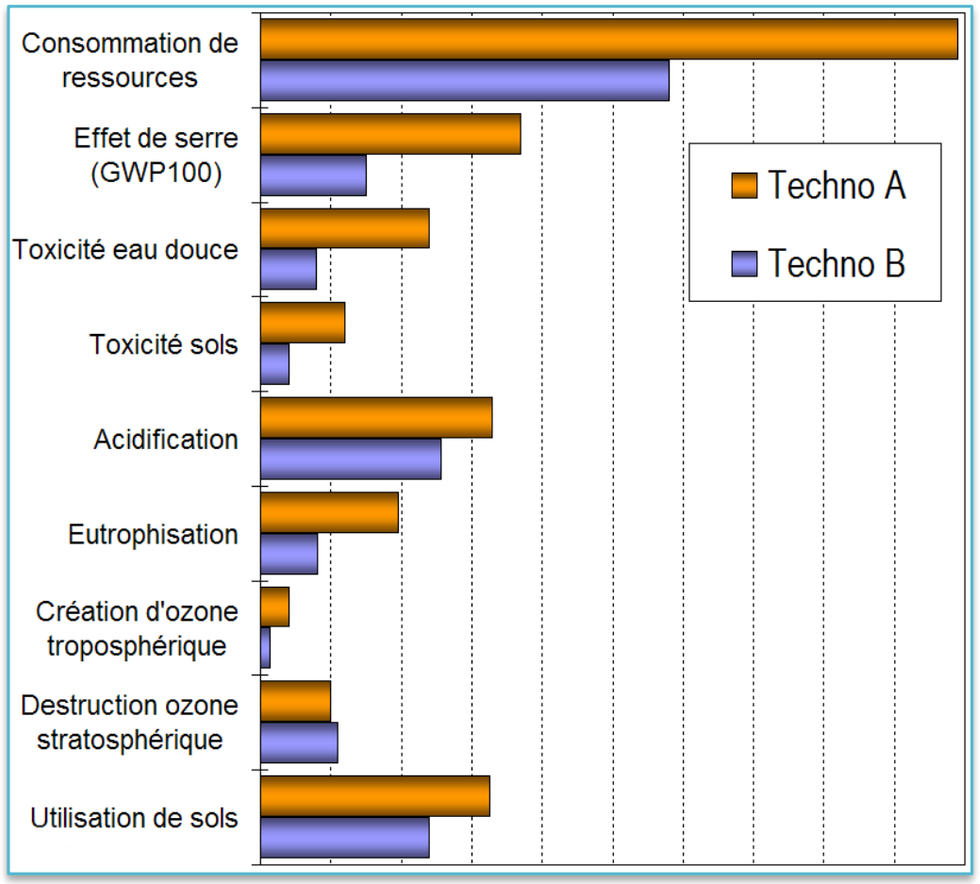

2. Multicriteria assessment : beyond Carbon footprint…

Life Cycle Analysis : 3 principles

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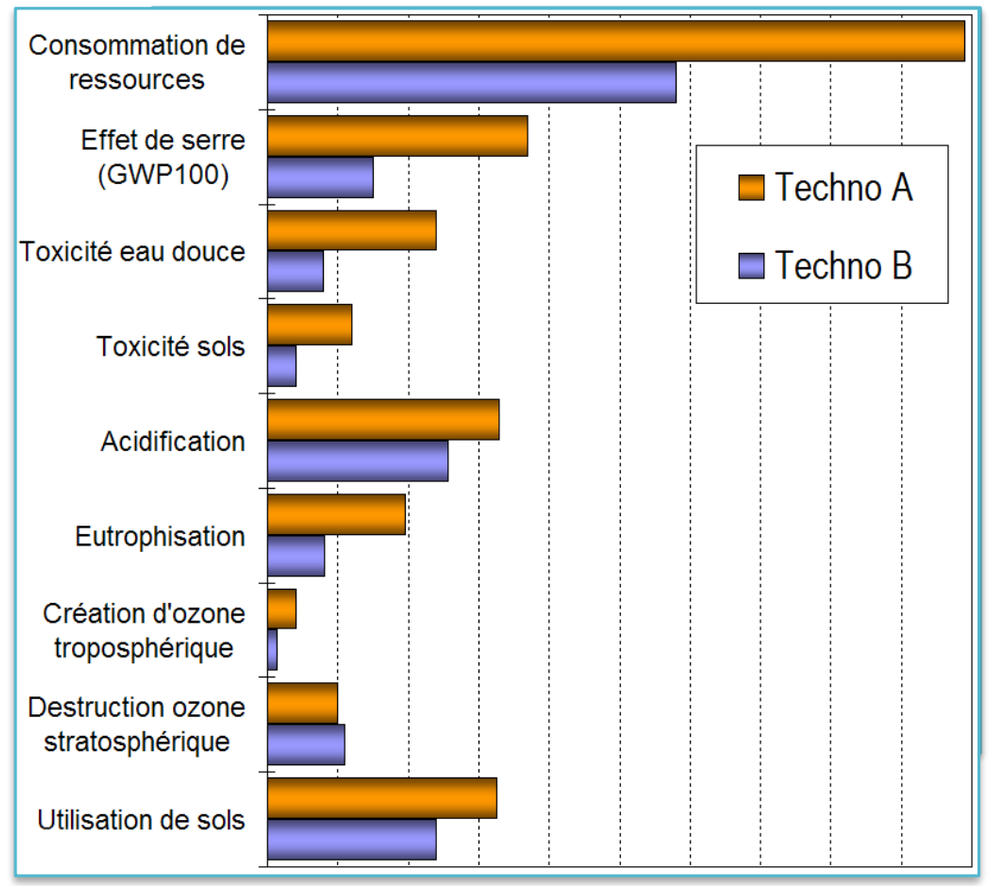

2. Multicriteria assessment : beyond Carbon footprint…

impacts/  impacts/  impacts/ 

3. Eco-efficiency : impacts/function

Inventory of flows

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Documentation | Input/output | Parameters | System description

Products

Known outputs to technosphere. Products and co-products

Name	Amount	Unit	Quantity	Allocation %	Waste type	Category	Comment
ROQ2 EA 52 HA	52	ha	Area	100 %		ACV S...\3- ROQ2 OL INT	
(Insert line here)							

Known outputs to technosphere. Avoided products

Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
(Insert line here)						

Inputs

Known inputs from nature (resources)

Name	Sub-compartment	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
(Insert line here)							

Known inputs from technosphere (materials/fuels)

Name	Amount	Unit	Distribution	SD^2 or 2*SMin		Max	Comment
ROQ2 CER ha	13	ha	Undefined				
ROQ2 MAIS ENSIL ha	5	ha	Undefined				
ROQ2 LUZ DAC HA	4	ha	Undefined				
ROQ2 PT hors RGI ha	17	ha	Undefined				
ROQ2 PT RGI ha	5	ha	Undefined				
ROQ2 PN HA	13	ha	Undefined				
ROQ2 BELIERS EMISSIONS	5	p	Undefined				
ROQ2 BREBIS EMISSIONS	314+100/12*11 = 406	p					
ROQ2 AGNEAUX EMISSIONS	497	p	Undefined				
ROQ2 NH3 PATURAGE	1	p	Undefined				
Concentrated feed agneaux, and tpt	2880+5220 = 8,1E3	kg					
Concentré orge et tpt	0	kg	Undefined				
Rape seed meal	1440+19260 = 2,07E4	kg					pour tourteau tann
Transport, combination truck, average fuel mix/US	(1440+19260)*S0 = 1,04E6	kgkm					tpt du tourteau tar
(Insert line here)							

Known inputs from technosphere (electricity/heat)

Cirad 1 | Pradelex-0 | 7.3.2 Analyst Multi user

Known inputs from technosphere (electricity/heat)

Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
(Insert line here)						

Outputs

Emissions to air

Name	Sub-comp	Amount	Unit	D	SD	M	Comment
Dinitrogen monoxide		ha_gores*FE2cp*44/28 = 654	kg				Emissions directes de N2O dues aux surfaces de sols organiques tempérées et de prairies
(Insert line here)							

Emissions to water

Products

Known outputs to technosphere. Products and co-products

Name	Amount	Unit	Quantity	Allocation %	Waste type	Category	Comment
FERTI IN ORGE GAS	1	ha	Area	100 %		ACV SELMET\1- ...\DETAIL	Flux intervenant sur le teritoire = émissions ; émissions des ferti minéraux et du fumier
(Insert line here)							

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Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
(Insert line here)						

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(Insert line here)							

Known inputs from technosphere (materials/fuels)

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(Insert line here)						

Known inputs from technosphere (electricity/heat)

Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
(Insert line here)						

Outputs

Emissions to air

Name	Sub-compartment	Amount	Unit	D	SD	M	Comment
Ammonia		6,62	kg	1			NH3 ; Brentrup
Dinitrogen monoxide		2,19	kg	1			N20
Nitrogen		15,74	kg	1			N2
Nitrogen oxides		0,46	kg	1			NO
(Insert line here)							

Emissions to water

Results

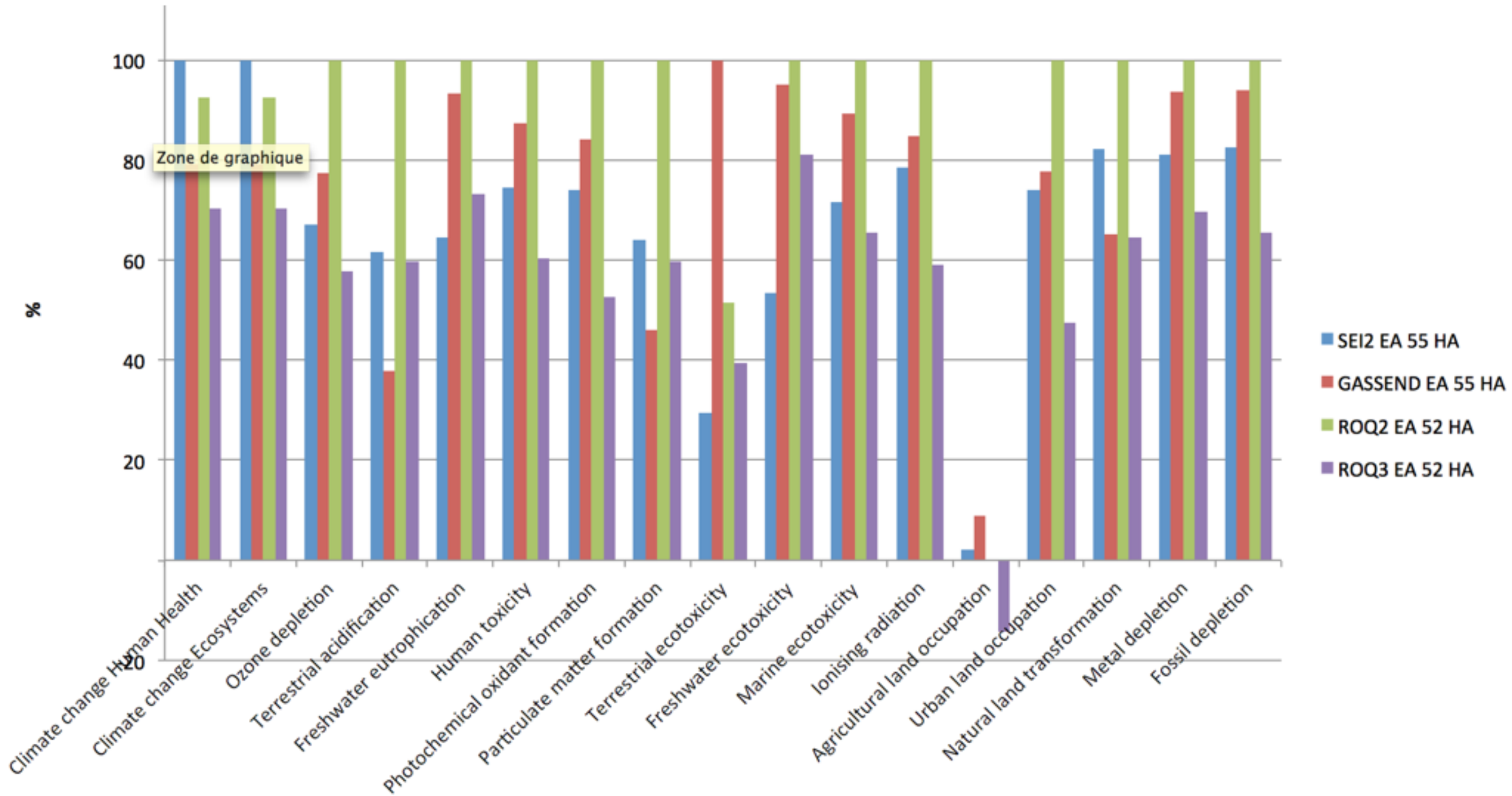
The Life Cycle Analysis : **Results**

impacts/ 

impacts/ 

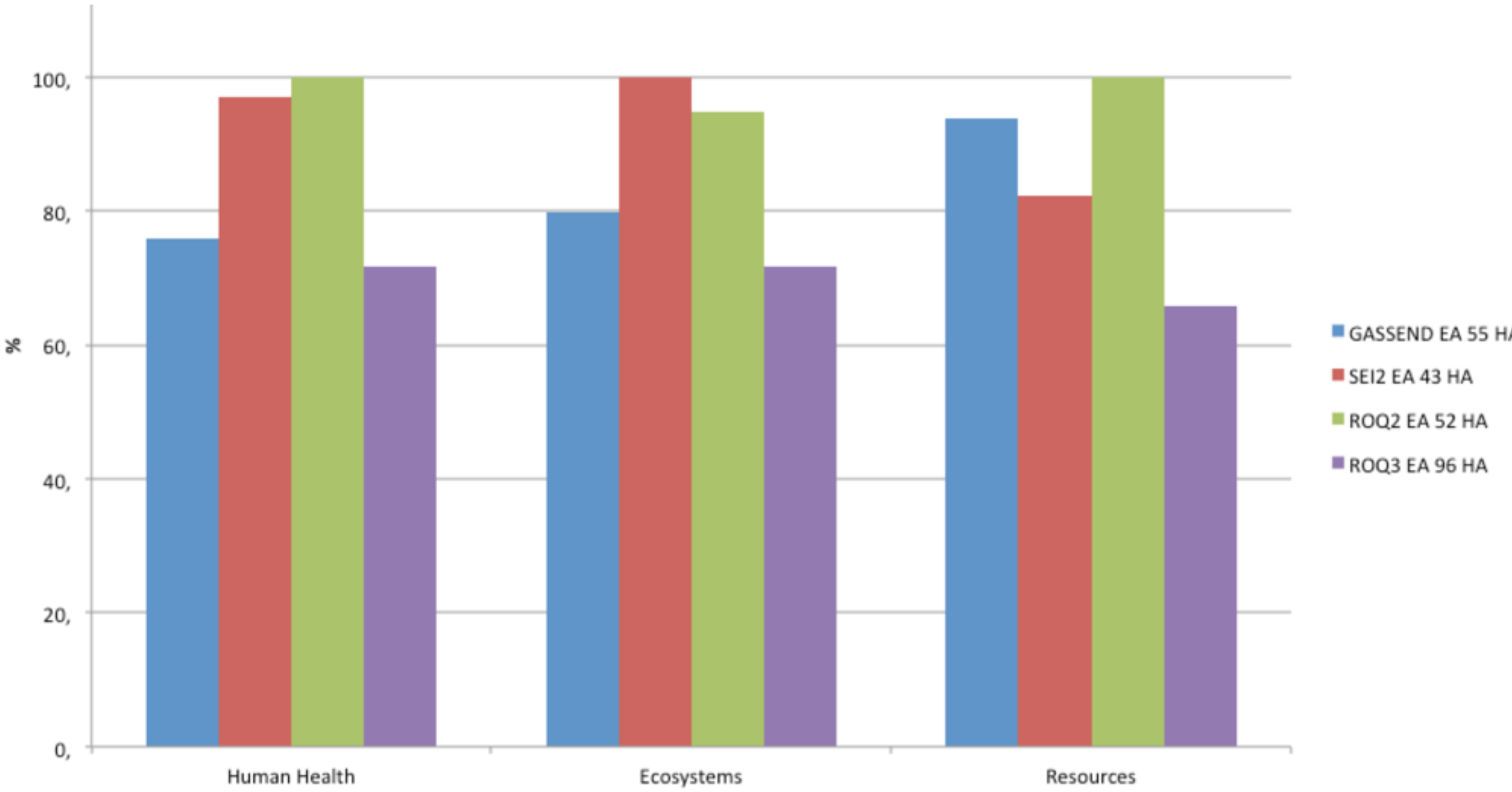
impacts/ 

Life Cycle Analysis FU ha



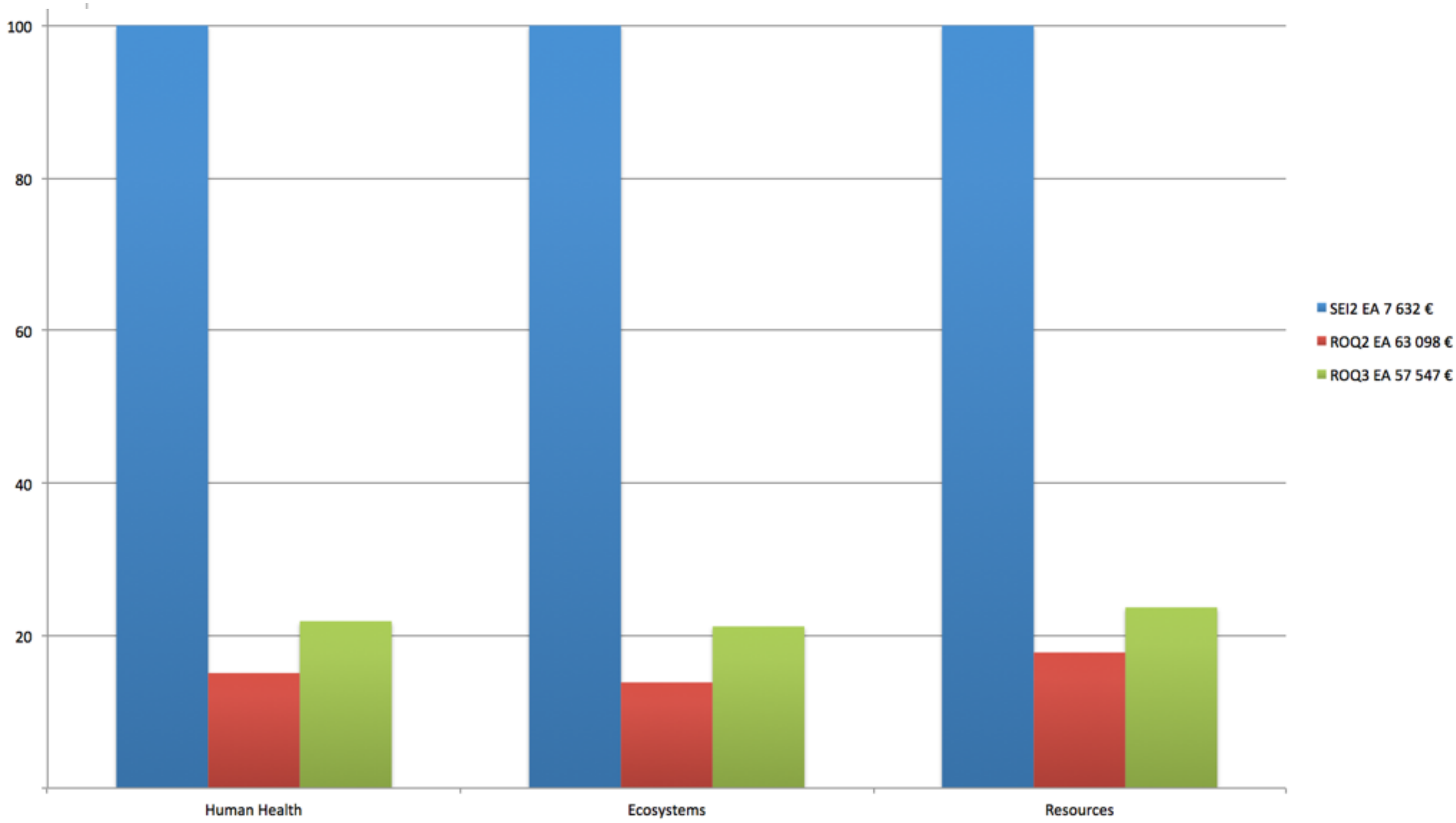
Comparing 1 ha 'SEI2 EA 55 HA', 1 ha 'GASSEND EA 55 HA', 1 ha 'ROQ2 EA 52 HA' and 1 ha 'ROQ3 EA 52 HA';
Method: Recipe Endpoint (H) V1.07 / World ReCiPe H/H / Characterization

Life Cycle Analysis FU ha

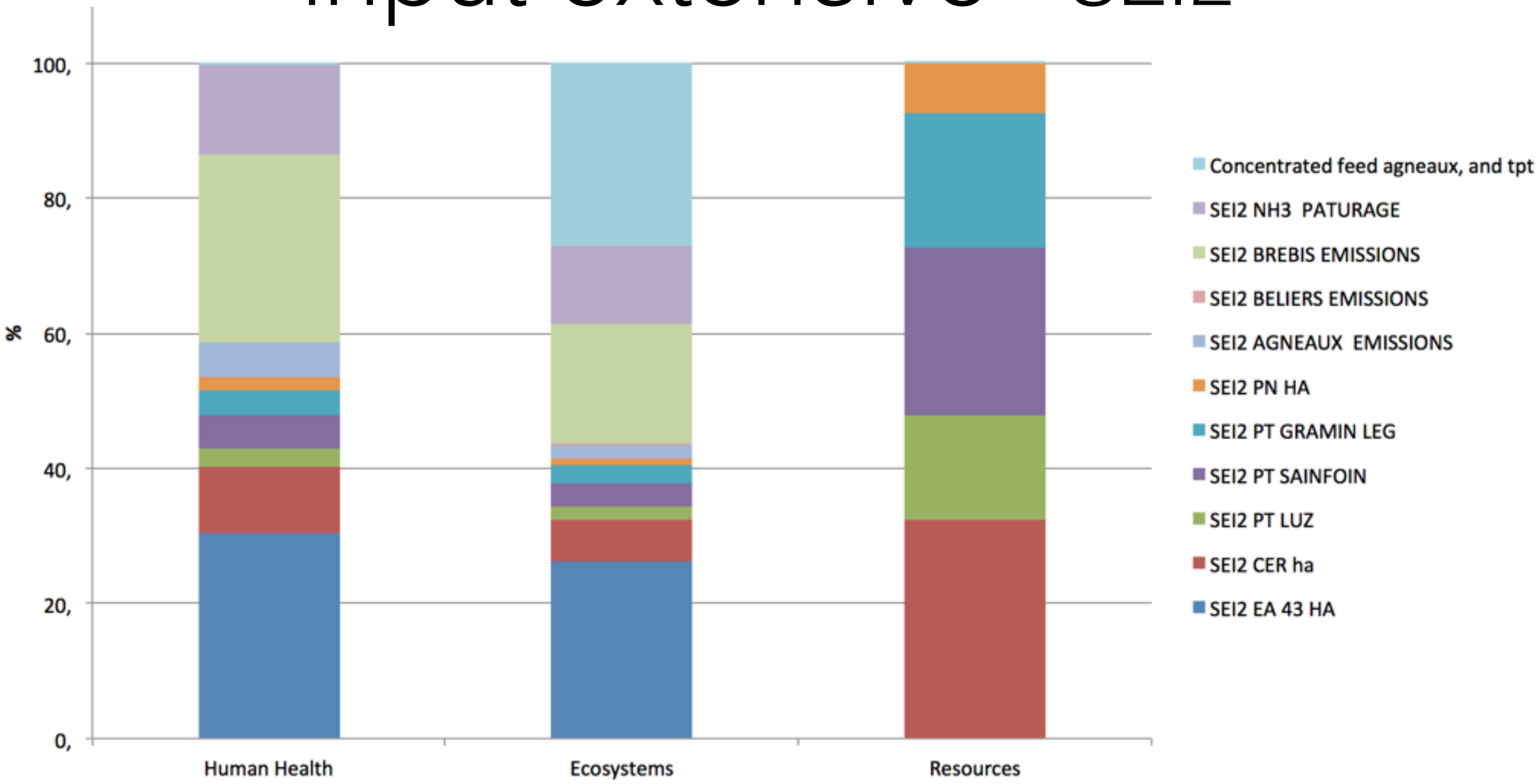


Comparing 1 ha 'GASSEND EA 55 HA', 1 ha 'SEI2 EA 43 HA', 1 ha 'ROQ2 EA 52 HA' and 1 ha 'ROQ3 EA 96 HA';
Method: Recipe Endpoint (H) V1.07 / World ReCiPe H/H / Damage assessment

Life Cycle Analysis FU Euro



Contribution analysis Meat input extensive - SEI2



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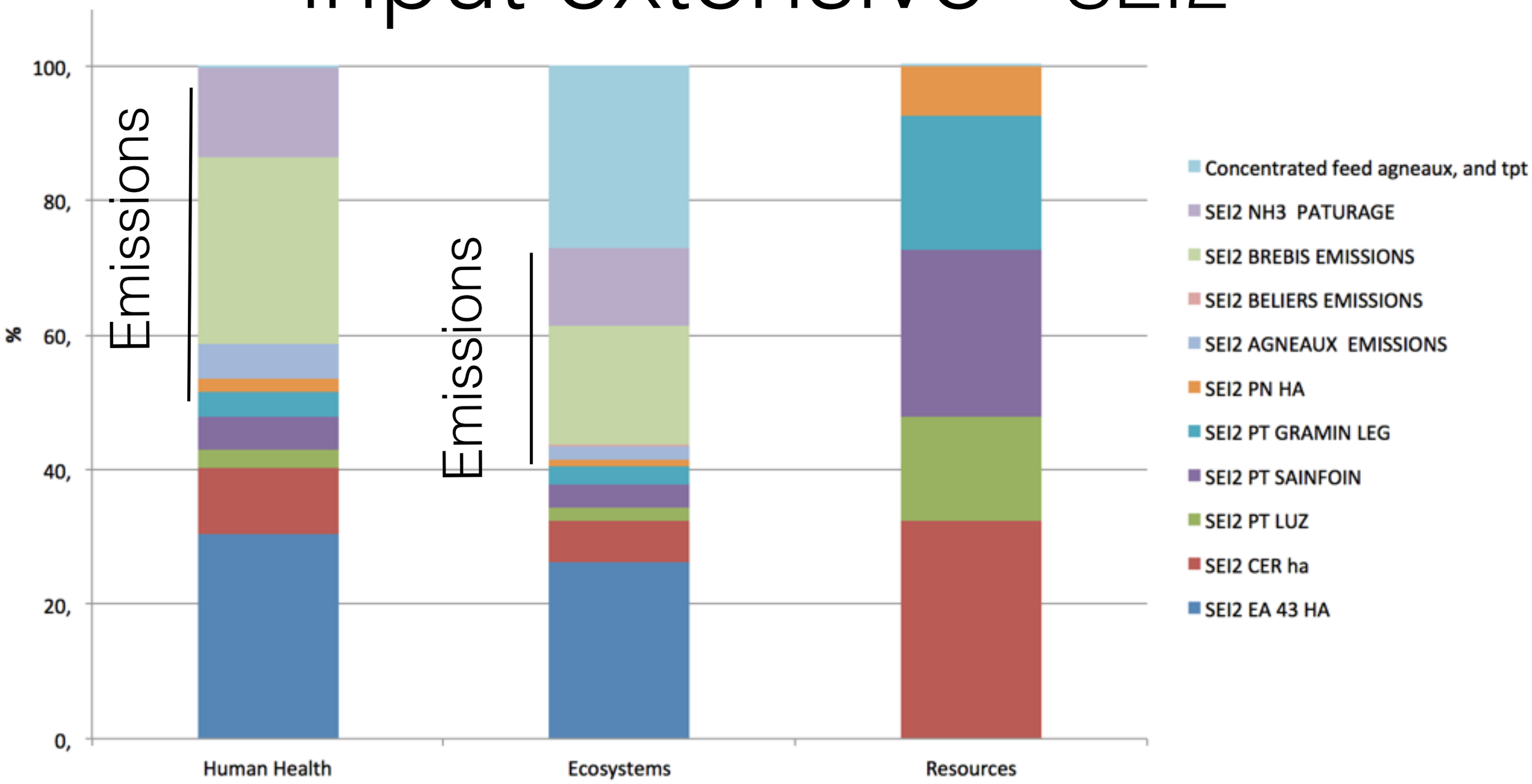

Analyzing 1 ha 'SEI2 EA 43 HA';
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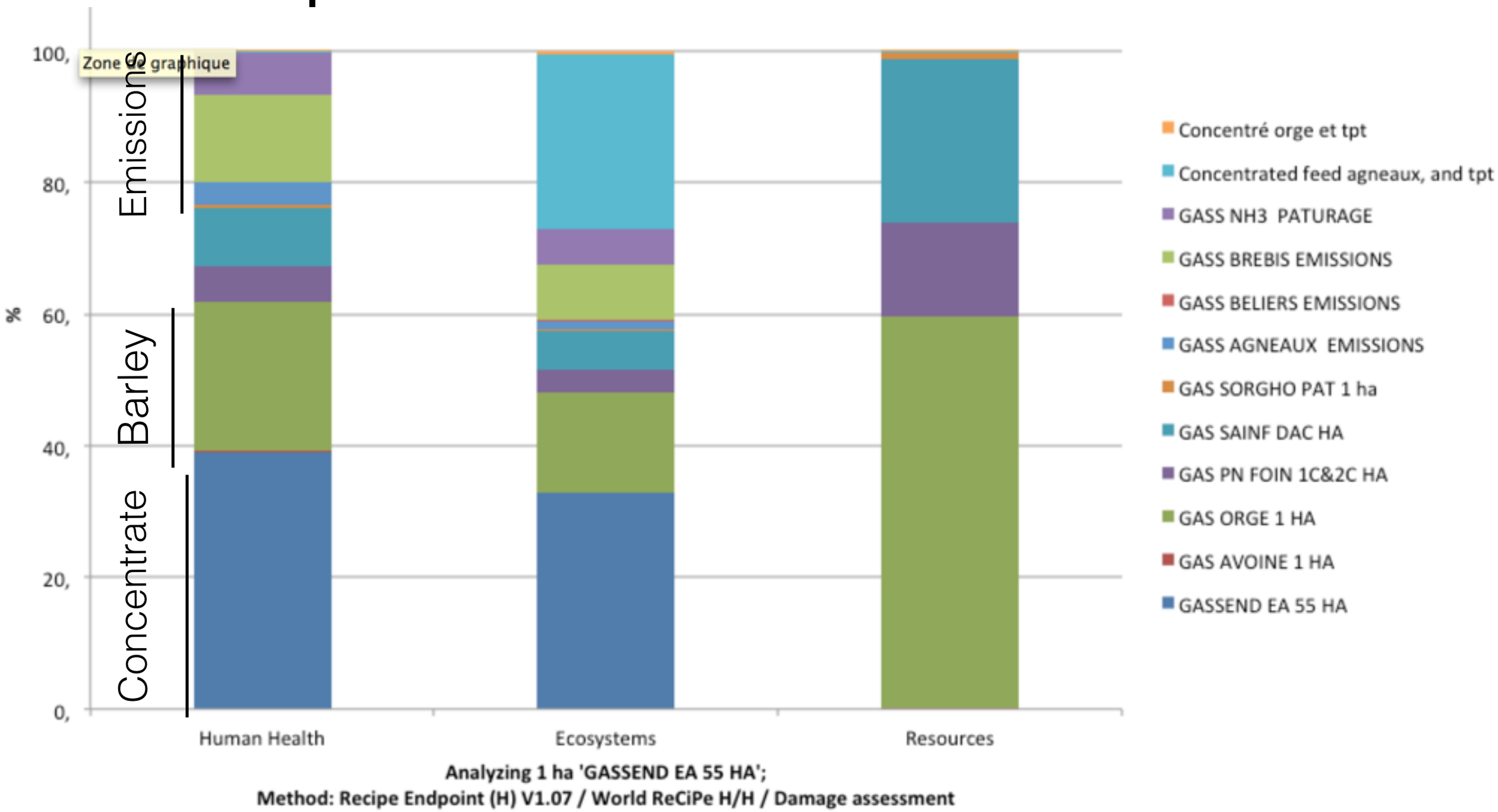
Emissions of livestock

	Brebis	Agnelles	Agneaux total (dont agnelles)	béliers	Total	***PRG eq CO2/kg***	PRG Total
Effectif	450	70	433	4			eq CO2
CH4 enterique	2880	336	304	30	**3549**	***25***	**88 731**
CH4 manure mngt	126	20	13	1	**160**	***25***	4 000
N-N20 manure	73	8	12	1	**94**	***300***	**28 077**
N-NH3 manure	570	89	257	2	**918**	***0***	0
Total N emissions	643	97	269	2	**1011**		
N-NH3 au pâturage	209	24	0	3	**237**		

Emissions

- manure management
- Grazing
- Farmyard manure spread

Contribution analysis Meat input intensive - Gassend



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Elementary process : Concentrated feed lambs

Products

Known outputs to technosphere. Products and co-products

Name	Amount	Unit	Quantity	Allocation %	Waste type	Category	Comment
Concentrated feed agneaux, and tpt	100	kg	Mass	100 %	not defined	ACV SELMET	
(Insert line here)							

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Known inputs from technosphere (materials/fuels)

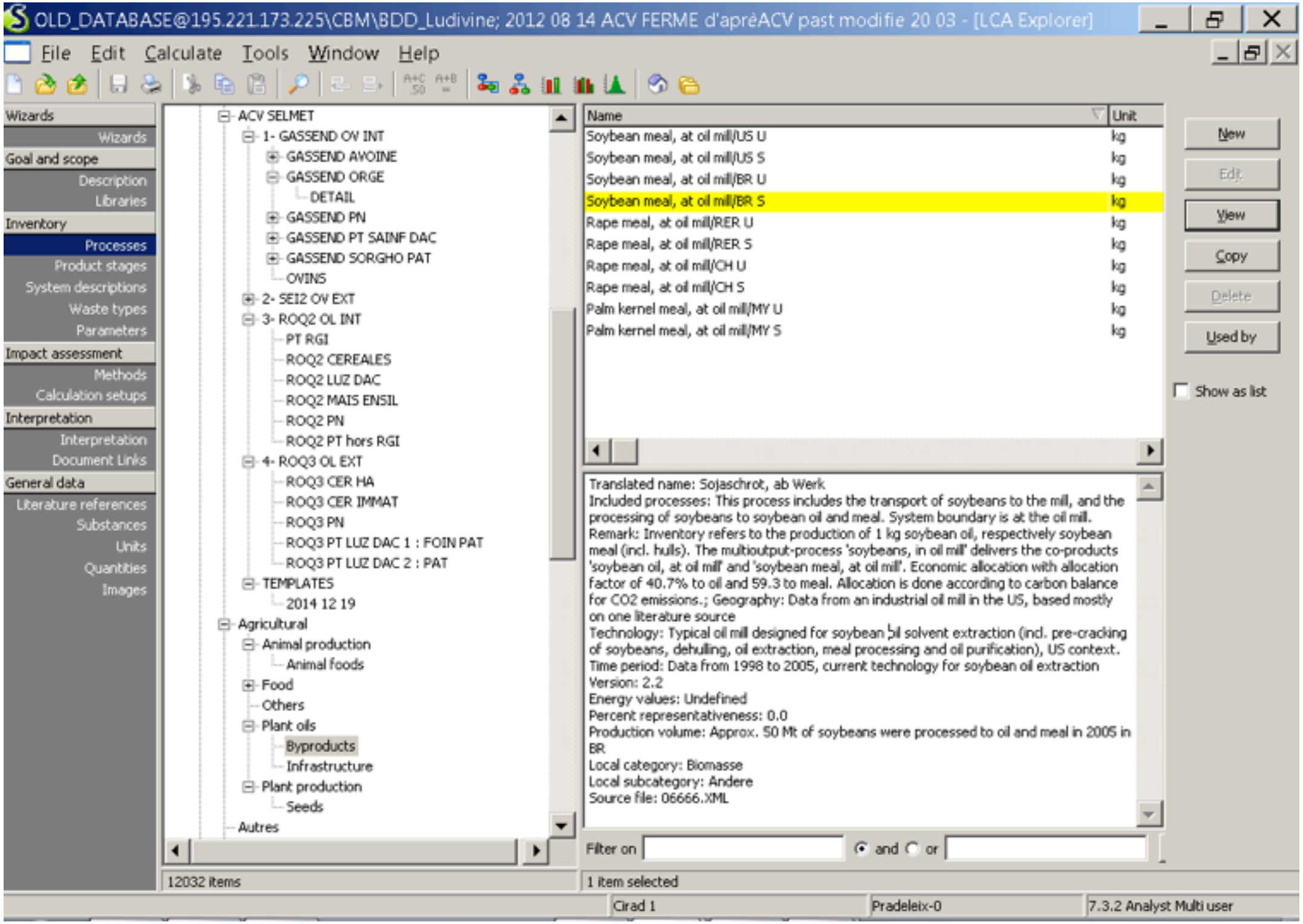
Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
Pulps, from sugar beet, at sugar refinery/CH S	4,8	kg	Undefined			
Rape seed meal	11,9	kg	Undefined			
Soybean meal, at oil mill/BR S	7,6	kg	Undefined			
Soybeans, at farm/BR S	0,1	kg	Undefined			
Transport, combination truck, diesel powered/US	100*50 = 5E3	kgkm				hypothese 50 km d
(Insert line here)						

Known inputs from technosphere (electricity/heat)

Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
(Insert line here)						

Outputs

Elementary processes : database



Elementary process :
e.g « **soybean meal, Brazil** »list of resources consumed and emissions released

Documentation | Input/output | Parameters | System description

Known outputs to technosphere. Products and co-products

Name	Amount	Unit	Quantity	Allocation %	Waste type	Category	Comment
Soybean meal, at oil mill/BR S	1	kg	Mass	100 %	Compost	Agricultural\...\Byproducts	BRAZIL

Known outputs to technosphere. Avoided products

Name	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment

Inputs

Known inputs from nature (resources)

Name	Sub-compartment	Amount	Unit	Distribution	SD^2 or 2*SMin	Max	Comment
Aluminium	in ground	0,00017476	kg	Undefined			
Anhydrite	in ground	0,00000000	kg	Undefined			
Baryte	in ground	0,00013918	kg	Undefined			
Basalt	in ground	0,00002214	kg	Undefined			
Borax	in ground	0,00000000	kg	Undefined			
Bromine	in water	0,00001621	kg	Undefined			
Cadmium	in ground	0,00000017	kg	Undefined			
Calcite	in ground	0,005425	kg	Undefined			
Carbon dioxide, in air	in air	1,1294	kg	Undefined			
Carbon, in organic matter, in soil	in ground	0,059869	kg	Undefined			
Chromium	in ground	0,00007017	kg	Undefined			
Chrysotile	in ground	0,00000002	kg	Undefined			
Cinnabar	in ground	0,00000000	kg	Undefined			
Clay, bentonite	in ground	0,00006718	kg	Undefined			
Clay	in ground	0,0022966	kg	Undefined			
Coal, brown	in ground	0,0058199	kg	Undefined			
Coal, hard	in ground	0,015652	kg	Undefined			
Cobalt	in ground	0,00000000	kg	Undefined			
Colemanite	in ground	0,00000050	kg	Undefined			
Copper, 0.99% in sulfide, Cu 0.36% and Mo 8.2E-3% in crude	in ground	0,00000495	kg	Undefined			
Copper, 1.18% in sulfide, Cu 0.39% and Mo 8.2E-3% in crude	in ground	0,00002735	kg	Undefined			

Discussion

Discussion

- LCA :The **ranking of farm** types regarding their Eco efficiency **varies** according to the **function assessed** (economic in Euro versus land management in ha)

- NA : interesting for **assessing specialization** versus diversification, and ability to adapt : resilience.

- **Modelling rules** : numerous and complex and should be **harmonized among farms** studied, especially for Network Analysis (results depend on it!)

- **Crop-Livestock integration at territory scale**

Plan for 2015

- Farm assessment to be continued, with development of two cases

- Agregation at territory scale

for four farm types
- Sheep specialization on rangelands, with mobility
- Sheep specialization on crops and rangelands, sedentary
- Crop-Livestock system
- Crop specialization

Assessment for scenarii of various combinations of the four types in a given territory (impact on land use, efficiency)