



**INRAE**  
la science pour la Vie, l'Humain, la terre


## ➤ Future of EU livestock: how to contribute to sustainable food systems

**J.L. Peyraud**

Conference: Scientific facts on the environmental impact of livestock farming  
Swiss Association for Animal Sciences

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## LCA have consistently showed the impacts of livestock



- 14.5% of GHG emission worldwide
- Significant use of resources
  - 70% of agricultural area
  - 60% of cereals produced in EU (30% worldwide)
  - 8 to 15% of water resource
- Deforestation and loss of biodiversity

**Kg CO<sub>2</sub>-eq / 100 g protéine**

Poore et Nemecek (2018)

Product	kg CO <sub>2</sub> -eq / 100g protéine
Beef (beef herd)	50
Lamb/mutton	20
Beef (dairy herd)	17
Farmed crustaceans	18
Cheese	11
Pork	7.6
Farmed fish	6
Poultry	5.7
Eggs	4.2
Tolu	2
Peanuts	1.2
Other legumes	0.8
Peas	0.4
Nuts	0.3

*Maybe simplistic, but reminds us that we need to find ways of improving the sustainability of livestock farming*

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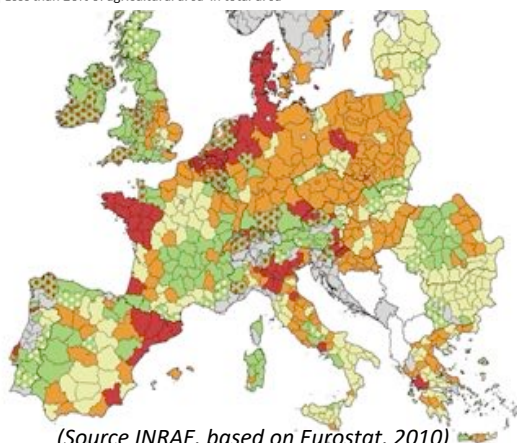
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## Importance of livestock farming in many EU regions

- Low proportion of grassland in agricultural area, high animal density
- High proportion of grassland in agricultural area, high animal density
- High proportion of grassland in agricultural area, medium animal density
- High proportion of grassland in agricultural area, low animal density
- Low proportion of grassland in agricultural area, corps and animals
- Low proportion of grassland in agricultural area, low animal density
- Less than 20% of agricultural area in total area



	AA (% total)	LU (% total)	LU/ha
■	10.5	29.5	2.15
■	6.7	14.6	1.70
■	19.3	18.5	0.75
■	6.8	2.1	0.25
■	31.6	26.6	1.20
■	25.0	8.6	0.30

- Livestock are present in almost all regions of Europe, 58% of EU farms hold animals,
- Livestock farming ensure rural vitality notably in region where it is the only economic activity,
- But a third of all farm animals are concentrated within a small number of areas,
- There is no "one size fit all" solution

(Source INRAE, based on Eurostat, 2010)

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## Part 1 : An new paradigm to think about the future



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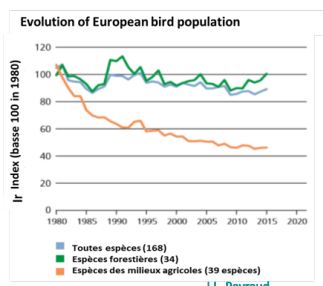
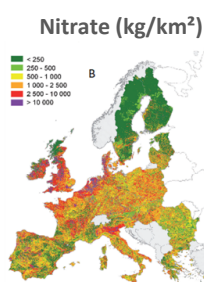
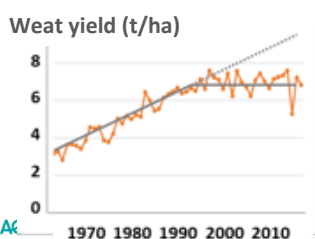
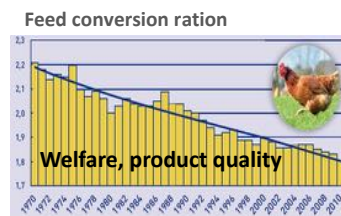
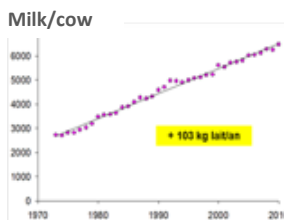
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## The green revolution has increased productivity

Intensification et specialisation of systems and regions



- Huge efficiency and productivity gains
- But an agricultural model that has reached its limits



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## Challenges : the landscape is changing



A society calling out for food systems to change

The demand is relayed by the political agenda



An urgent need to rejuvenate agri-food systems at farm level and beyond

Changing the interplay between the livestock and crop sectors is a desirable way to progress

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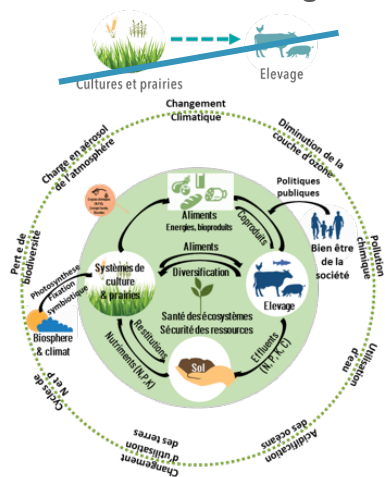
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## A new paradigm for thinking the future of livestock farming

- A conversion of the agricultural sector is required that targets nearly every aspects

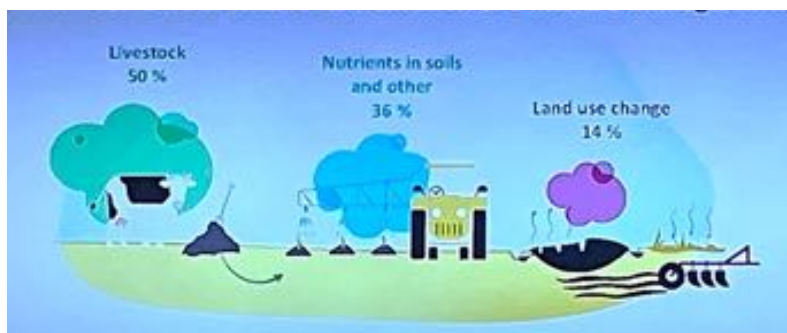


- **Livestock are key, they are recyclers by nature**
  - Recycling non edible plant biomass
  - Provide nature based organic fertilizers
  - Make easier crop diversification
  - Synergies between ruminants and non ruminants
- **But difficulties remain to be solved**
  - A sector that must evolve in depth – rethink its performances
  - A protein shift of our diets
  - New business models to share value added
  - Proactive public policies to support transition
  - Progress based on science



## Part 2 : Reduce the shadows of livestock farming

## Livestock impact on climate



- Livestock represents 81- 86% of emission
- 50% of which come from enteric fermentation

Leip et al., 2010

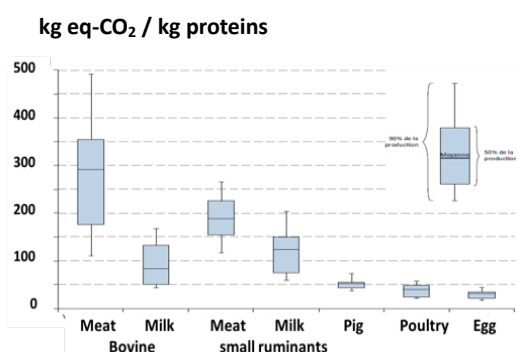
**Mainly CH<sub>4</sub>**  
Feed digestion  
Manure storage

**Mainly N<sub>2</sub>O**  
Chemical fertilizer  
Manure deposition

**Mainly CO<sub>2</sub>**  
Cultivation of drained organic soil  
C sequestration

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## GHG mitigation options: decrease intensity of emission



From Gerber et al., 2013

Animal efficiency (CH <sub>4</sub> )	Animal	<ul style="list-style-type: none"> <li>• Low emitting animal</li> <li>• More robust animal</li> </ul>
	Feeding	<ul style="list-style-type: none"> <li>• Use Feed additives</li> <li>• Increase forage quality</li> </ul>
	Herd management	<ul style="list-style-type: none"> <li>• Meat from milk</li> <li>• Age at slaughtering</li> </ul>
Circularity (CH <sub>4</sub> , N <sub>2</sub> O)	Feed production	<ul style="list-style-type: none"> <li>• Use N fixing plants</li> <li>• Use dual purpose crops</li> <li>• Avoid critical feeds</li> </ul>
	Manure management	<ul style="list-style-type: none"> <li>• Smart use of manure</li> <li>• Energy production</li> </ul>
	C Sequestration	<ul style="list-style-type: none"> <li>• Grassland, agroforestry</li> </ul>

- A reduction of up to 50% of net emission intensity is possible
- Consequences on the production cost, market valuation?

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## Meat from milk: same amount of milk and meat with fewer animals

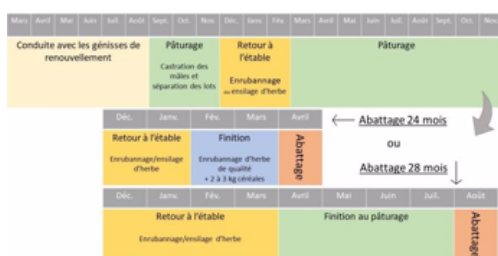


**Calf to beef system**  
12 - 14 kg eq-CO<sub>2</sub>/kg CE



**Young bull from dairy herd :**  
5 - 7 kg eq-O<sub>2</sub>/kg CE  
(Dollé et al, 2015)

- More robust cow will reduce the need for replacement heifers
- Cross breeding or sex-semen
- Use early breeds to fatten on grass with no (very little) concentrate
- Reducing the number of beef cow will free some land for fattening



- Holstein, Normand, Jersey X Angus bull
- Light carcass : 260 to 350 kg
- Less than 200 kg cereal/animal (≈ 1 kg/kg meat)

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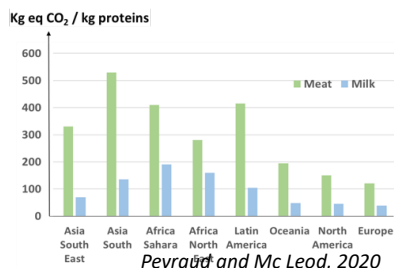
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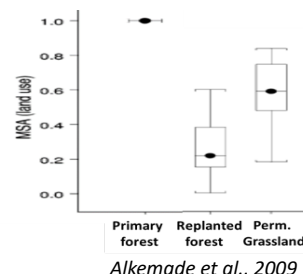
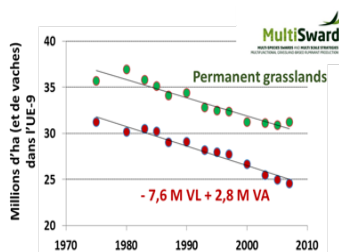
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## One dimensional reduction of livestock in Europe may lead to unintended outcomes

- Reduction of GHG emission in EU might be offset by increased impacts in other regions,
- Conversion of grassland to cropland: loss of soil C, wild live habitat, ecosystem services,
- Abandonment of grassland: loss of biodiversity, fermentation of plants, risk of fires.



*Peyraud and McLeod, 2020*



*Alkemade et al., 2009*

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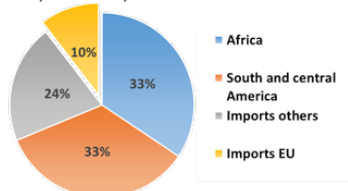
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## Reduce dependence on imported soy



- EU = 10% of the global embodied deforestation : soya (6%), meat, palm oil, cocoa, rubber, timber



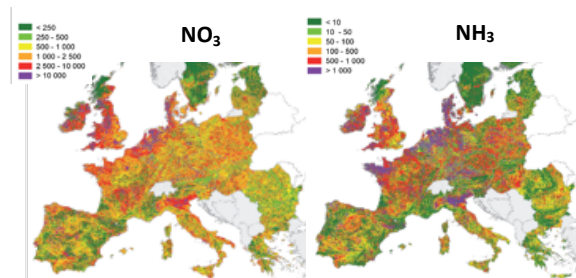
(European commission, 2019)

- Major loss of biodiversity
- GHG emission
- GMO feed
- Sensitivity to market fluctuations

- Alternative protein sources

Protein rich plat	Alternative resources
<b>Grassland</b> Protein crops (peas, lupin, faba bean), Rapeseed, sunflower cakes	Animal meals, Insects,
Low nutritional value	High nutritional value
Cost Availability	Cost, availability, Social acceptability

## Reduce local pollution



- 80% of nitrogen of agricultural origin present in aquatic environment,
- 90% of NH<sub>3</sub> emissions of the agricultural sector
- Emissions concentrated in intensive livestock farming regions

Sutton et al., 2011 Leip et al., 2015



- Increasing N use efficiency at animal level
- Manures : Avoiding N losses between animal and effective supply to the soil
- Bio refinery of manures, transfer between regions
- Local organization of agricultural activities
- Reducing density in some regions



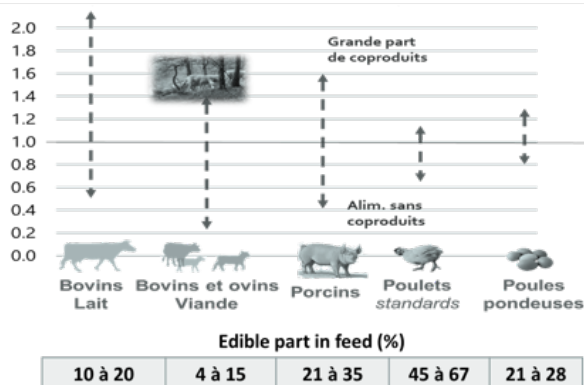
## Part 3 : Increase services provided by livestock in circular agriculture

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## The added value of animals to valorise non edible part of plants

- 50 to 95% of feed protein are not consumable as food protein

Kg of protein of animal origin per kg of edible plant protein used as feed



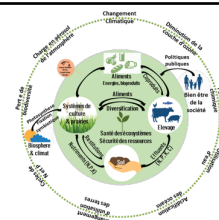
Non arable land

Sown grassland

Coproduits

Former food

*Ruminants are very efficient ...  
provided they value grassland*



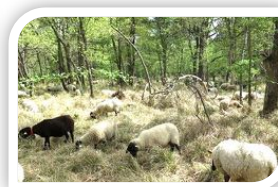
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## Food from marginal Land? Ruminants can do!!!

- Globally,
  - 57% of land used for feed production is not suitable for food production
  - 86% of animal feed is not edible as food

*Mottet et al., 2017*



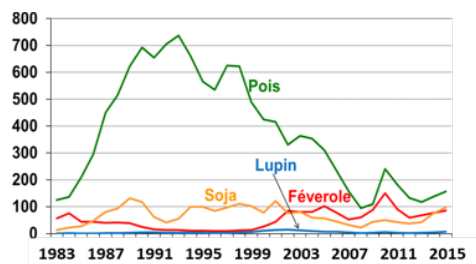
- Europe,
  - permanent Grasslands and rangelands cover 73 M ha (40% Eu AA)

*Eurostat,*

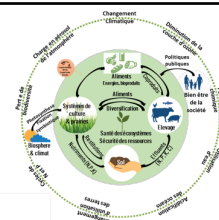
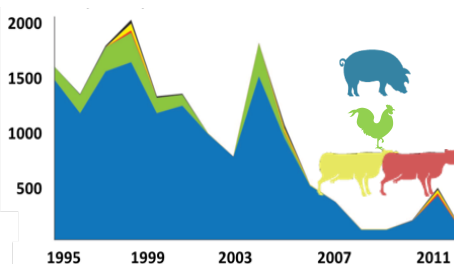


## Livestock to facilitate crop diversification

Acreage (x1000 ha)



Volume (x1000 t proteins)



- Animal feed can be adapted to the availability of raw materials and thus allows diversification of crops and crop rotations
- Using N fixing plants is a win-win strategy as part of a protein plan in Europe

## Livestock to maintain/enrich local biodiversity



Agro-biodiversity and patrimonial biodiversity

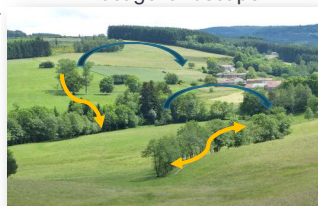
- Higher diversity of species cultivated in rotation (including honey plants with different flowering dates) and permanent grasslands



- Diversification of soil use, landscape and maintenance of open habitats



Bocage landscape



Open fields

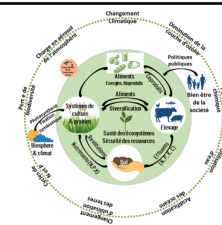


1 LU is associated with 90 m of hedges

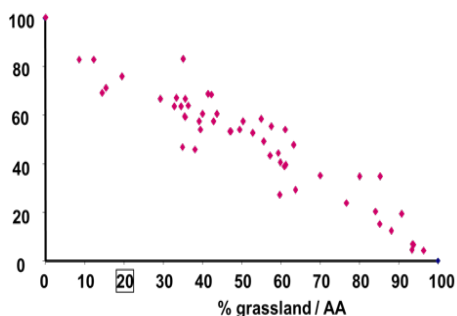


- “About 50% of the plant endemic plant species in Europe and 50% of the bird species depend on the permanent grassland biotope (Eckhard et al., 2009 ; Pain and Pienkowski, 1997)

## Livestock to reduce pesticide use



% AA with 1 or more pesticide application




(Raison et al., 2008), Projet Greendairy




- Crops receiving less pesticide,
- Diversification of cultures to break the cycles of pathogens,
- Introducing grasslands in the rotations,
- Introduction of animals into (perennial) crops,
- With positive effect on biodiversity

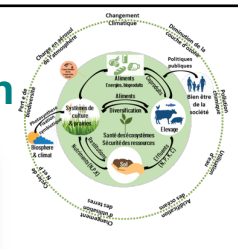
## Livestock to manage soil fertility and soil erosion

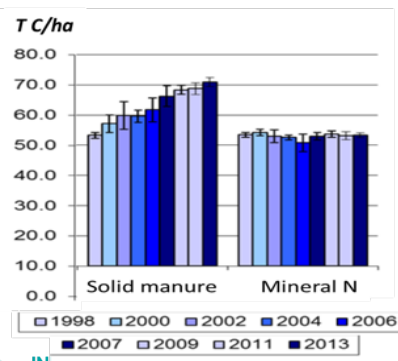


**Manures, grasslands**



**Soil OM content**  
**Soil structure**  
**Soil erosion**  
**Soil biology**






**TC/ha**

Treatment	1998	2000	2002	2004	2006	2007	2009	2011	2013
Solid manure	55	60	65	68	70	72	73	74	75
Mineral N	52	53	54	55	56	57	58	59	60

t/ha	30	70
OM	30	70
Erosion (t OM/ha/y)	3.6	0.3
Invertebrates	0.5	3.5
Microbes (µg/g soil)	8.0	11.6



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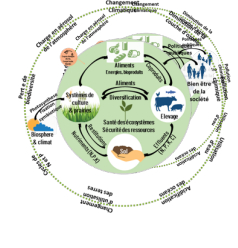
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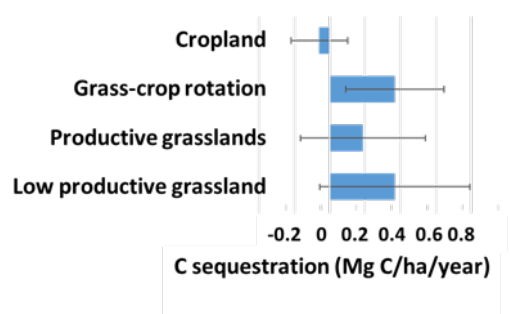
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## Livestock to increase soil C sequestration

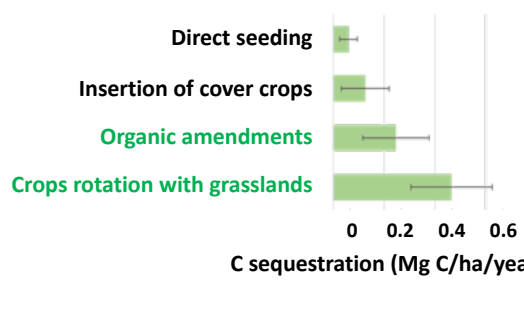


- **Maintains current stocks**




**C sequestration (Mg C/ha/year)**

- **Additional sequestration**



**C sequestration (Mg C/ha/year)**

*4P1000 study (Pellerin et al., 2019)*



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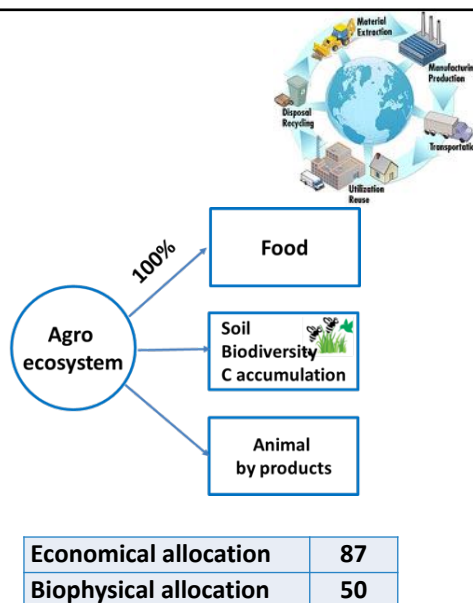
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## Some flaws in LCA analysis

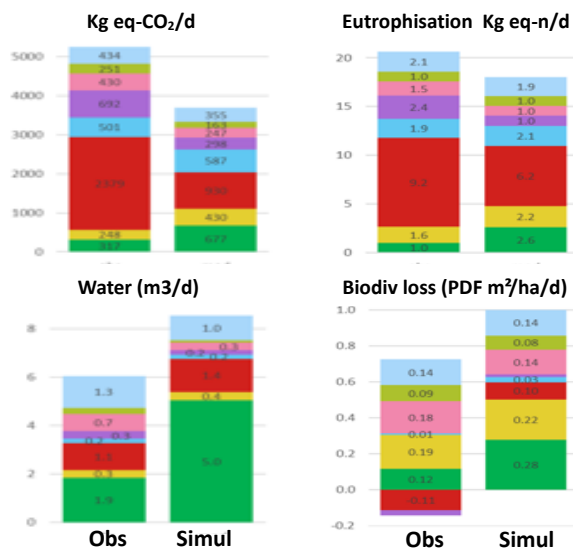
- Struggles to comprehensively assess aspects that are critical for long-term sustainable food production:
- Give advantage of intensive systems at the expense of agroecological systems
- By focusing on animal level the method do not consider properties emerging at system level
- Imperfectly considers
  - the aptitude of animals to recycle non-edible biomass and to use marginal land not able to produce crops
  - the provision of raw materials from animal by-products : economical vs biophysical allocation



## Part 4 : Consumption pattern

## Environmental impacts of nutritionally adequate diets

Kcal/day		Obs	Simulé
Fruits, vegetables	■	151	329
Cereals, potatoes	■	478	605
Dairy products	■	196	156
Meats	■	234	113
Eggs	■	25	43
Fish	■	45	52
Prepared Dishes	■	210	124
Sugar products	■	329	259
Animal fat	■	74	27
Plant fats	■	145	194
Sweet drinks	■	50	37



Darmon et al, submitted

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Darmon et al, en cours de publication

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## Conclusions



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- **Do not step into a simple way of thinking**
  - Opposing plant vs animal is a narrow vision of sustainability,
  - Look for synergies between livestock and crops from field to plate,
  - Grassland based systems have many advantages for circularity
- **Conditions for developing circular and sustainable agriculture**
  - An in-depth evolution of the sector is required (reducing density/concentration, quality),
  - Diversity of livestock production systems is essential to fit various demand and local contexts
  - Articulate the production of food (resource efficiency) and the production of ecosystems services (resource protection), the local and the global level,
  - Develop new coordination between actors (upstream, farmer, downstream, retail),
  - Propose proactive public policies to stimulate technical and organisational innovations,
  - Develop more accurate models to track progress and to assess the multi-functionality of livestock agriculture.



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