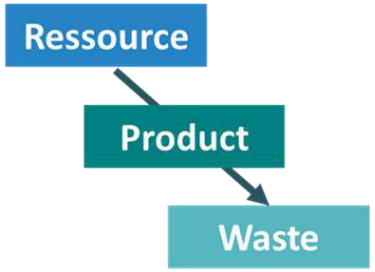
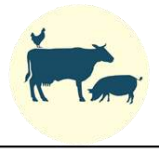
About the essential role of ruminants in agroecological and circular food systems

Jean-Louis Peyraud
Scientific direction of Agriculture

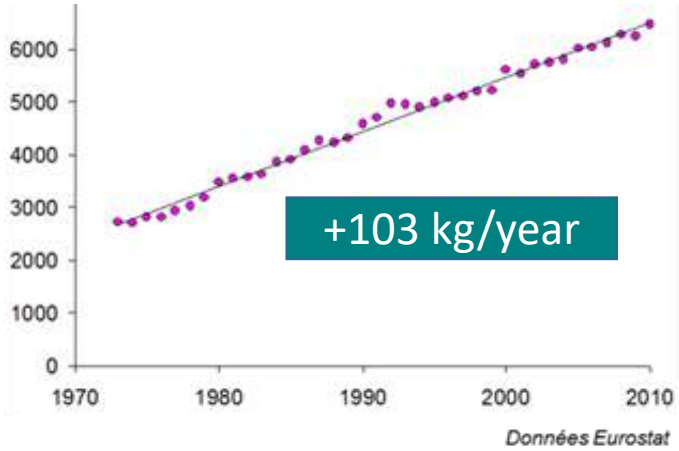
Part 1 :
Rethinking the paths of progress

Linear approach of agriculture: Not a sustainable pathway

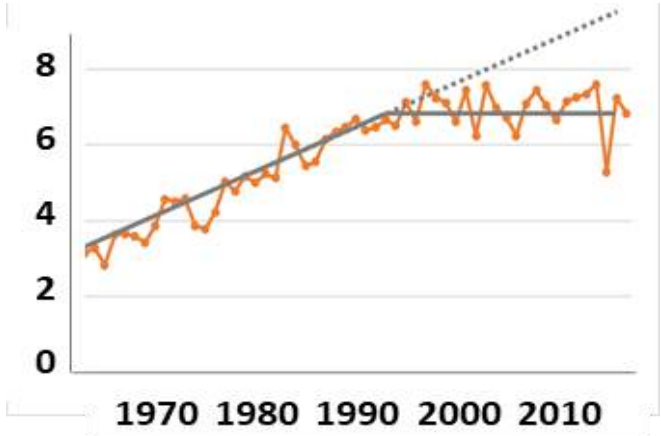


Production	Common Resources
	Mineral fertilizers, pesticides
	Crop Feeds

Milk (kg/year)

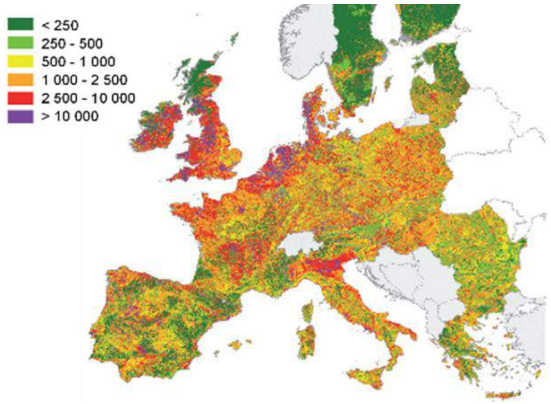


Yield gaps (Wheat, t/ha)



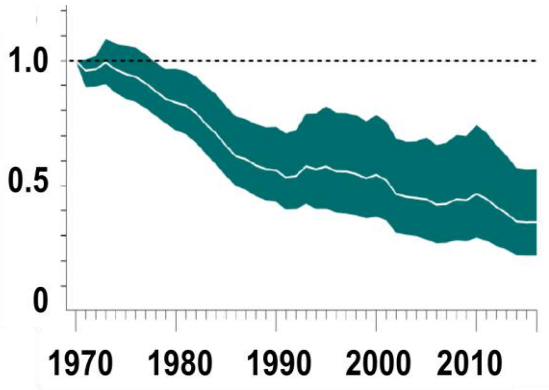
Climate change (kg CO_2e/kg protein)

Pollution (Nitrate kg/km²)



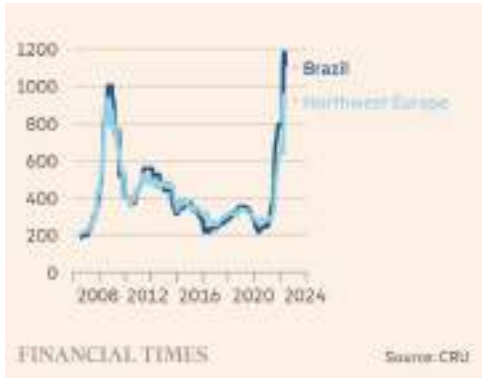
Sutton et al., 2011

Biodiversity losses (LPI)



From WWF

Price volatility (Mineral N)



Leip et al., 2015

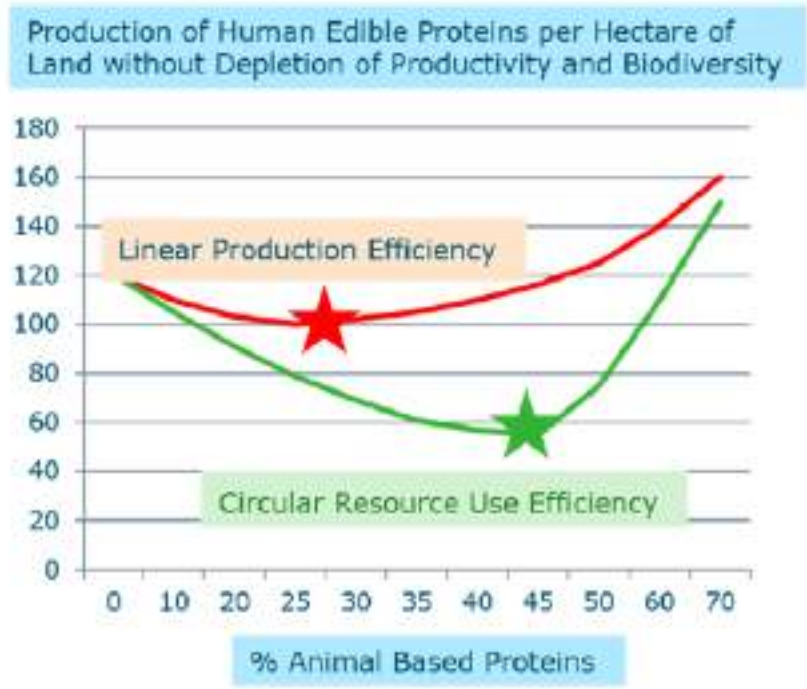
Animal welfare issue

Livestock: fading away or essential? Footprint versus role in circularity, finding the balance

Avoiding meat and dairy is 'single biggest way' to reduce your impact on earth

Livestock connects !

Soil is the base!

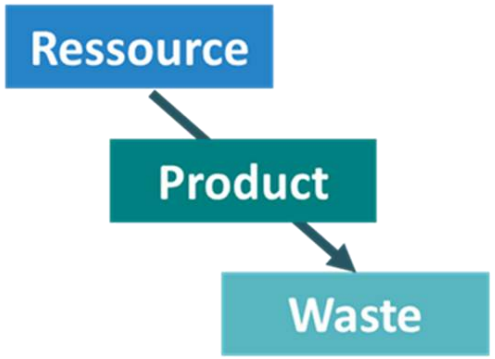


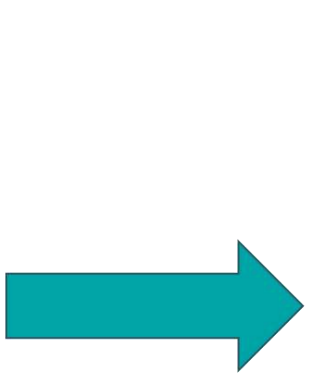
Classical LCA is not the whole story to direct a food transition

Livestock has undisputable shadows which must be reduced

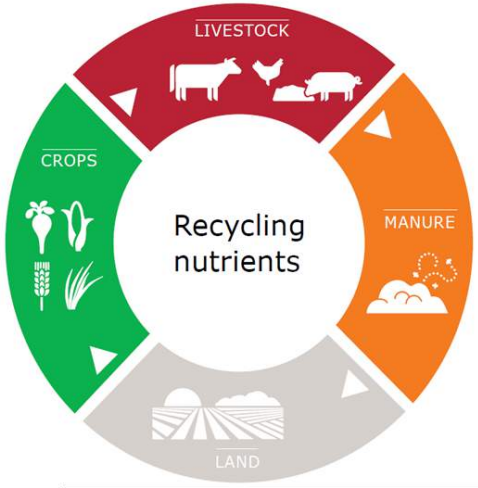
but in the same time, livestock is also part of the solution

Livestock (ruminants) are key for circularity





Livestock connects!



Soil is the base!

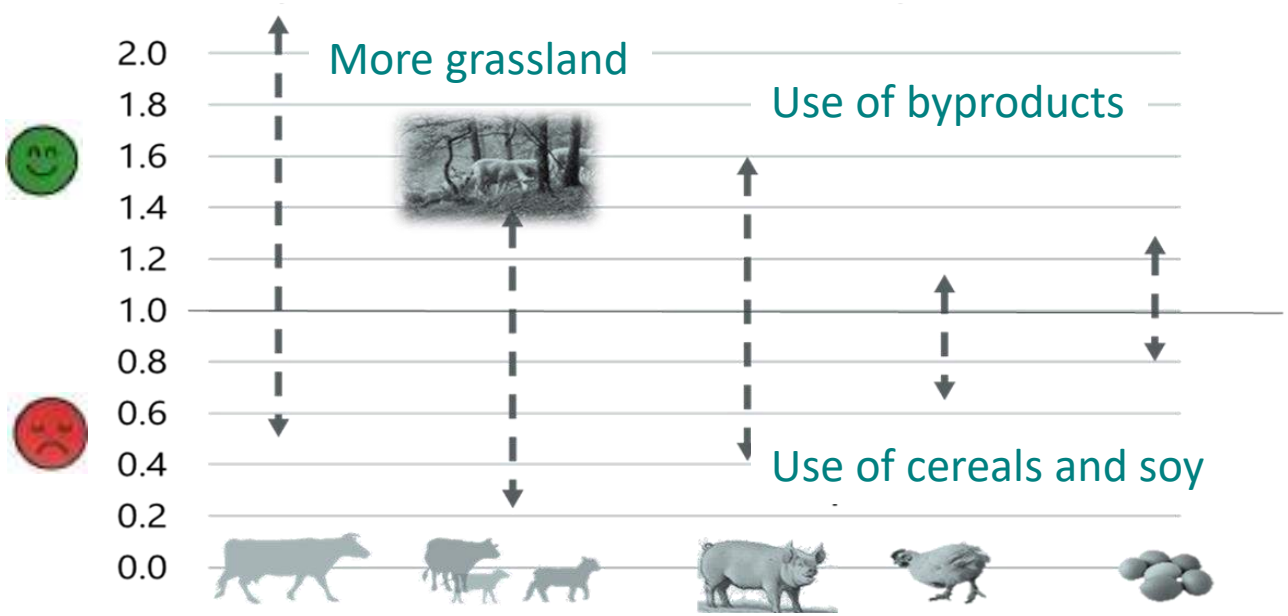
- **Recycling non edible-biomass**
- **Providing nature based organic fertilisers**
- **Enhancing crop diversification**
- **Providing ecosystem services**

Toward another story…

Part 2 :
Improving the contribution of ruminants to agroecological and circular food systems

1. Circularity in feed efficiency: from a wide range of resources, fit for feeds

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



Edible part in feed (%)				
10 à 20	4 à 15	21 à 35	45 à 67	21 à 28

(Laisse et al., 2019)

- **Food from marginal land? Ruminant can do!!!**

Europe: Permanent Grasslands and rangelands cover 73 M ha (40% Eu AA)

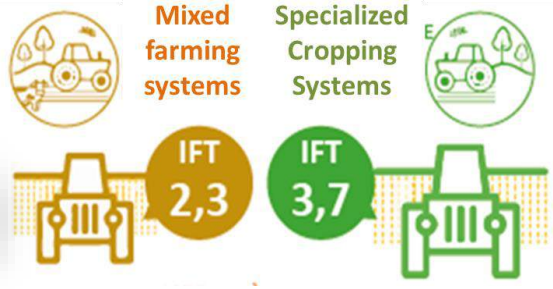
Eurostat, 2012

1. Circularity in feed efficiency: Valorisation of a diversity of resources with positive trade off

- More local protein sources
- Less mineral N fertilizers
- Less N_2O emission
- Increased agro-biodiversity

- Less land use for feed crop

- Crop diversification & Less pesticides use



- Alternative feeds for monogastrics

1. Circularity in feed efficiency: Potential use of legumes by dairy herds

- **Legumes, a winning resource in dairy farming**

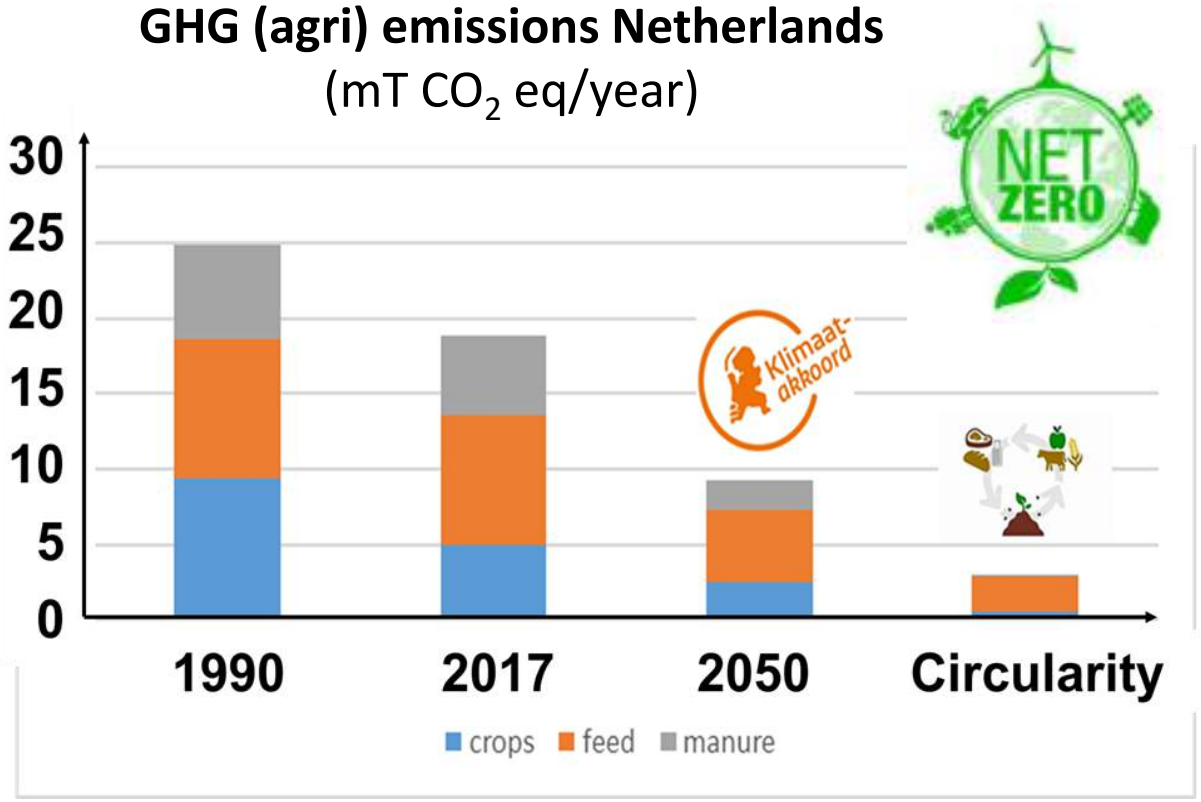
	Term of use	milk
Tall legumes are good companions of maize silage	Up to 50% of MS	=/-
Multispecies swards for grazing (Gram + Leg)	Deep/shallow rooting	++
Grain Legumes to replace cereals and soy protein	Up to 10% DM intake	=

Adapted for Chenais et al., 2003 ; Rouillé et al., 2010 ; Hoden et al, 1992 ; Delagarde et al, 2014)

- **Consequences for land use and protein autonomy** *(Peyraud, unpublished)*

Replacement of 30% of maize silage with alfalfa for 2M cows over the winter period	Saving 200,000 t of soy protein (35% of total) 1 ha of maize vs 1.8 ha of alfalfa and cereals.
Incorporation of 5% (poultry) to 20% (fattening pigs) of seeds in feed	A potential of 1.5 Mt of protein (pea > Faba bean > Lupine) i.e. more than 2 M ha

2. Circularity lead to net zero: climate smart food production



Manure: valorisation as compost and mineral concentrates saving use of mineral fertilizers

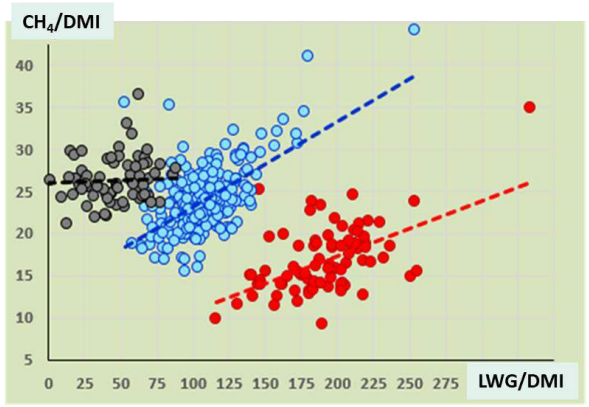
Feed: using 100% forage and coproducts instead of imported specific feed crops

Crops: changing land use with a dual food/feed production instead of one-culture food and feed crop production land

2. Circularity lead to net zero: herd efficiency

- **More efficient animals**
  - High production: Less CH_4/kg milk (FAO; 2006, Gleam) but less meat/kg milk, less grassland, more concentrate, indoors feeding
  - Low emitting animals: antagonism with the efficiency of digestion

(Renan et al., 2016 ; Mc Donnell et al., 2016; Olijhoek et al., 2018)



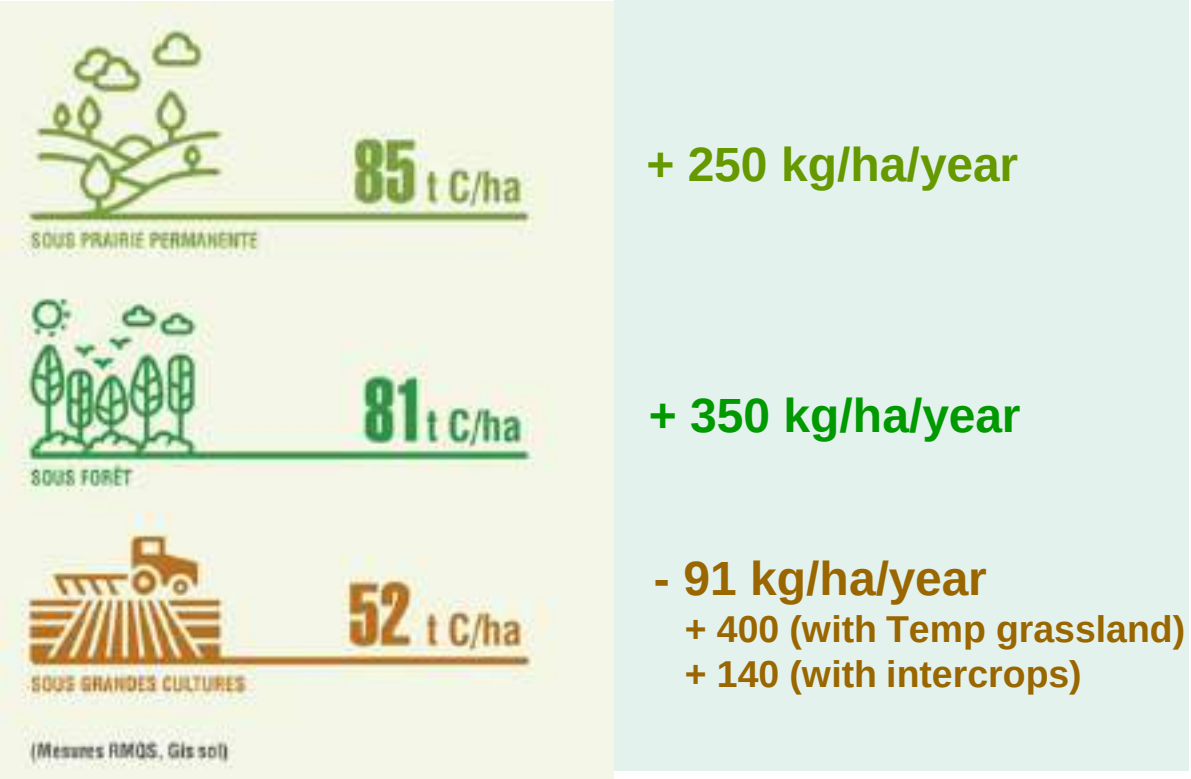
74 heifers (hay), 232 heifers (grass silage), 81 youg bulls (pettets)

- **Reducing the number of animals for the same production**
  - Advancing age at 1st calving (28-30 to 24 month) : - 5% CH_4/milk
  - Reducing culling rate (35-40 to 25%): - 10% *Adapted from Dall-Orsoletta et al., 2019*
  - Meat from milk (5 - 7 vs 12 – 14 kg CO_2e/kg CE) *Adapted from Dolé al., 2015*
  - Less NO_3, NH_3, less land use, increased autonomy

- **Feeding management**
  - Forage legumes: - 5 to - 15% CH_4/ milk (Luscher et al., 2014 : Eugène et al., 2015) & many advantages
  - Feed additives: -15 to -30 % CH_4/milk but social acceptability, cost
  - Precision livestock feeding : - 10%

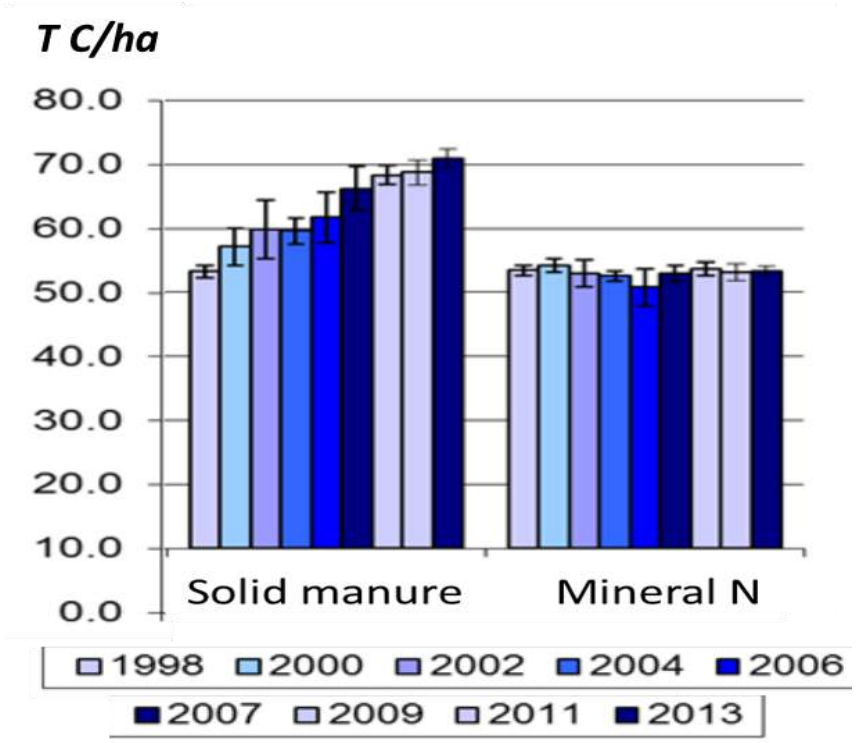
2. Circularity lead to net zero: Soil C sequestration

- **Soil C stock and additional C storage**



Etude 4P1000 (Pellerin et al., 2019)

- **Solid manure application**



3. Circularity in manure based fertilization: Turning a problem into an opportunity

- **Manure N vs Mineral N:**
  - Similar production (10 Mt EU-27)
  - Less N_2O emission (< 3 vs 30 kg eq-CO_2/kg N)
  - but high NH_3 emission (20-30%)

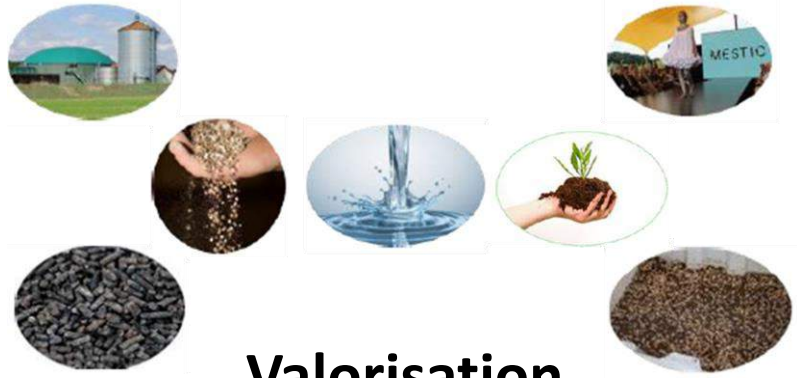
(kg eq CO_2/kg N)	Synthesis	Spreading
Chemical fertilizer	**28.5**	**4.6***
Manures	**0**	**1.6**

(Adapted from Peyraud et al., 2014 ; GIEC 2919)

- **Give more value to manures**

Treatment

manu RE source



Valorisation

Avoiding losses between animal and effective supply to the soil

New products (including energy) and more value added

3. Circularity in manure based fertilization: Take advantage of manure N (and P)

- **Avoiding losses between animal and effective supply to the soil**

Potential reduction	CH4	NH3
Grazing (direct recycling)	+	++
Slurry tank cover	-	Up to 80%
Rapid burying	< 10%	Up to 90%

Quality of manure	☺
Reduced volume	☺
Cost of fertilisation	☺
Leaching potential	☹

Peyraud et al., 2014; Henning L. et al 2011; Martin et al. 2013; CITEPA 2019

- **Innovative processes for new products and more value added**
  - Cascading approaches: Extraction of ingredients > minerals > energy > water,
  - Production of composts: Transported to other areas (but risk of NH_3 loss),
  - Energy, biogas
  - Other possibilities: Insect production, innovative products….

INRAE

4. Circularity in nature based agriculture: Promoting agro-biodiversity

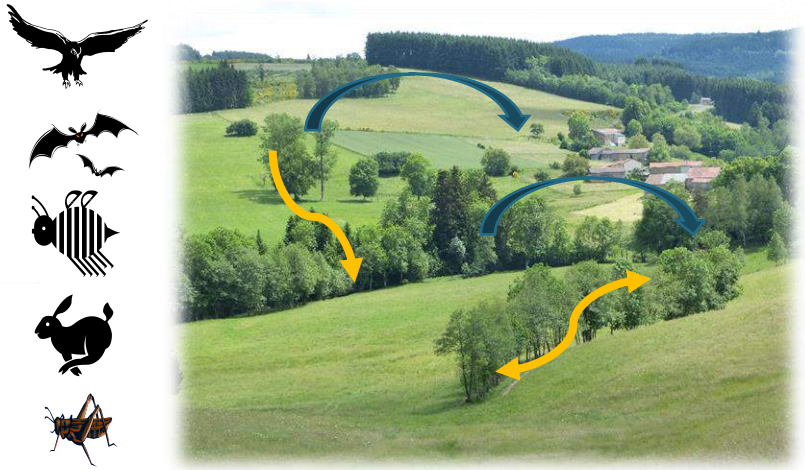
- **Higher diversity of species cultivated in rotation (including honey plants with different flowering dates) and permanent grasslands**

- **Diversity of animal species & breeds**

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

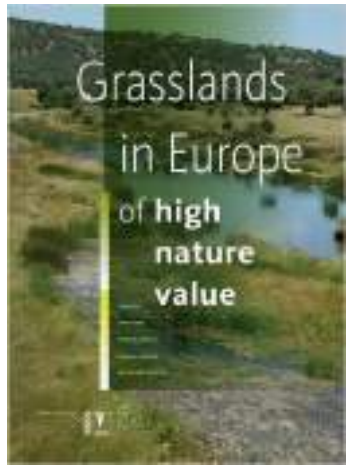
1 LU is associated with 90 m of hedges

Bocage (hedges, groves, selvedges, ...)



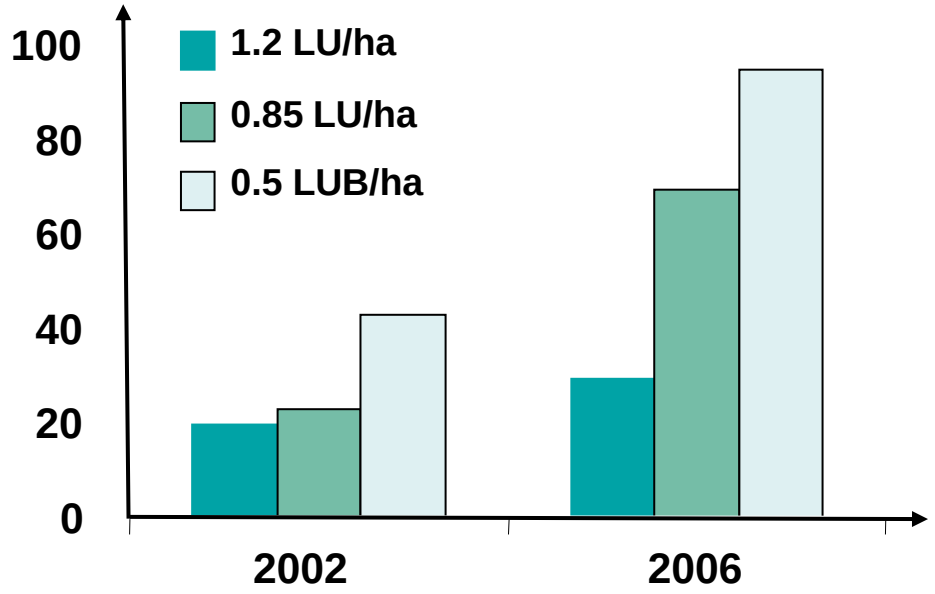
Open fields

5. Circularity in nature based agriculture: Promoting agro-biodiversity



About 50% of endemic plant species in Europe depend on the biotope of the PGs *(Eckhard et al..2009)*

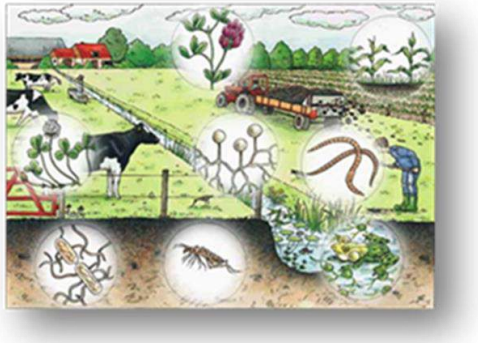
- **Effect of stocking rate**



Specific richness increases with decreasing stocking rate

6. Circularity for long term sustainability: soil is the base

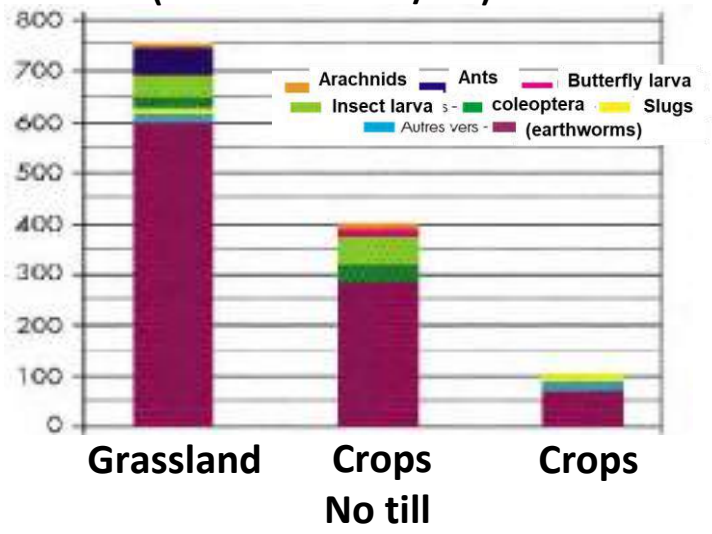
Soil OM content
Soil structure
Soil erosion
Soil biology



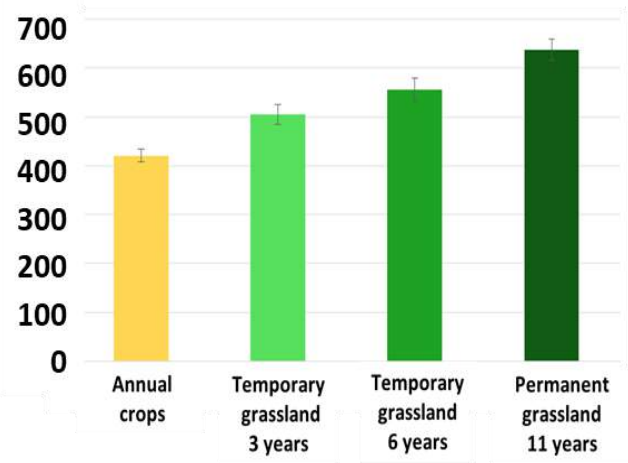
Soil erosion (t OM/ha/year)

Eurostat (2011)

Soil biological activity
(N invertebrates / m²)



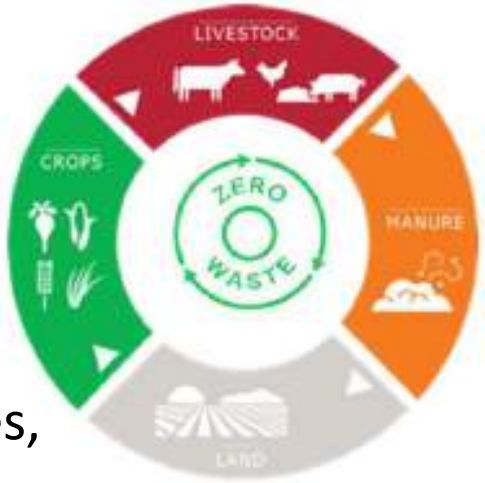
Soil Biological activity
(Protease µmol.h^{-1}.g^{-1} sol sec)



Petitjean et al., 2018

Gobat et al. 2003- Le sol vivant

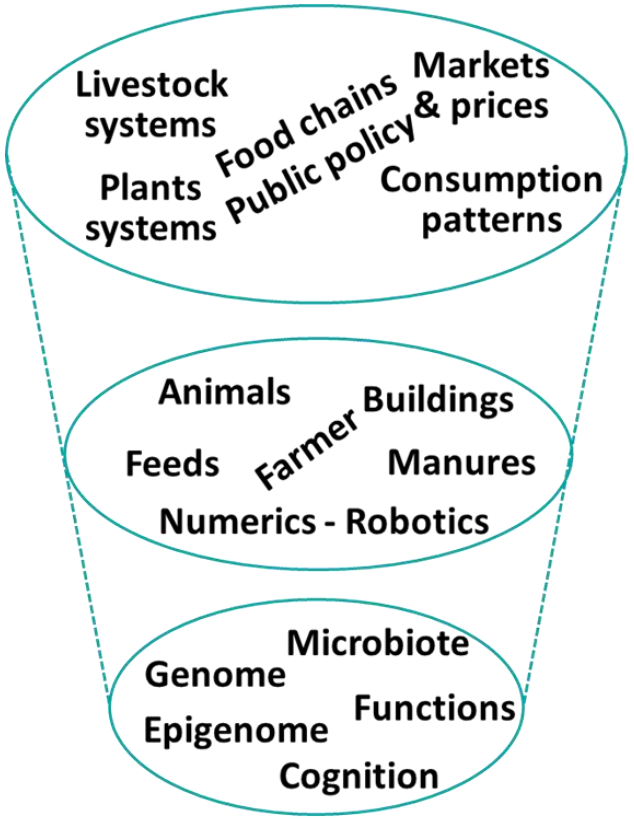
Take home message



- Connected circularity in the integrated agro-food-system is the only option for a resource sufficient and emission free food production within the planetary boundaries in compliance with the green deal ambition and related EU strategies,
- Ruminants are needed to close the cycle in regenerative use of resources, to optimize circularity in the agro-food-system,,
- The production systems should be transformed to optimize their integrative role in circularity,
- The “shadow of ruminants” can be mitigated and counterbalanced,
- Grassland (and other marginal crops) is the basics, the residual from the food system is the bonus
- Need to articulate local and global scales, production of food and production of immaterial functions,

Take home message

- To maximize the roles of livestock in circular food security and safety we need Integrated, Inclusive & Interdisciplinary approach and research



Governance for sustainable food systems

Achievement of multi-performing systems

Obtaining "circular animal" : Efficient, robust & resilient

Efficiency	Low emitting & robust animals Feeding practices Herd management Animal health…
Resource recycling	More efficient use of crops
	Smart use of organic fertilizer
Nature based solutions	Use of N fixing plant & longer rotation
	Green Energy production
	Soil C sequestration & fertility


Thanks for your attention
Ruminant farming systems are much more than only food production