Research And Innovation Towards A More Sustainable And Circular European Agriculture

Exploring synergies between the livestock and crop sectors

EAAP Annual Meeting 2021

Jean-Louis Peyraud, Animal Task Force

Amrit Nanda, Plants for the Future ETP

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A joint initiative

The European Technology Platform (ETP) 'Plants for the Future' is a membership-based platform representing the agricultural innovation system from fundamental plant research to crop production and food processing.

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- **Marc Cornelissen, President, BASF**
- **Aleksandra Malyska,**
- **Amrit Nanda, Executive Manager**

Animal Task Force (ATF) is a European Public-Private Partnership and a leading body of expertise linking European industry and research providers for developing innovation in the livestock sector.

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- **Jean-Louis Peyraud, President, INRAE**
- **Vivi H. Nielsen, Vice President, Aarhus University**
- **Florence Macherez, Secretary General, Idele**
- **Just Jensen, Aarhus University**
- **Michael Lee, Rothamsted University**

Aim and purpose of the vision paper

Aim

- To identify **research goals and policy recommendations** that aim at improving sustainable food production at the interplay of the plant and livestock sectors

Purpose

- Align societal expectations and public policies which impose changes in agri-food systems
- Provide direction towards Horizon Europe for a rejuvenated sustainable agriculture based on **synergies between livestock and crops**

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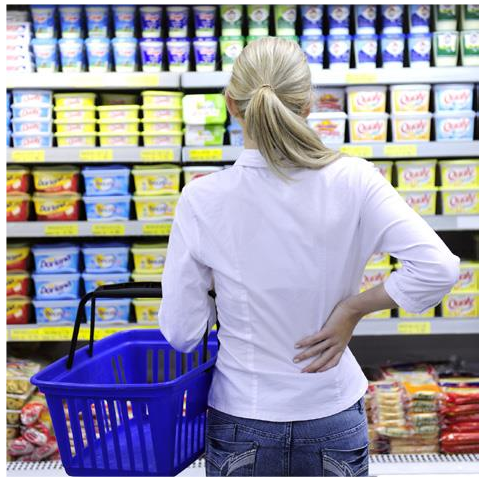
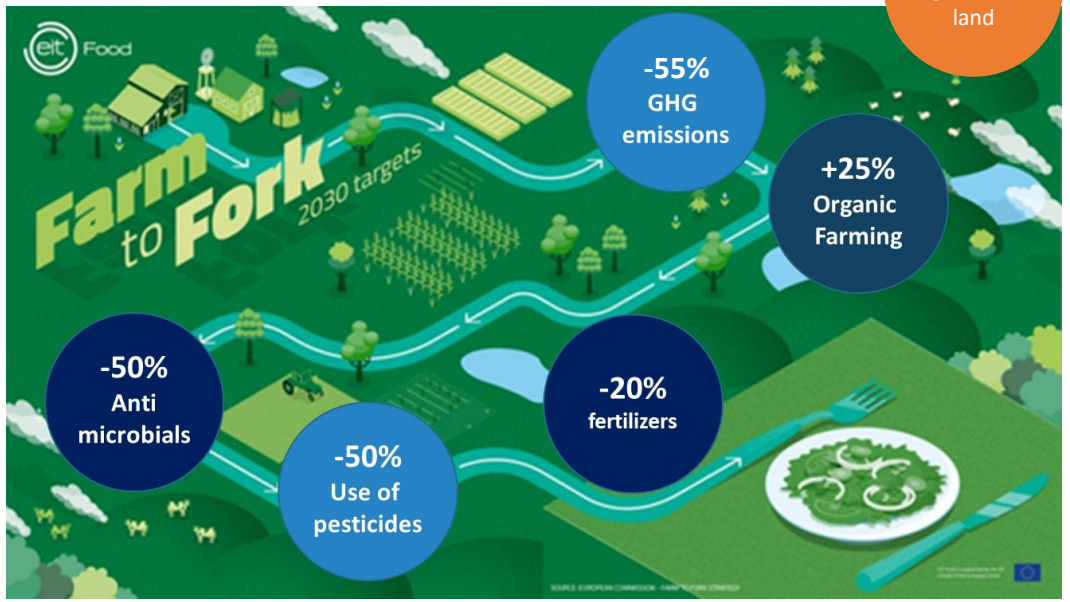


A society calling out for food systems to change

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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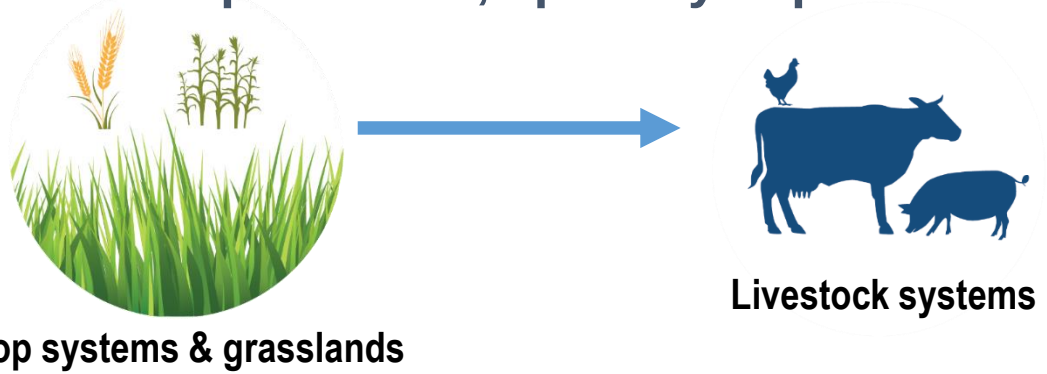
The landscape

A Green Revolution to improve productivity…

Systems have become more intensive more specialized, spatially separated

Monocultures
Mineral N fertilizer
Pesticides



Crop systems & grasslands

Livestock systems

High levels of N outputs
Imported protein
GHG
Land use

… is causing negative effects

Loss of soil fertility, loss of biodiversity, degradation of ecosystems…

Tackling the undesired effects by changing the interplay between sectors

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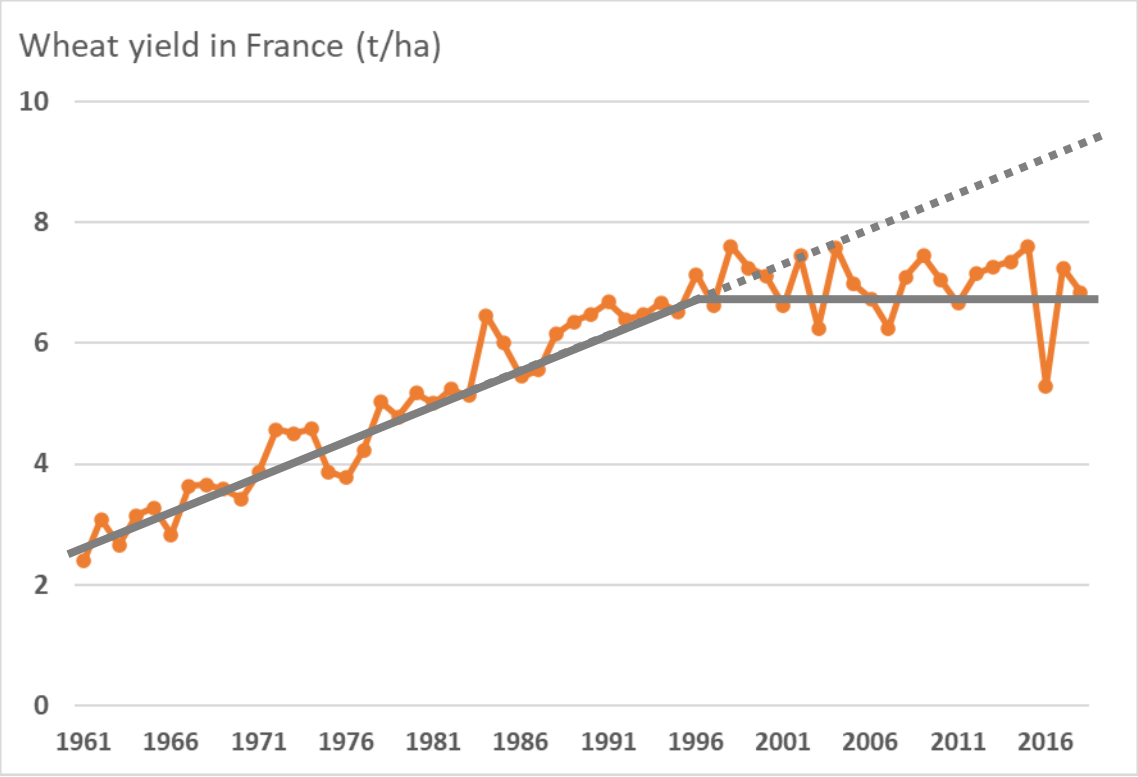
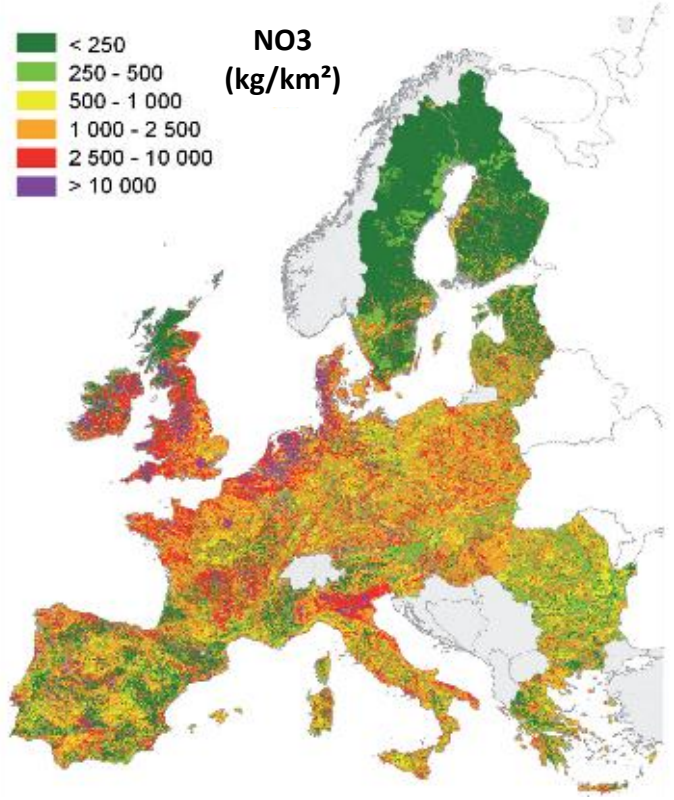
An agricultural model that has reached its limits

- **A yield gap**



Hannah Ritchie and Max Roser (2013) - "Crop Yields". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/crop-yields'

- **Excess of N in intensive livestock farming systems**



Nitro Europe 2011 (Leip et al., 2015)

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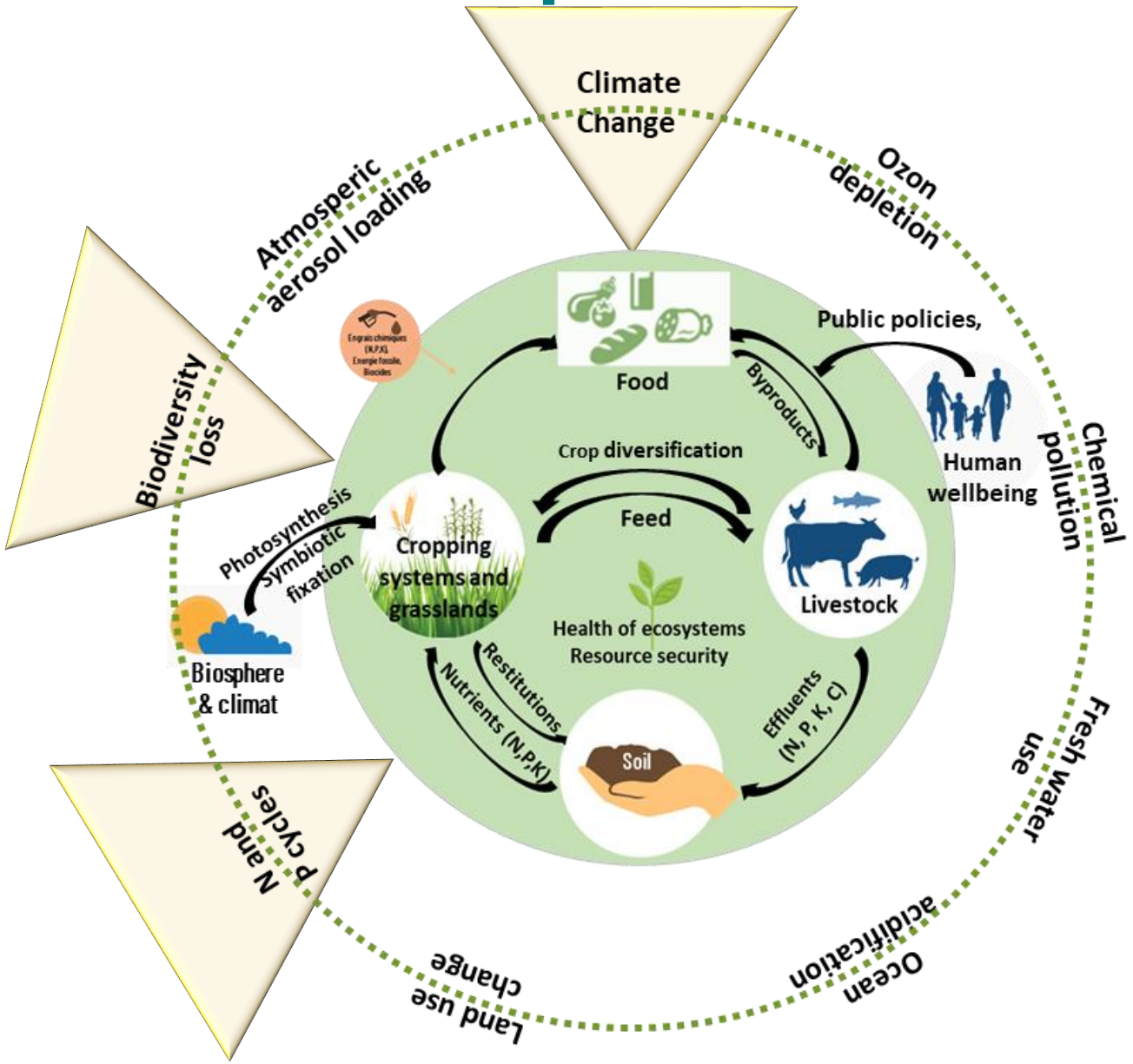
The landscape



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

Synergies may be derived by connecting livestock farming and crop farming at different level (farm, region)

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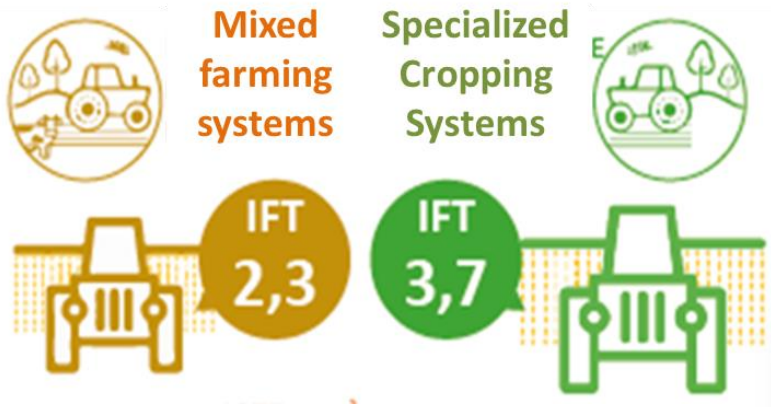
Some potential benefits of reconnection

- **Reduction of pesticide use**

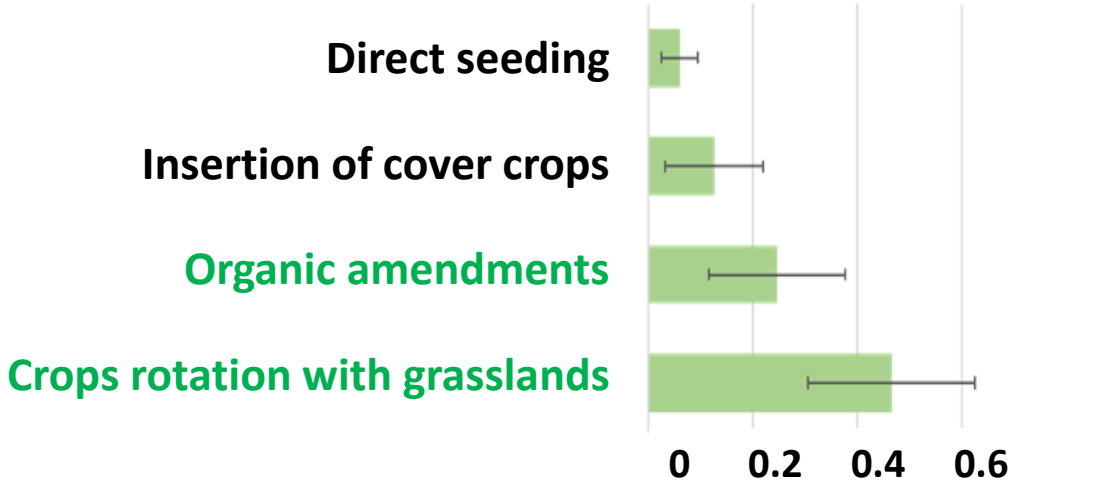


Index of Treatment Frequency

More diverse species in rotation allow

- Breaking of pest cycles
- Crops needing less pesticide treatments

- **Additional C sequestration**



4P1000 study (Pellerin et al., 2019)

Some potential benefits of reconnection

- **Increased agro-biodiversity**
  - Higher species diversity (including honey plants with different flowering dates)

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

- **Increased En, N, P & protein autonomy**
  - Reduction of the use of mineral fertilizers & green energy production

  - Use of local protein sources

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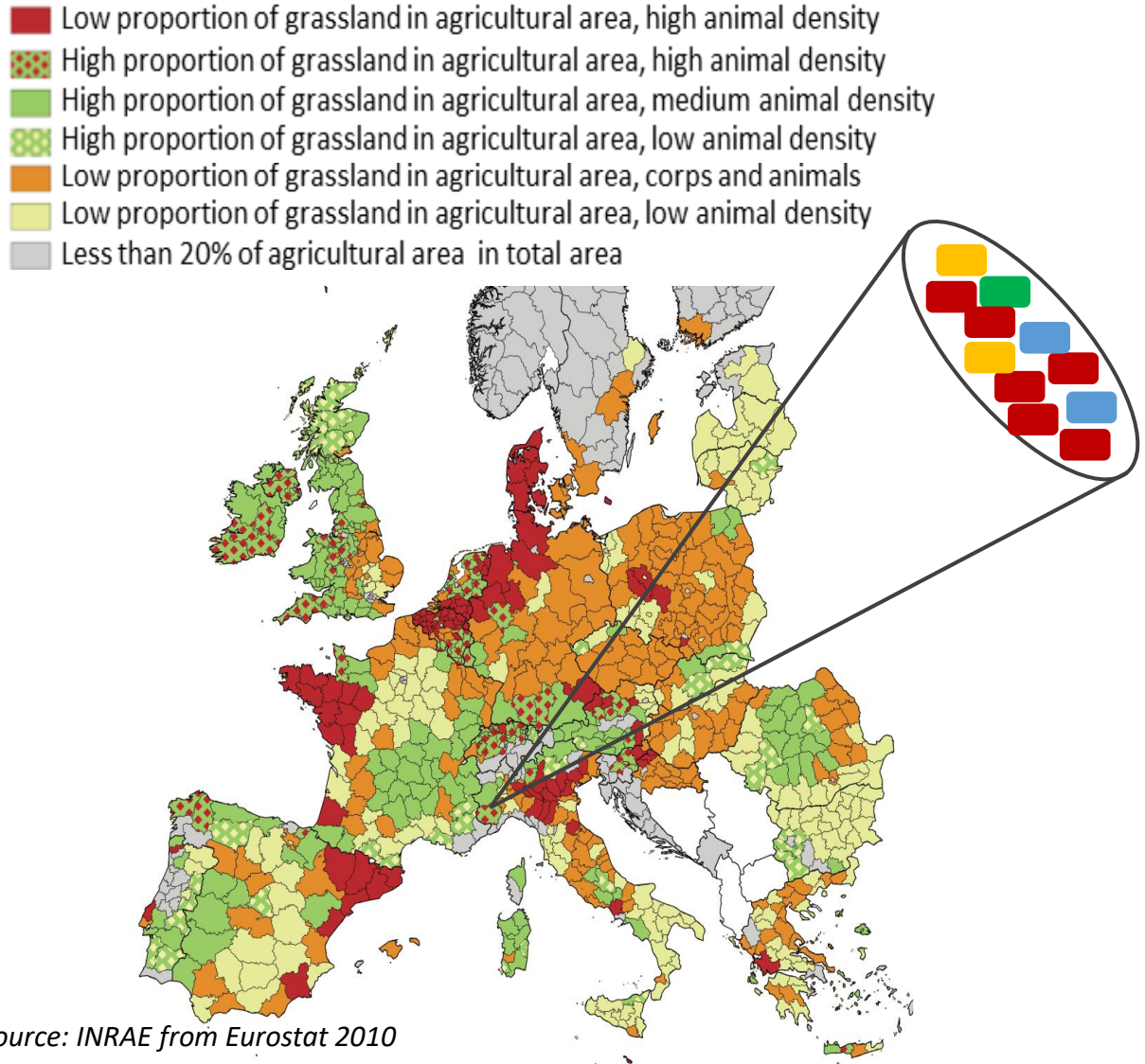
The landscape: a diversity of characteristics and solutions



Source: INRAE from Eurostat 2010

- **Solutions are to be based on science**
- **Solutions are to be found according to the political choices and the territorial contexts**
- **There is no "one size fits all" solution**

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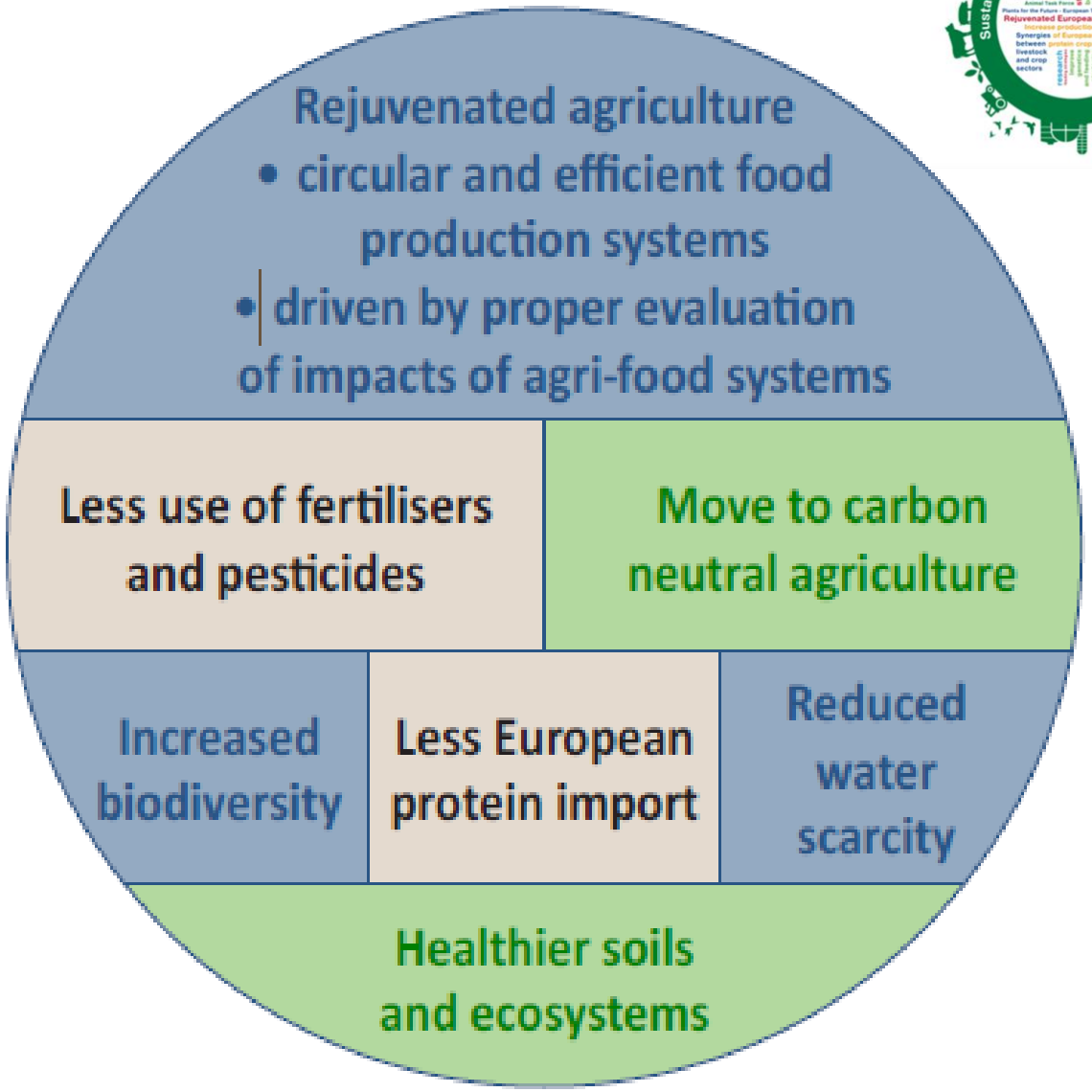
Expected impacts

The goal is to arrive at climate change-mitigating, circular, resource efficient agri-food systems with closed nutrient cycles, healthy soils and ecosystems, restored biodiversity and an attractive landscape



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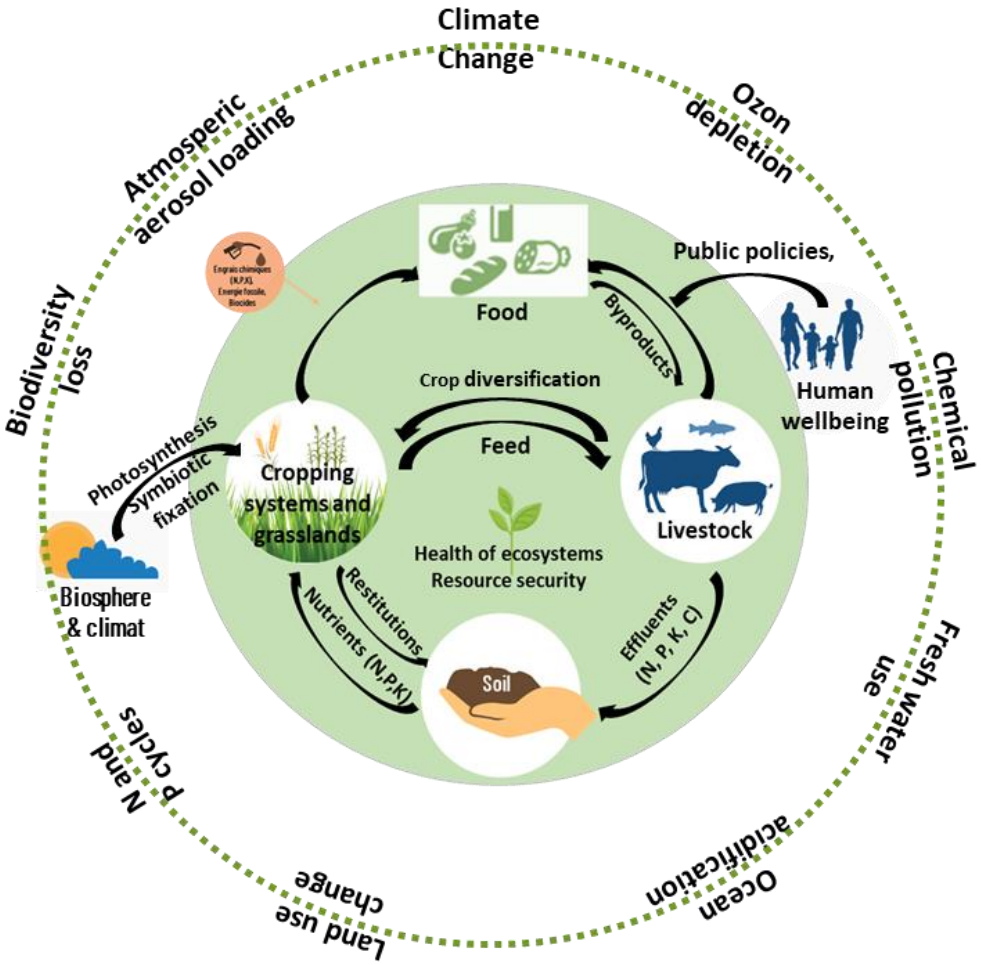
Some difficulties to overcome

- A systems approach is required
- Shift from a focus on efficiency of single products towards efficiency of the whole system
- New actors coordination to change the socio-technical system
- Numerous production, economic and policy inter-dependencies



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Recommendations: topics for research and innovation

Recommendation 1

An LCA upgrade to track progress towards more sustainable farming

- **More accurate models to assess the multi-functionality and complexity of agriculture**
- **Evaluation of sustainability on a long term basis**
- **Capturing a variety of performances** (biodiversity, soil fertility, employment, etc.)
- **Capturing interactions between crop and livestock sectors in a circular economy**

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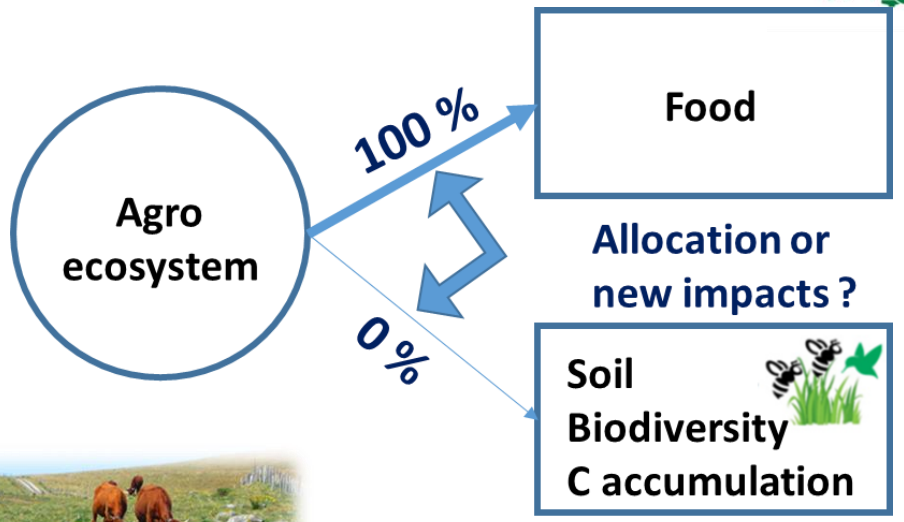
Some flaws of LCA to evaluate circular agriculture

- **Focus on reduced impact per unit of product:** Favours intensive and specialized systems
- **Do not consider the multi-functionality of agro-ecosystems:** critical aspects for long term sustainability soil fertility, soil erosion, biodiversity…
- **Provide a partly biased vision of resource use efficiency:** no distinction between arable/non arable land and edible/non edible biomass
- **Does not capture properties emerging at landscape level:** buffer zones, landscape architecture, etc.



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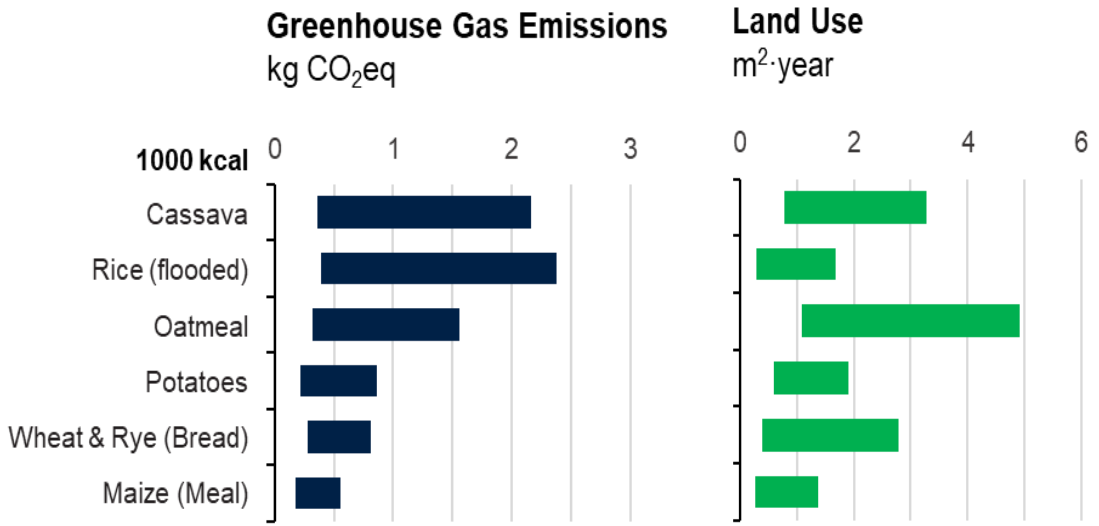
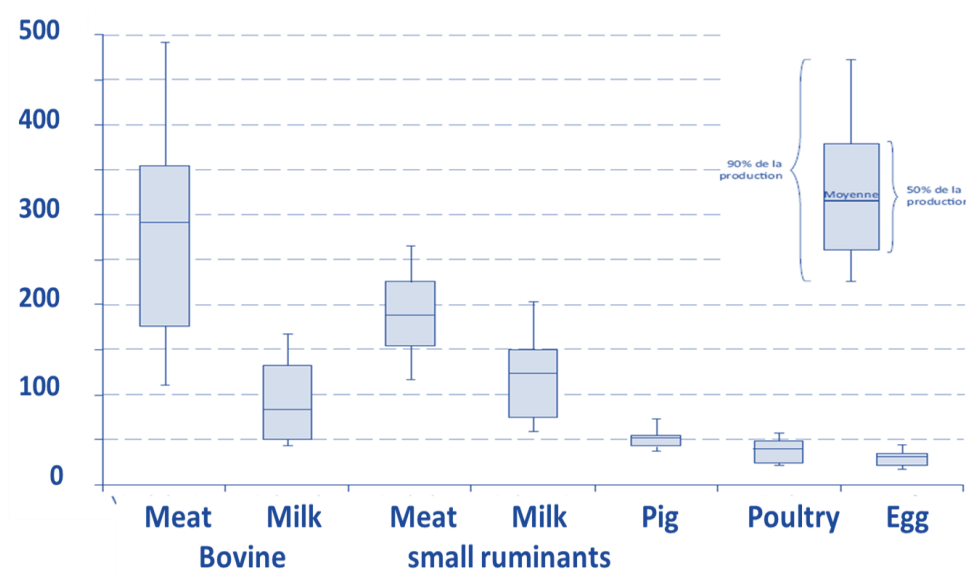
Environmental impacts (EI) vary between and within product classes



Poore & Nemecek (2018)



Gerber et al., (2013)

Broad variation in EI within and between product classes: offers the basis for progress and a labelling approach that could help lower EI while turning otherwise economically underperforming products into viable business propositions

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Recommendations: topics for research and innovation

Recommendation 2

Optimise synergy in circular livestock-cropping systems

- Innovative cropping and livestock farming systems
- Plant materials and animals adapted to the new context
- Improvement of plant and manure processing methods to maximize circularity

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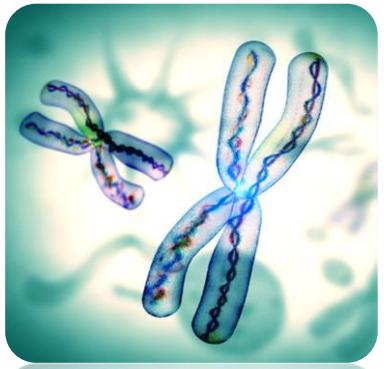
Recommendations: topics for research and innovation

Recommendation 2A

Identification and development of innovative cropping and farming systems

- **Identification-development of a panel of crops & rotations:** resource efficient crops; diversity in cultivation requirements; multi-purpose crops; green forages in rotations; agroforestry, cultivation and harvest regimes**.**
- **Development of innovative feed-livestock value chains**: use of diverse feed sources; management of efficiency and safety.
- **Development of manure as commercial bio-fertilizer** supplying N-P-C to crops, reducing dependency in imports (P, energy).
- **Machinery, robotics and precision agriculture**

Recommendations: topics for research and innovation



Recommendation 2B

Genetic improvement of plants and animals to maximise resource use efficiency (RUE)

- **Development of precompetitive research based on phenotyping and genomic information:** new biodiversity (wild species, local breed) for RUE, tolerance to stress & volatile weather conditions; role of microbiomes; improved root functions, genomic selection & NBT
- **Plant improvement:** novel crops; multi-purpose crops; protein yield; varieties adapted for mixed cropping; nutritional value (Amino Acids, anti-nutrients, bio-availability)
- **More robust animals :** adaptation to more diverse and lower quality feed; efficient fibre digestion vs low CH4 emission; robustness and functional traits

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Promoting knowledge transfer: example of a crop improvement platform

Harmonisation and curation of vast collection of published work

Different questions depending on crop and location

Progressive sustainability standards in variety testing will offer breeders focus and global competitiveness

Different questions depending on biology and discipline

Virtual predictive breeding workflow

Source: TIBS Opinion paper (Cornelissen et al., 2020)

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Recommendations: topics for research and innovation

Recommendation 2C

Development of bio-refineries to maximise European self-sufficiency

- **Up-scaling of plant bio-refinery methods:** protein extraction from forages and oil seed; plant secondary metabolites as health promoting component
- **Reducing ruminal degradation of proteins**
- **Development of innovative processing of manure** : recovery of N and P, C and energy, homogeneity & safety of processed products

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Recommendations: topics for research and innovation

Recommendation 3

Governance, roles of stakeholders and public policies to promote changes over time

- **Look for the option space to turn otherwise economically underperforming products into viable business opportunities**
- **Actors coordination to change the socio-technical system:** explore and demo business models ; redistribution of added value ; analysis of collective strategies and case examples (locally contextualized) ; re-introduction of livestock
- **Design of public policies to guide and support transitions:** most appropriate tools for supporting transitions, protection of innovation niches

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Visual illustration how impulses trigger a stepwise migration from specialized to circular agriculture

Shift to circularity in production systems			impact waves based on changing demand and sector response (in years)			
stakeholder group		action	0-2,5	2,5-5	5-15	15-30
end consumer	< ademia >	Focus on sustainable products				
retailer		provide customer with transparancy on production sustainability				
		intensify marketing products on sustainability of production				
		start marketing products based categories on production sustainability				
producer		install source origin traceability				
		rejuvinate ad/or supplement product portfolio				
processor Includes slaughterhouse, dairy, factories (plants)		install source origin traceability				
		install tailored bio-refinery approaches				
		co-localize with integrated production centers				
trader		install source origin traceability				
farmer		develop and implement meaningful traceability parameters related to production sustainability				
		install new business models to leverage sustainability advantages of integrated food, feed, fibre and fuel production				
farm supplier		develop new genetics at plant and livestock level to optimise productivity				

Direction needed for R&I to meet 2050 goals

Shift to circularity in production systems			impact waves based on changing demand and sector response (in years)			
stakeholder group		action	0-2,5	2,5-5	5-15	15-30
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farm supplier		develop new genetics at plant and livestock level to optimise productivity				

- Clear targets for 2030 allow to set milestones in time and predict market needs
  - 2030 targets will be met with innovations already in pipeline
- Lack of clear targets for 2050 create uncertainty about future market needs
  - *De novo* innovations will be needed for 2050 carbon neutral goal

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Concluding remarks

- Delivery on the proposed R&I topics will contribute to EU Green Deal goals and is expected to require additional research and EU-funding
- Some themes are already being funded, yet do not fully address issues in a changing environment
- Some technical solutions have already been developed, yet they are insufficiently applied across territories and shared among stakeholders. EIP-AGRI and multi-actor projects needed to facilitate uptake

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Position Paper and **Policy Brief** available on www.plantetp.org and www.animaltaskforce.eu

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