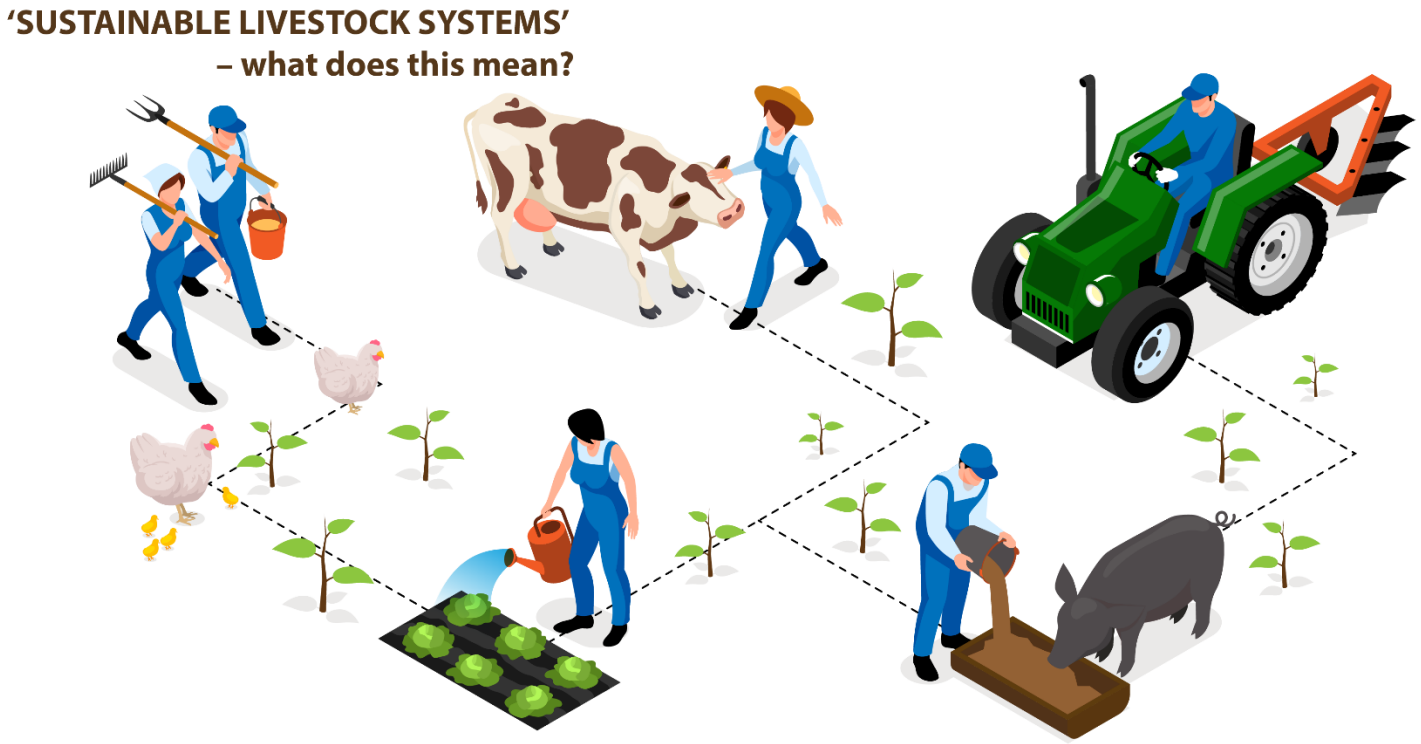
atf animal task force

A European Public-Private Partnership

13th ATF Seminar

'Sustainable livestock systems' – what does this mean?



LCA: strengths and challenges

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RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

INRAE science for people, life & earth

Outline

- What is LCA?
- Strengths
- Challenges
- An example: LCA of biodiversity-friendly cattle systems
- Conclusions

What is LCA?

Life Cycle Assessment (LCA) is a structured, comprehensive and internationally standardised method

It quantifies all relevant emissions and resources consumed and the related environmental and health impacts and resource depletion issues that are associated with any goods or services (“products”)

European Commission - Joint Research Centre, 2010

Life cycle assessment

A knowledge-integration approach

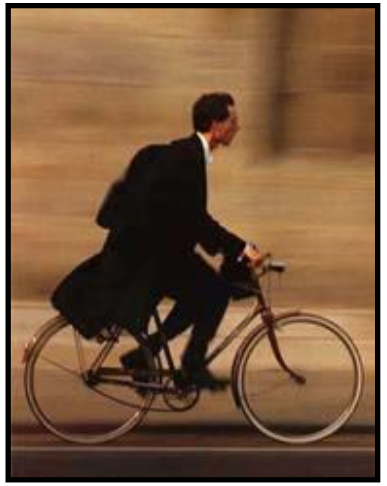
- Objective: estimate environmental impacts of human activities
- A model of a complex reality:
  - Pollutant emissions and resource uses of a product or service
  - Environmental impacts of these emissions and resource uses
- Every model is a simplification of reality: potential impacts

➢ Two key features:

- ➢ Consideration of the product life cycle
- ➢ Multi-criteria impact assessment

A “cradle to grave” product life cycle

Production



Use

Disposal or recycling

Raw material transformation

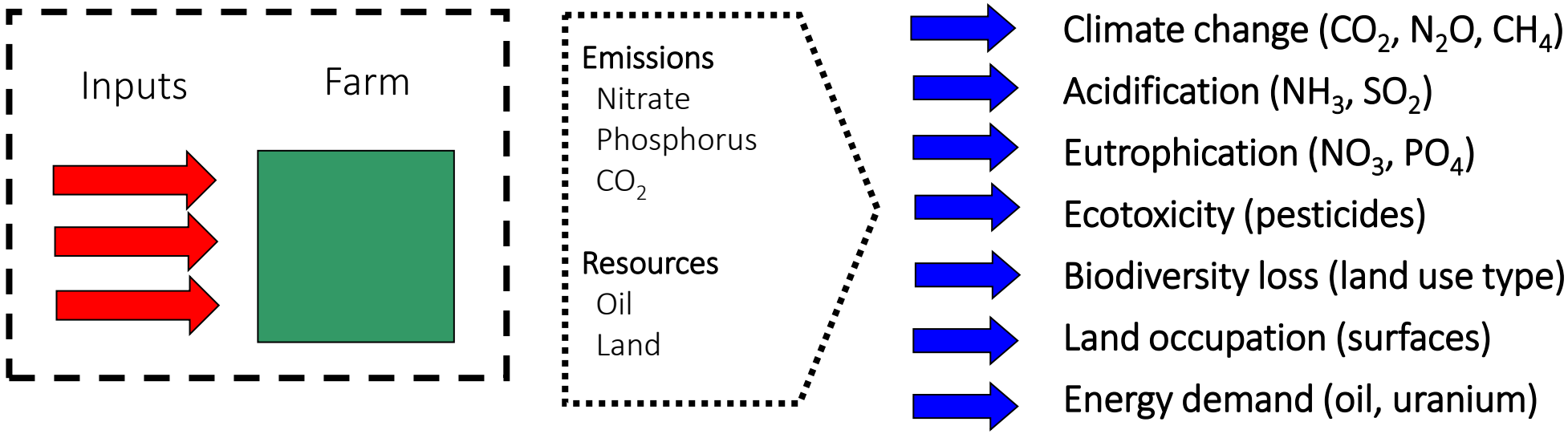
Raw material extraction

Cradle to farm gate LCA of a farm, main phases

Goal and scope definition

Inventory analysis

Impact assessment



LCA is increasingly used to assess agri-food systems

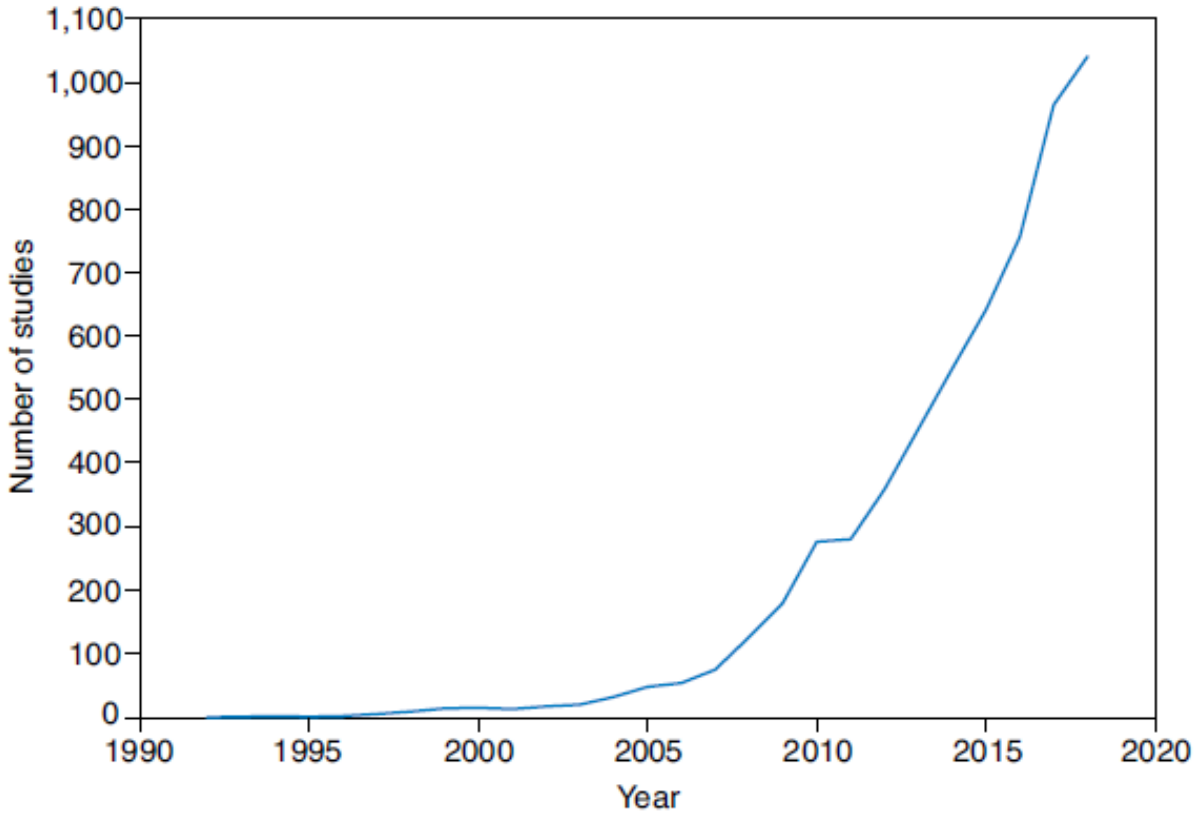
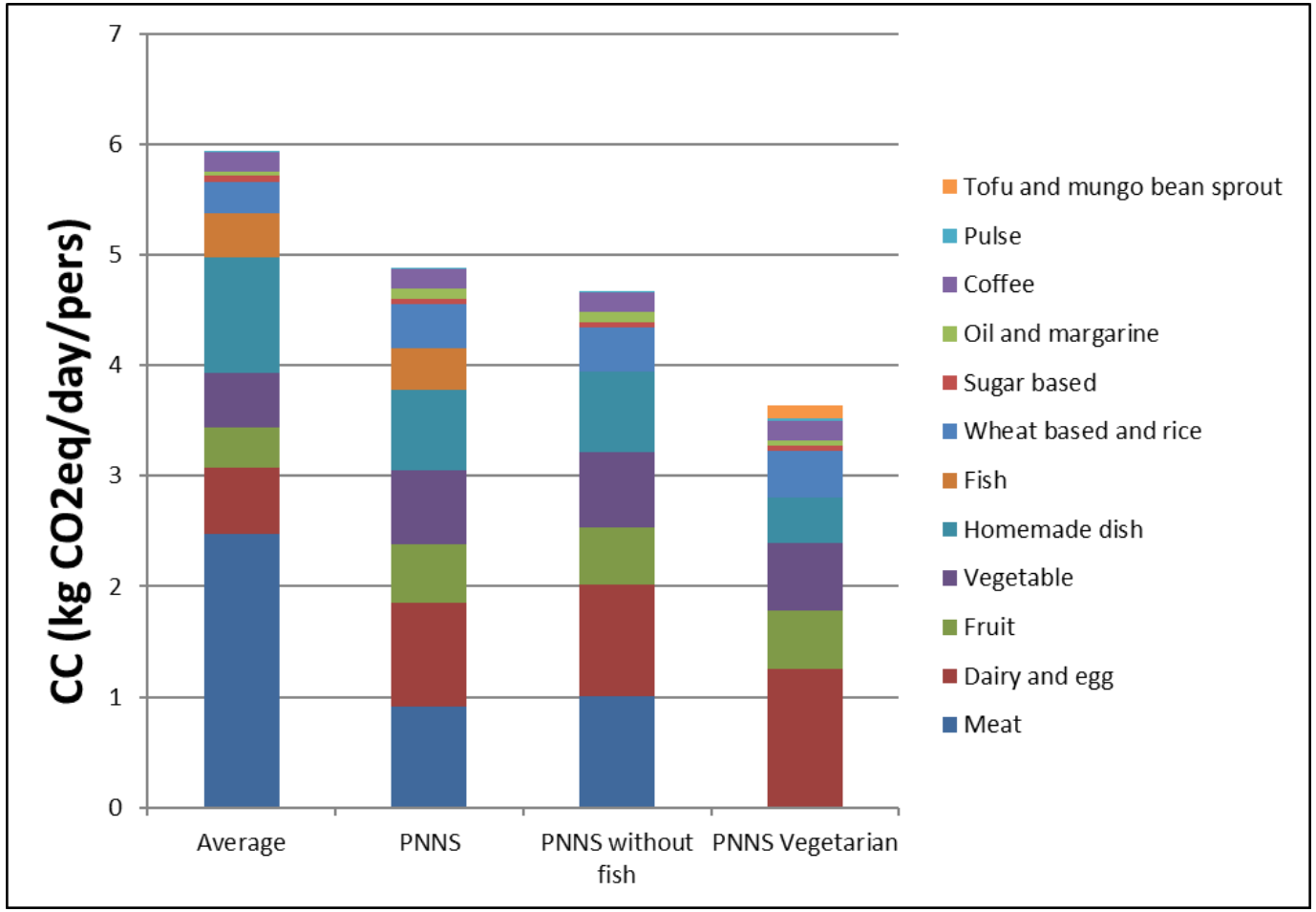


Fig. 1 | Annual number of peer-reviewed English-language articles published from 1990–2018 using LCA to assess agricultural and food systems. $n = 5{,}954$.

van der Werf et al., 2020

Climate change impact of four diets/day/person

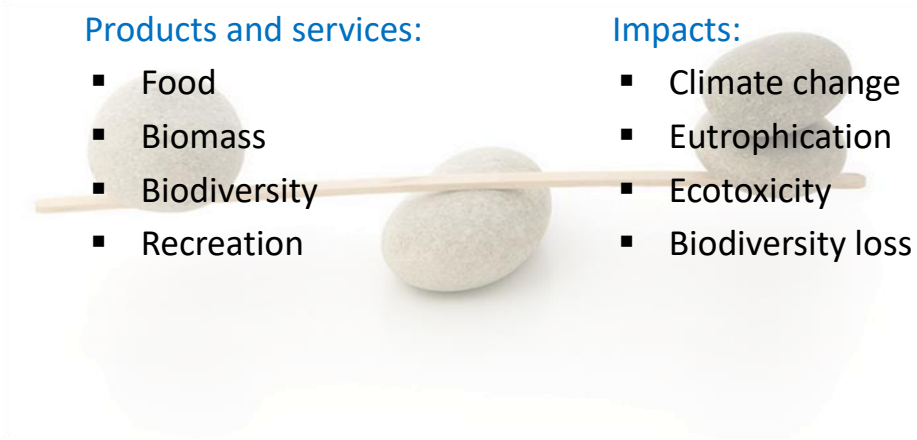


In France, climate change impact of diet is 3.6 (vegetarian) to 6 (average) kg CO_2-eq. per person per day.

Average > Healthy > Healthy no fish > Vegetarian

Pernollet & van der Werf, 2015

Strengths



- Provides a “balance sheet” of a system:
  - Products/services fulfilled versus impacts
- Product life cycle consideration
- Multi-criteria: identifies burden shifting
- Science-based, transparent, standardised, international method
- Continuous integration of scientific advances
- For all sectors of the economy
- Software and databases available
- A tool for product eco-design

Challenges

nature sustainability

PERSPECTIVE

https://doi.org/10.1038/s41893-020-0489-6

Check for updates

Towards better representation of organic agriculture in life cycle assessment

Hayo M. G. van der Werf[1]✉, Marie Trydeman Knudsen[2] and Christel Cederberg[3]

Organic vs. conventional, impacts per kg of product

Environ. Res. Lett. **12** (2017) 064016

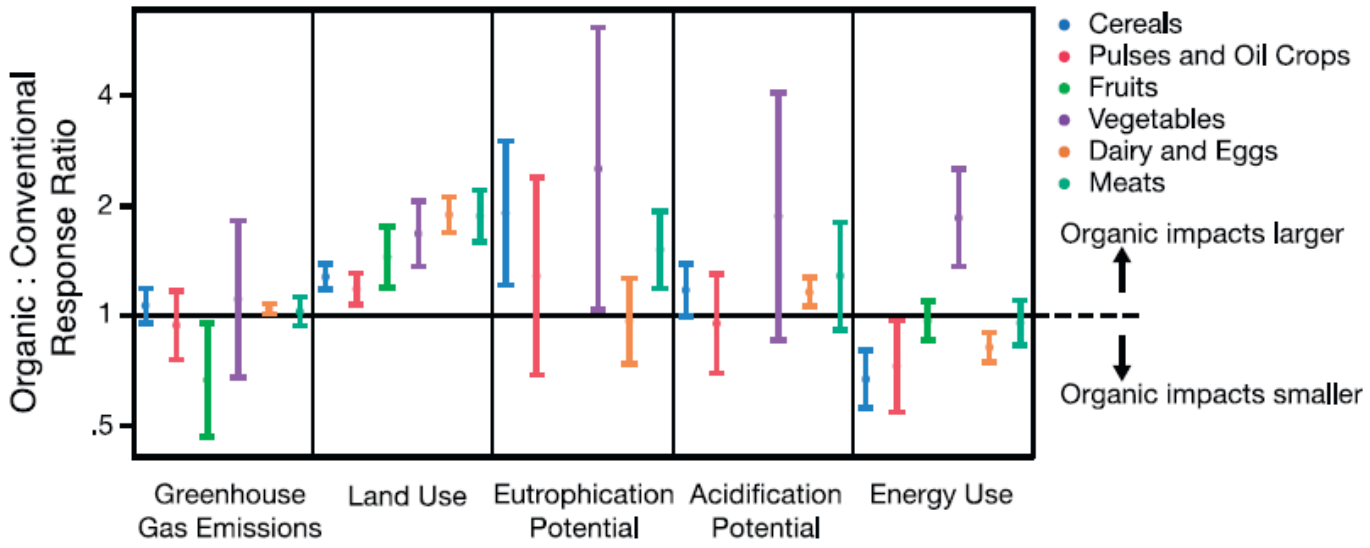


Figure 1. Response ratio of the environmental impacts of organic and conventional food production systems. Comparisons were made within publication to control for agronomic and environmental differences between publications. Plotted on a log base 2 scale, where a ratio greater than one indicates organic systems have higher impacts; a ratio less than one indicates organic systems have lower impacts. Bars are means and standard errors.

Meta-analysis of 164 publications

Per kg food, organic systems required more land, caused more eutrophication, used less energy and had similar climate change impact

Clark & Tilman, 2017

Organic vs. conventional, climate change impact

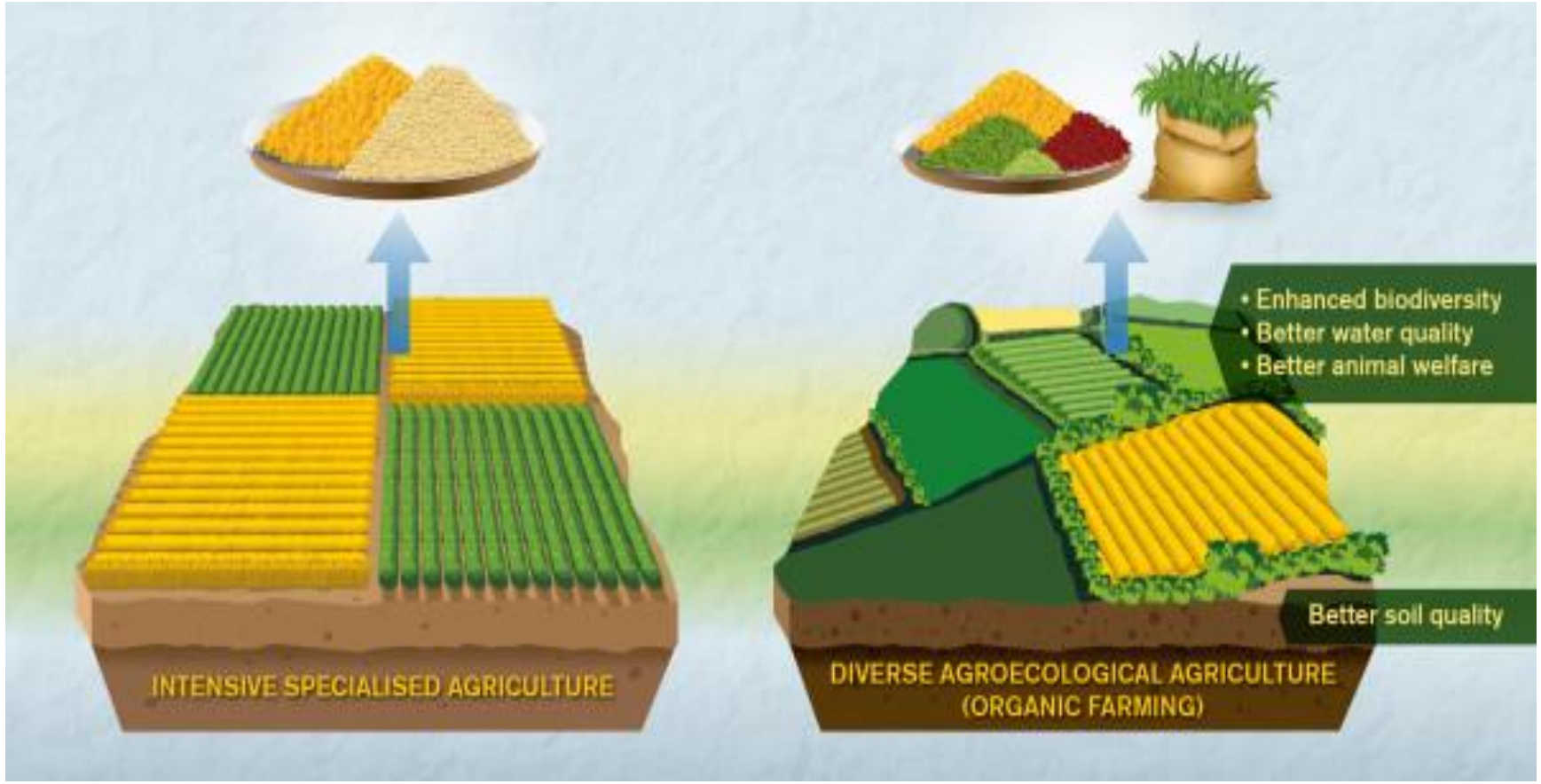
Product	Difference org./conv. per ha	Difference org./conv. per kg	Number of studies
Milk	-67 to -13%	-38 to +53%	10
Beef	-60 to -24%	-15 to +15%	3
Pig	-41 to -5%	-11 to +73%	3
Poultry	-71 to -33%	-24 to +46%	4
Eggs	-72%	+17%	1
Fruits and vegetables	-90 to 121%	-81 to +130%	8
Arable crops	-92 to -69%	-41 to +45%	8
Average	**-60 to +3%**	**-30 to 54%**	
	-32%	**+12%**	

Results of a literature review of 34 LCA studies

Climate change impact of organic systems was lower per ha, but higher per kg of product

Meier et al, 2015

Agroecology, a challenge for LCA



Conventional vs. organic agriculture

van der Werf et al., 2020

Challenge 1:
A narrow perspective on functions of agricultural systems

- LCA: a product-based approach; by default, impacts per kg of product
- This favours intensive, high-yield conventional systems:
  - Per unit area, these systems have more impact, but also more yield
  - They may have less impact per kg of product (land use, eutrophication)
- Difficult to consider the quality of a product
- The "territorial" function of agriculture is ignored

➢ Express impacts per unit area and per quantity of product

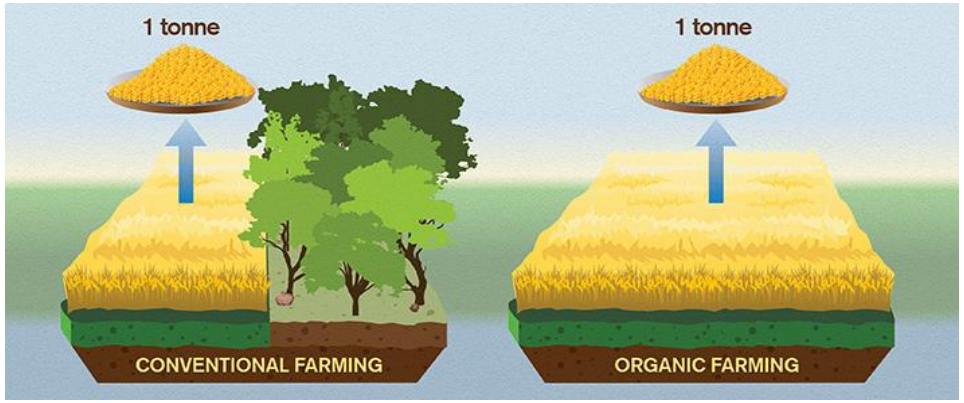
➢ Combine LCA and ecosystem services approaches

Challenge 2:
Neglected environmental issues

- Organic vs. conventional farming:
  - 30% more biodiversity
  - Much fewer pesticides
  - Better soil quality
- Few LCA studies consider impacts on biodiversity, pesticide impacts, or impacts on soil quality

➢ As a result, LCA comparisons of organic farming to conventional farming are often unbalanced

Challenge 3:
Indirect effects of switching to organic farming



- Lower yields ➔ need for more land ➔ deforestation
  - Models for assessing land-use change are ill-suited to the shift to lower-yield systems
  - No consideration of public-policy effects (GHG reduction, forest protection)
  - No consideration of changes in diet
  - No consideration of rebound effects (organic products are more expensive)

➢ If indirect effects are included, results should be interpreted very carefully because of the high uncertainty

Example: LCA of biodiversity-friendly cattle farms

Aymeric Mondière, Michael Corson, Hayo van der Werf

Knepp farm, Sussex, UK

Trévarn farm, Finistère, France

Four cattle farms

Farm	Type	Objective	Biodiversity potential
Knepp (UK)	Agricultural rewilding	Restore ecological processes while producing a small amount of meat	0.90
La Barge (F)	Paysans de nature	Conserve natural environments while producing meat in an economically viable way	0.67
Trévarn (F)	Agroecology	Follow agroecological practices based on grassland management	0.44
Derval (F)	Conventional	Obtain data on milking, use of new technologies and energy transition	0.18

Knepp

La Barge

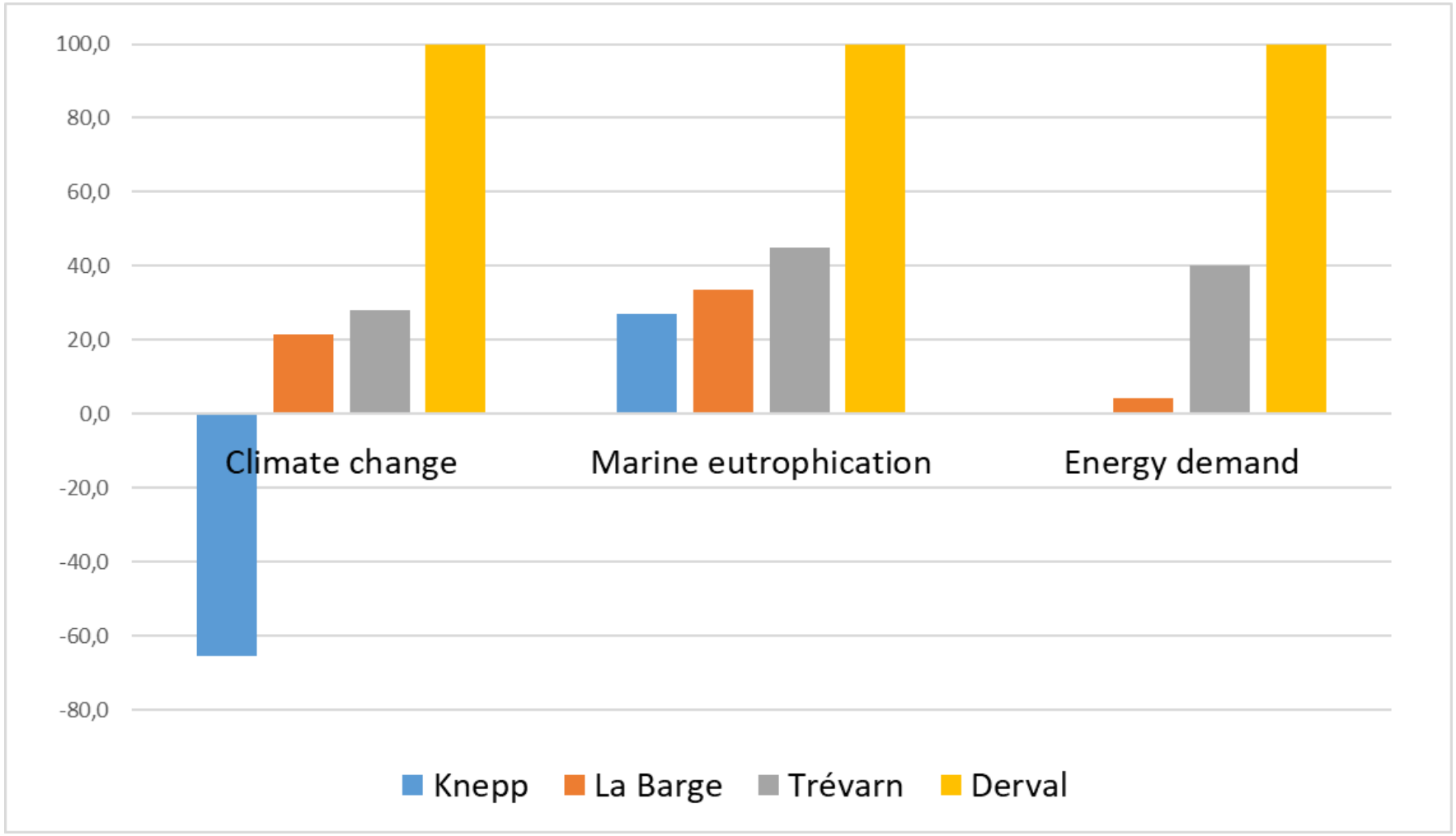
Trévarn

Derval

Four cattle farms

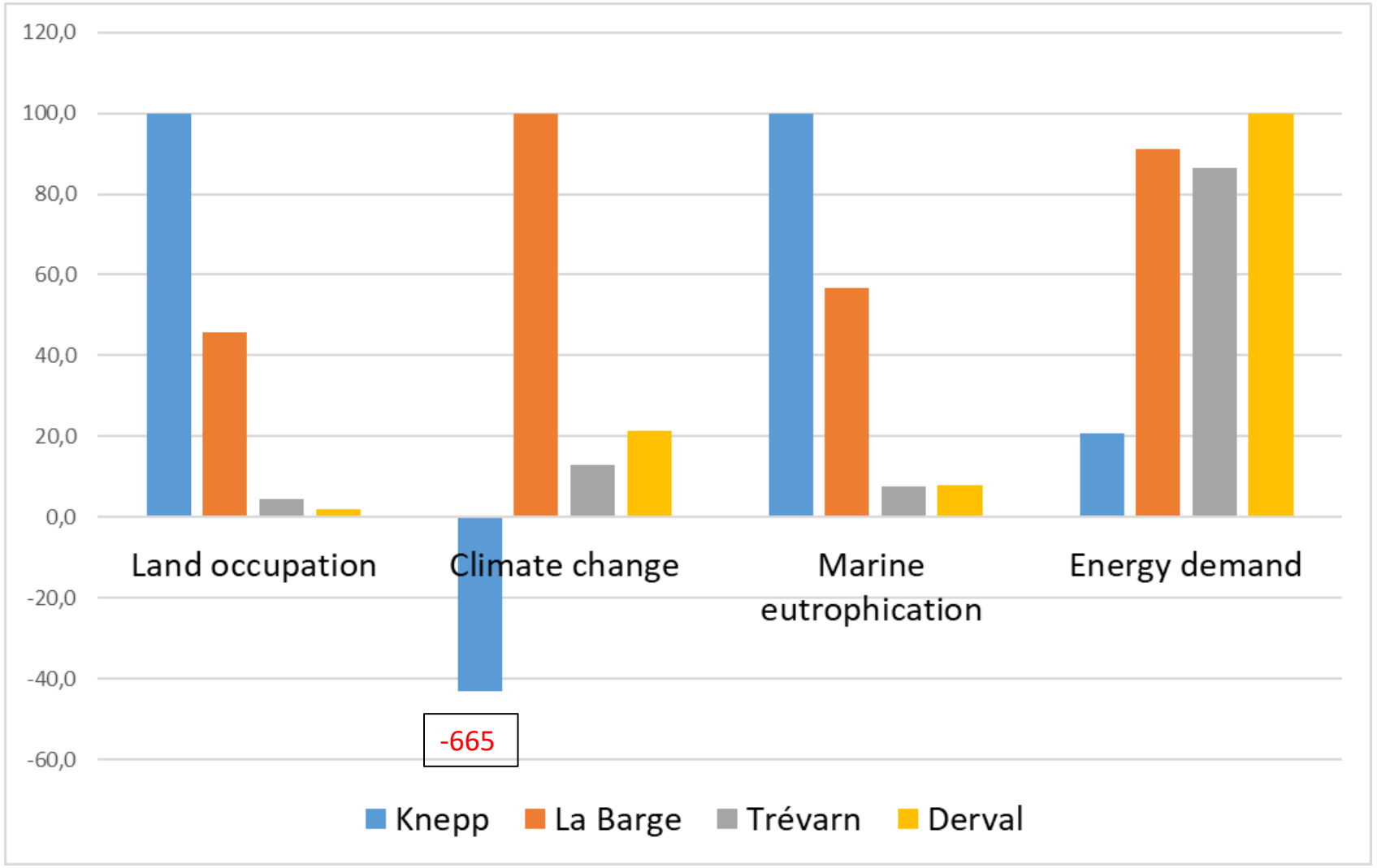
Characteristic	Farm			
	Knepp	La Barge	Trévarn	Derval
Main product	Meat	Meat	Milk	Milk
Diesel consumption (L/ha/year)	1	10	39	100
Stocking rate (LU/ha)	0.18	0.53	0.79	1.30
% of year outside	100	75	67	41
Animal protein produced (kg/ha/an)	5	11	111	239

Environmental impacts per ha of land used



Impacts increase with input use and stocking rate

Environmental impacts per kg of animal protein

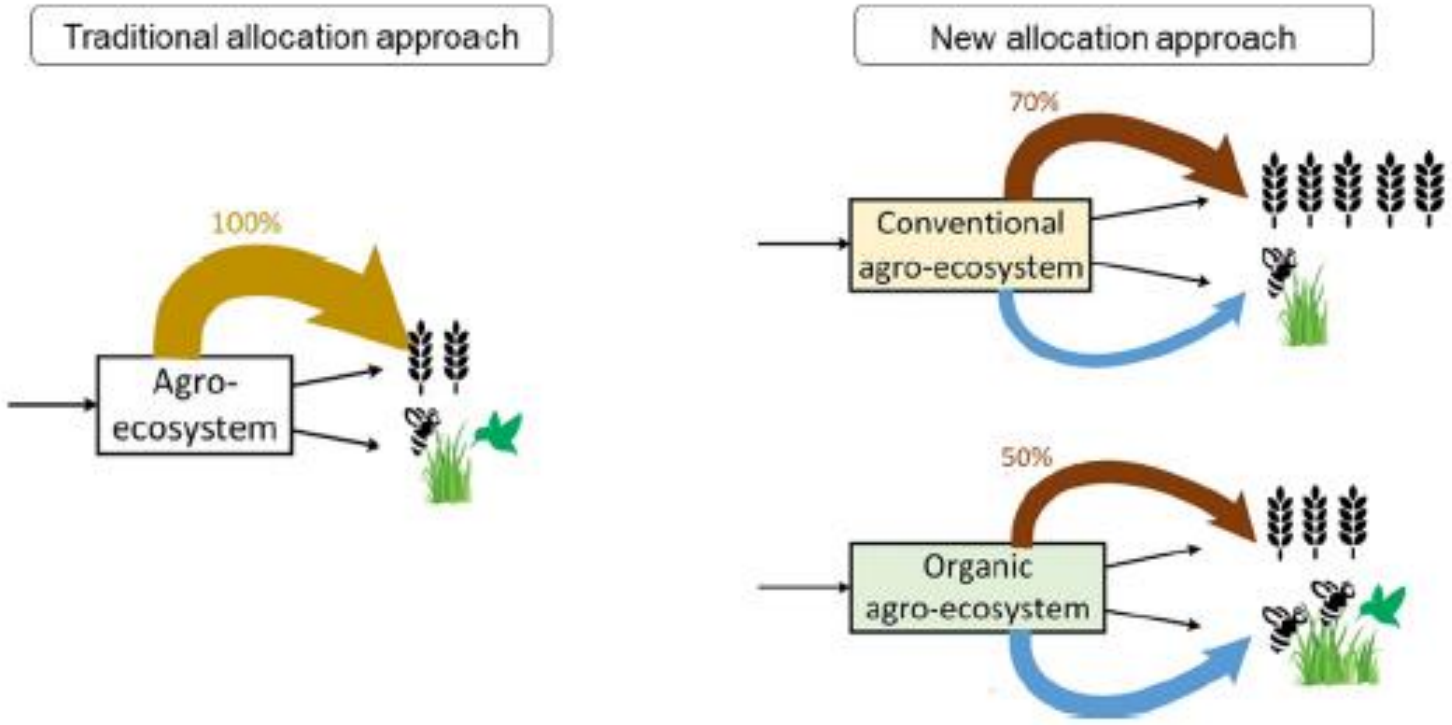


Derval and Trévarn best for land occupation and marine eutrophication, Knepp best for climate change and energy demand

Does expressing impacts per kg make sense for extensive systems?

Expressing impacts per kg product only does not make sense for multifunctional farms

- Agroecological, organic, biodiversity-friendly livestock farms supply more than meat and milk
- Allocating part of the impacts to other services may address their multifunctionality



Boone et al., 2019

Conclusions

- Strengths:
  - LCA: a science-based, transparent, international framework
  - Allows for multi-criteria environmental impact assessment
  - Scientific advancements are regularly integrated
- Challenges:
  - Its narrow perspective on functions of agricultural systems
  - Neglected environmental issues
  - Inconsistent modelling of indirect effects
- Recommendations:
  - Express impacts per unit area and per quantity of product
  - Combine LCA and ecosystem services approaches
  - Assess land degradation, biodiversity and pesticide effects
  - If indirect effects are included, results should be interpreted carefully

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LCA and ecosystem services

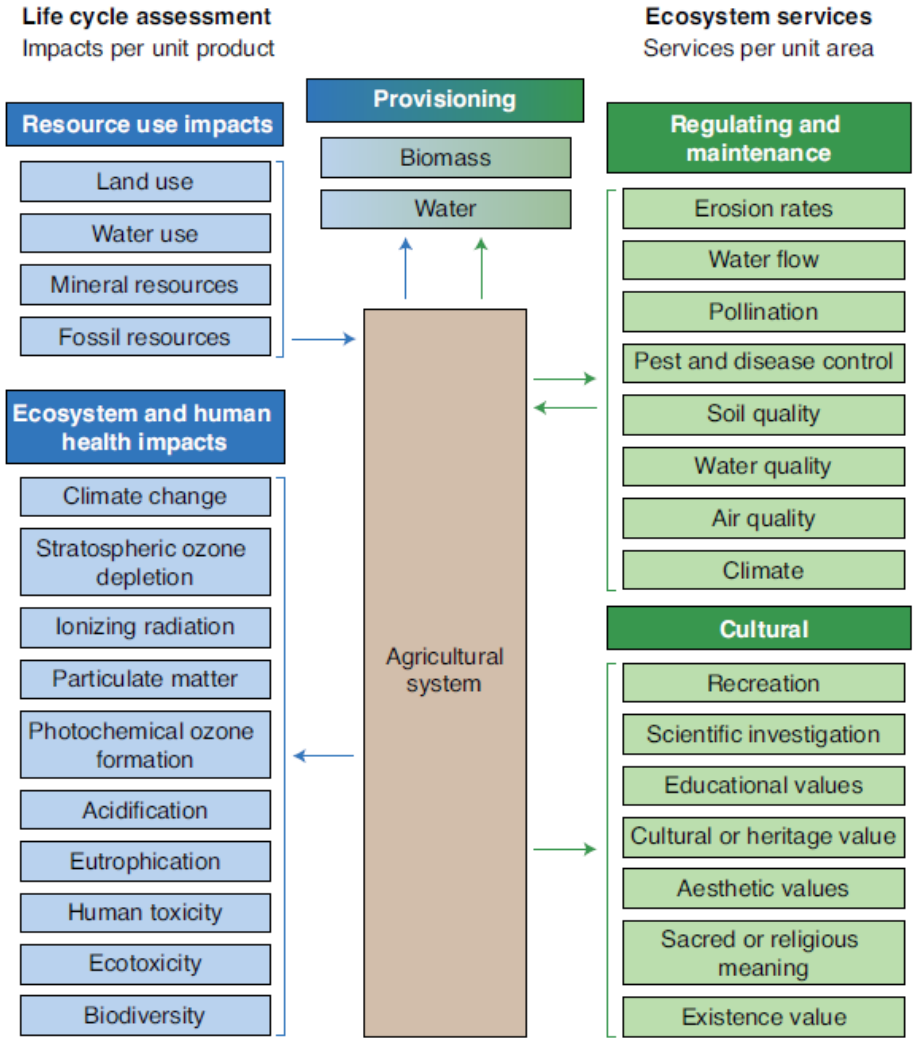

Fig. 3 | LCA and ecosystem services conceptual frameworks. The

van der Werf et al., 2020