



# Life cycle assessment (LCA) of alternative proteins

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Joint  
Research  
Centre

Alternative Proteins for Food and Feed, International  
Conference  
3 – 5 December 2024, Berlin

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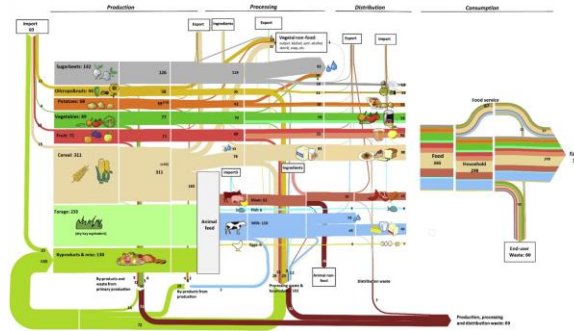
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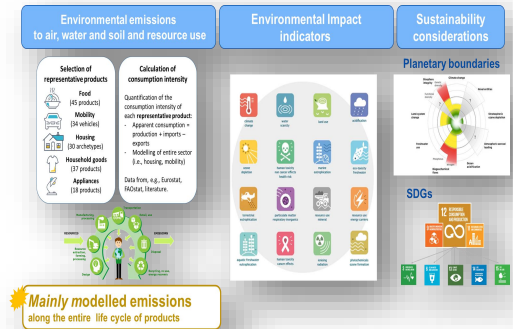
> 2000 staff



# Contents



## Understanding EU food system, and its circularity



## Analysing environmental impacts of food system



## Life cycle assessment (LCA) to assess alternative proteins

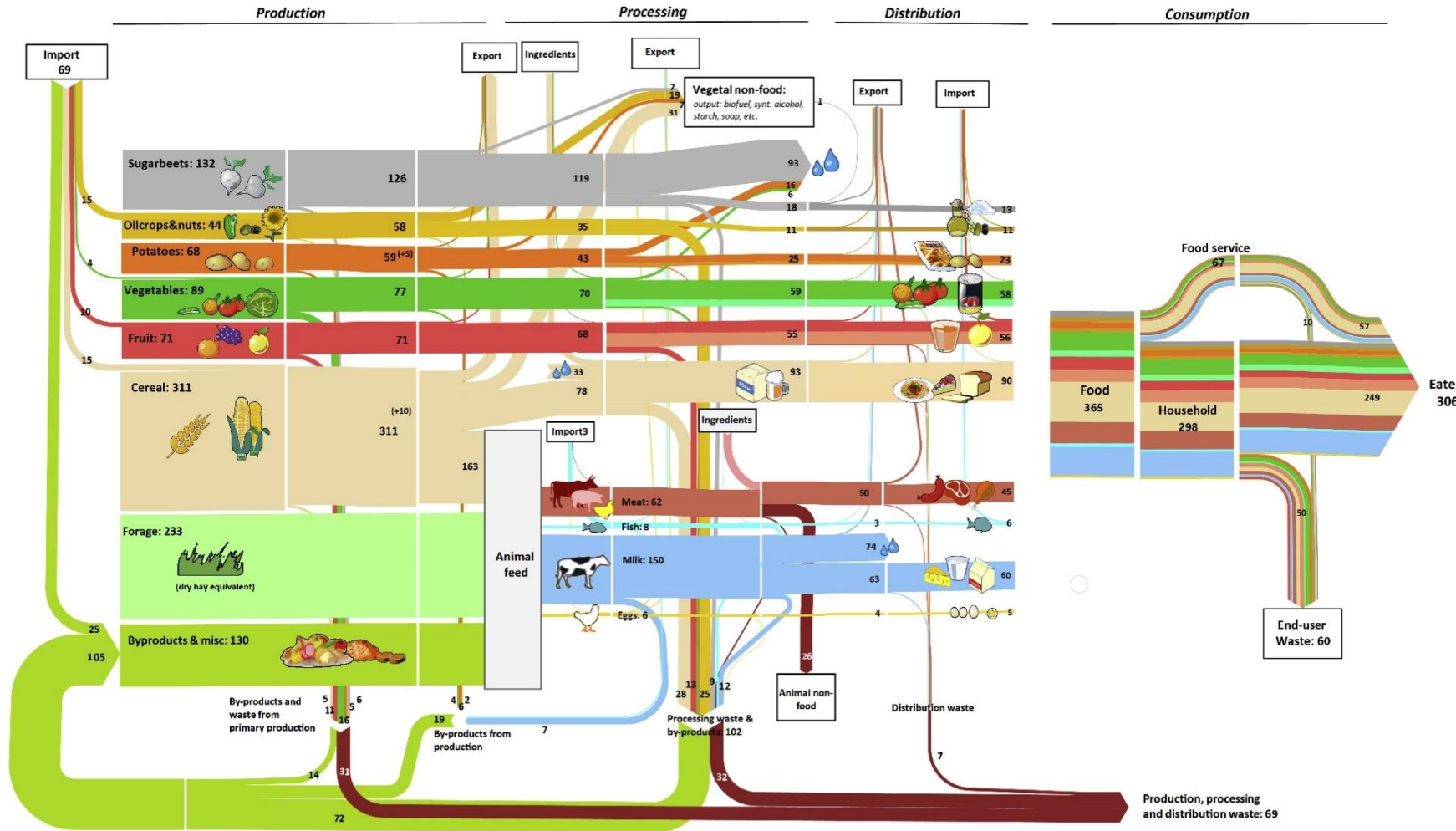


## Safe and sustainable by design innovation



## Challenges and opportunities

# Understanding the food system



Which are the associated impacts?

# Circularity, biotechnologies and green chemistry

Bioresource Technology 312 (2020) 123575

Contents lists available at ScienceDirect

Bioresource Technology

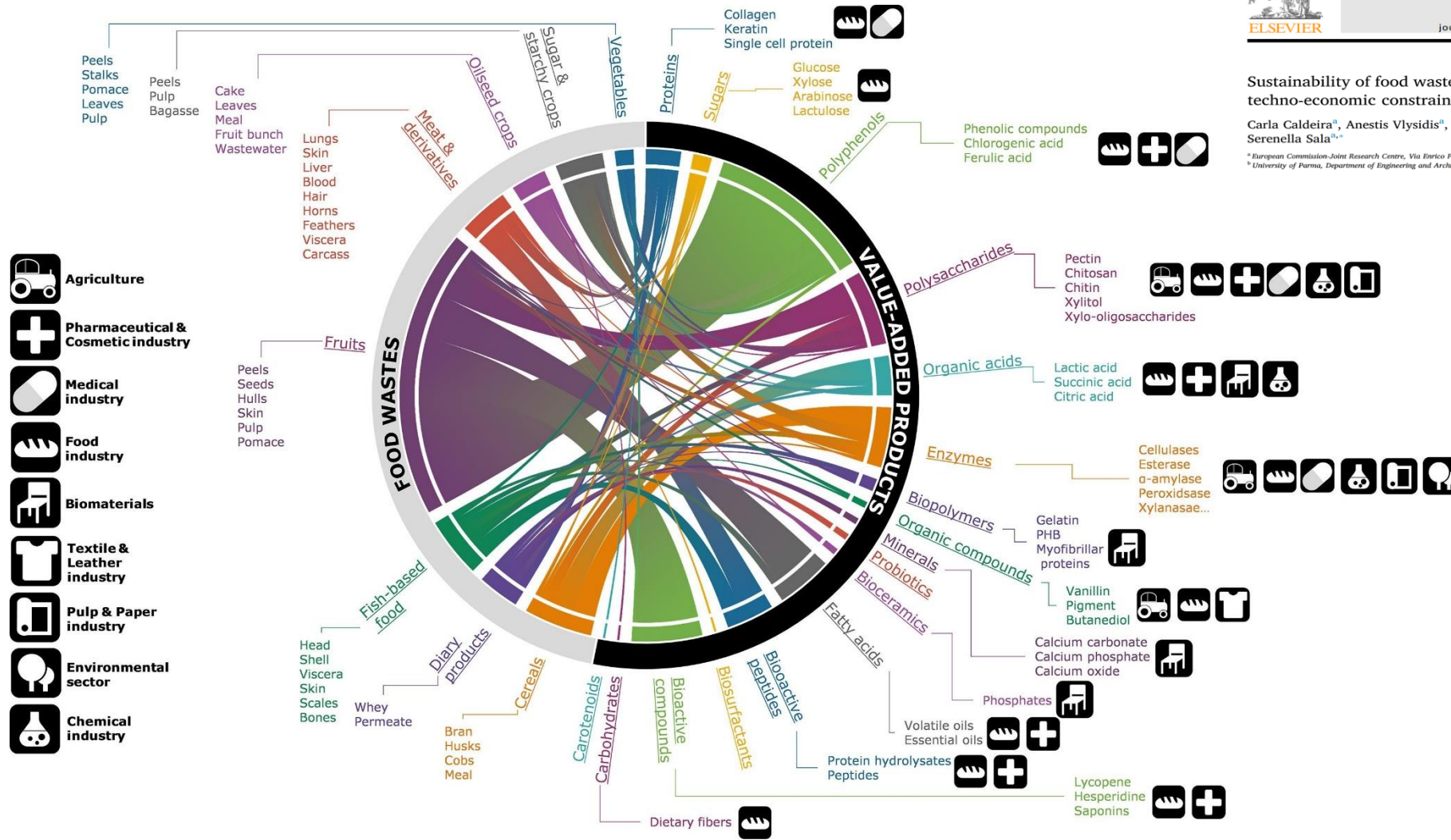
journal homepage: [www.elsevier.com/locate/biortech](http://www.elsevier.com/locate/biortech)



Sustainability of food waste biorefinery: A review on valorisation pathways, techno-economic constraints, and environmental assessment

Carla Caldeira<sup>a</sup>, Anestis Vlysidis<sup>a</sup>, Gianluca Fiore<sup>a</sup>, Valeria De Laurentiis<sup>a</sup>, Giuseppe Vignali<sup>b</sup>, Serenella Sala<sup>a\*</sup>

<sup>a</sup> European Commission Joint Research Centre, Via Enrico Fermi 2749, I-21027 Ispra, VA, Italy  
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Which are the associated impacts?

# Life Cycle Assessment (LCA) to support EU policymaking



European Platform on Life Cycle Assessment  
<https://eplca.jrc.ec.europa.eu/>

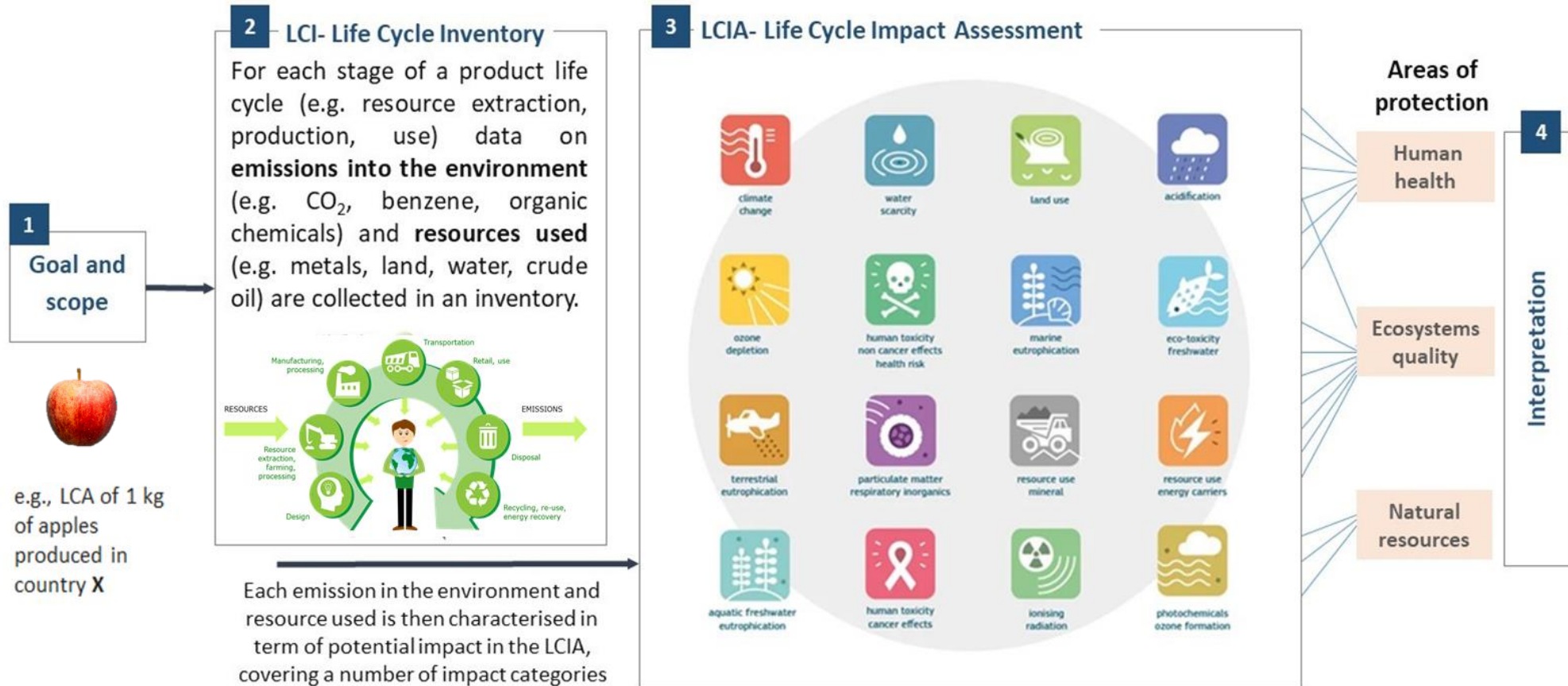
Embracing all steps  
of the value chains

Fostering  
comprehensiveness

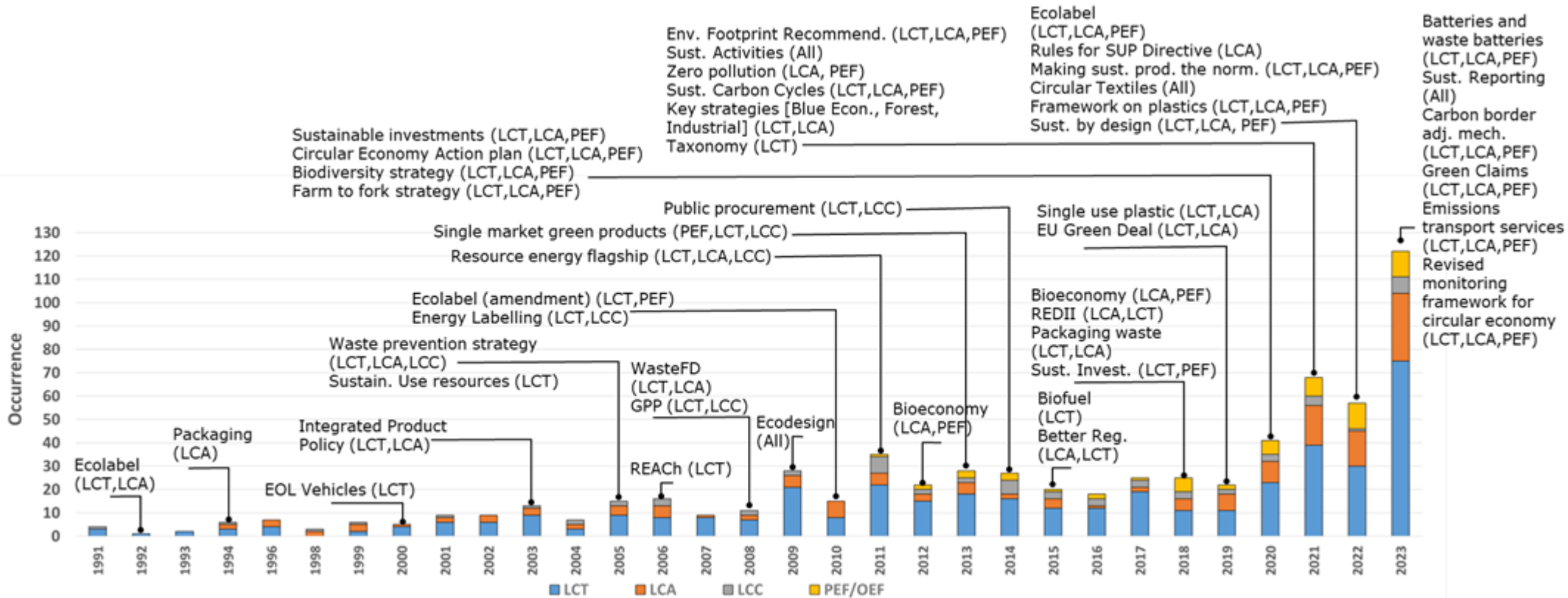
Unveiling  
trade-offs

Addressing  
environmental and  
socio-economic  
impacts

# How to perform Life cycle assessment?



# Evolution of LCA use in EU policies

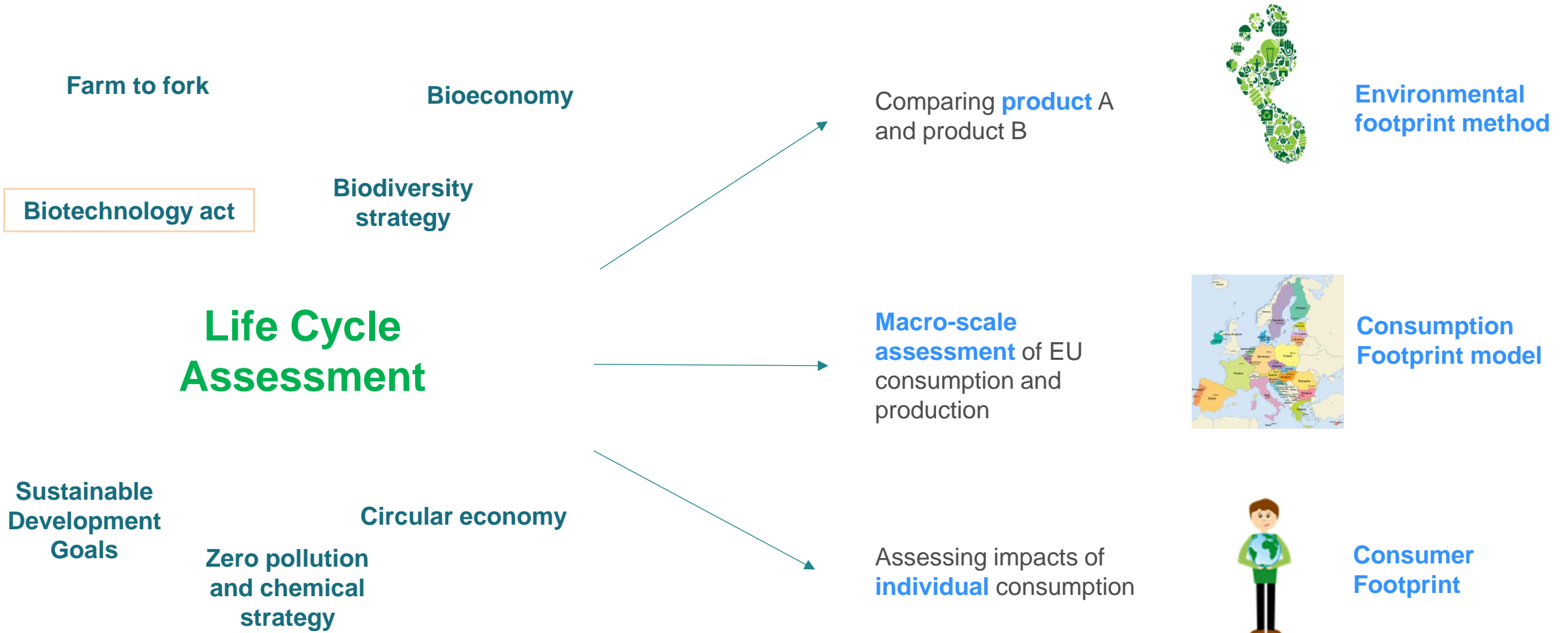


LCA is a tool in the EU Commission Better Regulation Toolbox

Updated from Sala et al. (2021). The evolution of life cycle assessment in European policies over three decades. *The International Journal of Life Cycle Assessment*, 26, 2295-2314.



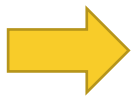
# LCA to support EU policies: *the approaches*





# The Product Environmental Footprint (PEF) method

1. Detailed **guidance** to support the LCA comparison of products performance
2. Providing a **level playing field** for operators
3. Guaranteeing the **reliability** of environmental information



Fostering transparency to support informed decision-making by businesses and consumers

16 environmental impact categories








[https://ec.europa.eu/environment/eussd/smgp/ef\\_methods.htm](https://ec.europa.eu/environment/eussd/smgp/ef_methods.htm)

EC(2021) 9332 final Commission Recommendation of 16.12.2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations

# Consumption Footprint model

## Environmental emissions to air, water and soil and resource use

### Selection of representative products

-  **Food**  
(45 products)
-  **Mobility**  
(34 vehicles)
-  **Housing**  
(30 archetypes)
-  **Household goods**  
(37 products)
-  **Appliances**  
(18 products)

### Calculation of consumption intensity

Quantification of the consumption intensity of each **representative product**:

- Apparent consumption = production + imports - exports
- Modelling of entire sector (i.e., housing, mobility)

Data from, e.g., Eurostat, FAOstat, literature.



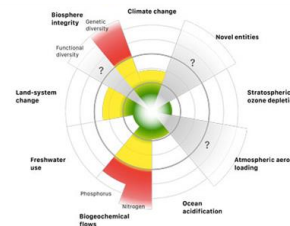
**Mainly modelled emissions along the entire life cycle of products**

## Environmental Impact indicators



## Sustainability considerations

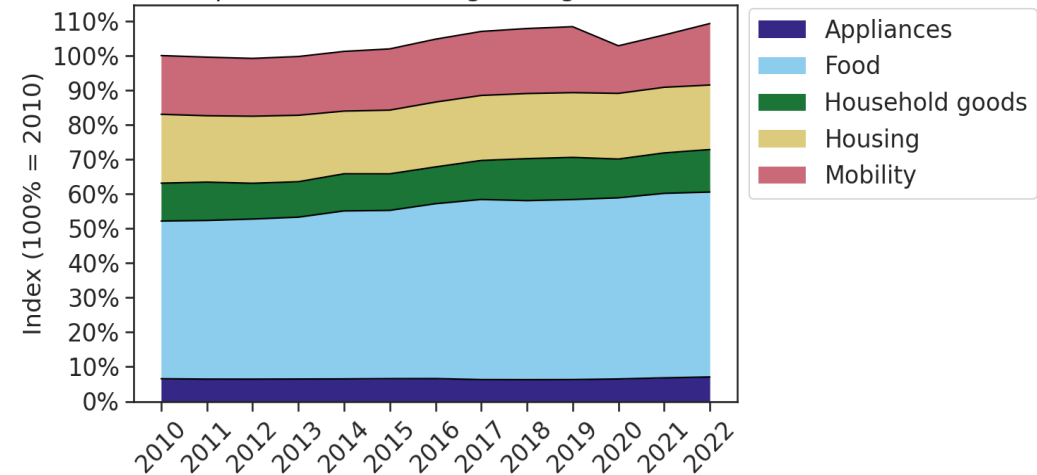
### Planetary boundaries



### SDGs



Consumption Footprint (2010-2022)  
European Union 27, Single weighted score



# EU Food System Monitoring Dashboard

Home Methodology EU overview Country Profile Help

You can visualize here data of one indicator at a time for all EU in the form of map or bar chart, with manual or auto-play options to change the year.

Full screen

FS model Supply chain component

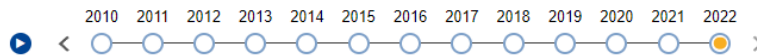
Select indicators grouped by the dimension, thematic area and domain.

Search indicators

- Environmental** (17)
  - Climate change (1)
  - Pollution and antimicrobials (4)
  - Sustainable use of resources (7)
  - Biodiversity (3)
  - Cross-cutting environmental (2)
  - Food loss and waste (1)
  - Consumption Footprint (1)
  - Consumption Footprint - Food
- Economic** (12)
- Social** (15)

## Consumption Footprint - Food

Assessment of the environmental impact of food consumption patterns. This is an extensive indicator: original values depend on the extent of the country.



EU-27  
**0.47**  
pt per capita

Force denomination  
OFF  ON  
Switch OFF to show the original value, not divided by Population

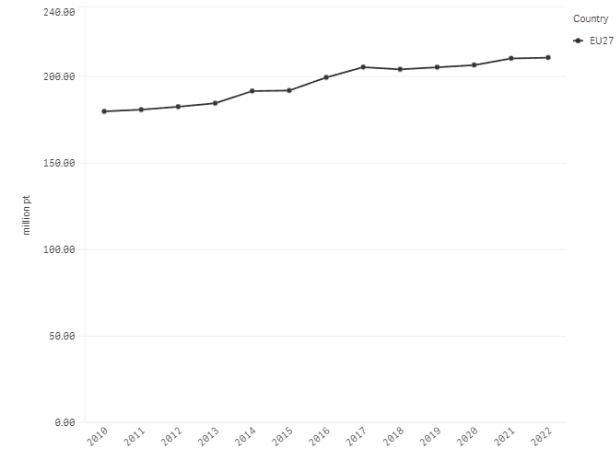
Map Bar chart Timeline Table

Consumption Footprint - Food 2022

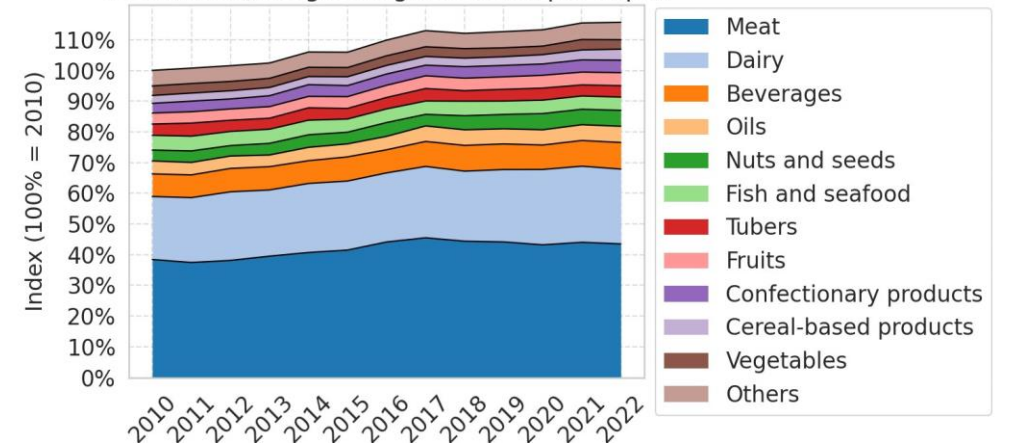


Source: <https://epica.jrc.ec.europa.eu/ConsumptionFootprintPlatform.html>

Consumption Footprint - Food



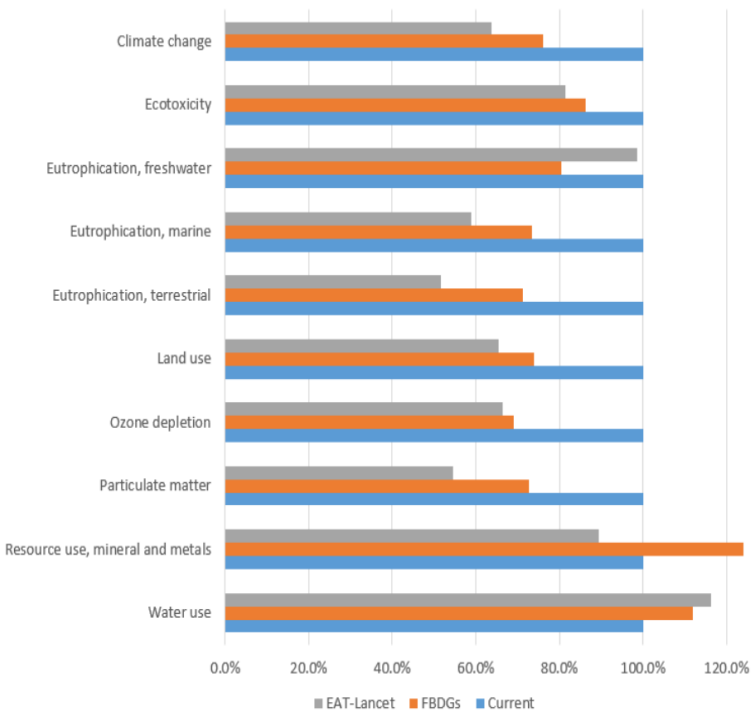
Consumption Footprint (2010-2022)  
EU-27, Food, Single weighted score per capita



# LCA for addressing and assessing solutions

## Dietary shift

### Food-Based Dietary Guidelines (FBDGs) and EAT-Lancet



## (Agricultural) management practices

- Milestone 1** – Modelling of pesticides
- Milestone 2** – LCI modelling of fertilisers
- Milestone 3** – Flows/direct emissions related to feed digestion and manure at farm
- Milestone 4** – LCI modelling of water use
- Milestone 5** – Biodiversity impacts
- Milestone 6** – Primary data collection/quality requirements at farm level
- Milestone 7** – Cross-cutting issues and additional points

Environmental footprint  
Agricultural Working Group

## Designing alternatives

**Journal of Integrative Agriculture**  
Volume 14, Issue 2, February 2015, Pages 249-254

**Analysis of the Cultured Meat Production System in Function of Its Environmental Footprint: Current Status, Gaps and Recommendations**  
by Maria Ignacia Rodriguez Escobar <sup>1</sup>, Erasmo Cadena <sup>1</sup>, Trang T. Nhu <sup>1</sup>, Margot Cooreman-Algoed <sup>1</sup>, Stefaan De Smet <sup>2</sup> and Jo Dewulf <sup>1</sup>

**A case for systemic environmental analysis of cultured meat**  
Carolyn S Mattick <sup>a</sup>, Amy E Landis <sup>b</sup>, Broden R Allenby <sup>b</sup>

**Review and gap-analysis of LCA-studies of cultured meat for The Good Food Institute**  
Authors: Andreas Scharf, Elke Breitmayer, and Michael Carus

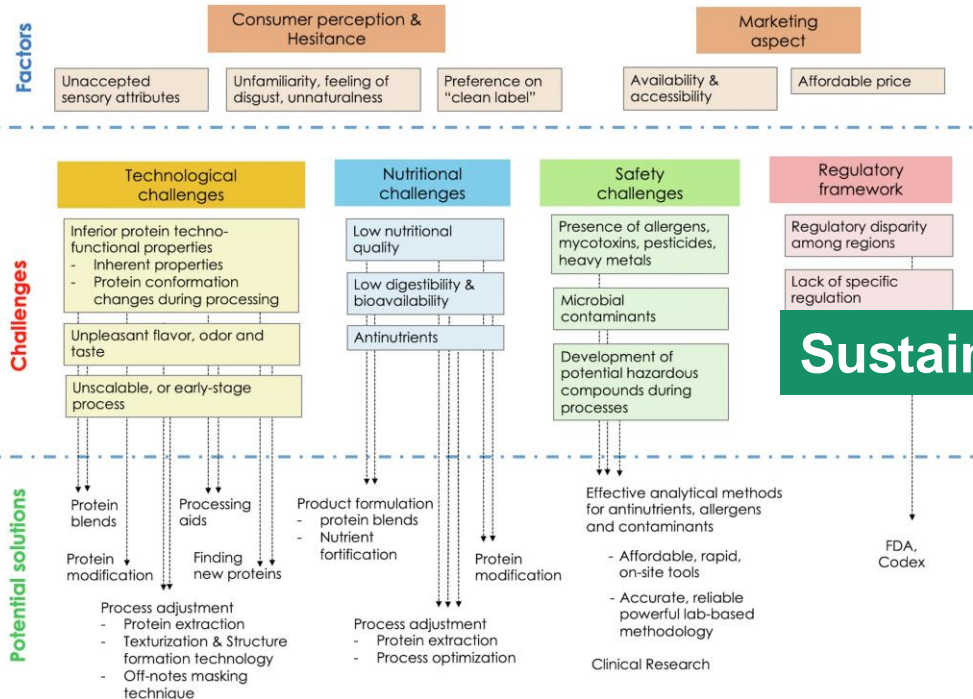
**Life cycle assessment of culture media with alternative compositions for cultured meat production**  
LCA FOR ENERGY SYSTEMS AND FOOD PRODUCTS | Open access | Published: 01 August 2024

**The Environmental Impacts of Cultured Meat Production: A Systematic Literature Review**  
Conference paper | First Online: 01 March 2024

**Life cycle assessment of animal-based foods and plant-based protein-rich alternatives: an environmental perspective**  
Andreas Detzel, Martina Krüger, Mirjam Busch, Irene Blanco-Gutiérrez, Consuelo Varela, Rhys Manners, Jürgen Bez, Emanuele Zannini

Sanye Mengual, E., Valenzano, A., Sinkko, T., Garcia Herrero, L., Casonato, C., Listorti, G. and Sala, S., Sustainable public procurement: current status and environmental impacts, Publications Office of the European Union, Luxembourg, 2024, <https://data.europa.eu/doi/10.2760/06145>, JRC134432.

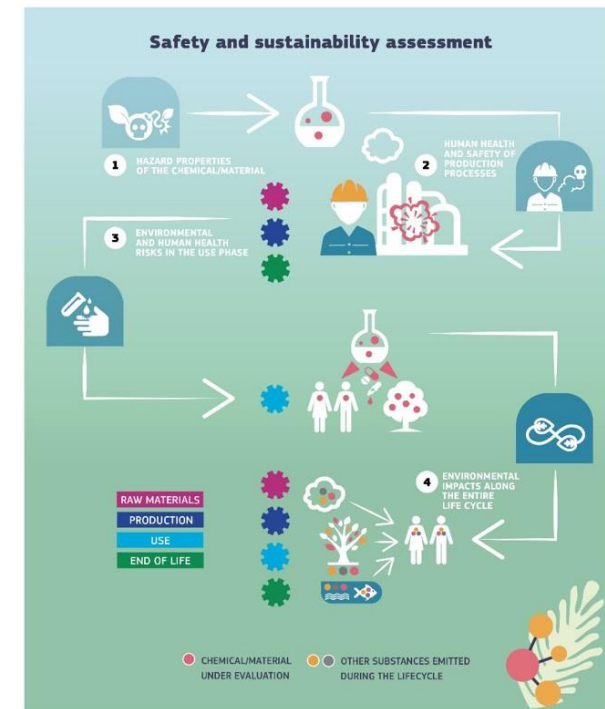
# Nutritious, safe and *sustainable* by design alternative proteins



**Sustainability challenge**

Mailla, Y et al. (2024). Current challenges of alternative proteins as future foods. *npj Science of Food*, 8(1), 53.

EC recommendation on **Safe and Sustainable by Design** chemicals and materials framework: *(Re)Design, Responsible Innovation, Avoiding Regrettable Substitution*

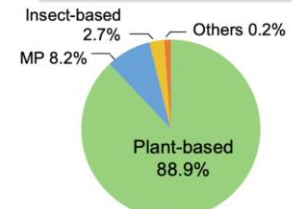


# Towards sustainable alternative proteins in food systems: challenges and opportunities

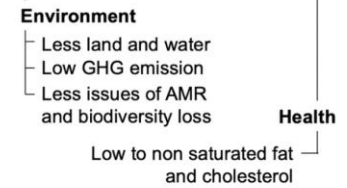
(a) Currently available alternative proteins



(b) Market Volume in 2023



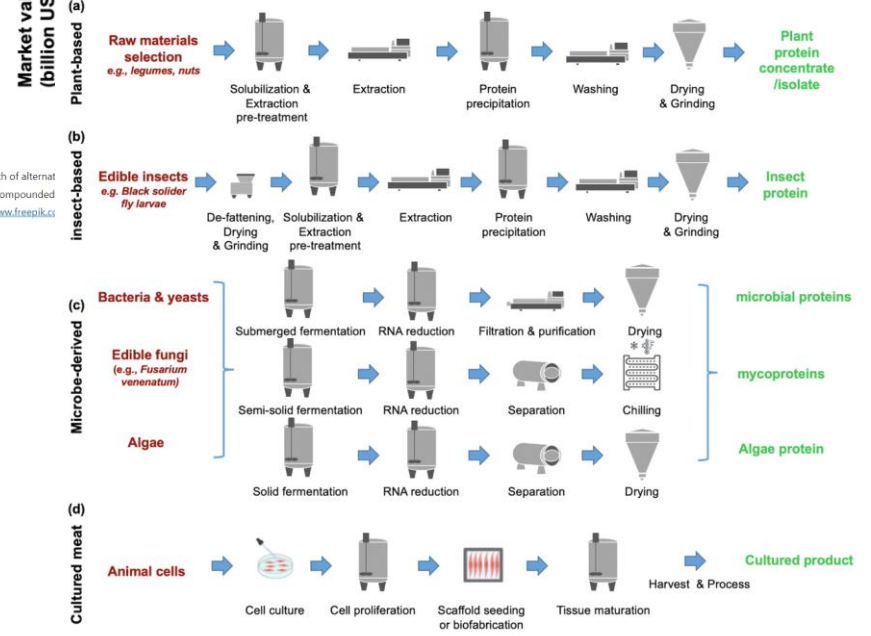
(c) Key Benefits



(d) Projected Global Market Growth



a Currently available AP, b market volume, c key benefits, and d projected market growth of alternat refers to greenhouse gases. AMR refers to antimicrobial resistance. CAGR refers to the compounded investment on the products. Pictures of each protein are designed by Freepik. <https://www.freepik.co>



a plant-based protein, b insect-based protein, c microbe-derived proteins, and d cultured meat and seafood.

- **Overall sustainability:** Identification of trade-offs due to the strong interrelations between supply chains, consumption patterns, **ecosystems, health, and planetary boundaries**
- **Affordability:** Ensuring everyone has access to a **nutritious diet in a sustainable way** ---> life cycle costing, social life cycle assessment

# Key messages

**Alternatives proteins** are key in the transition to food system sustainability

To foster sustainability transitions, a **system approach** needs to be adopted, considering all actors involved and sustainability dimensions

**LCA** is instrumental to:

- Address the **impacts along the entire value chain**, including trade-offs
- **Steer innovation**, avoiding regrettable substitutions



# Thank you !



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Slide 3: Alexander Raths, stock.adobe.com