Enviro-nutritional assessment methods, data limitations and potential opportunities for the dairy sector

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RFA003 - Harper Food Innovation
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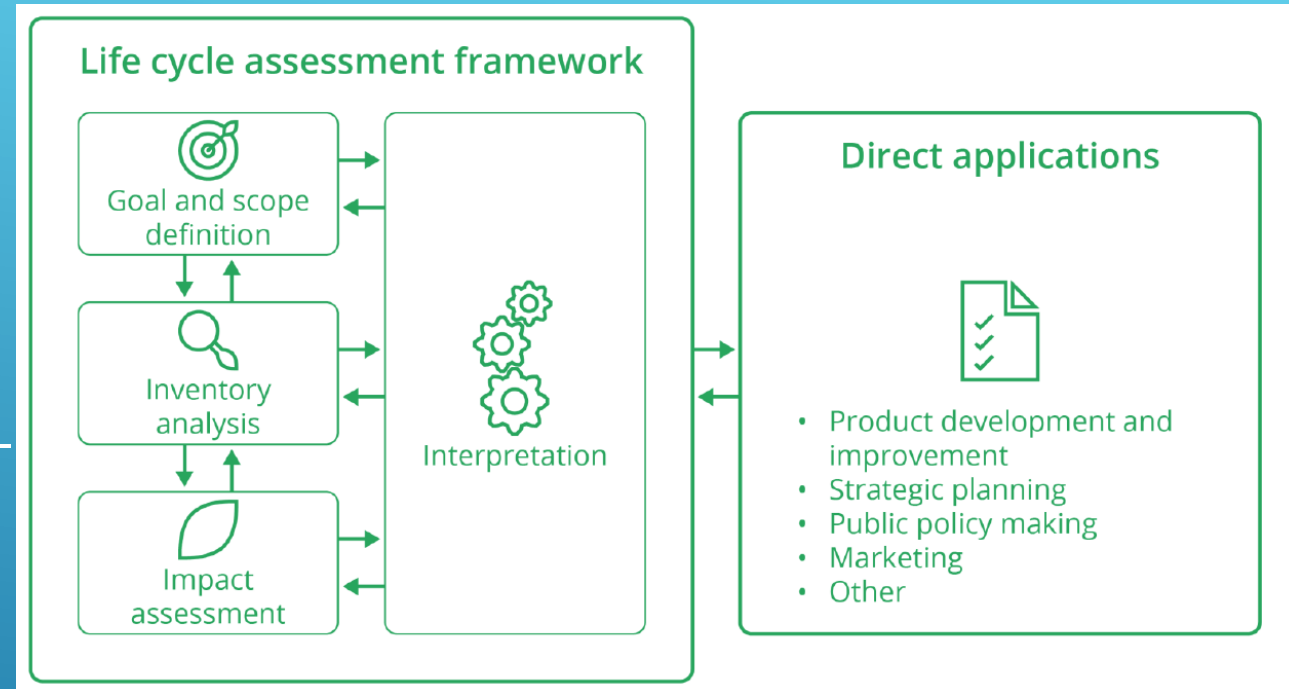**Harper Adams University**

- **Today's talk will *primarily* cover the following:**

  - Introduction to Life Cycle Assessment
    - History, theory, and real-world applications
    - Essential approaches when conducting LCA

  - Why are we seeing a rise in nutritional LCA (nLCA)?:
    - Voluntary & mandatory sustainability reporting
    - Changing consumer behaviour

  - nLCA in practice & what is next
    - Case studies on priority micronutrients and protein quality
    - What is required so that nLCA can serve sustainability gains in the food sector?
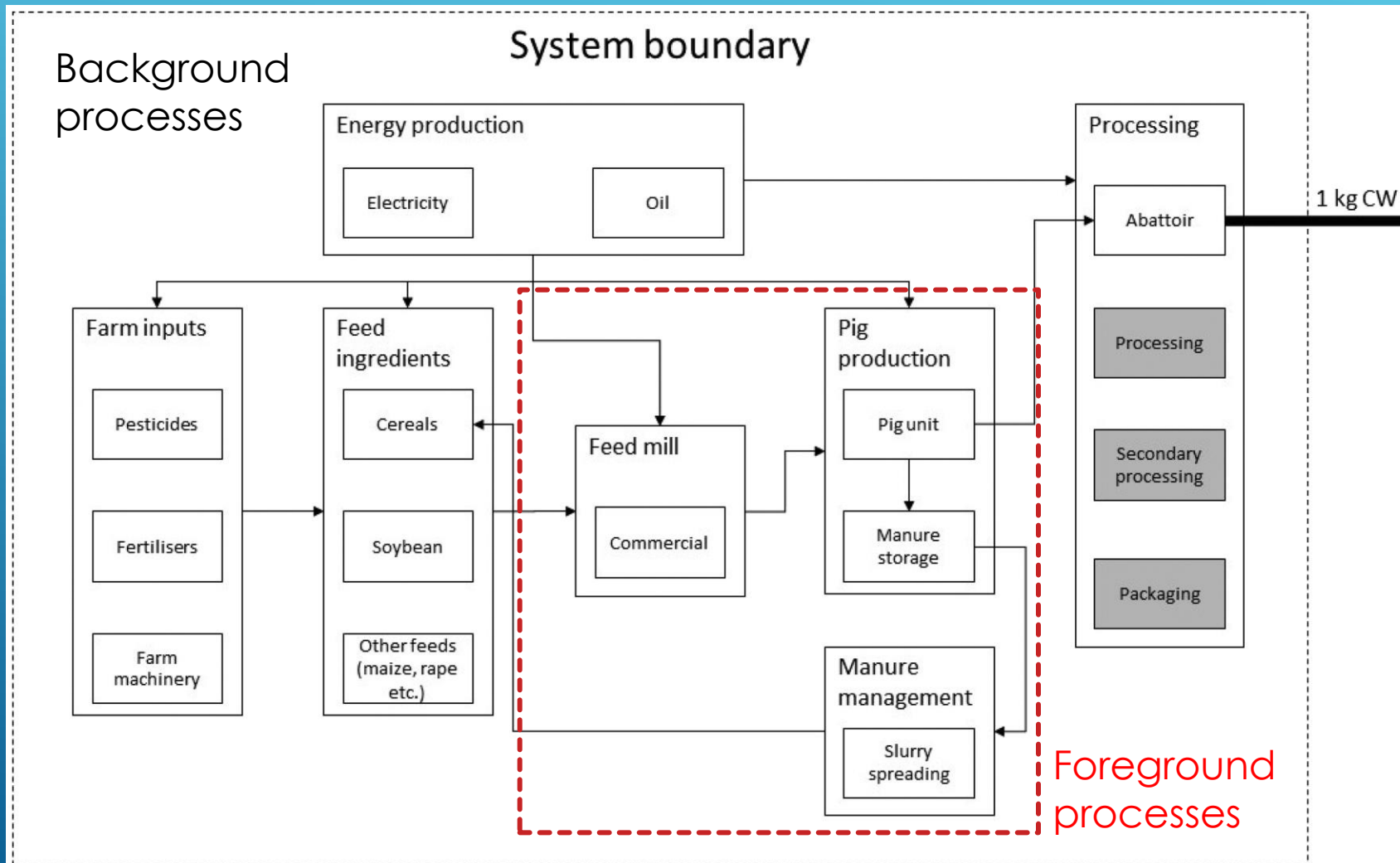

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- Life cycle assessment (LCA) is a systems-based modelling tool originally developed in the late 1960s

- It has been applied to the food sector for decades now

- Generally used by decision-makers in the real-world (e.g., businesses), demonstrated via increasing demand for consultants to tackle sustainability-related reporting audits

- An LCA is conducted under four interlinked stages, making modelling an iterative process

Life cycle assessment framework

Goal and scope definition

Inventory analysis

Impact assessment

Interpretation

Direct applications

- Product development and improvement
- Strategic planning
- Public policy making
- Marketing
- Other

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Background processes

System boundary

Energy production
- Electricity
- Oil

Farm inputs
- Pesticides
- Fertilisers
- Farm machinery

Feed ingredients
- Cereals
- Soybean
- Other feeds (maize, rape etc.)

Feed mill
- Commercial

Pig production
- Pig unit
- Manure storage

Manure management
- Slurry spreading

Processing
- Abattoir
- Processing
- Secondary processing
- Packaging

1 kg CW

Foreground processes

What is the function of the system?
FUNCTIONAL UNIT

H
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Multi-National Corporations

Voluntary Sustainability Standards
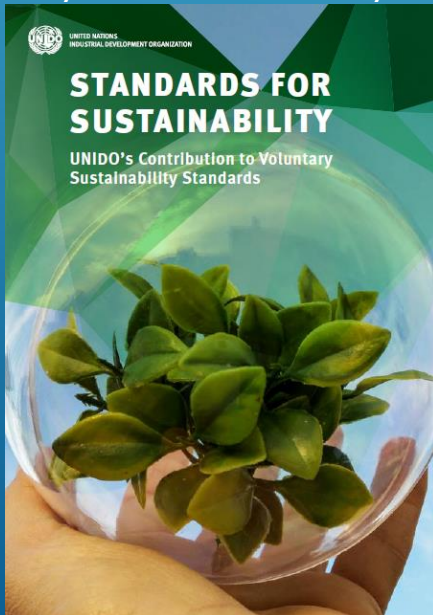
Greenwashing concerns

The legal side: mandatory sustainability reporting

ESGs

European Financial Reporting Advisory Group (EFRAG)

- Most ecolabels are created using simple data

- Impact data often come from commercial databases which scientists, consultants, or large-scale, in-house, sustainability teams have access to
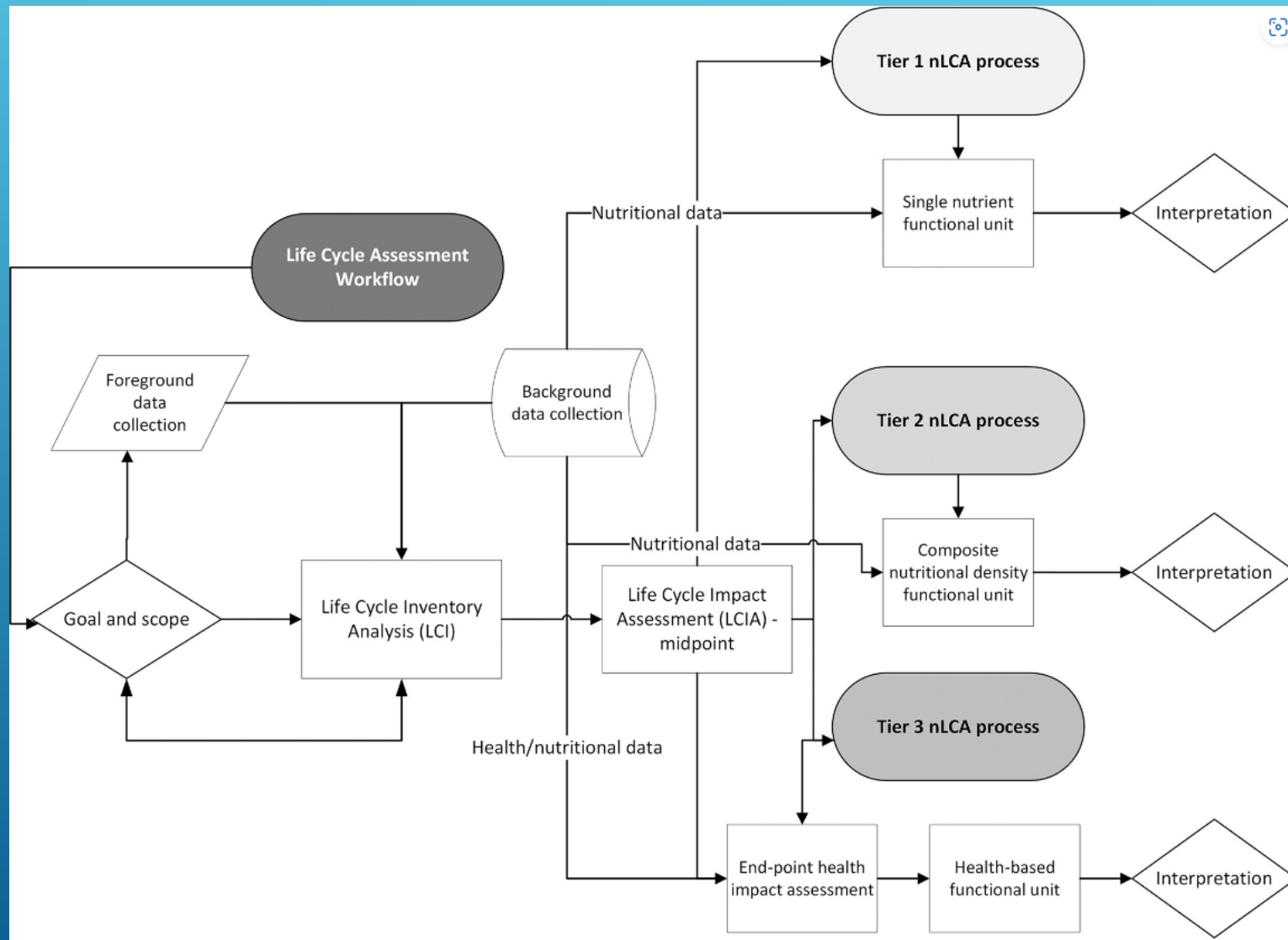
- Several VSSs remain based on simple scoring mechanisms and minimalist peer-review processes, if any at all, which under LCA standards does not adhere to protocols

- The same as above can arguably be applied to nutritional labelling…

NUTRI-SCORE
A B C D E

What is nutritional Life Cycle Assessment (nLCA)?

In short: exploring the environment-nutrition nexus ('Enviro-nutri')

Note: this is largely used (to date) for in-house/scientific studies as there are no labelling systems developed yet
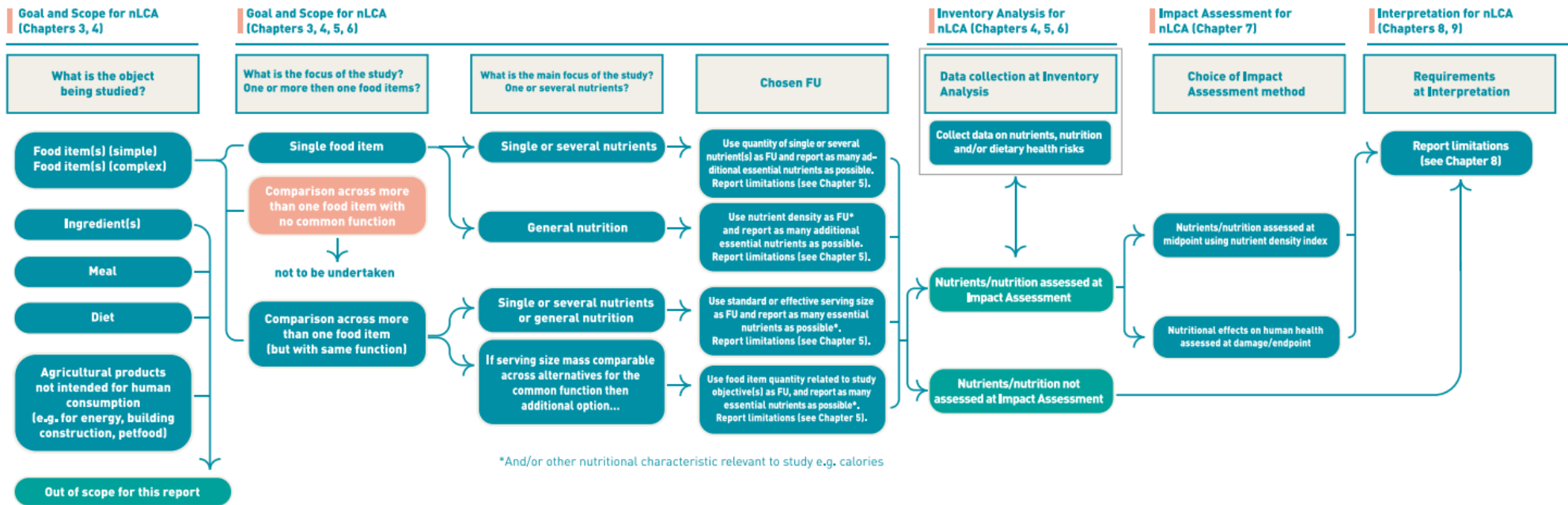
McAuliffe et al., 2023; DOI: https://doi.org/10.1002/fes3.480
McAuliffe et al., 2020; DOI: https://doi.org/10.1007/s11367-019-01679-7

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Shining light on a lawless territory!

- In 2020 the FAO approached experts in the field of nLCA to provide guidance for practitioners or newcomers to the method given there were no official standards to adhere to

- To this day it remains the only official documentation offering *some* level of operating protocols, though it is not, nor does it claim to be, a formal standard

- **No standard exists to this day**, partially explaining the risks described earlier (and more to come)
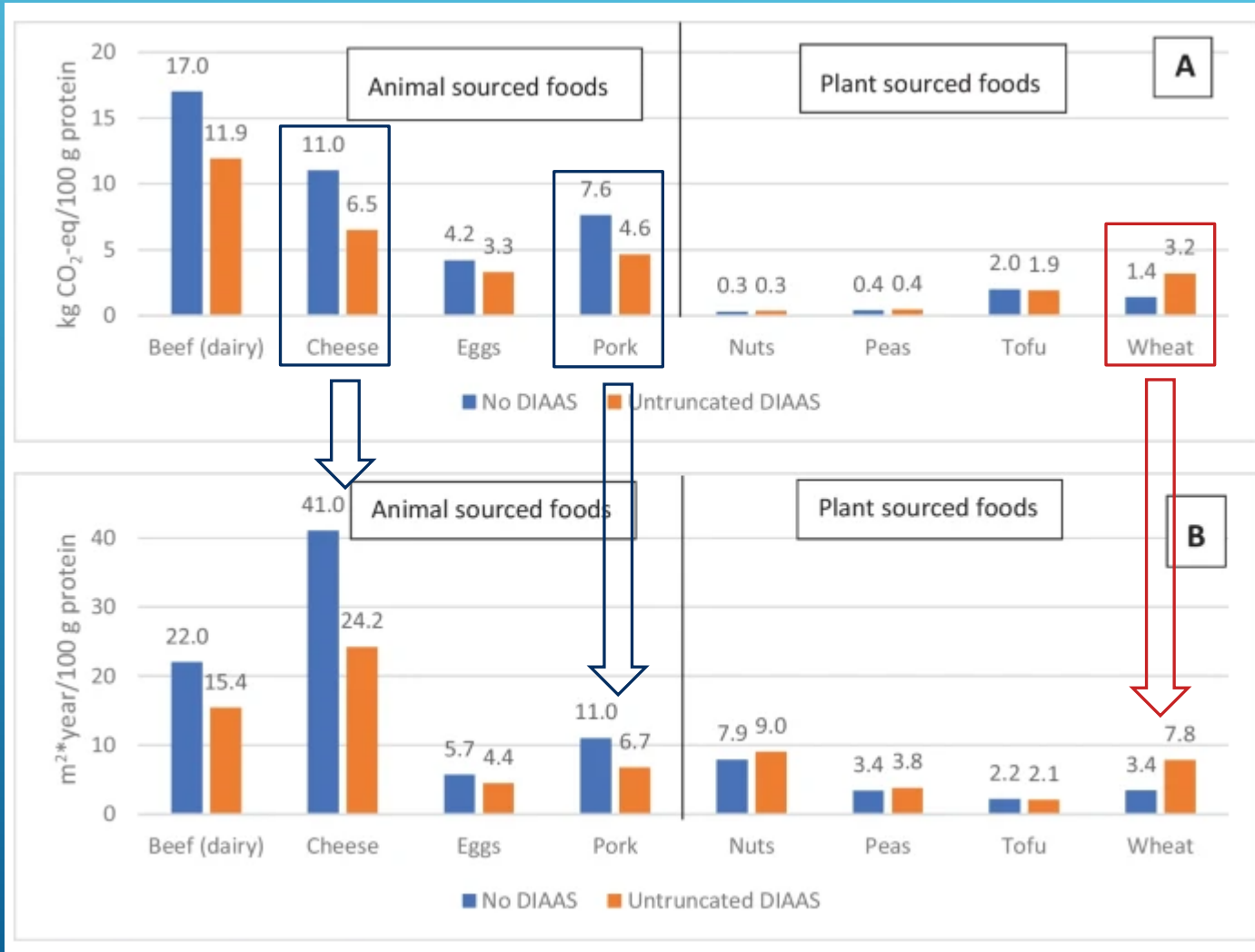
Differences in **A** global warming potential (GWP$_{100}$; kg CO$_2$-eq / 100 g protein) and **B** land use (LU; m.^{2}*year) / 100 g protein) per product according to internationally weighted averages calculated by Poore and Nemecek (2018a) when products are either uncorrected for protein quality (No DIAAS) or corrected using untruncated DIAAS (as labelled in both graphs), based on DIAAS values reported in Table 2. Whilst protein values are reported in Poore and Nemecek (2018a) for most products, the value used for wheat was unidentifiable (cereals were simply reported as 'variable protein'); as a result, we adopted the protein value from the same food commodity used in Table 1 which equated to 11.2% protein (USDA 2019; product code 08,144); however, the GWP value was transformed from bread to wheat and may therefore be slightly misaligned with primary processing into consumable wheat, though the protein content was not sensitive following a check with similar food items in USDA (2019)

The problem is the **digestibility** of certain **amino acids** combined with **anti-nutritional factors** (ANFs; e.g., phytic acid abundant green veg)

McAuliffe et al., 2023; DOI: https://doi.org/10.1007/s11367-022-02123-z

A one-sided 'debate' on the *perils* of (n)LCA

- The old saying about all models being wrong, but some being useful applies **heavily** to LCA
- Unfortunately, however, some people have begun to assume that models which are highly uncertain are factual
- This leads to a story of scientific debate on the strengths and weaknesses of nLCA
- For visual context, see the graph on the right
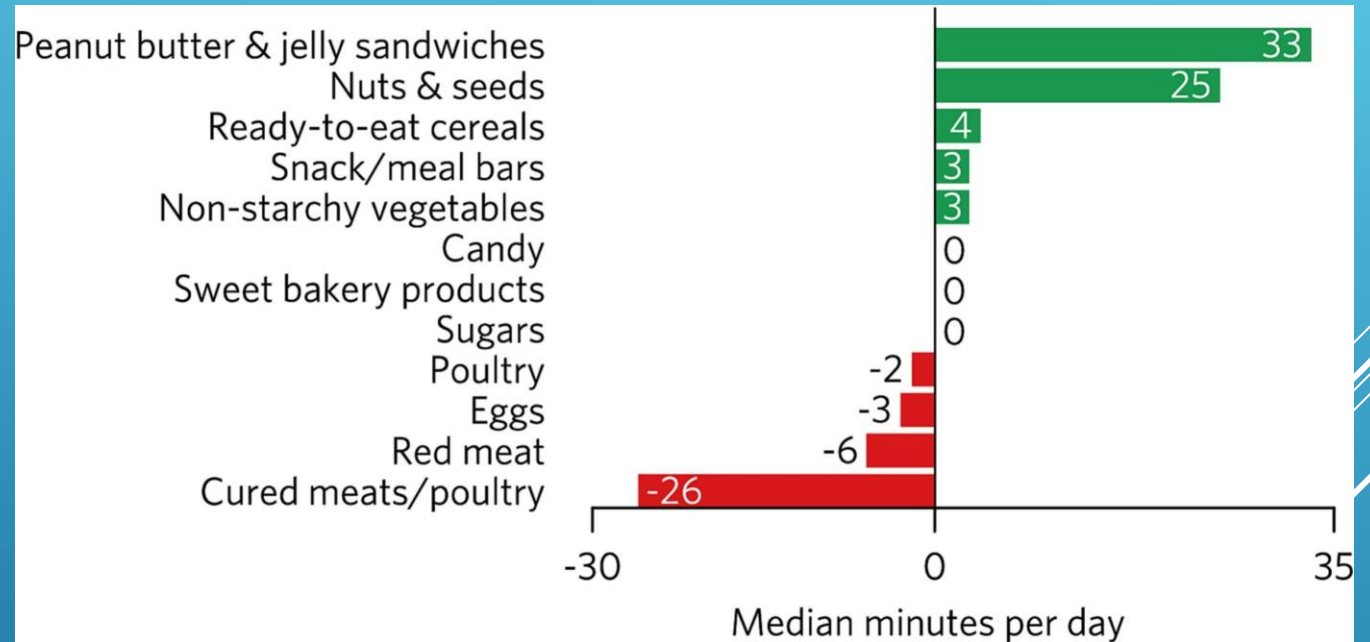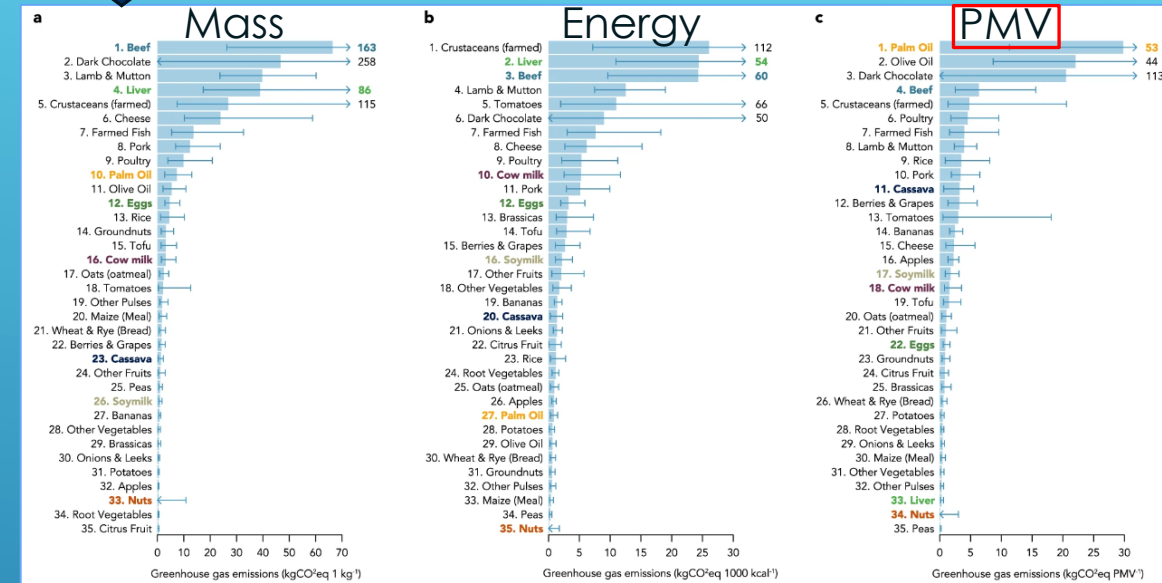
nLCA done properly: testing assumptions

The global mean carbon footprints (reported in kg CO₂-eq) of food portions required (**a**) per kg or l, (**b**) per 1,000 kcal, and (**c**) per target Priority Micronutrient Value (an average of one-third of recommended intakes of vitamin A, folate, vitamin B₁₂, calcium, iron, and zinc for adults ≥25 years, with each micronutrient's contribution capped at 100% of recommended intakes). Footprints are ranked from highest to lowest in each

nLCA done properly: improving data availability

Functional units (impacts/kg, kcal, or composite score)

- Most nutritional profiling used in nLCA studies has relied on secondary data

- Whilst unavoidable largely, nutrients may be cherry-picked to favour one product over another

- Therefore, we developed the Priority Micronutrient Value – a scoring index which assesses a food for the most globally deficient nutrients

- Only primary data from real-world producers can help scientists unveil the true sustainability of foods
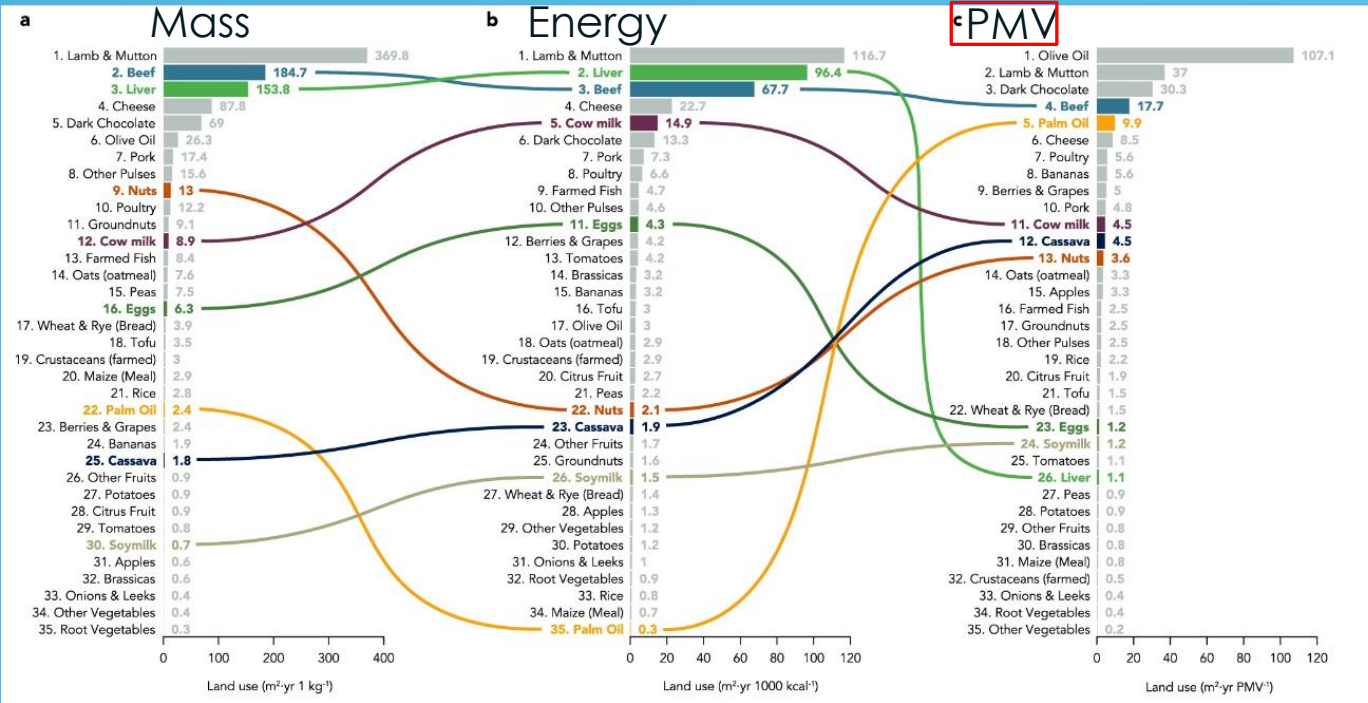
Conducting the first index-based nLCA of UK food systems

| Species	System	Mass-based GWP (kg CO_2-eq/kg meat)	Quality-based GWP (kg CO_2-eq/g omega-3)	Quality-based GWP (kg CO_2-eq/g EPA + DHA)
Beef	Concentrate	9.8[a]	48.0	288.1
	Forage	18.3[a]	18.5	67.7
Lamb	Lowland	26.1[a]	28.7	99.2
	Upland	30.9[a]	30.0	98.9
Chicken	Intensive	4.4	1.2	25.1
	Free range	5.1	2.4	34.7
Pork	Intensive	7.4[a]	14.4	50.3

- Developed the UK Nutritional Index (UKNI)

- The version created was for protein source comparisons only

- Overall, small but not negligible differences were observed under UKRI, as concentrate beef had a lower GWP than chicken under a dietary-centric research question
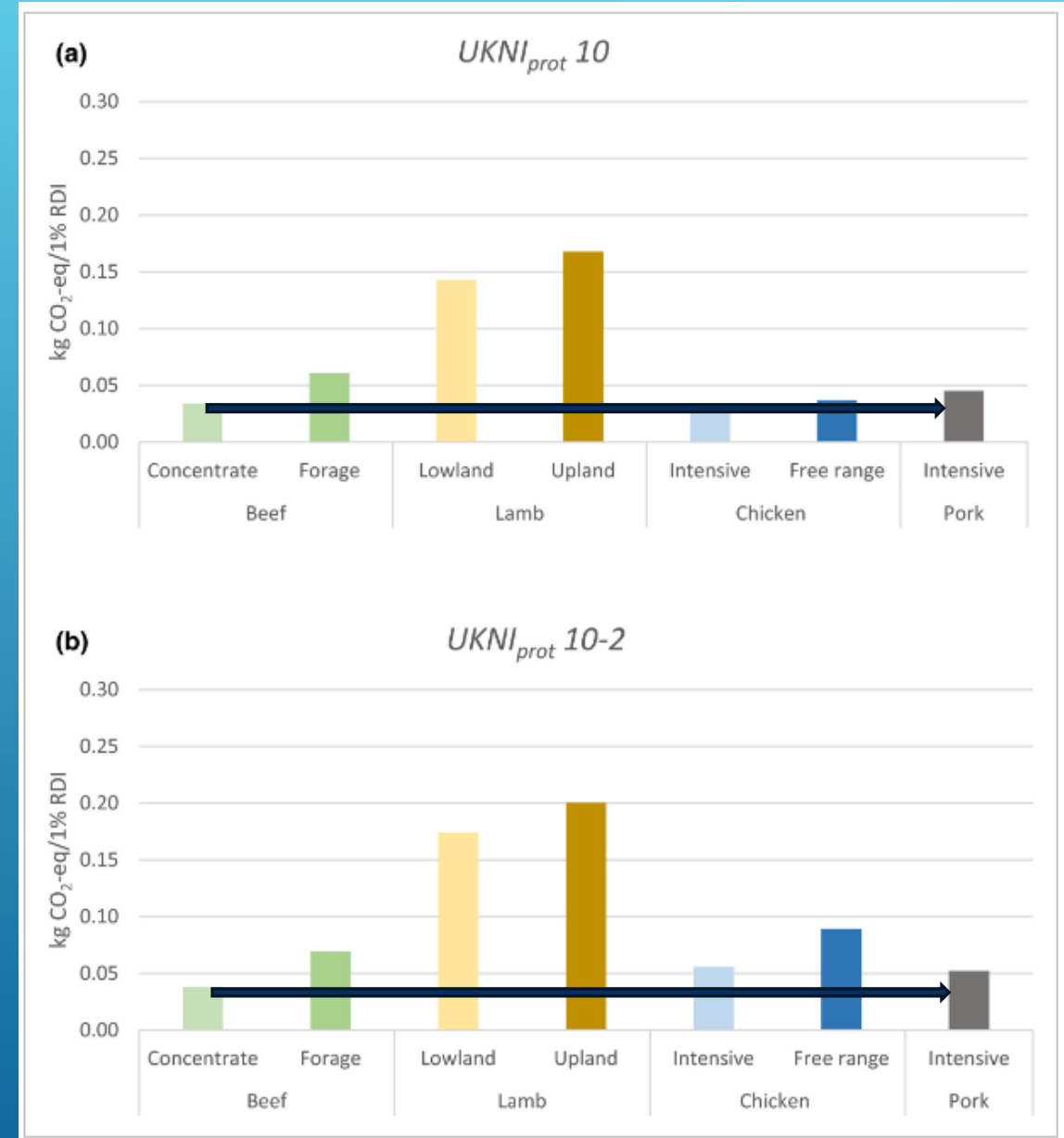
- Sustainability assessments can only improve if our fundamental understanding of the food system deepens

- First, we need better representation not only of primary production, but processing, packaging, distribution, retail, and preparation – Currently looking for industry partners to join an Artificial Intelligence project (no financial costs required!)

- As more and more 'healthy alternatives' come on the market, in reality we know very little about their true nutritional composition & quality

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Nutritional Value Score chart showing: Spinach 100, Chicken organs 97, Bivalves 81, Fish 73, Crustaceans 73, Zucchini 65, Sunflower seeds 64, Edamame 64, Beef 61, Pork 58, Egg 57, Pumpkin 56, Mung beans 54, Chicken 54, Tofu 51, Peanuts 50, Whole cow milk 49, Sweet potato 49, Guavas 49, Unsweetened soymilk 48, Potato 42, Mango 39, Cucumber 37, Corn 33, Pasta (whole & refined wheat) 30, Rice (brown & white) 22, Watermelon 22, Congee 1. Legend: Fruits, Vegetables, Legumes, nuts, & seeds, Animal-source foods, Starchy staples.

Food and Agriculture Organization of the United Nations

- **Major project 1: Indonesian nLCA**
  - The nutritional value score has been designed to account for bioavailability and digestibility across food groups

  - It is being trialled in Indonesia, with expansion projects on-going in the UK & Kenya

- **Major project 2: FAO alt-ASF review**
  - HAU working alongside Cornell, GAIN, and FAO to explore alt-ASFs

  - Main task is exploring if env. claims by alt-ASF products are verifiable & true

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If interested in the enviro-nutri nexus…

EDITORIAL article

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Sec. Nutrition and Sustainable Diets
Volume 8 - 2024 | https://doi.org/10.3389/fsufs.2024.1471102

This article is part of the Research Topic
Pushing The Frontiers Of Nutritional Life Cycle Assessment (nLCA)
To Identify Globally Equitable And Sustainable Agri-Food Systems

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Editorial: Pushing the Frontiers of nutritional Life Cycle Assessment (nLCA) to identify globally equitable and sustainable agri-food systems

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McAuliffe et al., 2024; DOI: https://doi.org/10.3389/fsufs.2024.1471102

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Circling back: how may nLCA benefit dairy?

- Multidisciplinary data (and ideas) provision

  - **Primary data** from, e.g., Future Farm, HFI, **industry partners**, NGOs, etc., can unlock novel insights

  - **Food waste** narratives/circular activities can be quantified (and/or upscaled) using LCA

  - Impacts associated with novel **food development** (e.g., a change in ingredients) can be calculated

- Recent work has focussed on **fatty acid quality** (rather than reductionist SFAs, MUFAs, & PUFAs), with untested implications for the cheese sector

- A similar gap goes for ASFs as whole: **digestibility and bioavailability** tends to be at very high levels with little to no anti-nutritional factors

- HAU is in the process of developing the world's first enviro-nutritional MSc programme, **preparing digitally talented postgrads for a career in sustainable foods**

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Any questions regarding topics covered today or broader research in the LCA/sustainability fields welcome

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