Making life cycle assessment work for food system transformation

Workshop hosted by the Tranforming UK Food Systems Programme at the University of Reading

8 November, 2024

This workshop brought together LCA practitioners from across TUKFS as well as stakeholders working at the intersection of the food system and Life Cycle Assessment.

The purpose of the workshop was to share research insights from across TUKFS and to discuss the role of environmental assessment tools and how best to use them to transform the UK food system.

Introduction

Life Cycle Assessment (LCA) is a tool used to assess the environmental impacts of a product across its entire life cycle – from the extraction of natural resources, through the production and use stages to waste management (including disposal and recycling). The purpose of LCA is to avoid problem shifting from one life cycle stage to another stage, or from one environmental impact to another impact.

The first major LCA study was commissioned by Coca-Cola in 1969 and compared different bottling solutions as a means to increase resource efficiency. Since then, LCA has developed, specialised and standardised, culminating in the publication of the ISO 14040:2006 standard in 2006. This standard set out the four key stages of LCA: (i) goal and scope definition, (ii) inventory analysis, (iii) impact assessment and (iv) interpretation. Different types of LCA have also developed, and these address different questions. For example, attributional LCAs seek to attribute the environmental burdens associated with production and use of a product, whereas consequential LCAs seek to measure the environmental consequences of a decision or a proposed change in the system under study.

The wider field of impact assessments continues to grow with the expansion of impact categories and new types of assessments such as social life cycle assessment in the ISO 14075:2024 standard. Yet, while the field is maturing, various challenges persist including issues around data availability and quality, comparability and scoping.

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"We have a tendency to focus on essentially collecting and measuring whatever numbers we can get hold of, rather than necessarily thinking about how LCA and similar tools can change mindsets."

Keynote talks

Dr Tara Garnett, Director of TABLE and researcher at the Environmental Change Institute at the University of Oxford.

Outlined the role of LCA in the context of achieving food system sustainability. Building on her 2014 paper, Garnett presented three perspectives on how such change might be achieved namely: efficiency-oriented, demand-restraint, and system transformation. The perspective selected in framing an LCA influences how results are represented, interpreted and their wider policy impacts. The use of LCA as a systems approach was further critiqued as it misses out people and institutions within its framework of impact assessment, as well as how they influence one another. LCA has played an important role in bringing the impacts of the food system to the forefront. However, to truly transform the food system, all aspects of the food system need to be considered and represented within its assessment.

Dr Laurence Smith, University of Reading

Provided insights into the practical application of LCA from a research and farming perspective. The inclusion of farmers is integral in food system LCAs especially if implementation and eventual transformation is the goal. The use of the Public Goods Tool (PG Tool) and farmer collaboration has helped build a better understanding of on farm practices, impacts and benefits to sustainability. Further work is needed to improve data availability, end user engagement and improving the representativeness of LCA metrics, however LCA is not able to do everything and it may be the case that other tools should be used in conjunction with LCA.

Lesley Mitchell, Policy Director for the Sustainable Food Trust (at the time of the workshop)

Discussed how LCA may adapt with the move from single commodity farming practices to more complex nature-based farming. This will have further implications within the supply chain, which in turn impact the policy focus. There is an urgent need for harmonised data, especially at the national level, on which to build food system policy. These policies can then inform stakeholder strategies and approaches such as ecolabelling for consumer facing stakeholders and regenerative agriculture for producers. Due to the myriad needs of the food system, there is a need for multivariate tools that can support the policy needs of the food system.

Summary of panel discussion

"We need to zoom out and think about what is important."

- The need for improved multisectoral collaboration is paramount to help combat the fragmentation within the food system with different bodies carrying out similar work within the field.
- The functionality of LCA was further discussed with questions arising on the practicality of LCA and its limitations. Researchers and LCA practitioners should be honest about what LCA can do and what it cannot do.

- Sole dependence on LCA poses the risk of creating “tunnel vision” when considering a product's environmental impact. Wider questions need to be addressed to overcome a ‘quantification mindset’. For example, “is this product needed? Who is making it? Are there wider systemic consequences for the production and use of this product?”
- There is room for the integration of LCA with tools that may provide this wider systemic view which may be sometimes ignored.
- Need for a multi sector space to accelerate technical data exchange between academia, industry and policy.

Participants were given the opportunity to present their research. Their presentation titles are listed here.

An expanded summary of these presentations, within the framework of LCA, is provided on the following two pages (numbering is consistent across the two tables).

	Participant/Project	Presentation title
1.	Jessica Bosseaux, TUKFS: FoodSEqual	Combined nutritional and environmental assessment (CONE-LCA): A case study of alternatives to potato crisps
2.	Nicholas Davison, Re-Livestock	UK Brewer’s spent grains utilisation pathways explored in LCA and LCC
3.	Michelle Felton, TUKFS: Increasing UK Dietary Fibre	Bread: a staple food in a changing environment. Using LCA to explore the impacts of the UK bread production
4.	Anne Mumbi, TUKFS: Pasture to Plate	Grass derived food ingredients: Environmental Assessment from the Pasture to Plate Project
5.	Beatrice Smyth, TUKFS: SUS-Health	Environmental LCA and nutritional data to support healthier consumer choices for people and planet
6.	Tom Staton. ReForest	Lifecycle Analysis of Agroforestry Systems: Opportunities and Challenges
7.	Sally Westaway, FoodLevers	Integrating sustainability assessment tools with LCSA for agroecological systems: a UK case study
8.	Jing Zhang, TUKFS: BeanMeals	Integrating LCAs into a Sustainability Compass for assessing food system outcomes: Insights from the TUKFS BeanMeals Project
9.	Mustapha Ali, TUKFS: H3	Sustainability assessment of hydroponic horticulture – a case study in the United Kingdom
10.	Mustapha Ali, Sheffield University	LCA of cultured meat production in the United Kingdom – a case study
11.	Ettore Settani, University of Cambridge	Fast and spurious: illusion of simplicity in food systems LCA
12.	Susan Lee, University of Leeds	Ecolabelling and Sustainable Food
13.	Taro Takahashi, TUKFS: SNEAK	SNEAK — Weekly menu optimisation informed by LCA data

	System Boundary	Commodity	LCA Type	Impact Category
1.	Lifecycle, Nutritional and Health Impacts of crisp snacks	Snacks (Crisps: potato, lentil & chickpea)	Attributional	Ionizing radiation; Freshwater ecotoxicity; Human Carcinogenic toxicity; Water Consumption
2.	Downstream Waste disposal	Spent Brewers Grains	Consequential	GWP, LCC, LUC
3.	Meta-analysis of UK wheat and bread production.	Bread and Wheat	Literature Review	N/A
4.	Upstream Production of grass, farm to processing.	Grass production and conversion to protein	Attributional	GWP; Stratospheric Ozone Depletion; Ionizing radiation; Eutrophication; Land Use; Water Consumption; Carcinogenic Toxicity
5.	Nutritional Scoring and Consumer Choice	N/A	N/A	N/A
6.	Cradle to Farmgate	Agroforestry	N/A	N/A
7.	Cradle to Farmgate	Beef, Carrots, tomatoes	LCSA	GWP; Agri-Environmental Management; Landscape; Soil Management; Water Management; Energy and Carbon; Food Security; Agricultural System Diversity; Social Capital; Farm Business Resilience; Animal Welfare
8.	Scenario Analysis	Beans and Pulses	Consequential	
9.	Upstream Production Practices Cradle to Gate - Hydroponics	Horticulture (Lettuce)	Attributional	
10.	Upstream Production of Cultured Meat	Cultured Meat	Attributional	

Aim/Objective	Contribution/Result	Data Sources/ Methods
Understand the environmental factors that contribute to Human Health Damages. Investigate the biggest factors to negative environmental impacts.	Considering processed food for CONE-LCA. Considering the effect of nutrients' association in consumer response (satiate feeling) . Recommended portions as the functional units	Agribalyse, literature
An analysis of environmental impacts from spent brewer grains utilisation through feed use and anaerobic digestion scenarios.	Anaerobic digestion of brewer's spent grains could provide large economic and GHG savings. But increased GHGs if soya is the feed replacement (not field beans). Risks of GHGs from extra land use requirements (especially deforestation)	Scenario analysis, literature
Part of Hi-Fi Bread Project aims to review previous UK bread LCAs. Develop new UK bread LCA with uncertainty and sensitivity analyses and couple LCA model with land-use allocation modelling to exploring possible national scenarios (climate change, environmental land management schemes and farming systems, Net Zero economy)	Develop UK specific LCA and LCI for bread in relation to wider Hi-Fi bread project.	Literature; Ecoinvent; WFLDB; market data; national statistics
To assess the environmental impacts of deriving grass proteins, lignin and oil rich yeast from grass in the UK using MEA.	Estimated to reduce land use by 95%, climate change emissions by 75-85% and nutrient pollution by 95% compared to conventional beef.	Primary data, literature and Ecoinvent
To co-develop, with stakeholders, a metric to describe a food's nutritional value and environmental impact, and thus support healthier consumer choices for people and planet	Consumers make more sustainable and healthier choices when the index is on the menu.	SimaPro 9; literature; primary data consumer choices (primary data).
The aim of this study was to review the literature relating to LCA in agroforestry systems, to identify opportunities and challenges for further research	Agroforestry systems are inherently diverse and multifunctional, with multiple products arising from a system with multiple benefits beyond global warming mitigation. Research is therefore urgently needed to develop robust approaches applicable to LCA in agroforestry systems (Quevedo-Cascante et al. 2023)	Literature
We present results from two contrasting methods of estimating thresholds of farm sustainability: (i) Whole farm sustainability assessments using the Public Goods Tool (PGT). (ii) Cradle-to-farm-gate LCSA of fresh products (beef, carrots and tomatoes)	LCSA is useful to estimate environmental impacts but is not the most suitable tool to consider wider aspects of the sustainability of agroecological systems. The addition of rapid on-farm sustainability assessment tools complements LCSA results and can encourage adoption by farmers.	Public Goods Tool (PGT); primary data
Novel beans varieties 'Capulet' and 'Godiva' are developed for UK conditions to mitigate the gaps between consumption and production.	Compared with NA, growing beans in the UK does not require phosphorus fertiliser, and nitrogen fertiliser inputs are relatively low, thereby reducing phosphorus surplus in the soil and lowering nitrogen emissions.	HESTIA
The goal of this study was to examine four different hydroponic treatments for lettuce production and compare these to conventional horticulture impacts and outputs.	Conventional system seems more sustainable than hydroponic alternatives. Despite transportation of lettuces over long distances from Spain, the hydroponic system appears less environmentally friendly but only marginally. Electricity use stood out as the main driver of environmental impacts.	ReCipe 2016 life cycle inventory; Ecoinvent and primary data,
The purpose of this LCA was to assess the environmental impacts of cultured meat produced using bioreactors located in the UK in the year 2024, and was accompanied by a health-economic assessment focussing on bovine spongiform encephalopathy (BSE) prevention as an outcome.	Cultured meat in current scenario was more sustainable than in baseline study. Protein derived from rapeseed is more sustainable than alternatives.	Scenario analysis, Ecoinvent and primary data

"It's not just about the data and the environmental impact. Once you get social, biodiversity and animal welfare impacts in as well then you're having to ask very different and much more systemic big picture questions."

Key Themes

During table discussions, the following points were raised as important and urgent issues that LCA and wider sustainability assessment tools need to address.

- Allocation of environmental burden is especially challenging within the food system due to often multi-product systems with different inherent value and waste/ by-products. A clearer understanding and application of allocation can improve the quality and usability of LCA results.
- Harmonisation is needed within the wider sustainability assessment field. The use of aligned methodologies and assumptions will allow for better cohesion and analysis at different levels (national, regional, global). Furthermore, the development of open access and transparent inventories such as national inventories) will improve the quality of the analysis and appropriate data use.
- Investigation of data quality for the UK context needed to identify where consistent discrepancies exist and revising these data is required for UK-focused LCAs
- Transformational LCA should be prioritised especially within the food system. The inclusion of metrics that reflect the system concerns at different scales. This includes metrics such as social and nutritional impacts. Overall, a holistic approach towards food system research including future forecasting scenarios.
- Improvement in the understanding of carbon sequestration and environmental impacts across different farm systems such as agroforestry, regenerative agriculture, crop rotations, etc. Furthermore, location specific land use and land use change impacts need to be properly accounted for (e.g. accounting for soil type and agro-climatic zone).
- Need for additional transparency in research study objectives including the use of functional units, goals and data sources. This will improve the confidence in studies and help end users to use results appropriately.
- The potential opportunities and challenges of artificial intelligence in LCA are still developing and may provide new insights for sustainability assessment.

Next Steps

A literature review is underway to further expand on the above themes and to build a more complete picture of current research and the gaps and opportunities for LCA to help to transform the UK food system.

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