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Measuring sustainable environment-food system interactions

Overview

- Food systems are built from the complex activities, interactions and networks of decision-makers, natural processes, human processes and infrastructure. They span all processes and activities involved in food production, processing, packaging, storage, distribution, consumption, and food loss and waste.
- These systems generate economic and nutrition benefits and interact with the environment in multiple ways.
- Achieving international and domestic climate change and environmental targets will require transformative change of global and UK food systems.
- Studies exploring options for reducing environmental impacts suggest that an integrated and coordinated systems approach is needed. This will require sound data, metrics and models to track progress towards transforming food systems.
- Metrics on environmental impacts of food across the whole supply chain could incentivise producers and retailers to improve product environmental sustainability. However, there are significant data collection challenges, as well as metric, method and modelling limitations.
- The UK Government's Food Data Transparency Partnership will develop a mandatory methodology for food labels and sustainability claims. A public consultation is planned.

Food systems

Food Systems are complex and dynamic systems made up of networks of decision-makers, natural processes and human activities (social and ecological).[1] They span all processes and activities involved in food production, processing, packaging, storage, distribution, consumption, and food loss and waste (Figure 1).[1] They can vary substantially and depend on location specific conditions.[2]

The interconnected nature of food systems means that decisions made in part of the system will have repercussions for decision-makers and processes in other parts of the system and lead to feedbacks (Figure 1).[1] These are challenging to quantify.

Food systems generate social, economic and environmental outcomes. There are global inequalities in food and nutrition security; in 2020 an estimated 40% of the global population could not afford a healthy diet.[3,4] Poor health outcomes are directly linked to poor quality diets (PN686), such as underconsumption of fruits and vegetables, high quality protein and micronutrients, and overconsumption of fats and oils, sugars, salt and highly processed foods.[5,6,7,8,9,10]

It is predicted that food systems will need to increase resilience to change and shocks caused by, for example, climate change, conflict and biosecurity risks (PN 626, PN 680, PB 51).[11,12,13] Agriculture is vulnerable to extreme weather impacts (such as droughts, early spring followed by frost, or floods), increasing water resource scarcity and soil fertility decline (PN 662).[14] Warming and acidification of oceans will challenge productivity of aquaculture and fisheries (PN 604).[11,15–17,18]

The resulting changes and shocks will affect prices of raw commodities and processing, and may disrupt transport, infrastructure, workforces, food safety, and consumer demand.[17] This will affect the availability, affordability, and accessibility of food.

Environmental impacts of food systems

Production activities

Production activities include agriculture, fisheries and aquaculture. Agriculture and its associated land-use change, such as deforestation,[19] are the main drivers of food system greenhouse gas (GHG) emissions,[a] over-abstraction of freshwaters and biodiversity loss (PN 617).[20,21] [15,20,21,23]

Currently, increasing agricultural production requires more natural resources (including land, soil and water) and manufactured inputs (including chemical inputs such as fertilisers, treatments and energy). These have adverse environmental outcomes such as deforestation, soil degradation (PN662) and air and water pollution (PN661), impacting biodiversity (PN 617).

[a] The food system is estimated to be responsible for 34% of global GHG emissions.[20] Agriculture and its associated land use have been estimated to produce 71-81% of these emissions, with the remaining from supply chain activities.[20,21] In 2022, the contribution of UK agriculture to total UK GHG emissions was estimated at 11%.[22]

Pre- and post- production activities

The pre- and post- production activities spanning transporting, processing and manufacturing, packaging, retailing and preparing food are reported as having a lower contribution to food systems' impacts. However, the energy, material and chemical resources used all contribute to adverse environmental outcomes.[21,24,25]

These food system elements encompass a diverse range of decision-makers and activities, and there is less data available about them than production activities such as agriculture.[23] The lack of data, uncertainties and knowledge gaps, are sometimes referred to as the 'missing middle in the debate'.[17,26]

Food loss and waste

The UN Food and Agriculture Organisation (FAO) describe food losses as occurring in the food supply chain and food waste as food discarded by retailers, food service providers and consumers.[b] It is estimated that one third of food is lost or wasted globally, although some studies suggest it is higher.[29,30] The 2021 UN Food Waste Index Report states that "data availability is currently low, and measurement approaches have been highly variable".[31]

Food loss and waste occurs along the whole supply chain.[32,33,34] Environmental impacts arise from the use of land, water, and energy resources in the production, processing, packaging and transport of this food, such as greenhouse gas emissions. Disposal of wasted food in landfill can contribute further to greenhouse gas emissions.[32,35]

In developed countries, household consumers are the main contributors to food waste.[27] In the UK, households contribute 70% of total food waste[36,37] but there are uncertainties in the data.[38,29] There is a Government commitment to work towards eliminating food waste going to landfill in England by 2030 (Table 1).[39]

Sustainable food systems

What are sustainable food systems?

The UN FAO describe a sustainable food systems as "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised".[40]

The UK Government's Food Strategy[41] and the international Sustainable Productivity Growth Coalition[42] propose transitioning to sustainable food systems. The EU has defined a legislative framework for sustainable food systems under the

[b] The UN FAO describe food loss as concerning all stages of the food supply chain up to, but excluding, the point where there is interaction with the final consumer and thus excludes retail, food service providers.[27] Food waste has been described as any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed of,[28] but there is no legally agreed definition (CBP 7552). The UN FAO describe food waste as the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food services and consumers.[27]

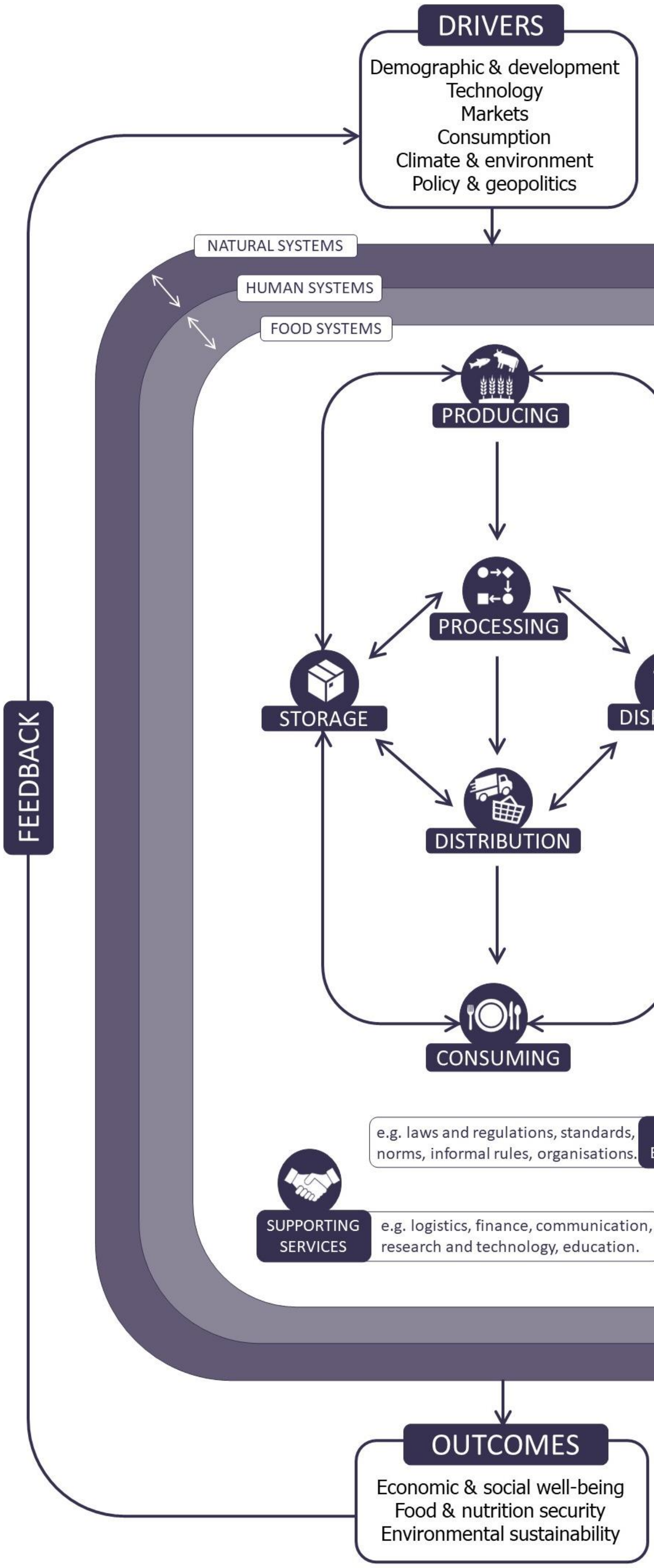

Figure 1 A conceptual model of the food system (adapted from Foresight4Food).[43] Under institutional environments, commercial standards include Global G.A.P. standard for farm production (PB 51), the Publicly Available Specification (PAS) 2050 for the assessment of the life cycle greenhouse gas emissions of goods and services, the Marine Stewardship Council Fisheries standard and others.[44,45,46]

Farm to Fork Strategy to be adopted by the end of 2023.[47,48]

Reaching agreement on sustainable food systems

Finding an even balance between economic, social and environmental bases is challenging, as interventions will feature benefits in one area and potentially losses in another area, due to trade-offs among objectives. Desired outcomes are subjective and vary between decision-makers depending on the context and their values (PB 42).[49]

Food systems operate on different scales and levels (households, local, national, regional, and global).[40] What sustainable food systems 'look like' will vary between these, creating difficulties in coordinating and integrating targets.[40]

Nevertheless, negotiations with stakeholders can create consensus and collective agreement for future strategies and research.[50–52]

A 'joined-up' approach to transforming food systems

Food system changes will be required to reach agreed multilateral environment agreements, including the COP21 Paris Agreement GHG reduction targets,[11,25,53] COP15 Kunming-Montreal Global Biodiversity Framework nature restoration targets,[54,55] and many of the UN's Sustainable Development Goals (SDGs):[56]

- SDG 2 outlines goals for food and nutrition security delivered via sustainable food production systems
- SDG 12 requires sustainable consumption and production across food systems
- SDG 14 and 15 seek to promote sustainable use of terrestrial and marine ecosystems[57]

Studies exploring options for reducing food systems environmental impacts call for integrated and coordinated action for global targets, as food systems transcend disciplinary, sectoral and institutional boundaries.[21,24–26,40,50,51,58–61]

The UKRI's Global Food Security programme aims to provide evidence for a systems approach,[c] alongside other research on reducing the environmental impacts of production activities,[60] and addressing climate change impacts and other likely environmental changes.[17,64] Transformations are needed at different scales to deliver sustainable food systems, requiring knowledge at multiple levels, new technologies and behaviour change.[65,66,11,49,58,59,67]

Strategies often focus on production activities. However, a joined-up food systems approach recognises that production decisions are connected to demand generated by industry and consumer behaviours, such as diet choices and food waste.[60,68,69] Consumer behaviour is influenced by major decision-makers such as multinational corporations, retailers and government policies and taxation.[70] The level of detail in

[c] Applying systems methods to policy areas such as food policy supports complex decision making,[62] without such approaches transformational change towards sustainability may be hindered by various barriers such as dependency on a particular technological approach, institutional inertia or maladaptation.[63]

policy changes, ambition and funding are all barriers to transformation.[59,71] However, delaying action may require bigger and faster changes in the future.[25]

Understanding the power dynamics of decision-makers involved in food system activities can inform mitigation approaches potentially leading to positive outcomes.[72,73]

Options for keeping within environmental limits

The EU Environment Action Programme to 2030 (the framework for coordinating environment and climate change policies) and EAT-Lancet Commission[d] refer to living within Planetary Boundaries.[75,69] The Planetary Boundaries framework outlines a safe operating space of humanity, and food systems, by defining biogeophysical limits of 9 key processes[e] influenced by humans.

There are many policy options for reducing food systems' environmental impacts including:[11,21,24,25,67,69,79,80,81,82]

- better management and natural resource use decisions to minimise degradation of terrestrial and marine ecosystems
- use of renewable energy
- reducing food loss and waste to reduce unnecessary production
- adoption of dietary changes[f]
- altering industry and consumer behaviours to change demand from less to more sustainable products
- improvements to increase resource efficiency across the whole value chain, such as optimising packaging and levels of water, fertiliser and pesticide use

The UK Government's 25 Year Environment Plan sets out environmental objectives for England, all of which can be influenced by food systems (Table 1).[85,86] However, food systems operate at a global scale. The UK imports 46% of its food as well as many supporting goods for domestic production, such as fertilisers and farm machinery. Environmental impacts occur in the exporting countries, such as

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[d] A non-profit organisation founded by the Strawberry Foundation, the Stockholm Resilience Centre and the Wellcome Trust seeking to transform the global food system.[74]

[e] As the largest global economic sector,[76] food systems contribute to exceeding planetary boundaries.[77,78] Research suggests almost half of current global food production feeding 3.4 billion people depends on exceeding four of the nine boundaries – changes in biosphere integrity, land-system change, freshwater use, biogeochemical (nitrogen) flows - but also suggests changes to food production and consumption would provide sufficient calories for 10 billion people without exceeding boundaries (such as dietary change, reducing food waste and improving water, nutrient and land management).[78] The other five planetary boundaries are climate change, stratospheric ozone depletion, ocean acidification, atmospheric aerosol loading (microscopic particles in the atmosphere) and introduction of novel entities (e.g. radioactive materials, and micro-plastics).[77]

[f] For example, the Climate Change Committee has recommended a 20% reduction in meat and dairy by 2030 and 35% reduction for meat by 2050 to meet climate targets.[83] The EAT-Lancet Commission recommended increased consumption of plant-based foods and a reduction in consumption of animal source foods to improve environmental and health outcomes, as did the National Food Strategy.[69,84]

deforestation to produce soya or palm oil that are imported in products or animal feed.[87,88]

Metrics and models for food systems

Data, metrics, and models can identify food systems' uncertainties and play a role in:

- Assessing what is achievable to help set environmental targets.
- Monitoring progress towards targets and assessing the effectiveness of strategies via reporting.
- Benchmarking and fairness, which relies on transparent reporting, collecting and analysis of data as well as transparency about methods.
- Communicating progress to policymakers, industry, and the public.

However, a lack of standardised metrics and methods for verifying environmental sustainability claims can reduce their credibility (PN 667). For example, OmniAction highlight the need for independent verification of data, given that much of the existing data is based on self-reporting.[89]

Increasing consistency and transparency of environmental reporting and highlighting uncertainties may provide greater certainty on environmental impact risks for investors and incentivise companies through benchmarking.[90]

8 major UK retailers have committed to WWF and WRAP's Retailer Net Zero Collaboration Action Programme.[g,90] In its first phase the programme will provide a standard method for calculating Scope 3 GHG emissions (Table 1).[90]

The Food Data Transparency Partnership (FDTP) is working collaboratively across government, industry, food system experts and civil society to develop consistent and defined metrics to objectively measure environmental sustainability.[41] A public consultation will take place on implementing mandatory public reporting for sustainability.

Environmental impact metrics

Environmental impact metrics should be well defined and verifiable. This ensures consistency in what is measured and how, allowing for comparison. Assessing what is grown, when, how and where may identify opportunities to reduce impacts,[21] and to adjust policies supporting mitigation approaches according to producers' circumstances.[21]

The Global Farm Metric (GFM) seeks to establish an internationally agreed framework to measure production sustainability,[113] but commentators suggest food system sustainability is wider and more complex.[114]

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[g] A joint programme building on WWF's Basket and Retailers' Commitment for Nature group sustainability reporting[91] and WRAP's Courtauld 2030 GHG target.[92]

Table 1 Policy targets and changes affecting food systems in England	
Land use frameworks	All UK nations apart from England have land use frameworks.[93] The House of Lords Land Use Committee called for a multifunctional approach that combines food production and environmental needs with other uses.[94] Further information on multifunctional land use is provided in PB42. Approaches to multifunctional land use have been set out by several organisations such as the National Food Strategy, Food and Farming Commission, Climate Change Committee and the Royal Society.[84,95,96,97] The Government Food Strategy committed to publishing an English land use framework in 2023.[41]
Agriculture and data sharing	The Agriculture Act 2020 introduced a requirement for Ministers to consider encouraging environmentally sustainable food production in England.[98] It also introduced new requirements on collection and sharing of data to increase transparency and fairness in food production supply chains.[98,99]
Environmental objectives	The Agriculture Transition Plan 2021-24 introduced the Environmental Land Management schemes (ELMs) to deliver environmental objectives (PN 678). The Environment Act 2021 identified four priority areas (air quality, water, biodiversity, and resource and waste reduction),[100] and the Natural Capital and Ecosystem Assessment will provide evidence to assess progress.[101]
Reporting GHG emissions	Since April 2019, large UK companies must report their global energy use and GHG emissions (Scope1&2) annually following Government guidelines.[102,103,104] Scope 1 covers direct emissions by companies. Scope 2 covers indirect emissions associated with their activities such as the electricity bought to heat buildings. Scope 3 covers all other indirect emissions that occur in supply chains upstream and downstream of the activities of a company, such as the emissions arising from the production of agricultural commodities purchased by an organisation. The Government Food Strategy indicated possible mandatory reporting of all emissions across a companies' whole value chain (Scope 3 emissions). However, measurement costs, lack of data and transparency creates challenges for calculating these.[105,106]
Reducing waste	Following a commitment to achieving the UN SDG 12.3 on halving food waste by 2030, the UK government set out a Resources and Waste Strategy for England that outlines steps to reduce food waste.[37,107] These include WRAP's voluntary Courtauld Commitment for companies to reduce food waste,[37,108] and statutory guidance on the food and drink material hierarchy.[109] In 2021, 63.2% of UK packaging waste was recycled,[110] but issues remain for food and drink packaging including single use plastics (PB 39).[111]
Mandatory food data reporting	The Government Food Strategy stated a Food Data Transparency Partnership (FDTP) will implement mandatory reporting on sustainability to inform consumers and incentivise industry.[41] A 2022 House of Lords report recommended making the environmental impacts of different food products more accessible, including implementing the FDTP, steps to ensure public communication and mandatory methodology for labelling (see below).[112]

Reliance on what is measured could lead to other unmeasured or hard to measure areas being neglected, risking shifting burdens and overlooking unintended consequences. If something is not measured it also risks not being valued, which can limit the ability to orchestrate changes.[84,115]

Measurement challenges

GHG emissions measurements are more advanced than most other environmental impact metrics for food systems.[116] The IPCC 100-year Global Warming Potential (GWP_{100}) measurement protocol forms the basis of reporting under the Paris Agreement.[117] However, there are concerns that GWP_{100} is oversimplified and misrepresents short lived GHGs such as methane[h].[61,119,120]

The National Food Strategy and the Dasgupta Review recommended measuring impacts on nature, but complex impacts on ecological systems can be hard to capture using simple metrics (PN 644).[59] Variation in biodiversity and the complexity of relationships linking food systems activities to biodiversity outcomes, along with lack of relevant studies, have led to data gaps and uncertainties for quantifying biodiversity gains and losses (PN 644).

There can also be a lag between implementing measures and improvements. For example, measurements have yet to demonstrate reduced water nitrogen concentration in water systems despite being in policies to reduce nitrogen fertiliser use since the 1990s (PN 661).[121]

Data collection is also constrained by costs and time. For example, there are concerns about placing additional demands on farmers for production data.[122] New technologies could increase the efficiency of collecting sustainability data,[123,124] but acquiring such data would have costs for producers, increasing the costs of end products.[125]

Mandatory data would require regulation and monitoring to ensure standardised collection procedures are followed. These need to balance the benefit and feasibility of data collection with the cost, representation, and quality of data. For example, given the complexity of ecological systems, the timing and frequency of biodiversity measurements as well as the spatial coverage and resolution should be considered (PN 667). However, mapping and monitoring spatial data, such as land use change, could help decision-makers visualise impacts.

[h] The GWP_{100} emission metric converts GHGs to carbon dioxide equivalent quantities to compare their warming potential over a 100-year time horizon.[117] As methane is short lived in the atmosphere but has greater initial warming effect than CO_2, this underrepresents it's short term warming effects, but overrepresents its longer term impact. For GHGs that persist longer than 100 years, especially CO_2, the situation is reversed. Alternative approaches include disaggregating the different gases arising from the production of a product and modelling their impacts, or different metrics that better reflect actual warming impact, such as GWP* or global temperature change potential[71,118]

Modelling

Overview of food system modelling

Conceptual models such as Figure 1 help visualise how food systems are organised. Mathematical models can indicate previous environmental-food system interactions and forecast them under future scenarios. Interventions can be simulated in 'virtual food systems' before applying them to the real world to highlight unknowns that cannot be modelled and risks for decision-making.[17,72]

However, models are a simplification of reality. For example, existing food system models do not effectively predict the impacts of acute risks, such as the Ukraine war. While the impacts of chronic risks, such as climate change, on food supply chains may be complex and uncertain.[72]

Models are usually designed to address specific questions and will reflect the assumptions and academic discipline of the developer; while assumptions can be comprehensively listed, there is a risk some may be unwitting.[72] Integrating social, economic or environmental perspectives into models can help evaluate trade-offs, but the complexity of food systems makes this difficult to achieve.

The scope of models varies depending on:

- The purpose of the model (the questions it looks to answer and who it is intended to be used by).
- The geographical area and time frame studied.
- Which parts of the system the model looks to assess, such as individual products, a specific sector, part of the supply chain or the whole system.
- The environmental interactions considered. For example, foot-print models focus on one element such as carbon or water whereas Life Cycle Assessment (LCA) models[i] (see below) account for a broader range of environmental concerns.

Approaches to modelling environmental impacts

Sectoral modelling approaches[129]

Approaches that combine sector information can give a broad overview, such as food system-environment scenario modelling for meeting the Paris Agreement. For example, the new GHG emissions model for the UK food & drink system developed by WRAP.[130]

Inputting the estimated contributions of interventions can help predict their combined impact. They can also be useful for policy design by providing understanding at the sector level and how sectors interact.

[i] LCA is a tool to evaluate the environmental impacts of a product over its life cycle from raw material extraction to disposal of any waste generated ("cradle-to-grave").[126] The LCA framework is standardised by the International Standards Organisation (ISO) 14040/14044 guidelines.[127,128]

Using data recorded consistently over time,[j] these models can become more dynamic and can allow long-term tracking of intervention effects. However, supplementary information may be required to determine what is driving change within sectors.

Product modelling approaches

Product modelling approaches, such as LCAs, can assess the environmental impacts associated with a particular diet, food product or food system activity.[21,131–133] They can highlight activities in the supply chain with high environmental impacts (hotspots).

Models with a broad coverage of environment indicators can help identify trade-offs that arise from reducing one environmental impact at the expense of another.[126,134] However, models with limited coverage of environment indicators may be misleading.[126,135]

Differences in LCA methodologies (see boundary setting below) can limit comparisons. LCA results are sensitive to methodological choices including data input, allocation methods, and impact calculation approaches.[136,137] Different scopes also limits comparison between studies.[24,135]

The HESTIA platform brings together standardised LCA data on agricultural production and corrects for all the different LCA methods. This platform is used by some eco-labelling schemes to estimate farm level data.[138,24]

However, product approaches do not account for the impacts of the overall scale of production, systemic interactions and impacts that arise at larger scales. For example, while modelling suggests environmental impacts per kg of pork and poultry are low, the impacts on the local environment within which intensive production occurs may not be accounted for.[139]

Communication of modelling methods

For effective use and comparison of models, their purpose, assumptions and uncertainties should be communicated, along with acknowledgement of limitations and unknowns.[140] Key aspects to communicate include data quality and availability and system boundaries and allocation of impacts.

Data quality and availability

Some data is commercially sensitive or under confidentiality restrictions, limiting transparency. For example, in order to protect identities, UK farm data recorded by Defra is not published at farm-level, which limits spatial resolution required by some models, such as field specific data on use of nitrogen fertiliser[k].[144,145]

Non-standardised data is difficult to integrate into models. For example, there are several different pesticide metric frameworks used globally, not all of which are free

[j] Time series data

[k] From 2012/13 to 2020/21, the face to face farm business survey of 1,580 farm businesses across England included a module on fertiliser use, which became compulsory in 2017/18, other sources of information include the British Survey of Fertiliser Practice, but these do not provide location specific detail. [141,142,143]

to use.[146] As a result it is challenging to collate, prepare and compare pesticide metrics,[146–148] and then integrate those into LCA models.[149]

Meeting large data requirements for LCAs means collating data from different sources (measured, estimated, and modelled), which are each associated with uncertainty.[126] Sensitivity analysis is used to highlight activities that contribute the most to environmental impacts of a product; gathering detailed data for these activities or items should then be prioritized, for example milk data for a yoghurt LCA.[126, l]

Conducting LCAs for each individual product using primary data can give high levels of accuracy, but would be time and resource intense for the 97% of UK food and drink manufacturing businesses that are small to medium enterprises.[150–152]As a lower cost alternative, the French Government is developing a national food eco-labelling methodology,[153] which uses data from their generic food product LCA database.[151,153] Using the product average data has limitations including missing variations in the impacts of agricultural production.[153]

System Boundaries

System boundaries set out what is and is not accounted for in a model and can be defined in various ways such as by sectors and the timeframes for impacts.[126] For environmental impact modelling at the product level, the terms cradle-to-cradle,[154] farm-to-fork[155] or farm-to-shelf[156] may be used as boundaries.

Cradle-to-grave models include the consumer stage whereas farm-to-fork or farm-to-shelf may not. Consumer data includes a range of activities such as preparation (cooking and storage) and waste, which are subject to high levels of data variability and uncertainty.

For sectorial level environmental impact modelling, system boundaries can affect model conclusions. For example, the term 'food-miles' are commonly described as the transport of food items from point of production to consumer. Based on this definition, models have estimated that food-miles contribute between 5-9% of global food systems' GHG emissions.[20,21,24] If emissions from transport of 'upstream' agricultural inputs (such as machinery, animal feed, fertilisers and pesticides) are included in food-miles, estimates for this emission category rises to 19%.[24,157,24]

Allocation

Allocation refers to the subdivision of LCA processes into multiple co-product outputs, such as milk, meat and leather. There are several allocation methods that can be used. For example, co-products can be allocated by economic value or energy content.

The lack of consensus in which allocation method is used for different types of products can create a large variability in results. For example, NGOs have highlighted when the allocation is split between co-products, using the allocation that gives the co-product the lowest level of assumed emissions may result in a proportion of the production emissions not being accounted for.[135]

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[l] For example, in modelling the environmental impact of a product, results will be highly sensitive to key ingredient data uncertainties, such as milk data for a yoghurt LCA.[126] Use of generic data for minor ingredients will have limited effect on the robustness of conclusions.

Labelling

The UK Government Food Strategy proposes the development of mandatory methodology for producing labels and making sustainability claims for products in England.[41] The EU have committed to setting out rules on sustainability labelling of food products in 2023.[158] They proposes a labelling framework to "empower consumers to make informed and sustainable food choices".[159] There are already more than 400 labels in Europe related to sustainable diets.[160] A 2021 Healthy and Sustainable Diets Consumer Poll by the Food Standards Agency indicated that 54% of UK consumers have stated they seek to change a more sustainable diet.[161]

Eco-labels have been applied to food products to communicate environmental metrics. They usually consist of a scoring system matched with traffic-light colour coding to indicate product performance and aim to incentivise changes in purchasing behaviour.[162]

However, the IFST[m] highlight flaws such as the "cherry picking" of environmental metrics.[163] Lack of relevant information about the environmental impacts of individual food products has been recognised as barrier,[161,162] and it is hard to assess how effective labels are in influencing consumers.[162,164] Eco-label information may differ from certification labelling initiatives, such as the Soil Association's symbol for organic foods, which are standards applied to qualifying products and are awarded for meeting process-based indicators.[150,165] Certification schemes can be incorporated in to eco-labelling.[150]

Objectives of labelling

Commentators such as WWF suggest labelling may incentivise product reformulation and provide competitive advantage for more sustainable products by differentiating these in the market.[166] If labelling is supported by the Green Claims Code it may increase transparency and accountability of industry.[41,167]

Generating environmental metrics for labels

LCAs are commonly used to generate environmental metrics of a product up to the point of retail[n].[150] Environmental impacts such as GHG emissions, are reported in relation to a unit of product, which provides the basis for comparison, such as 1 kg of product. However, this may be less straightforward for some impacts, such as biodiversity loss. Units can be based on a range of values including mass, portion or nutrition and will affect how products are ranked.[153] However, methodological issues associated with LCAs make comparisons problematic.[150] Multi ingredient products add further complexity, and other aspects of sustainability to be considered, such as fair trade labelling relating to social impacts.

The European Commission's Product Environment Footprint (PEF) outlines a methodology to help calculate environmental impacts based on "reliable, verifiable and comparable information".[168] PEF assesses product performance based on 16

[m] Institute of Food Science + Technology

[n] For example, they do not include the impact of consumer choices post retail, such as transportation to the home, refrigerated storage in the home, the method of cooking in conventional vs microwave ovens etc.

environmental indicators, such as climate change and water use, but does not capture all environmental impacts and ecosystem services.

Indicators can also be combined to give one score. However, this involves weighting the environmental impacts relative to each other, leading to loss of clarity where trade-offs have been made between environmental impacts. Product Environmental Footprint Category Rules detail additional steps for different product categories to help capture category specific issues, but these differences can create difficulties comparing categories .[150]

In 2022, a joint open letter from farmers organisations to the European Commission raised concerns over PEF methodology,[169] and the French Science Council have highlighted the need for better accounting of the benefits of agroecological approaches, such as increased biodiversity.[153,170] As with other LCA methodologies, PEF scoring is influenced by the high yields from high inputs of more intensive production practises.[171,172]

Labelling initiatives, including OmniAction, Foodsteps and Foundation Earth, have highlighted the need for standardised methods and recognising potential PEF improvements, such as accounting for beneficial production practices, and are working with UK Government's FDTP to address these issues.[41,173,174] Commentators have highlighted the need for globally interoperable standardised methods that include differentiating the method-of-production.[175]

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