Defining sustainable proteins

Academic and industry perspectives on the challenges of environmental data acquisition in proteins

1. Introduction

In the context of the food system and its contribution to environmental change, there is a considerable amount of interest in quantifying the environmental impacts of food from both the food industry and academia. This is a focus for the WWF-UK, who cite food production and consumption as the biggest threat to nature today. WWF-UK works with producers, retailers, buyers, governments, and citizens to promote more sustainable supply chains and consumption patterns and to establish credible standards in order to reduce the key environmental impacts of food.

Protein is often particularly resource-intensive and therefore environmentally impactful to produce. Recent studies suggest protein sources account for 35% of the greenhouse gas emissions of a healthy diet[1], despite accounting for less than 16% of the weight[2]. Protein is therefore a key focus of efforts to calculate and reduce the environmental impact of food. Establishing a common understanding of 'sustainable' protein production and consumption will require consistent and comprehensive reporting of the impacts of their production in a range of systems. This is important to a number of stakeholders in the food industry and wider society. Key examples include producers and supermarkets reducing the impact of the food they sell, policymakers reducing the impact of the food system as a whole, and consumers reducing the impact of the food they buy and eat. However, as of yet, environmental impact data on proteins is not widely available, calculated or reported outside of academic papers. This represents a significant barrier to each of these stakeholder groups in reducing the impacts of their protein sources, as well as being able to define what 'sustainable' proteins look like.

There are many reasons why the environmental impacts of proteins may not yet be widely calculated or reported. For example, it has been recognised in the academic literature that challenges such as a lack of standardised metrics for calculating the environmental impacts may be limiting the availability and comparability of environmental data in food supply-chains. Additionally, the data itself has not been collected from protein producers consistently. While these factors have been acknowledged independently in different academic papers, there is a lack of comprehensive documentation and understanding of the full range of these barriers and how they limit different stakeholders in the protein supply-chain in their ability to calculate and understand the environmental impacts of protein, from farm to fork.

Given the important role that good data on the environmental impacts of protein could play for multiple stakeholders in the transition to more sustainable food systems (farmers, suppliers, retailers, consumers, and policymakers), it is important to improve visibility and understanding of the barriers to collecting good data, as well as the range of potential solutions.

In response to this challenge, this report aims to explore three central questions:

- ❖ What is the current availability of environmental impact data on proteins?
- ❖ What does this mean in terms of our understanding of the ‘sustainability’ of protein sources?
- ❖ What are the challenges to getting more data on the environmental impacts of proteins? Does this vary across stakeholders in protein supply-chains?

The purpose of this project was therefore to interrogate the availability of environmental impact data on proteins, and to understand the challenges faced by industry stakeholders and researchers in gathering more data. To achieve the stated purpose, Foodsteps conducted academic and industry research on behalf of WWF. The academic research involved assessing the availability of environmental impact data across different proteins and views on the challenges of collecting more environmental impact data. The industry research involved stakeholder interviews to assess the degree of understanding of ‘sustainability’ of proteins and what are perceived to be the biggest challenges around collecting data to build this understanding, as well as a range of potential solutions.

2. What is good data?

To conduct environmental impact assessments of food, a considerable amount of data is required. Outlining the principles of what ‘good data’ looks like can help to create alignment across the food industry and drive better standardisation of environmental impact calculations.

From an output perspective, it is clear that ‘good data’ is that which enables stakeholders to confidently answer the most important questions such as *Which food products have the lowest and/or highest impact on the environment?; How much variation is there between the environmental impacts of similar products?; Which ways of producing this food lead to better environmental outcomes?* However, there is a wide range of input data used in calculations in the academic literature and food industry, from modelled studies to detailed farm-level life-cycle assessments, making it challenging to determine what ‘good’ looks like.

Below we outline principles for ‘good data’ on the environmental impacts of food, and why each of these principles is necessary to build confidence in our understanding of sustainable food. For the purposes of this report, defining ‘good data’ was a prerequisite to answering the first question of ‘What is the current availability of environmental impact data on proteins?’, since the research was only interested in data which could answer questions about sustainable protein. Academic studies which did not meet these requirements were excluded from the analysis in this report (see Section 3.1).

- **Product-specificity:** All data provided should be clearly linked to a specific product, if multiple are produced by the organisation. This often requires a degree of estimation and as such is a key source of difficulty in acquiring good data, as described in section 3.
- **Site- or farm-specificity:** Differentiating collected data by site allows interrogation of how impacts vary according to the production system. This is especially important in the context of typically high-impact proteins, as it provides necessary information and incentive for producers to switch to lower-impact production methods.
- **Current:** Using recent data will ensure that the model created accurately reflects the current state of the production system. This often requires a data collection system to be maintained to consistently have current data to hand.
- **Real world relevance:** Real collected data on specific processes is always preferable to estimation and modelling. This can often be drawn from existing records kept for other purposes.
- **Appropriate detail:** At every stage of its life-cycle, detailed information on every activity relating to the product is required, with clear units and definition of the data coverage (i.e. data is per product, or per year, etc). This may only be possible for an organisation to collect for the stages under its direct control. Efforts must then be made to engage with other supply chain actors to collect the data.
- **Quantitative and qualitative:** In general, qualitative data is required to contextualise quantitative data provided.
- **Scope:** This varies by protein type. For alternative proteins collecting detailed data on the processing stage is particularly important, while for simple protein sources the farm stage is typically responsible for the largest proportion of the impact and so should be the focus of data collection efforts.

Focusing on data from farms, Table 1 outlines types of data that might need to be collected, and the typical nature of them.

Table 1: Data required for assessments

Data type	Examples
Site	❖ Land area used ❖ Land use management and history ❖ Climate measurements ❖ Soil measurements (e.g., Soil organic matter (%))
Production system	❖ Crop/product name ❖ Production cycle start/end dates ❖ Herd composition and weights ❖ Qualitative production method overview ❖ Standards adhered to and evidence ❖ Tillage regime ❖ Grazing regime
Input usage	❖ Electricity ❖ Fuels ❖ Feed ❖ Bedding ❖ Materials and infrastructure ❖ Machinery ❖ Fertilisers and other soil amendments ❖ Pesticides ❖ Water ❖ Seeds, saplings, and their planting depth & density ❖ Sourcing information (location, transport) for all inputs
Output production	❖ Yield of main product and any co-products ❖ Above- & below-ground crop residue, and its management ❖ Manure production and management

3. Academic and Industry Perspectives

3.1 Availability of environmental impact data in academic literature

A rapid review of academic literature was conducted across a range of protein sources (Annex A) to summarise academic perspectives on the challenges associated with collecting data to calculate environmental impacts. Exclusion criteria were followed to remove ineligible studies (Annex B). The focus of the review was on life-cycle assessments (LCAs), which are a standardised method to quantitatively assess the environmental impacts arising from the life-cycle of an item. The availability of environmental impact data in the academic literature was found to vary significantly across the different proteins (Figure 1).

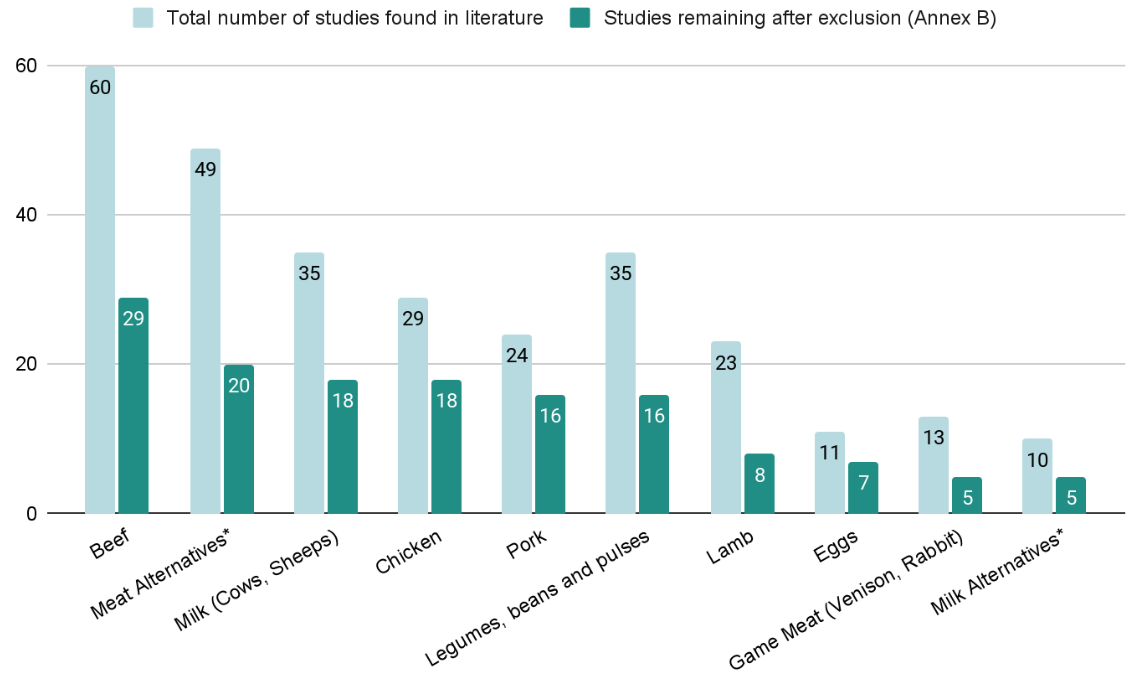

Figure 1: Studies sourced by a review of the literature, comparing the initial number of studies found and the number remaining post-exclusion (annex B) for each protein source.

* indicates that the literature review was carried out for a publication date in the last 20 years (2002-2022), rather than 2017 onwards.

Figure 1 highlights that the environmental impacts of protein sourced from cows (beef, milk) were the most widely studied since 2017. Foods sourced from lamb and eggs are less studied. A relatively high number of studies on meat alternatives was initially collected, though a large proportion of these did not meet the exclusion criteria (see Annex B). The excluded meat alternative studies commonly modelled production processes rather than collecting real data, owing to the challenges of data collection in this industry as described in Section 3.2. Differences in the types of challenges commonly encountered when studying animal versus plant protein production systems are also discussed further in section 3.2.2.

Europe was found to be the most prominent source region for this research, producing just under half of the non-excluded studies, with a focus on beef, milk, and pork. Italy and Spain were key contributors. South and South-East Asia were prominent study locations for environmental impact data on legumes, pulses, and the alternative proteins markets, with many tofu and tempeh studies from Indonesia in particular. In comparison, there was a distinct lack of UK-based production studies found across all protein types. This is a key gap with respect to UK stakeholders. A scarcity of environmental impact assessments of UK production makes it extremely difficult to compare impacts across different systems of production. Globally, this remains an issue as most studies tend to focus on conventional and intensive production systems, with less data available on more extensive and organic production.

3.2 Challenges

In addition to challenges gleaned from the literature review outlined above, stakeholder interviews were conducted to obtain the views and inputs of stakeholders throughout the food system, including farmers, processors, wholesalers, retailers, and technology providers. Interviewees were asked questions regarding data for environmental impact assessments of food, exploring its existing availability and the challenges of its collection. Discussion in both the literature and the interviews centred on several areas: Standardisation; Expertise; Motivation; Time requirements; Low data quality; and Trust.

Table 2: Data collection challenges reported across academic and industry perspectives

Area of discussion	Detail
Standardisation Many researchers and industry stakeholders raised the issue of a lack of standardisation in data collection and the ensuing calculation. Varying methods are a concern for academic researchers as it makes comparing their work with other research difficult, while industry stakeholders are given less confidence in the assessment process. Consumers are thought to be unlikely to read the small print, and therefore are unaware of variation in input data specificity or calculation methodology leading results to vary.	*Industry: Data requirements:* Ad-hoc calculation methods are used due to varying levels of data availability. Industry stakeholders may require guidance on what is strictly essential, and what is optional, though this can be subject to debate.
	Industry: Data collection: Every actor in the food system keeps records in a different way, even from farm-to-farm. As such, impact calculations often require many sources and formats of data to be integrated. Systematic data collection would be made easier through better guidance. A lack of a common language to describe input data adds to the confusion, making it hard to compare completed assessments.
	Industry: Calculation tools: Different organisations may produce different results for the same production system depending on the calculation tools used. For example, those acquainted with various rapid LCA tools raised the issue that different tools produce different outputs when fed the same input data, which reduces confidence in the tools themselves.
	Academic: Evolving science and methods: The methods used to calculate impacts are in some cases still evolving, which leads to difficulty in standardising them. Examples are given below: ❖ The potential for farm systems to remove carbon dioxide from the atmosphere through 'carbon sequestration' in soil or trees is commonly omitted from life cycle analysis, which can disadvantage extensive animal production systems[3]. Researchers have pointed to a lack of accurate and trusted methods to collect data to incorporate this [4,5]. Similar

	constraints are reported for including factors such as biodiversity, natural resource management[6] and meat quality[7]. ❖ Also at the farm stage, physical flows of carbon and nitrogen create complex interactions between different components of the production system. This raises difficult research questions over how to allocate greenhouse gas emissions to isolated components of the farm and therefore identify hotspots for targeted impact reduction. Clearer guidelines are needed to standardise this and avoid confusion for data collectors [8]. ❖ At the processing stage, calculation issues arise when multiple products are produced during simultaneous operations which share equipment and energy inputs. This can lead to inaccuracies in the allocation of energy use to certain products, leading to underestimation for some products and overestimation for others[9,10].
Expertise Data collection can be complex work, sometimes requiring prior training[11]. Alternative methods of data collection and additional guidance may ease the impact of a lack of technical expertise in industry, however the process must remain time-effective for the data collector to enable collection at the scale required.	*Industry: Collection format*: Onsite visits by a third party were generally agreed to be the preferred data collection format to mitigate a lack of expertise and time availability in industry, however there was an understanding that this would be time-consuming for the data collector. Phone interviews are considered next-best as the collector can provide live guidance. For self-operated data collection solutions, the time requirement of training creates an additional barrier, especially when outside of the intended user's comfort zone. Any collection attempt without live assistance, such as an app or questionnaire, would need to be accompanied by detailed guidance.
	Industry: Variation in expertise: Technological data collection, such as using apps, was only thought to be suitable for a minority of farmers who are younger and situated in regions where digital adoption is high. Smaller-sized farms are generally further behind in digital adoption and their understanding of environmental impact data and calculations. This variation in expertise of the data collectors leads to additional pressure on users of the data to validate it, which is difficult when mistakes aren’t necessarily obvious.
	Industry and Academic: Inapplicability of data requests: Data requests often require generic inputs like energy and fuel usage to be apportioned to specific crops or animals on the farm, which is a difficult task when one vehicle or building is used for multiple crops/animals every day. Requested data may also be hard to collect, for example the growing rates of animals like fish or extensively reared livestock, due to logistical difficulties in weighing them. Animals within a species also develop at different rates which makes it hard to extrapolate from sampled growing rates. For some environmental impact studies, researchers may ask farmers to manipulate their production practices such as their water or fertiliser use, to determine the least impactful practices. However, in regions of the world where economies and climates are less stable, farmers often cannot always afford to do this for the sake of a field trial[12].

Motivation Calls for better environmental data are widespread; however, this must be matched with adequate incentives for data collection to be sufficiently prioritised.	*Industry: Consumers*: This is most relevant to consumer-facing stakeholders. Consumers want to use the least impactful products, and it is important therefore to present this information using a common language. Industry is aware of the need to build consumer trust and keep it. This requires calculations based on comparable data using consistent methodologies.
	Industry: Retailers: Upstream actors, such as farmers, often require pressure from their retailer customers to act. However, an additional retailer requirement may cause a significant proportion of their suppliers to walk away and find another buyer without this requirement.
	Industry: Government: Legislation will force companies to act, and many are acting now in anticipation of future legislation. However, the limited resources for enforcing regulations may reduce compliance.
	Industry: Financial incentives: This was suggested to be the most effective method of guaranteeing action from food producers, as this could offset the costs associated with shifting to more sustainable production systems, such as the labour cost of data collection.
	Industry: Prioritisation: Data collection is often the lowest priority when under time pressure as it is often an onerous time commitment, for example if it involves paper records or if there is a large list of questions to be answered.
Time requirements Data requested is not often collected by farmers already, which increases the burden of data collection.	*Industry: Data additional to existing data collected*: Data may not be immediately available in the requested form. The structures for collecting and storing the additional data may take some time to be established.
	Industry: Aligning to existing data systems: Existing farm management systems collect information such as field records; work plans; and pesticide, fertiliser, and nutrient management. This overlaps significantly with data required for impact assessments, and so data should be first taken directly from these systems, with the farmer engaged to fill remaining gaps.
	Academic: Collecting new data requires long time-frames: Researchers often need to conduct studies over long time-frames, covering full or even multiple production cycles[8] and variable weather conditions[13], in order to collect representative data to calculate environmental impacts.
Low data quality Data gaps appear across the studied system within a single instance of data collection, and through time	*Industry: Inconsistent collection by farmers*: Farmers simply don't have the time to record data as they go, with areas like contractor input usage being a consistent gap. In other cases, a lack of understanding of the data required results in farmers returning data collection forms to researchers with key pieces of information missing[15]. It is however thought that most data required for assessments is already being collected for various purposes but

across multiple or continuous instances of data collection. As a result, researchers may have to narrow the range of production practices[14] or the geographical area[7] studied, limiting their ability to draw comprehensive conclusions[15].	bringing this together is a challenge as it is rarely held centrally in one place.
	Industry: Inconsistent collection by stakeholders: Data collection exercises provide answers to specific questions at a point in time, but it is difficult to get a consistent stream of data required to track progress.
Trust Distrust and a resulting lack of transparency often hamper efforts to share data throughout the food system.	*Industry and Academic: Farmers*: They consider themselves to be honest people who want the best for their land. They must be approached from a position of trust to themselves trust and engage with the process. If this cannot be achieved, researchers are forced to use secondary data or models[16,17] which often rely on heavy assumptions.
	Academic: Long supply chains: In order to assess the sustainability of a full supply chain, there must be coordinated data collection, collaboration and trust between various widely-dispersed actors[18]. However, collaboration can be challenging when data retention varies considerably for different actors[19]. Additionally, distrust in potential usage of the data means upstream stakeholders are keen for data to be blind further than immediate downstream partners who the data has been directly passed to. This can result in a lack of transparency in the literature concerning the data being used[20,21].

3.2.1 Academic Versus Industry Perspectives

An analysis of the above issues raised in academic perspectives and by industry stakeholders is shown in Figure 2, which highlights where the two groups agree and disagree on the primary challenges faced in collecting environmental data.

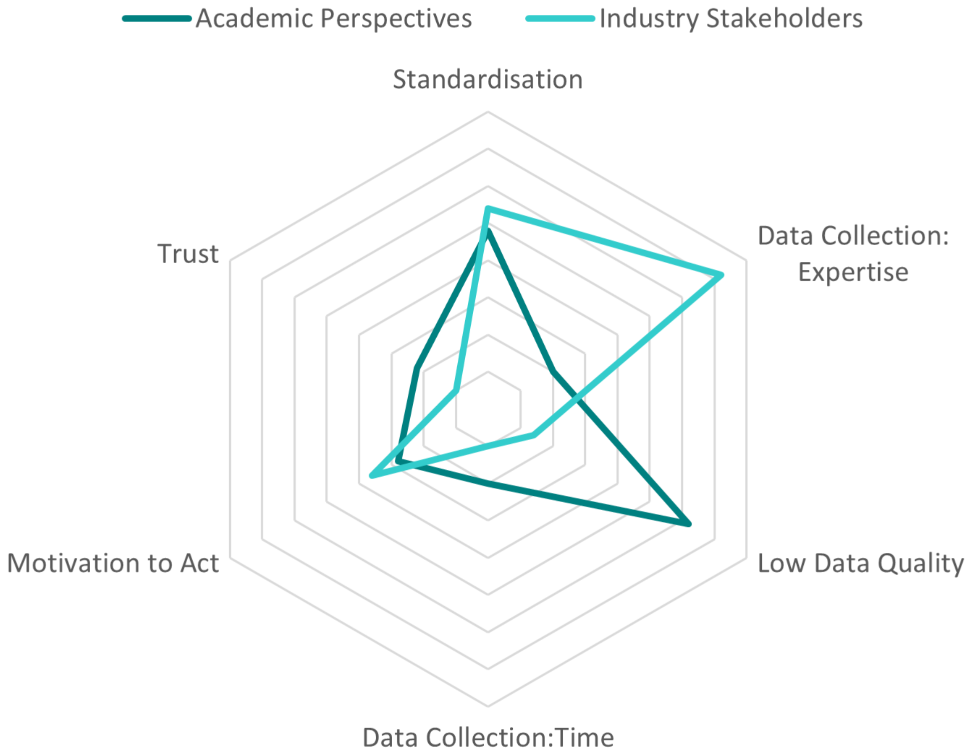

Figure 2: The relative frequencies with which key environmental data collection challenges are raised by academics and food industry stakeholders.

Industry stakeholders tended to focus on challenges such as a lack of data collection expertise and standardisation concerning which data they are being asked to collect and how, with motivation to act also mentioned with some frequency. Contrastingly, challenges that were mentioned less frequently included concerns around low data quality, and the time required for data collection. Issues of trust were also less frequently mentioned.

Academic perspectives on the challenges faced focused primarily on low data quality and a lack of standardisation. Other challenges faced that were raised less frequently were: motivation to act; trust; data collection time; and data collection expertise.

The far greater credence given to the challenge of low data quality by academic researchers as compared to industry stakeholders may indicate a comparatively limited industry understanding of the data required to calculate environmental impacts. This could be countered by providing more guidance around why each datapoint requested is important, at the point of data collection.

3.2.2 Animal Versus Plant Protein

There are some clear distinctions between the data collection challenges raised when studying animal versus plant protein production systems. For example, the lack of standardised guidelines for collecting data on factors such as carbon sequestration, biodiversity, and natural resource management, and incorporating these into environmental impact analysis, is a particularly prominent issue for systems with grazing ruminants. Both academics and industry stakeholders have raised concerns regarding complex supply chains in animal production systems and the consequent difficulties in coordinated data collection. There are also inherent difficulties in collecting data from live animals as opposed to croplands, owing to variation in the animal development times and tracking their movement across grazing areas.

For plant-based proteins however, there tends to be a different set of issues encountered preventing adequate data collection. This is partly due to a lack of industry guidelines and standards, especially in emerging industries such as meat alternatives and insect protein, resulting in low quality data due to a lack of standardised methods to collect data for environmental impact calculations. For example, no standardised methods yet exist for the processing and storage of insect protein[22], which hinders widespread, comparable data collection in this industry. In general, the extensive and sometimes overlapping processing steps required to produce products from their raw crop ingredients also raises difficulties in accurately measuring energy use for distinct products.

3.3 Solutions

The wide-ranging challenges outlined in both academia and industry also raised recommendations as to how to mitigate them, organised below in relation to the key challenges they address.

3.3.1 Standardisation

The consensus across industry and academia is that standardisation of data collection and calculation methodologies is a key challenge. Variation in calculation methodology is sometimes inescapable due to varied available input data, and so more consistent data collection would somewhat mitigate the perceived lack of standardisation. WWF-UK outlined in *the Pathway to Harmonised Metrics for the Food Industry*[23] report that key solutions such as the Global Farm Metric (GFM) (a self-assessment tool for consistent on-farm data collection) and Hestia (a platform for standardised storage of data with the ability to recalculate environmental impacts using harmonised methods) will allow stakeholders to collect, store and share data in a common language. Such standardisation will be a significant data collection timesaver, especially for large companies collecting data from a wide range of stakeholders in their supply chain. The report also pointed to standardisation of methods as a key goal, noting that a balance must be struck between the scientific credibility of methods and their accessibility, to facilitate wider uptake.

There is also space here for legislation to better define the methodology that must be used to carry out environmental impact calculations. For example, the Green Claims Code[24] published by the UK Competition and Markets Authority in 2021 specified a cradle-to-grave system boundary for any publicly claimed environmental impacts. Prior to this point, varied system boundaries and a lack of disclosure on this led to a large degree of uncertainty in industry around what system boundary should be used.

3.3.2 Data Collection Demands: Time and Expertise

Should farmers find the time to carry out data collection, the perception of an expertise deficit often prevents engagement with the collection process. Integrating with existing farm data collection systems, such as farm management software, may be an effective route to collecting data and reducing demands upon farmers, again outlined in the recent *Pathway to Harmonised Metrics for the Food Industry* report[23].

Farm advisory services could also be utilised here to help farmers understand and adhere to data collection requirements, benefitting from their close liaison with industry stakeholders such as the National Farmers Union (NFU). Any additional demands on the time of food producers should be appropriately incentivized. Financial incentives are widely agreed to be the most effective, though this does create implications for the cost of any data collection exercise.

The inapplicability of data requests to multi-species farms due to a requirement to apportion between species is an area where farmers require more guidance. One possible solution here is for those collecting data to begin by studying single-species farms. The data collected in these studies could then be used to inform apportioning in the case of larger multi-product farms.

4. Conclusions

The purpose of this project was to interrogate the availability of environmental impact data on proteins, and to understand the challenges faced by industry stakeholders and researchers in gathering more data. While there was a wide range of issues raised, opinion coalesced around a few key areas. Encouragingly, many solutions were proposed, and the challenge now is to incorporate those into future data-gathering exercises.

Key findings include:

- ❖ Varied quality and availability of data across different protein sources and production systems hinders a comprehensive comparative understanding of environmental impacts.
- ❖ A lack of standardisation in methods and therefore required data prevents widespread and scalable data collection. Legislation has significant potential to drive rapid progress in standardisation.
- ❖ A lack of technical data collection expertise in industry requires assessors to consider ways to reduce the burden of data collection on the data provider, either through requesting a lower volume of data or providing a larger amount of guidance.

Key recommendations for this report vary by stakeholder:

- *Farmers*: Establish a consistent electronic system for collecting and storing data. This will allow all collected data to be stored in one digital location, regardless of the purpose for which it was collected. The benefit of this will be that future data collection requirements will be a much smaller time burden as most data will be available in the system established. This will also allow farmers to maintain ownership and control of their data.
- *Post-farm food system actors (processors, wholesalers, retailers)*: Understanding the various requirements of data collection may lead to hiring of specialist resources being the appropriate solution to collecting data from the supply chain. The data collector (internal or external) should provide extensive guidance to any supply chain actors data is being requested from. The volume of data collected should be reduced by engaging any data systems used by stakeholders for other purposes. If data collection requires a material labour cost for the party from which data has been requested, this should be appropriately reimbursed via financial incentives.

5. Annexes

Annex A. Proteins included/excluded in this work

Included	**Excluded**
Milk	Turkey
Pork	Duck
Beef	Other Poultry
Eggs	Dairy (excl. Milk)
Milk Alternatives (Oat, Almond, Soy, Coconut, Rice, Potato, Insect)	Goat
Rabbit	Fish and Seafood
Venison	Nuts
Chicken	Seeds
Lamb	Grains
Legumes, beans, and pulses (lentils, chickpeas, baked beans, kidney beans, butter beans, black beans, fava beans, lupin beans)	Algae (Seaweed)

Meat Alternatives (Soy (Tempeh & Tofu), Wheat (Seitan), Pea Protein, Mycoprotein, Soy Protein, Oat Protein, Insect Protein)	

Annex B. Literature Review Study Exclusion Criteria

The criteria used to exclude the studies were as follows:

1. Must include farm stage data.
2. Must be written in English.
3. Must not use data from other studies, such as a meta-analysis.
4. Must not use national aggregated data for the entire farm stage inventory. This was not applied in the case of milk alternatives and meat alternatives, where the studies were generally focused on the processing stage.
5. Must not be reporting the results of models (i.e., not collecting real data).
6. For well-studied protein sources (Milk, Pork, Beef, Eggs, Chicken, Lamb and Legumes, beans, and pulses), the studies were required to have a publication date of 2017 or later. For the less studied protein sources (Milk Alternatives, Rabbit, Venison, Meat Alternatives), they were required to be written in the last 20 years (i.e., publication data of 2002 or later).

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