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Identifying and Bridging Data Gaps for True Cost Accounting Assessments of European Diets

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Abbreviations

1,4-DB	1,4-Dichlorobenzene
ALYs	Animal life years
CFC11	Trichlorofluoromethane
DALY	Disability-adjusted life years
EFSA	European Food Safety Authority
-eq	-Equivalent
FAO	Food and Agriculture Organization of the UN
FTE	Full-time equivalent
GHG	Greenhouse gas
ha	Hectares
JRC	Joint Research Centre
LCA	Life Cycle Assessment (Analysis)
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
MSA	Mean species abundance
NMVOC	Non-methane volatile organic compounds
PIC	Prior informed consent
PM2.5	Fine inhalable particles, with diameters 2.5 micrometers or smaller
s-LCA	Social Life Cycle Assessment
SOC	Soil organic carbon
TCA	True Cost Accounting
TEEB	The Economics of Ecosystems and Biodiversity
TEEBAgriFood	The Economics of Ecosystems and Biodiversity for Agriculture and Food
UNEP	United Nations Environment Programme

Key messages

Dietary transition is key to effecting food systems transformation.

Ensuring the sustainability and health of our food systems requires a fundamental shift in dietary patterns. The importance of dietary transitions lies in their potential to catalyse transformative changes across environmental, social, and health impacts.

True Cost Accounting (TCA) can play a key role in the transition to sustainable and healthy diets.

TCA emerges as a crucial approach to navigating the complex landscape of dietary transitions. It plays a pivotal role in quantifying the hidden costs and benefits associated with food production and consumption, guiding the shift towards sustainable and healthy diets by facilitating more informed decision-making by consumers, businesses, and policymakers.

A novel TCA methodology for dietary assessment provides the necessary holistic perspective.

Given that TCA calculations have not been previously performed in a dietary context, the report introduces a novel TCA methodology for dietary assessment, providing a framework for analysing the true costs of diets. The methodology employs a comprehensive approach to assessing the environmental, social, and health impacts associated with food production and consumption. TCA

utilizes monetary valuation to quantify impacts in the same unit, allowing for a holistic understanding of the hidden costs of various dietary patterns. This methodological framework involves data collection, analysis, and interpretation, providing valuable insights that contribute to evidence-based decision-making for sustainable and healthy food systems.

Work needs to be done to fill existing data gaps...

Despite the potential of TCA, data gaps pose significant challenges in conducting comprehensive analyses of diets. Existing gaps range from the lack of detailed production and consumption data to limitations in monetizing social and human capital impacts. These gaps hinder our ability to grasp the full spectrum of environmental, social, and health costs associated with dietary choices and a concerted effort is therefore necessary to bridge these information voids.

...because data gaps may hinder effective action...

The consequences of data gaps extend across various stakeholders. TCA researchers encounter limitations in providing essential analyses for evidence-based decision-making. This means that policymakers may face challenges in formulating effective strategies, businesses might miss transformative opportunities, and consumers lack comprehensive information for informed dietary choices. However, there is already sufficient data that can be acted upon to create more sustainable food systems.

...but specific actions can bridge these data gaps.

To overcome the existing data gaps, the report proposes a set of comprehensive recommendations. These include enhancing data availability through standardized frameworks, advocating for dedicated funding at the national level, and fostering collaboration among stakeholders. Improving data accessibility is suggested through open data policies and the creation of publicly accessible databases. Methodological enhancements, harmonization, and efficient utilization of data are proposed to enhance usability and quality. Additionally, the report recommends the establishment of a robust data governance framework that aligns with existing EU initiatives and designates specific bodies for governing TCA data.

Executive summary

True Cost Accounting (TCA) can be used as a transformative tool, shedding light on the hidden costs generated by the environmental, social, and human health impacts of food systems. In the realm of dietary analysis, TCA provides a holistic lens to expose the true costs of European diets, facilitating the identification of key impacts, prioritizing improvement actions, and fostering strategies to move toward sustainable and healthy food systems. Presenting hidden environmental, social, and health impacts in monetary terms simplifies communication and facilitates the integration of sustainability into decision-making by policymakers, businesses, and consumers.

Conducting a TCA analysis heavily relies on data. However, effectiveness may be hindered by significant data gaps. This report critically examines the availability, accessibility, and usability of secondary data sources for a TCA analysis of European diets. It reveals limitations in data availability and accessibility and highlights existing gaps that impede a comprehensive TCA analysis.

Key findings of the report

The report highlights significant challenges in conducting a comprehensive TCA analysis of European diets, due to gaps in secondary data availability, accessibility, and usability (Table 1).

Information regarding **food consumption and composition** for European Union (EU) countries is of good data availability, access, and usability. However, more sophisticated nutritional analyses are only accessible via subscription-based services, which can potentially affect the accessibility and completeness of food composition data.

Data on **inputs (e.g. energy use) and outputs (e.g. greenhouse gas emissions)**, as well as regarding **management practices (e.g. working conditions)**, is relatively good for the production and processing stages but becomes scarcer as one moves further down the value chain, with consumption-stage data being almost non-existent. While this production and consumption data is to some extent available at country level (e.g. annual water use by the agricultural sector), it often lacks product-specific details (e.g. annual water use in potato production), with paid life cycle inventory (LCI) databases offering more detailed information.

Data on the **environmental impacts** of food production provided by various Life Cycle Assessment (LCA) databases are of good availability compared to data on social and human capital impacts which have very limited availability and contain large uncertainties. While environmental LCA data is freely available for some countries of production (e.g. France), access to databases including data for other countries requires expensive subscriptions, which makes access more difficult. The few sources available for **social and human capital impact** data often require payment for access too.

Available global **monetization methods and factors** allow translation of environmental impacts into monetary values, though data quality varies and national or region-specific valuation factors are scarce. The valuation of social and human capital impacts is still difficult, although progress is being made in developing monetization methods and factors for already-developed qualitative social and human capital impact indicators.

Table 1. Overview of data availability, accessibility, and usability for True Cost Accounting of diets

Data type		Availability	Accessibility	Usability
Food consumption and composition		🟩 green	🟨 yellow	🟩 green
Input/output and management		🟧 orange	🟧 orange	🟨 yellow
Environmental imapct		🟩 green	🟨 yellow	🟩 green
Social impact		🟧 orange	🟧 orange	🟨 yellow
Human impact (inc. health)		🟧 orange	🟧 orange	🟨 yellow
Monetization factors	Environmental impacts	🟩 green	🟩 green	🟩 green
	Social impacts	🟧 orange	🟩 green	🟩 green
	Human impacts	🟨 yellow	🟩 green	🟩 green

Availability concerns whether the required data exists, **accessibility** concerns whether the data can be easily retrieved and used, and **usability** concerns whether the data is suitable for TCA assessment. **Green** indicates that the data is widely available, accessible, or usable, **yellow** indicates a lower level of availability, accessibility, or usability, and **orange** denotes very rare availability, accessibility, or usability.
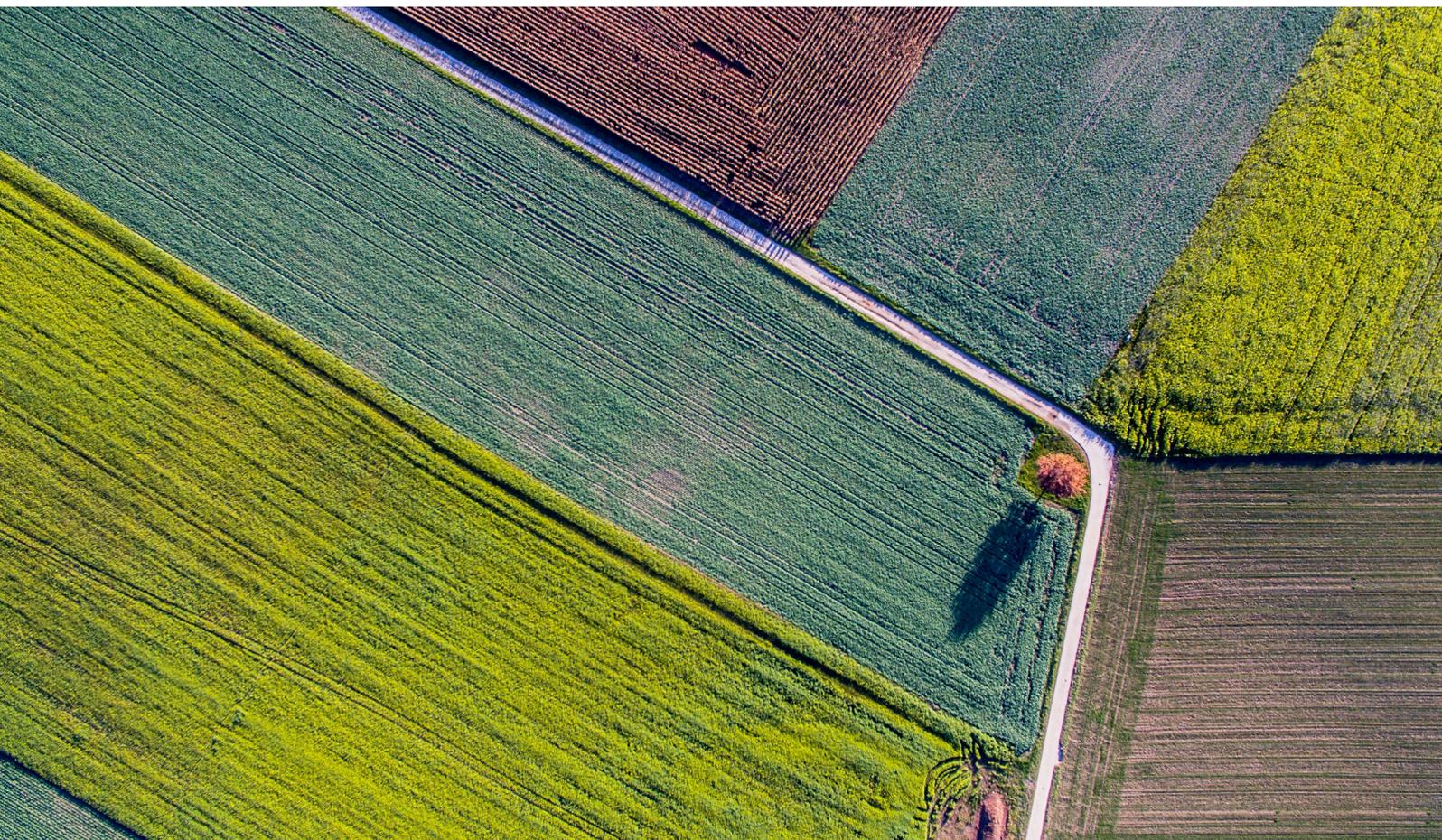
Recommendations for policymakers, data standard setting, and governmental bodies

The report offers a set of recommendations for policymakers on how to close TCA data gaps in the context of dietary assessment, thereby promoting the adoption of TCA and supporting the urgently needed dietary transition to sustainable, healthy, and fair diets in Europe:

Enhance data availability

International standard setting bodies should develop standardized data collection frameworks, establish data collection mandates, and develop standardized methodology and reporting guidelines. On a national level, dedicated funding should be allocated for research and data collection efforts.

Enhance data accessibility

The European Commission should improve data accessibility through publicly accessible databases or repositories, foster data sharing and collaboration among stakeholders, and encourage EU governing bodies, international organizations, national governments, and research institutions to adopt open data policies.

Establish data governance

The European Commission should support establishing a data governance framework, align TCA data harmonization with existing EU initiatives, incorporate TCA data into the European Data Portal, designate the Joint Research Centre as the TCA data governing body, and scale up AGRIBALYSE on a European level.

Recommendations for researchers and TCA practitioners

The report outlines a detailed TCA methodology tailored for dietary assessment. This framework provides researchers with a structured approach to analyse diets and quantify hidden environmental, social, and health costs associated with food production and consumption. Researchers can find a critical examination of the current data landscape, highlighting both available resources and significant gaps. The appendix further details the available data sources for TCA of European diets.

To address the data challenges and bridge the data gaps, the report offers recommendations for researchers and TCA practitioners and suggests future research directions.

Enhance data usability and quality through methodological improvements

Improve and harmonize of TCA methodologies, account for spatial and temporal variations in agricultural production, and enable a more efficient utilization of data for multiple purposes, thereby optimizing resources and reducing data collection efforts.

Future research directions

Future research could conduct scenario-based modelling to explore different future pathways and assess the potential impacts of policy interventions and consumer behaviour changes on the true costs of European diets. This would help identify the most impactful strategies for achieving sustainability goals and thereby inform effective policy decision-making.

1. Introduction to the Data Gaps Report

1.1. Understanding the implications of European dietary choices and the need for transformation

Over the last five decades, global dietary patterns have shifted toward energy-intensive and animal-based foods, leading to environmental damage and rising rates of obesity and non-communicable diseases. Unhealthy diets low in fruits, vegetables, and whole grains but high in red meat, processed meat, sugar, and salt pose a significant risk to health. In 2019, dietary risks ranked third in global disease burden (GBD, 2019).

Dietary habits in the EU have notable health, environmental, and social implications. In terms of **health implications**, poor diets in the region accounted for approximately 20% of deaths (1.6 million) in 2019 and contribute to up to 50% of cardiovascular diseases, which are the leading cause of death and disability in Europe (GBD, 2019). Food security represents one of the main sustainability challenges listed among the Sustainable Development Goals (SDG 2). While recent years have seen a slight decline in food insecurity in Europe, it still affected 8.1% of the population in 2024 and, in Europe, this is seen largely in terms of hunger, obesity, and undernourishment (FAO, IFAD, UNICEF, WFP, & WHO 2025). In 2022, 8.3% of people in the EU could not afford to eat meat, fish, or an equivalent vegetarian meal every other day (EUROSTAT, 2023). A 2022 report from the World Health Organization (WHO, 2022) states that nearly two thirds of adults and one third of children in Europe are overweight or obese, leading to increased risks of cancer, strokes, heart attacks, type 2 diabetes, and other non-communicable diseases.

Environmental impacts from food consumption, biodiversity loss, and resource-intensive agriculture result in a quarter of global anthropogenic greenhouse gas (GHG) emissions. In the EU, almost half of the environmental footprint is linked to food consumption, with reliance on imports contributing to global environmental issues (Joint Research Centre, 2024). Food loss, food waste, and intensive farming practices, including pesticide use, further compound environmental concerns.

Dietary patterns have significant **social implications**, notably impacting livelihoods due to the food industry's role in employment, where many workers face low wages and inadequate labour protection (Fanzo & Davis, 2019). European diets are dependent on global supply chains that include child and forced labour. To protect workers' rights and vulnerable populations worldwide, the EU must work to ensure supply chains with fair labour practices and living wages and without child labour (European Commission, 2020).

Transforming food systems at the EU level offers an opportunity to enhance healthy, sustainable, and fair diets. Increasing consumption of plant-based foods will be crucial for this goal.

True Cost Accounting (TCA) is a novel approach that holistically considers the present and future environmental, social, and health impacts of agrifood systems, thereby identifying strategies for reducing associated hidden costs. By framing sustainability issues in monetary terms, TCA simplifies the integration of sustainability aspects into decision-making by policymakers, businesses, and consumers. However, existing data gaps and associated difficulties in accurately assessing the true costs of European diets pose challenges for the effective implementation of TCA.

The primary objective of this report is therefore to analyse data availability, accessibility, and existing limitations for assessing the true cost of average national diets in EU member states. In so doing, we aim to show the transformative potential of using TCA to evaluate European dietary patterns, while also highlighting the challenges faced when carrying out such an analysis. Since the significant negative externalities of diets are often overlooked, the report exclusively focuses on evaluating hidden costs, omitting the hidden benefits of current diets. An analysis of benefits—especially the potential benefits of transitioning to more healthy and sustainable food systems—would be a valuable direction for future research.

The analysis of the true cost of European diets provided in this report is valuable for:

- **Policymaking**. It enables policymakers to make informed decisions when formulating agricultural, environmental, and health policies. Accurate TCA assessments can help identify the trade-offs and synergies between different sustainability goals, such as reducing GHG emissions, conserving natural resources, and promoting human health and social equity. By quantifying the true costs of current diets and proposed transformations, policymakers can prioritize interventions that align with sustainable development objectives and effectively transform food systems.

- **Consumer education**. TCA can play an essential role in promoting sustainable and healthy dietary choices among consumers. By providing a comprehensive assessment of the true costs associated with different diets, individuals can make more informed choices regarding their food consumption patterns.

- **Future research**. The report contributes to the scientific literature on the true costs of food and diets, particularly in the European context. By highlighting existing data gaps and deficiencies, researchers and policymakers can prioritize future research directions and data collection efforts, ultimately leading to more accurate assessments and informed decision-making.

The structure of the report is as follows: Chapter 1 outlines the novel methodology of TCA for European diets. Chapter 2 evaluates the current data landscape, including food consumption and composition data, supply chain data, impact data, and monetization data. It also summarizes the key data gaps identified in these areas. Chapter 3 explores the potential consequences of data gaps, examining how they affect policymaking, business transformation, consumer guidance, and research. Chapter 4 provides recommendations for closing or bridging data gaps, focusing on enhancing data availability and quality, improving data accessibility, strengthening data governance, and outlining future research directions.

1.2. Methodology for TCA of European diets

True Cost Accounting (TCA), the practice of defining, quantifying, and monetizing (food system) impacts, has seen a rise in international interest over the past years. Multiple organizations have published reports on the benefits and needs of TCA to inform the transformation of food systems (e.g. FAO, 2023). However, most of these reports remain on a relatively high level and do not provide methodological details (de Adelhart Toorop et al., 2021), while some offer procedural guidelines and suggestions for indicator and valuation approaches (e.g. True Cost Initiative, 2022).

Figure 1. Dependences and impacts of the four capitals in the agri-food system

The TEEBAgriFood framework, presented in *TEEBAgriFood Scientific and Economic Foundations* (TEEB, 2018) outlines the basis for a systemic economic evaluation of food systems. It was developed by the TEEBAgriFood Initiative, launched in 2015 by the United Nations Environment Programme (UNEP) in collaboration with the UN Food and Agriculture Organization (FAO), the EU, and others. It makes a strong case for applying systems thinking—i.e. articulating the interrelationships and interdependencies between system constituents—to the evaluation of food systems. The framework expresses a need to clearly represent all material interactions between the environment (natural capital), economy (produced capital), society (social capital), and people (human capital) at all stages of the supply chain, from cradle to grave (Figure 1). Since publication, the TEEBAgriFood framework has been widely embraced as the definitive point of reference for TCA for food systems analysis.

The TEEBAgriFood TCA methodology involves the following steps: (1) framing the analysis; (2) defining scope, boundaries, and assumptions; (3) identifying impact categories for produced, natural, human, and social capitals in diets, as well as the valuation method; and (4) communicating and applying the assessment results to drive stakeholder action. In our methodology of TCA of diets we focus on the first three steps, excluding step 4 (see Figure 2).

TEEB TCA STEPS	1. FRAME	2. SCOPE	3. MEASURE & VALUE	4. TAKE ACTION
	Frame the issue of interest and the purpose of your assessment and prepare to undertake it.	Describe the relevant eco-agri-food system and scope the focus of the assessment to ensure all impacts relevant to the assessment are identified.	Measure impacts using a selection of models, methods, and data and value or monetize these impacts.	Communicate the results stakeholders and partners to take ensure your assessment has an impact on practice and policy.
TCA OF DIETS	Defined goal: to assess the natural, social, and human capital impacts and hidden costs of European diets.	• Subject: individual food items that comprise dietary patterns • Functional unit: daily per capita consumption • Boundary: the EU • Scope: cradle-to-consumer (excluding waste management)	Total of 61 externalities along 3 capitals collected using literature review. Suggestion to measure impacts using e.g. LCA and to monetize using suitable monetization factors.	This step excluded from the current study.
DATA REQUIREMENTS	• Information on policy priorities • Aims for sustainable diets	• Food consumption data of population group • Food items in dietary patterns • Production countries and production practices of food items • Food production and trade statistics	• Input/output data • LCIs • Impact data • Management data • Monetization factors	• TCA assessment results
STAKEHOLDERS	• Government • Policy agencies • Research institutes • NGOs	• Government • Policy agencies • Research institutes • Consumer groups • Food sector actors • NGOs	• Research institutes • Environmental, health, and social impact consultants	• Government • Policy agencies • Civil society • NGOs
POTENTIAL CHALLENGES	Disagreement or disalignment around the problem or goals to be achieved.	• Unavailability of up-to-date food consumption data • Lack of precision in information on intake amounts	• Data limitations and unavailability • Methodological uncertainties in LCA models	• Resistance from industry/other stakeholders • Challenges in communicating technical results to the public
EXPERTISE NEEDED	• Food system interactions • Sustainability • Nutrition and public health • Policy analysis	• Food systems • Agricultural production • Supply chain	• Impact assessment • LCA modelling • Monetization of impacts	• Science communication • Policy advocacy • Strategic planning

Figure 2. TCA method for diets

STEP 1: Frame

The first step of a TCA analysis is to frame its purpose. Our goal is to work toward making European dietary patterns more healthy and sustainable. By using TCA to measure the natural, human, and social capital impacts and hidden wcosts of European diets, we can identify the most effective levers for change. Policymakers, health practitioners, nutritionists, and sustainability experts can then use these insights to develop actionable recommendations that balance nutritional needs with environmental and social sustainability goals.

STEP 2: Scope and boundaries

The second step involves defining the subject, functional units, boundaries, scope, and assumptions of the analysis. This includes determining the

systems behind various components of diets, setting geographic and agri-food value chain boundaries, outlining the processes within these boundaries, selecting the functional unit of the assessment, and identifying potential externalities.

For our analysis, the subject is individual food items that comprise dietary patterns; the functional unit is daily per capita consumption; the geographical boundary is the EU; and the scope is cradle-to-consumer (excluding waste management).

When assessing dietary impacts, a comprehensive diet-level approach is necessary, considering both the individual food items and their combined effects within representative dietary patterns. This requires data on consumption patterns (i.e. a representative compilation of food items consumed over a period, following the approach by McLaren et al., 2021) and the nutritional composition of food. Given the limited data on the relationships between food items and their production and consumption processes, it is assumed that the overall impact of a diet can be approximated by summing the impacts of individual food products. To evaluate diets' nutritional quality, the literature distinguishes between essential, non-essential, and conditionally essential nutrients, as well as macro- and micronutrients (ibid).

Ideally, a TCA analysis of a diet should cover the entire food value chain, from primary production to processing, distribution, consumption, and discard or reuse. This requires information about countries of production and trade information. However, for this report, the geographic boundary has been limited to the EU to ensure data gap analysis feasibility within the available time and resources of this study. While this simplifies the analysis, it overlooks the significant impacts of the many foods consumed

in Europe but imported from outside the EU. Since the primary production stage often has the greatest environmental and social impacts, future TCA assessments should account for impacts across the full value chain, including in countries of primary production.

The agri-food value chain scope in this report includes all food system activities from production to consumption, but excluding waste management, research and development, marketing and branding, as well as activities from food services, due to time constraints. Figure 3 shows the various components and stages considered in the cradle-to-consumer boundary, as well as the main data needs for various food supply chain stages.

In Life Cycle Assessment (LCA), functional units allow for comparison of results across different products or systems that serve the same function (Heller et al., 2013). Within this study, we focus on diet sustainability in terms of environmental and social burdens and healthiness in terms of the nutritional function of food consumption. Hence, ideally, the functional unit should consider all of these impacts. So far, no appropriate functional unit for food and diets is available, as it is challenging to capture the nutritional function of food in a comparative way. For this reason, functional units based on mass or energy (e.g. kg, serving of a meal, kcal) are generally relied upon for food products.

VALUE CHAIN STAGE	AGRICULTURAL PRODUCTION	MANUFACTURING AND PROCESSING	DISTRIBUTION AND RETAIL	CONSUMPTION
ACTIVITIES	Growing crops (inc. livestock feed) and raising livestock	Turning raw agricultural products into consumer products	Storing, distributing, and selling food	Transporting food from retail to home, cooking, and consumption
INPUT, OUTPUT, AND MANAGEMENT DATA NEEDED	• Land use (yield, land management systems, crop rotation) • Resource use (water amount and source; energy amount and source; fertilizer types, amount, application rate and method; pesticide amount, type, active ingredients, application rate, and method; seed varieties; machinery type and fuel use) • Livestock feed and husbandry system (feed type, amount, and conversion ratio; grazing practices; manure management practices; housing systems) • Labour input (working hours, gender distribution) • Working conditions (housing, wages, wages per gender hours, occupational safety) • Food loss (loss during harvest due to pests and/or diseases)	• Energy use (amount, sources) • Water use (amount, sources) • Labour input (working hours, gender distribution) • Working conditions (housing, wages, wages per gender hours, occupational safety) • Food loss (loss during sorting, processing, storage)	• Energy use (amount, sources) • Transportation mode (road, rail, ship, air) • Distance travelled • Labour input (working hours, gender distribution) • Working conditions (housing, wages, wages per gender hours, occupational safety) • Food prices • Food loss (e.g. via improper handling, food safety standards, expired food)	• Energy use (amount, sources) • Water use (amount, sources) • Food waste (e.g. via food preparation, excess food, expired food, spoiled food, plate waste)

Figure 3. Agrifood value chain scope and data needs for True Cost Accounting of diets

STEP 3: Measure and value

The next step involves identifying impact indicators, choosing analytical methods, gathering and validating data, managing uncertainties, and monetizing impacts (see Figure 3 for the input, output, and management data needed for TCA of diets). For this study, an LCA approach is used to evaluate the environmental, social, and health impacts of European diets. The analysis focuses on natural, social, and human capital data and excludes produced capital, assuming such costs are largely reflected in food prices. Impact categories and indicators are prioritized based on their potential materiality for food systems, data availability, and monetization feasibility. While most indicators are directly tied to food production and consumption, some indirect externalities, such as elevated suicide rates among farmers, are included to capture the broader complexities of food systems. Certain externalities, such as animal welfare, lack defined scientific indicators but are still highlighted to provide a more comprehensive understanding of diet-related externalities.

Environmental impacts have been studied for longer and therefore have relatively good data coverage, whereas human health, social, and biodiversity impacts still have less coverage in the scientific literature and limited data. Recognizing such limitations in quantification and monetization, the report emphasizes the need to bridge data gaps to cover all externalities and understand the true costs of diets.

Natural Capital

The environmental domain is the most researched and standardized in the literature. Table 2 provides an overview of relevant environmental impact indicators for the assessment of dietary outcomes along a number of impact categories.

Notes to Table 2:
*According to the new *TEEBAgriFood Operational Guidelines for Business* (Capitals Coalition, 2023), animal welfare is categorized under Natural Capital, in contrast to the earlier TEEB Framework, which included it under Social Capital.
**See abbreviations table for unit definitions.

Table 2. Overview of globally relevant environmental impact indicators of diets

Impact category	Impact indicators	Unit**	Source
Contribution to climate change	Greenhouse gas emissions	kg CO_2-eq	Huijbregts et al. (2017)
	Carbon dioxide losses due to land conversion	kg CO_2	McLaren et al. (2021)
Pollution of the living environment	Particulate matter formation	kg PM2.5-eq	Huijbregts et al. (2017)
	Terrestrial ecotoxicity (air pollution)	kg 1,4-DB-eq	
	Terrestrial ecotoxicity (water pollution)	kg 1,4-DB-eq	
	Freshwater eutrophication	kg P-eq to freshwater	
	Marine eutrophication	kg N-eq to marine water	
	Terrestrial ecotoxicity (soil pollution)	kg 1,4-DB-eq	
	Freshwater ecotoxicity (soil pollution)	kg 1,4-DB-eq	
	Marine ecotoxicity (soil pollution)	kg 1,4-DB-eq	
	Acidification	kg SO_2-eq	
	Ozone layer depleting emissions	kg CFC11-eq	
	Ammonia emissions	kg NH_3	Fitzpatrick et al. (2019)
	Photochemical oxidant formation	kg NMVOC-eq	True Price (2023)
Degradation of land	Soil loss from wind erosion	kg soil lost	Fitzpatrick et al. (2019)
	Soil loss from water erosion	kg soil lost	
	Soil organic carbon loss/build up	kg SOC	
Depletion of scarce abiotic resources	Fossil fuel depletion	kg oil-eq	Huijbregts et al. (2017)
	(Other) non-renewable material depletion	kg Cu-eq	
	Scarce water use (blue water)	m^3	
Degradation of biodiversity and ecosystems	Land occupation	MSA ha/yr	True Price (2023)
	Land transformation	ha	
Animal welfare*	Animal years suffered	ALYs	Scherer et al. (2018)

Human capital

The metrics that characterize dietary impacts on human capital have also been thoroughly studied in the literature and standardized sets of indicators have been developed, with the most common ones addressing cancer, mortality, type 2 diabetes, and cardiovascular disease. Table 3 provides an overview of relevant human capital externalities from food systems identified in the literature.

Table 3. Overview of globally relevant human capital impact indicators of diets

Impact category	Impact indicators	Unit**	Source
Occupational health and safety risks	Worker harassment (physical/non-physical, sexual/non-sexual , severe/non-severe)	Number of workers	True Price (2023)
	Non-fatal occupational incidents	Incidents	
	Fatal occupational incidents		
	Health conditions due to excessive working hours	DALYs	True Cost Initiative (2022)
Mental health	Contribution to increased suicide rates in agriculture (indirect)	n/a	n/a
Production-related human health impacts	Human toxicity (air pollution)	DALYs	Huijbregts et al. (2017)
	Human toxicity (water pollution)		
	Human toxicity (soil pollution)		
Consumption-related human health impacts	Health impact of undernutrition*		Fitzpatrick et al. (2019)
	Health impact of dementia		
	Health impact of overweight and obesity		World Business Council for Sustainable Development (WBCSD, 2018)
	Health impact of hypertension		
	Health impact of noncommunicable diseases		
	Health impact of malnutrition*		
	Health impact of food poisoning		
	Health impact of pesticide exposure		
Public health threats from livestock production	Health impact of antibiotic use		Fitzpatrick et al. (2019)
	Contribution to the exposure to zoonotic diseases (indirect)		n/a

Income	Wage gap below minimum wage	€	True Price (2023)
	Wage gap below living wage		True Cost Initiative (2022)
Income security	Workers without legal social security	FTE	True Price (2023)

*These indicators represent diet-/food system-level impacts and not food-item related impacts (as proposed by the functional unit choice of the TCA methodology described in STEP 2 above).
**See abbreviations table for unit definitions.

Social capital

The social domain has the least coverage in the scientific literature when it comes to validated metrics for dietary impact assessment. Table 4 provides an overview of relevant social impacts of diets and their indicators.

Table 4. Overview of globally relevant social capital impact indicators of diets

Impact category	Impact indicators	Unit*	Source
Food security	Food security index measuring ratio of change in price of a basic food basket per change in cost of a product	n/a	Capitals Coalition (2023)
Benefits sharing	Change in number of people reached through community engagement	n/a	Capitals Coalition (2023)
Lack of union rights	Instances of denied freedom of association	Number of violations	True Price (2023)
Discrimination	Gender gap in hours worked	Minutes per day	Organisation for Economic Co-Operation and Development (2025)
	Wage gap from unequal opportunities (e.g. gender, racial, and other forms of discrimination)	€	True Price (2023)
Laws and regulations	V-Dem Accountability Index measuring accountability of government	n/a	FSCI (2023)

Laws and regulations	Corruption Perceptions Index measuring corruption (0–100 Index)	n/a	*Corruption Perceptions Index* (Transparency International, 2023)
	Adherence to Prior Informed Consent (PIC) procedures for trade of pesticides and chemicals	Number of export notifications and responses	PIC Regulation—Chemicals subjected to PIC (European Chemicals Agency, n.d.)
Food affordability	Food affordability index measuring food price in relation to standard income	n/a	Herforth et al. (2020)
Social risk	Social Hotspot Index assessing social risk on the production side	n/a	Frehner et al. (2021)
Food availability	Net imports relative to production	%	Turner et al. (2018)
Acceptability	Mean departure from observed diet	%	Perignon et al. (2016)
Integration of workforce into communities	Index measuring change in number of migrant workers with feeling of exclusion	n/a	Capitals Coalition (2023)
Human rights violation	Underage workers below minimum age	Child FTE	True Price (2023)
	Forced labour	FTE	True Price (2023)
		DALYs	True Cost Initiative (2022)

*See abbreviations table for unit definitions.

1.3. Selection criteria for data sources

To assess if a TCA analysis of European diets can be performed based on secondary data sources, we performed a systematic data search. The following criteria for secondary data collection were used:

Data timeliness: We prioritized data sources spanning from 2015 to September 2023 (when the data search was performed), to account for technological advancements and ensure an accurate assessment of TCA impacts.

Geographic coverage: As the geographic and supply chain boundaries were set to the EU, we searched for data sources relevant to the region.

Accessibility: We explored a wide spectrum of data sources, focusing on those that are open access. Additionally, we also included data sources that require a subscription or paywall access, but that provide sufficient information on the data or methodology behind the data to understand the coverage without full access.

2. Evaluating the current data landscape

This section thoroughly assesses the availability, accessibility, and usability of secondary data necessary for implementing TCA of dietary patterns. It focuses on: 1) food composition and consumption data; 2) supply chain data; 3) impact data; and 4) monetization data.

Data **availability** assesses whether the data needed exists and can be collected or obtained. Data **accessibility** refers to the ease and efficiency with which data can be retrieved or obtained. It assesses factors such as the location of data repositories, permissions, price, and the required access methods or tools. Data **usability** is a measure of the data's suitability for TCA analysis in the context of diets.

2.1. Food consumption and composition data

The **food consumption data** sources analysed in Table 5 offer freely accessible data suitable for TCA

analysis of dietary patterns. For example, the European Food Safety Authority's (EFSA) food consumption database offers comprehensive coverage of the dietary patterns of different population groups, from infants to elderly, allowing for a detailed dietary analysis per age group.

Most of the **food composition data** outlined in Table 6 is also freely accessible but has varying data availability and usability. There are also commercial sources that offer subscription-based services that aggregate nutritional data, such as EuroFIR, which provides datasets and allows users to analyse the nutritional composition of food items and to calculate the nutrient density of multiple ingredients within a single product, helping assess complex foods with various components.

Table 5. Availability, accessibility, and usability of food consumption data

Data source	Data type	Data availability by:		Data accessibility	Data usability
		Country	Product		
EFSA Food Consumption Database	Individual food consumption, surveys	High	High	High/open access	High
Eurostat Household Budget Surveys	Household budget expenditure on food, surveys	High	Low/not available	High/open access	High
FAO Food Balance Sheets	Food supply data at national level	High	High	High/open access	Moderate
National Dietary Surveys*	Food consumption patterns at national level	High	Low/not available	High/open access	High

*Please refer to countries' governmental agencies.

Table 6. Availability, accessibility, and usability of food composition data

Data source	Data type	Data availability by:		Data accessibility	Data usability
		Country	Product		
EFSA Food Composition Database	Data on nutrients	Moderate	High	High/open access	High
EuroFIR Food explorer	Data on nutrients	High	High	Low/paid	High
FAO INFOODS	Directory of food composition databases	High	High	High/open access	High
National Dietary Surveys*	Data on nutrients	High	Moderate	High/open access	High
USDA FoodData Central	Data on nutrients and ingredients	Moderate/ mostly US	High	High/open access	High

*Please refer to countries' governmental agencies.

2.2. Supply chain data

The availability of supply chain data varies across different stages, with national statistics offering information at country level but often lacking information on a product basis. Open access statistics like FAOSTAT and AQUASTAT provide aggregated production-stage data at country level. Paid Life Cycle Inventory (LCI) databases focused on agriculture and food products contain more product-specific data such as fertilizer use, other input materials, and energy use per product, but they are not freely accessible (Table 7). Data becomes scarcer further down the supply chain, with consumption stage data almost non-existent. Researched databases do not cover information on input data at food consumption level (e.g. energy used to boil water for a cup of tea), given that information related to the consumer stage is generally based on primary data or assessed using high-level averages. Similarly, secondary databases typically do not incorporate transportation data, as it is often highly specific to particular cases and

sourced from primary data collection. Food waste data is particularly hard to obtain, and open access sources typically lack information on food waste per product. The Joint Research Center (JRC) technical report *Building a balancing system for food waste accounting at National Level* (De Laurentiis et al., 2021) models food supply chain food waste for EU member countries. The modelling could be repeated for more recent years if more up-to-date background data is available.

Table 7. Availability, accessibility, and usability of supply chain data

Data source	Supply chain stage	Supply chain data	Data availability by:		Data accessibility	Data usability
			Country	Product		
Agri-Footprint	Production	Agricultural inputs Energy and processing	High	High	Low/paid	High
FAO AQUASTAT	Production Processing	Water use	High	Low/not available	High/open access	High
FAOSTAT	Production	Crops and livestock	High	Low/not available	High/open access	High
IFASTAT	Production	Fertilizer use by crop	High	High	High/open access	Moderate
JRC report (Bertoldi et al., 2015)	Production Processing Distribution Consumption	Energy used in food production	Moderate	High	High/open access	High
JRC report (De Laurentiis et al., 2021)	Production Processing Retail/distribution Food services Household consumption	Food waste for selected food groups	High	Moderate	High/open access	High
Ladha-Sabur et al. (2019)	Production Processing Distribution	Energy consumption	High	Moderate	High/open access	Moderate/low
ESU World Food Database	Production Processing Distribution Consumption	Food supply chain data	High	High	Low/paid	High
ecoinvent	Production Processing Distribution Consumption	Agricultural supply chain data (detailed information is behind a paywall)	High	High	Low/paid	High

2.3. Impact data

ENVIRONMENTAL IMPACT

While numerous LCA databases offer insights into environmental impacts, data availability varies. Some databases are open access and free, while others require a subscription. The data situation is varied, with some environmental impact indicators having widely available, accessible, and usable data, while the data for others remain rare or completely absent. Natural capital impact data for common impact indicators including GHG emissions, eutrophication, acidification, water scarcity, and land use are readily accessible. However, open data sources are deficient in impact indicators for soil loss, soil organic carbon, and terrestrial and marine ecotoxicity. Additionally, animal welfare impact is currently absent from all LCA databases. In LCA, measuring biodiversity also remains a challenge. Currently, there is no direct midpoint indicator for biodiversity loss. Instead, biodiversity impacts are assessed through related indicators, such as land use change and its effects on ecosystems. Paid LCA databases generally offer broader coverage of indicators and are expected to encompass a more extensive range of impact indicators. Natural capital data is generally applicable for TCA of food products and whole diets.

Table 8. Availability, accessibility, and usability of environmental impact indicators

Environmental impact indicators	Availability	Accessibility	Usability
GHG emissions	🟩	🟩	🟩
Carbon dioxide emissions due to land conversion	⬜	⬜	⬜
Acidification	🟩	🟨	🟩
Ozone layer depleting emissions	🟨	🟨	🟩
Photochemical oxidant formation	🟨	🟥	🟩
Particulate matter formation	🟨	🟥	🟩
Ammonia emissions	🟥	🟥	⬜
Soil loss from wind erosion	⬜	⬜	⬜
Soil loss from water erosion	⬜	⬜	⬜
Soil organic carbon loss/build up	⬜	⬜	⬜
Fossil fuel depletion	🟨	🟥	🟩
(Other) non-renewable material depletion	🟨	🟥	🟩
Scarce water use (blue water)	🟩	🟩	🟩
Freshwater eutrophication	🟩	🟩	🟩
Marine eutrophication	🟩	🟩	🟩
Freshwater ecotoxicity (soil pollution)	🟨	🟥	🟩

Terrestrial ecotoxicity (air pollution)			
Terrestrial ecotoxicity (water pollution)			
Terrestrial ecotoxicity (soil pollution)			
Marine ecotoxicity (soil pollution)			
Land occupation			
Land transformation/Land use	🟩	🟩	🟩
Animal years suffered			

Availability concerns whether the required data exists, **accessibility** concerns whether the data can be easily retrieved and used, and **usability** concerns whether the data is suitable for TCA assessment. **Green** means the data is widely available (6–9 sources), accessible, or usable, **yellow** indicates a lower level of availability (3–5 sources), accessibility, or usability, and **orange** denotes very rare availability (1–2 sources), accessibility, or usability. **Grey** indicates no data availability.

SOCIAL IMPACT

Social impact data related to agriculture and food production are notably limited compared to natural capital impact data. Conducting a Social Life Cycle Assessment (s-LCA) to understand social impacts is challenging due to the scarcity of data. There are two extensive social Life Cycle Impact Assessment (LCIA) databases—the Social Hotspot Database (SHDB) and PSILCA—but both are paid, with detailed impact indicators are behind a paywall. The two databases provide results as risk levels for various social indicators rather than as quantified impacts; i.e. the risk levels reflect the likelihood or severity of a situation that poses social risks along the value chain. For this reason, it is not currently possible to monetize the risk assessment results, as existing monetization factors are designed for quantified impacts. However, the risk assessment can be used to identify supply chain stages or product categories with the highest social risks. Descriptions regarding the content of these databases and the covered impact indicators are available online. However, there is no specific information available regarding the coverage of agriculture and food products. Indicators related to food

security, food loss and waste, food availability, and food affordability are noticeably absent from these databases, which results in a data gap concentrated in these areas of social capital. The overall data situation for social impact has significant data gaps, although some areas have available data. Social impacts can therefore be included in a TCA of food and diets only to a very limited extent with the current available secondary data sources.

Table 9. Availability, accessibility, and usability of social impact indicators

Social impact indicators	Availability	Accessibility	Usability
Ratio of change in price of a basic food basket per change in price of a product	Grey	Grey	Grey
Change in number of people reached through community engagement	Grey	Grey	Grey
Worker freedom of association and collective bargaining	Green	Orange	Green
Gender gap in hours worked	Orange	Orange	Green
Gender pay gap	Green	Orange	Green
V-Dem Accountability Index	Grey	Grey	Grey
Corruption Perceptions Index	Grey	Grey	Grey
PIC procedures for trade of pesticides/chemicals	Grey	Grey	Grey
Food price in relation to standard income	Grey	Grey	Grey
Social risk on the production side	Grey	Grey	Grey
Net imports relative to production	Grey	Grey	Grey
Mean departure from observed diet	Grey	Grey	Grey
Wage gap from unequal opportunities	Green	Orange	Green
Change in number of migrant workers with feeling of exclusion	Green	Orange	Green

Availability concerns whether the required data exists, **accessibility** concerns whether the data can be easily retrieved and used, and **usability** concerns whether the data is suitable for TCA assessment. **Green** means the data is widely available (6–9 sources), accessible, or usable, **yellow** indicates a lower level of availability (3–5 sources), accessibility, or usability, and **orange** denotes very rare availability (1–2 sources), accessibility, or usability. **Grey** indicates no data availability.

HUMAN AND HEALTH IMPACT

Human and health impact data for the production and consumption of food products are very limited. Although some databases offer insights into human toxicity impacts associated with chemicals used during the production of agricultural and food products (e.g. pesticides), they focus primarily on certain toxicities. The Global Burden of Disease (GBD, 2019) study provides in-depth analysis of health outcomes, primarily focusing on dietary risks and health impacts across different countries and age groups. As with social impact data, the overall data situation for human capital impacts is mixed. It is possible to assess some aspects of human capital impacts in TCA for foods and diets with the available data for human toxicity and human labour impacts (derived from environmental LCA models). However, there is a knowledge and research gap on the diet-related health impacts of nutrition and malnutrition, as well as on diet-related diseases such as obesity, hypertension, and dementia.

Table 10. Availability, accessibility, and usability of human impact indicators

Human impact indicators	Availability	Accessibility	Usability
Non-physical, non-sexual harassment of workers			
Non-fatal occupational incidents	🟩	🟧	🟩
Fatal occupational incidents	🟩	🟧	🟩
Health conditions due to excessive working hours			
Contribution to increased suicide rates in agriculture (indirect)			
Child labour	🟩	🟧	🟩
Forced labour	🟩	🟧	🟩
Human toxicity (air pollution)	🟩	🟨	🟩
Human toxicity (water pollution)	🟩	🟨	🟩
Human toxicity (soil pollution)	🟩	🟨	🟩
Health impact of undernutrition			
Health impact of malnutrition			
Health impact of overweight and obesity			
Health impact of hypertension			
Health impact of non-communicable diseases	🟧	🟩	🟨
Health impact of dementia			
Health impact of food poisoning			
Health impact of pesticide exposure			
Health impact of antibiotic use			
Contribution to zoonotic disease exposure (indirect)			
Wage gap below minimum wage	🟩	🟧	🟩
Wage gap below living wage	🟩	🟧	🟩
Workers without legal social security			

Availability concerns whether the required data exists, **accessibility** concerns whether the data can be easily retrieved and used, and **usability** concerns whether the data is suitable for TCA assessment. **Green** means the data is widely available (6–9 sources), accessible, or usable, **yellow** indicates a lower level of availability (3–5 sources), accessibility, or usability, and **orange** denotes very rare availability (1–2 sources), accessibility, or usability. **Grey** indicates no data availability.

2.4. Monetization data

Monetization factors translate quantitative assessments of environmental, human health, and social impacts into monetary terms, representing either costs or benefits. These factors are created by different organizations and vary in their approaches and relevance. For example, they may represent the costs of restoring environmental quality to its initial state or the burden borne by society due to impacts. Monetization approaches for external impacts include market price proxies, stated preference methods, and revealed preference methods. Monetization factors for most environmental impacts are available (Table 11), while relatively few are available for social and human capital impacts (Tables 12 and 13). In terms of monetization for environmental impact indicators (Table 11), factors representing

remediation costs by True Price (2023) are available at global or country-specific level, depending on the considered impact category. Monetization factors representing prevention costs in the *TCA Agrifood Handbook* (True Cost Initiative, 2022) are single global estimates for each impact category. CE Delft's *Environmental Prices Handbook* (De Bruyn et al., 2018) provides monetization factors for the damage costs approach, with one value for the EU average and one for the Netherlands. Although open access monetization factors are available for some social impact indicators, the data gaps in this area are significant (Table 12). Some monetization factors are available for production-related human capital impacts and certain labour and wage impacts. Data for other human capital impacts is largely unavailable (Table 13).

Table 11. Availability of monetization factors for environmental impacts

Environmental impact indicator	Availability
GHG emissions	
Carbon dioxide losses due to land conversion	
Acidification	
Ozone layer depleting emissions	
Photochemical oxidant formation	
Particulate matter formation	
Ammonia emissions	
Soil loss from wind erosion	
Soil loss from water erosion	
Soil organic carbon loss/build up	
Fossil fuel depletion	
(Other) non-renewable material depletion	
Scarce water use (blue water)	
Freshwater eutrophication	

	Availability
Marine eutrophication	🟩
Freshwater ecotoxicity (soil pollution)	🟩
Terrestrial ecotoxicity (air pollution)	🟧
Terrestrial ecotoxicity (water pollution)	🟧
Terrestrial ecotoxicity (soil pollution)	🟧
Marine ecotoxicity (soil pollution)	🟧
Land occupation	🟧
Land transformation / land use	🟩
Animal years suffered	⬜

Colours represent data availability based on the 4 scanned data sources: **green** is high (3–4 sources), **yellow** is medium (2 sources), and **orange** is low (1 source). **Grey** indicates no data availability.

Table 12. Availability of monetization factors for social impacts

Social impact indicator	Availability
Ratio of change in price of a basic food basket per change in price of a product	⬜
Change in number of people reached through community engagement	⬜
Worker freedom of association and collective bargaining	🟨
Gender gap in hours worked	⬜
Gender pay gap	🟩
V-Dem Accountability Index	⬜
Corruption Perceptions Index	⬜
PIC procedures for trade of pesticides and chemicals	⬜
Food price in relation to standard income	⬜
Social risk on the production side	⬜
Net imports relative to production	⬜
Mean departure from observed diet	⬜
Wage gap from unequal opportunities (e.g. gender/racial/other discrimination)	🟩
Change in number of migrant workers with feeling of exclusion	⬜

Colours represent data availability based on the 4 scanned data sources: **green** is high (3–4 sources), **yellow** is medium (2 sources), and **orange** is low (1 source). **Grey** indicates no data availability.

Table 13. Availability of monetization factors for human impacts

Human impact indicator	Availability
Non-physical, non-sexual harassment of workers	🟨
Non-fatal occupational incidents	🟩
Fatal occupational incidents	🟩
Health conditions due to excessive working hours	⬜
Contribution to increased suicide rates in agriculture (indirect)	⬜
Child labour	🟩
Forced labour	🟩
Human toxicity (air pollution)	🟩
Human toxicity (water pollution)	🟩
Human toxicity (soil pollution)	🟩
Health impact of undernutrition	⬜
Health impact of malnutrition	⬜
Health impact of overweight and obesity	⬜
Health impact of hypertension	⬜
Health impact of non-communicable diseases	⬜
Health impact of dementia	⬜
Health impact of food poisoning	⬜
Health impact of pesticide exposure	⬜
Health impact of antibiotic use	⬜
Contribution to the exposure to zoonotic diseases (indirect)	⬜
Wage gap below minimum wage	🟨
Wage gap below living wage	🟨
Workers without legal social security	🟨

Colours represent data availability based on the 4 scanned data sources: **green** is high (3–4 sources), **yellow** is medium (2 sources), and **orange** is low (1 source). **Grey** indicates no data availability.

2.5. Summary of key data gaps

In summary, the feasibility of performing TCA for diets depends on a number of factors, including the methodology and data situation, the complexity of the system (in this case, the dietary analysis), and practical aspects such as the costs associated with conducting a TCA analysis.

Our analysis has shown that both methodological (e.g. indicators, valuation approaches) and data gaps exist, hindering the capacity to perform a thorough TCA analysis of European diets. The supply chain data situation varies depending on the stage, with data for the consumption stage being particularly scarce. Natural capital data availability is mixed, with some areas being well-covered and others lacking data. Social capital data is notably limited, with paid databases offering some insights. Human capital data is also limited, with variations in toxicity impact coverage.

In conclusion, it is not possible to perform a truly comprehensive TCA analysis (i.e. covering environmental, health, and social costs, as recommended by TEEB (2018)) solely based on secondary data. While it is possible to assess most natural capital impacts using secondary data, there are still significant data gaps, particularly in the area of biodiversity. Meanwhile, secondary data for the social and human capital domains is insufficient for a comprehensive TCA assessment of diets. Given the recognized potential of TCA for facilitating the design of effective measures for transforming systems toward greater health and sustainability, it is essential that primary data collection efforts are prioritized and supported.

3. Mind the gap: potential consequences of data gaps

The data gaps outlined in Chapter 2 can limit opportunities to improve decision-making processes for both policymaking and business transformation, while consumers lack complete information to guide their dietary choices. These gaps also make it more challenging for researchers to conduct comprehensive analyses that could inform transformational processes. Figure 4 shows the potential positive impacts of filling the data gaps.

3.1. TCA for policymaking

Policymaking efforts aimed at promoting sustainable dietary practices would benefit from a more comprehensive understanding of the true costs associated with various dietary patterns, which TCA could provide if data gaps were filled. That said, the current level of data already provides good evidence to indicate effective levers to reduce environmental impacts, mitigate climate change, and improve social and public health outcomes. Policymakers should not wait to implement measures to transform food systems toward greater health and sustainability.

The European Green Deal and the Farm to Fork Strategy both focus on increasing environmental sustainability. However, without accurate data on interconnected environmental impacts such as carbon emissions or biodiversity levels, this may be challenging to achieve. TCA can serve as a valuable tool for navigating and addressing such interconnected impacts, providing policymakers with a comprehensive understanding of the true costs associated with different aspects of the food system.

Detailed health-related data can support effective health policies. For instance, specific data on the links between diet and non-communicable diseases can support the design of policies aimed at reducing obesity rates and improving public health. This impedes design of targeted interventions to improve public health outcomes.

Social impact data gaps hinder the potential to comprehensively account for the social dimension when developing agri-food policy. Increased data on social capital could inform policies that address labour and ethical issues in the food supply chain, thereby supporting European goals for fair and ethical food systems. For instance, the European Pillar of Social Rights emphasizes fair working conditions, but without comprehensive data on labour practices along the supply chain, including for countries of production outside of Europe, it is difficult to assess progress in this area.

3.2. TCA for business transformation

Impact assessments and TCA of food supply chains and products provide valuable insights that can drive sustainable innovation and collaboration across the food system. TCA data can support the identification of opportunities for sustainable production and consumption practices, technological advancements, and the development of new business models.

Incomplete environmental data and lack of transparency hinder sustainable business transformation and investment decisions. The European Corporate Sustainability Reporting Directive (CSRD) seeks to

align corporate reporting with sustainability goals, but businesses and investors may struggle to accurately assess their environmental impact without comprehensive data. TCA can address these gaps by providing a detailed assessment of environmental impacts, enabling more informed and sustainable business decisions.

EU nutrition and health regulations aim to protect consumers and encourage healthier choices, but data gaps can hinder the capacity of institutions (e.g. consumer advice centres) to monitor businesses' compliance and impacts. More accurate TCA data can support the enforcement of these regulations, ensuring that businesses adhere to guidelines that promote public health.

The EU made a commitment to responsible business conduct within the UN 2030 Agenda, but monitoring progress can be hindered by incomplete data on social impacts. TCA can provide comprehensive data on social impacts in production and supply chains, thus enhancing due diligence strategies and supporting the EU's goals for responsible business conduct.

3.3. TCA for consumer guidance

TCA assessments can be used to provide consumers with reliable guidance on the impacts and hidden costs of food products to support informed dietary choices, both via informational (e.g. labelling that communicated impacts and/or hidden costs) and policy measures (e.g. a sugar tax that encourages more healthy eating). The more comprehensive picture of environmental, social, and health impacts and costs provided by TCA can increase the effectiveness of such measures and empower consumers with the knowledge needed to align

their diets with health and sustainability goals.

An EU proposed sustainable labelling framework (part of the legislative framework for sustainable food systems) seeks to support the transition to a more sustainable food system by empowering consumers with information on the nutritional, climate, environmental, and social impacts of food products. Comprehensive data provided by TCA can increase the accuracy and effectiveness of such labelling, so that consumers can make healthier, sustainable, and socially responsible choices.

3.4. TCA for research on sustainable food systems transformation (FST)

TCA can be used in research to provide a holistic view of the environmental, social, and health impacts of food production and consumption. By identifying and quantifying the true costs associated with various food groups or production systems, researchers can provide accurate and effective recommendations for transforming diets and food systems toward increased health and sustainability. Existing data gaps make it more challenging for researchers and TCA practitioners to carry out comprehensive TCA analyses, often requiring additional time and resources. Enhancing the availability, usability, and accessibility of data for research could support more effective decision-making for policymakers, businesses, and consumers who rely on evidence-based insights.

BETTER DATA

Comprehensive, accurate TCA analysis enabled by data and monetization factors that are available, accessible, and usable, with good coverage across all three capitals

BETTER FOOD SYSTEM ANALYSIS

- Holistic understanding of interconnected impacts & hidden costs
- Evidence-backed identification of foods with highest hidden costs
- Clear indication of effective levers for change
- Identification of trade-offs between environmental, social and health impacts
- Increased transparency

BETTER DECISION-MAKING

- More effective agri-food policy (aligning policy for health, diets, agriculture, and urban planning)
- Increased transparency and accountability for businesses' sustainability reporting
- Enhanced consumer education and decision-making

HEALTHY AND SUSTAINABLE FOOD SYSTEMS

More sustainable food systems, with reduced hidden costs across environmental, health, and social capitals
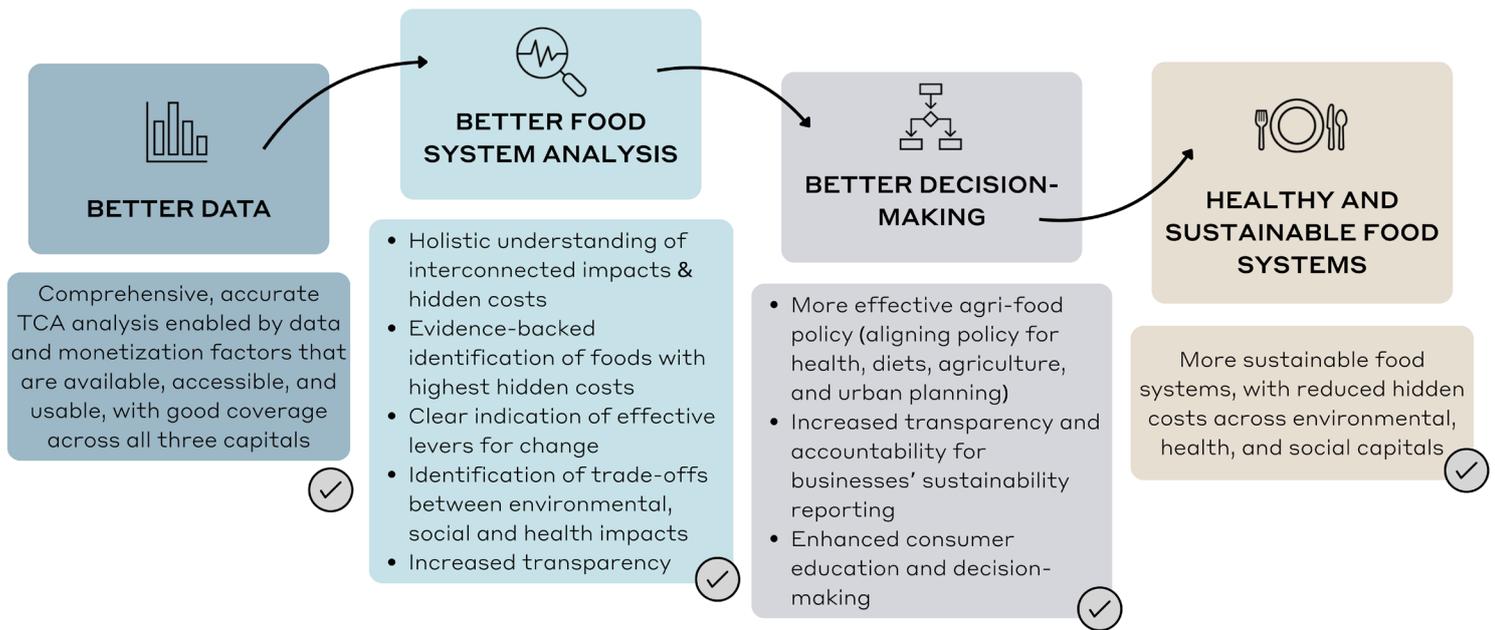
Figure 4. How filling data gaps can create more sustainable food systems

4. Recommendations on bridging the data gaps

TCA analysis of European diets seeks to comprehensively evaluate the hidden costs and benefits associated with the environmental, social, and health impacts of food systems and consumption choices. The previous chapters have outlined the current data situation, showing that:

- Food consumption data is freely available for various age groups across European countries, but lacks granularity on socio-economic levels and for population groups with specific health issues.
- Input data for production is available and freely accessible at an aggregated country level, but it often lacks product-specific details, therefore necessitating the use of paid data sources.
- Data and methodologies for environmental assessments are more robust, but still not fully developed.
- Impact data for human and social capital is scarce and, in some cases, behind expensive paywalls, while methodologies are not robustly defined.

There are multiple data gaps that may hinder comprehensive TCA analyses. This chapter outlines recommendations on 1) how to enhance data availability, accessibility, and usability for TCA of European diets; 2) how to improve data governance in this context; and 3) concrete priorities for bridging current data gaps. This set of recommendations are designed to inform the creation of a standardized and collaborative data collection and governance framework, ensuring that data collection, reporting, and measurement efforts align to provide a holistic understanding of the impacts of European diets. Figure 5 summarizes the recommendations.

While data gaps may pose challenges, it is important to recognize that TCA can be a powerful policy tool for driving the transition to healthy, sustainable, and fair diets, within Europe and globally. By implementing the following recommendations and fostering international collaboration, the EU can harness the potential of TCA to drive informed decision-making, address the complexities of global supply chains, and ultimately contribute to a more sustainable and equitable future for food systems worldwide.

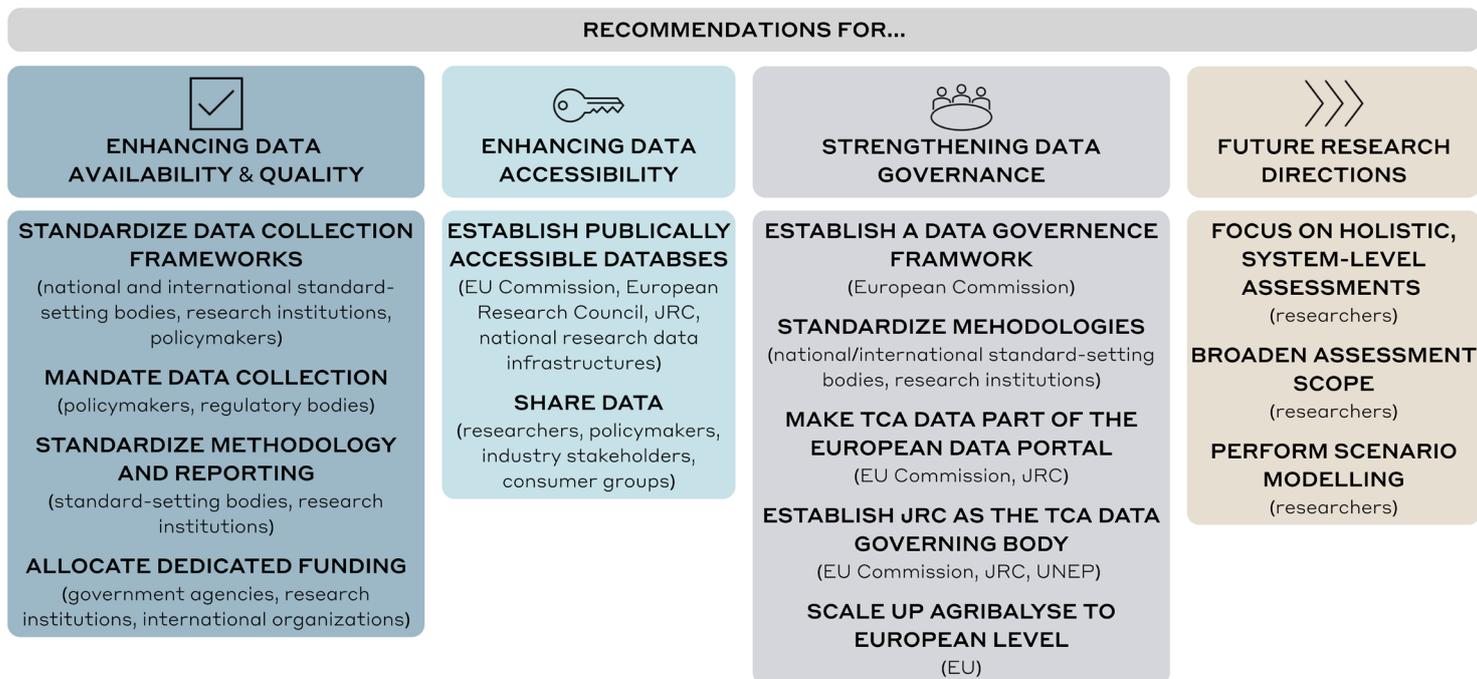| ENHANCING DATA AVAILABILITY & QUALITY	ENHANCING DATA ACCESSIBILITY	STRENGTHENING DATA GOVERNANCE	FUTURE RESEARCH DIRECTIONS
STANDARDIZE DATA COLLECTION FRAMEWORKS (national and international standard-setting bodies, research institutions, policymakers) **MANDATE DATA COLLECTION** (policymakers, regulatory bodies) **STANDARDIZE METHODOLOGY AND REPORTING** (standard-setting bodies, research institutions) **ALLOCATE DEDICATED FUNDING** (government agencies, research institutions, international organizations)	**ESTABLISH PUBLICALLY ACCESSIBLE DATABSES** (EU Commission, European Research Council, JRC, national research data infrastructures) **SHARE DATA** (researchers, policymakers, industry stakeholders, consumer groups)	**ESTABLISH A DATA GOVERNANCE FRAMWORK** (European Commission) **STANDARDIZE MEHODOLOGIES** (national/international standard-setting bodies, research institutions) **MAKE TCA DATA PART OF THE EUROPEAN DATA PORTAL** (EU Commission, JRC) **ESTABLISH JRC AS THE TCA DATA GOVERNING BODY** (EU Commission, JRC, UNEP) **SCALE UP AGRIBALYSE TO EUROPEAN LEVEL** (EU)	**FOCUS ON HOLISTIC, SYSTEM-LEVEL ASSESSMENTS** (researchers) **BROADEN ASSESSMENT SCOPE** (researchers) **PERFORM SCENARIO MODELLING** (researchers)

Figure 5. Recommendations for bridging data gaps
Relevant actors for each recommendation given in parentheses.

4.1. Recommendations for enhancing data availability and quality

Standardize data collection frameworks

National and international standard-setting bodies, research institutions, and policymakers should encourage the harmonization of methodologies for data collection and impact measurement to ensure consistency and comparability across studies. A framework for LCI should cover the entire food supply chain, including production, processing, distribution, and consumption stages, as well as all four capitals (produced, social, human, and natural). These frameworks should specify data requirements, data documentation, and data-sharing mechanisms to ensure consistency and comparability across studies. This can be achieved through alliances of TCA practitioners and researchers or by building on existing initiatives for environmental impact data—such as the Global Guidance for Life Cycle Impact Assessment Indicators and Methods (GLAM) or Global LCA Data

Access Network (GLAD) under UNEP—and extending these for social and human capital impact data.

Promoting the harmonization of data collection can support the use of data. For instance, data collected during social audits, certifications, or other statistics, should be available for diverse purposes. This can be achieved through a standardization of assessment protocols, data quality control procedures, and calculation methodologies, thereby reducing redundancy.

Mandate data collection

Policymakers and regulatory bodies should establish policy frameworks that mandate the collection of relevant data for TCA assessments of European diets. This can include requirements for reporting and disclosing environmental, social, and health-related data by food producers, processors, and retailers. For example, this could become an integral part of current EU legislation initiatives, such as the Corporate Sustainability Due Diligence Directive (CSDDD). Additionally, TCA and a TCA database

can serve as valuable tools for companies to align with emerging EU sustainability and supply chain regulations.

Standardize methodology and reporting

Standard-setting bodies and research institutions should develop standardized methodology and reporting guidelines and frameworks for TCA assessments, ensuring consistent reporting of data and results across studies. This will enhance the transparency, comparability, and reliability of TCA assessments. The harmonization of impact assessment methods (akin to the ongoing efforts at the European level by the JRC within the Environmental Footprint 3.1 framework) will fortify the availability of consistent LCIA data for TCA. Integrated reporting frameworks that incorporate sustainability information into financial reporting should also be developed.

Allocate dedicated funding

Governments and philanthropic institutions should allocate dedicated funding for research and data collection efforts to bridge the data gaps and support the transition to more healthy and sustainable food systems. Government agencies, research institutions, and international organizations should provide financial support for comprehensive data collection, quality control, and modelling research in the field of TCA assessment.

4.2. Recommendations for enhancing data accessibility

Establish publicly accessible databases

The EU commission, the European Research Council, the JRC, and national research data infrastructures should improve data availability and accessibility by establishing publicly accessible databases or repositories that house relevant data on the environmental, social, and health impacts of European diets. These repositories should adhere to data privacy and security regulations while promoting transparency and open access to support future research and policymaking. EU governing bodies, international organizations, national governments, and research institutions should be encouraged to adopt open data policies.

Share data

Researchers, policymakers, industry stakeholders, and consumer groups should be encouraged to share data and collaborate in data collection efforts. Such collaboration could facilitate the pooling of resources and expertise, leading to more comprehensive and reliable datasets and overcoming current data silos.

4.3. Recommendations for strengthening data governance

Establish a data governance framework

The European Commission should establish a data governance framework for TCA data, defining the roles and responsibilities of data collection, maintenance, and dissemination for TCA of diets and food systems in accordance with the EU's Data Governance Act.

Standardize methodologies

TCA data harmonization efforts should be aligned with existing EU initiatives such as Product Environmental Footprint (PEF) and the Organization Environmental Footprint (OEF) as a standard LCA methods for environmental data. Similar standardized methodologies should be expanded to social and human capital impacts, making it easier to integrate TCA into broader sustainability assessments that look at all three dimensions of sustainability and their interconnections.

Make TCA data part of the European Data Portal

TCA data should be incorporated into the European Data Portal, ensuring compliance with established rules and data creation processes. Member states could contribute their national data to this integrated platform, transforming it into a comprehensive repository for TCA-related data, thereby enhancing accessibility for stakeholders and researchers. Inclusion of the TCA data into this platform would also encourage cross-border collaboration among EU member states for data sharing and collaborative TCA-related projects, as well as facilitating data initiatives to achieve a harmonized TCA approach at the EU level.

Establish JRC as the TCA data governing body

Recognizing the imperative for a robust governance structure in managing TCA data, we recommend designating the EU's JRC as TCA data governing body. Given its pivotal role in data management, quality assurance, and standardization, JRC emerges as an invaluable institution for TCA data governance at EU level. A cooperation between JRC and UNEP could make data efforts more aligned and efficient by, for example, expanding the Global LCA Data Access Network (GLAD)

Scale up AGRIBALYSE to a European level

Following the example of the AGRIBALYSE database, which is currently limited to food consumption in France, we recommend setting up an LCI database for food and agriculture that encompasses the entire EU. This expansion would necessitate active participation from all EU member states, who would contribute valuable data and insights to enrich the database's content. This expansion would establish a harmonized EU-level LCI database, ensuring consistency and standardization in data collection and analysis across the region and facilitating comprehensive TCA assessment of food consumption in Europe. This data could then be used to inform effective EU policymaking in the areas of food, health, urban planning, and agriculture. The Life Eco Food Choice project, designed to replicate AGRIBALYSE for selected European countries represents a promising advancement in this area.

4.4. Recommendations for future research directions

Focus on holistic, system-level assessments

More research should focus on the interplay of environmental, human, social, and produced capital impacts to attain a more holistic grasp of the trade-offs entailed in dietary shifts. The lack of system-level assessments can be partially attributed to the data gaps described in this report (i.e. especially regarding social and health impacts, but also certain environmental impacts such as biodiversity) and future research efforts should therefore aim to encompass all three dimensions of sustainability.

Broaden assessment scope

Currently, there is a scarcity of research that establishes links between consumption and production-related impacts. Future research should aim for comprehensive cradle-to-grave system assessments, in order to facilitate a full understanding of the entire lifecycle of food products and their associated environmental, health, and social impacts.

Perform scenario modelling

Scenario-based modelling to explore different future pathways can facilitate the assessment of potential impacts of policy interventions and consumer behaviour changes on the true costs of European diets. This could help identify the most effective strategies for achieving sustainability goals and inform policy decision-making.
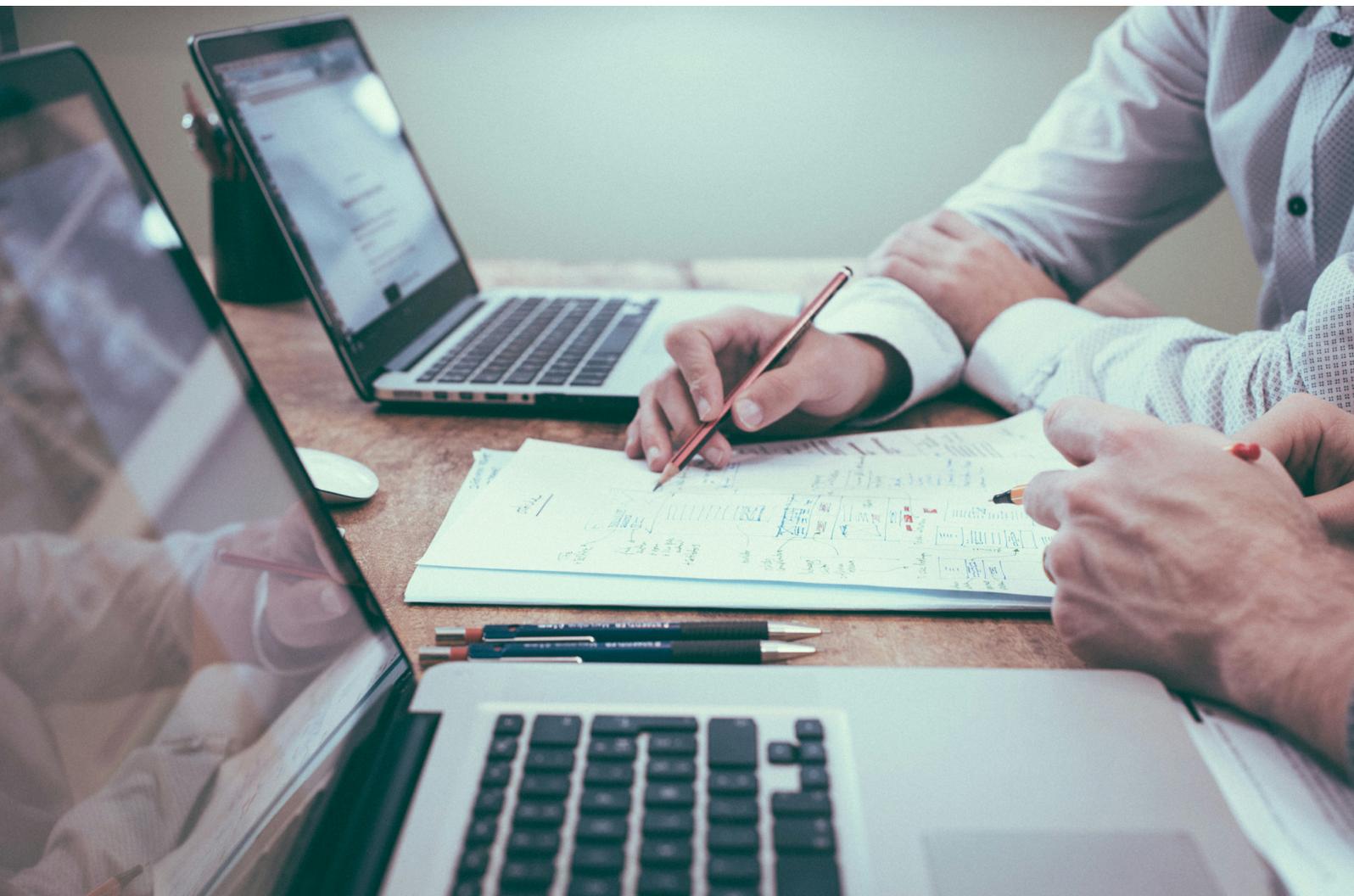
Appendix

This technical appendix gives an overview of the data sources useful for TCA assessments of European diets.

Table A1. Summary of data availability, accessibility, and usability of supply chain data

Data source	Supply chain stage	Supply chain data	Data availability by:		Access-ibility	Usability
			Country	Product		
Agri-Footprint*	Production	Agricultural inputs (food, feed, biomass, fertilizer use)	Yes	Yes	Paid	Easy to use format and structure; data is expected to be consistent and complete. LCI data is suitable for TCA of food and diets.
		Energy and processing	Yes	Yes		
FAO AQUASTAT	Production Processing	Water use	Yes	No	Open access	Data comes in excel or csv format and is complete, consistent, and well-organized. It can be used to estimate environmental impacts up to the farm gate at national level. In this format it does not allow a product-level assessment and therefore would not be suitable for TCA of food and diets.
Ecoinvent*	Production Processing Distribution Consumption	Agricultural supply chain	Yes	Yes	Paid	Expected easy-to-use format and structure. Data is expected to be consistent and complete. LCI data is suitable for TCA of food and diets.
EUROSTAT Agriculture, Forestry and Fisheries Surveys	Production	Agricultural production (area of cultivation, harvest amounts, yields, livestock)	Yes	No	Open access	Data comes in excel or csv format and is complete, consistent, and well-organized. It can be used to estimate environmental impacts at the farm gate for country level. Direct use of the data in the current format is not suitable for TCA of food and diets. It can be used to estimate environmental impacts complemented with other data.
FAOSTAT	Production	Crops (production, yield, crop area harvested)	Yes	No	Open access	Data comes in excel or csv format and is complete, consistent, and well organized. It can be used to estimate country-level environmental impacts at the farm gate. In this format it does not allow a product-level assessment and would therefore not be suitable for TCA of food and diets.
		Livestock (livestock numbers, livestock products such as meat, milk, eggs)	Yes	No		
		Energy used in agriculture	Yes	No		
		Land use	Yes	No		
		Fertilizers by nutrient	Yes	No		
		Fertilizers by product	Yes	No		
		Livestock manure	Yes	No		
		Pesticide use	Yes	No		
		Agricultural machinery	Yes	No		
		Agricultural employment	Yes	No		

Data source		Impact indicator				Quality/Usability
IFASTAT	Production	Fertilizer by crop	Yes	Yes	Open access	Estimations for many countries are linked with significant uncertainties. Data comes in excel format and is consistent. It is useable for product-level assessment and suitable for TCA of food and diets.
JRC science and policy report (Bertoldi et al., 2015)	Production Processing Distribution Consumption	Energy used in food production	EU average	Yes	Open access	While the publication is open access, compiled energy data is not directly included in the report. The data is incorporated within the text or figures. Structure of the data is not fully suitable for TCA of food and diets. It requires further insights and data manipulation.
JRC technical report (De Laurentiis et al., 2021)	Production Processing Retail and distribution Food services Household consumption	Quantifies food waste at each supply-chain stage for selected food groups and EU member states	Yes	Yes	Open access	The publication is open access and all background data and results are available as excel sheets. The "Balancing system for food waste accounting" excel sheet presents food waste by each supply chain for selected food groups in all EU member states. Data can be used for TCA of food and diets.
Mapping energy consumption in food manufacturing (Ladha-Sabur et al., 2019)	Production Processing Distribution	Energy consumption data for production and distribution of food	Yes	For food product groups	Open access	The accuracy of the data reported could not be ascertained. Data does not come in a directly usable format and might need further manipulation. Energy consumption data per food product group can be used as proxies for TCA of food and diets.
ESU World Food Database	Production Processing Distribution Consumption	Food supply chain data	Yes	Yes	Paid	Easy-to-use format and structure. Data is expected to be consistent and complete. Life cycle inventory data is suitable for TCA of food and diets.

*No access to detailed information on further availability of exact supply chain data due to paywall.

Table A2. Summary of data availability, accessibility, and usability of environmental impact data

Data source	Impact category	Impact indicator	Availability	Access	Quality/Usability
AGRIBALYSE	Contribution to climate change	Greenhouse gas (GHG) emissions	Offers an in-depth LCA, detailing the environmental footprint of agricultural and food products for France.	Open access	High data quality assessment applied. Database is available in excel format. Easy to use format and structure. Data is consistent and complete. LCA data is suitable for TCA of food and diets.
	Pollution of the living environment	Ozone depletion Ionizing radiation Photochemical ozone formation Particulate matter Land and freshwater acidification Freshwater eutrophication Marine eutrophication Land eutrophication Ecotoxicity for freshwater aquatic ecosystems			
	Depletion of scarce abiotic resources	Water resource depletion Energy resource depletion Mineral resource depletion			
	Degradation of biodiversity and ecosystems	Land use			
Agri-footprint*	Behind a paywall	19 impact indicators (details behind a paywall)	Extensive data on agricultural inputs including feed, food, and biomass. Exact content is unknown due to the paywall.	Paid	High data quality assessment applied. Impact indicators are suitable for TCA use. Expected easy-to-use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.

Ecoinvent*	Behind a paywall	Not specified (behind a paywall)	Various data from agriculture and animal husbandry sector. Exact content is unknown due to a paywall.	Paid	High data quality assessment applied. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.
Clark et al. (2022)	Contribution to climate change	GHG emissions	Impacts on food products consumed widely in UK and Ireland.	Open access	Applied sensitivity analysis to test the robustness of their approach. Background data and LCA data is partly available in excel format. Impact indicators are suitable for TCA of food and diets.
	Pollution of the living environment	Aquatic eutrophication potential			
	Depletion of scarce abiotic resources	Water stress			
	Degradation of biodiversity and ecosystems	Land use			
FAOSTAT (Climate Change: Agrifood systems emissions)	Contribution to climate change	GHG emissions	Provides data on GHG emissions from agrifood systems.	Open access	High data quality assessment applied. Database comes in excel and csv format. Easy to use format and structure. Data is consistent and complete. Impact data can be used for country-level assessment. It is not suitable for TCA of food and diets.
Idemat	Contribution to climate change	GHG emissions	Includes some agricultural products.	Open access	Includes certain assumptions and uncertainties. Data accuracy and timeliness is ensured. Database is available in excel sheet. Easy to use format and structure. Data is consistent and complete. LCA data is suitable for TCA of food and diets.
	Pollution of the living environment	Acidification Freshwater ecotoxicity Particulate matter Marine eutrophication Freshwater eutrophication Terrestrial eutrophication Ionising radiation Ozone depletion Photochemical ozone formation			
	Depletion of scarce abiotic resources	Fossil resource use Mineral and metal resource use Water use			
	Degradation of biodiversity and ecosystems	Not specified			
Poore and Nemecek (2018)	Contribution to climate change	Greenhouse gas emissions	A comprehensive meta-analysis on environmental impacts of food products. The database covers 40 products and five impact indicators.	Open access	High data quality assessment applied. Background data and LCA data is available in excel format. Impact indicators are suitable for TCA of food and diets.
	Pollution of the living environment	Acidifying and eutrophying emissions			
	Depletion of scarce abiotic resources	Freshwater withdrawals weighted by local water scarcity			
	Degradation of biodiversity and ecosystems	Not specified			

Data source	Impact category	Impact indicator	Availability	Access	Quality/Usability
RIVM Food Consumption Database	Contribution to climate change	Greenhouse gas emissions	Environmental impact of around 250 foods commonly consumed in the Netherlands	Open access	No information regarding data quality assessment provided. Database is available in excel sheet. Easy to use format and structure. Data is consistent and complete. LCA data is suitable for TCA of food and diets.
	Pollution of the living environment	Freshwater eutrophication Marine eutrophication Soil acidification			
	Depletion of scarce abiotic resources	Blue water consumption			
	Degradation of biodiversity and ecosystems	Land use			
ESU World Food Database*	Behind a paywall	Not specified (behind a paywall)	Extensive data on agriculture, food processing, and consumption activities.	Paid	High data quality assessment applied. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.

*No access to detailed information on impact indicators due to paywall.

Table A3. Summary of data availability, accessibility, and usability of the monetization factors for environmental impacts

Data source	Impact category	Impact indicator	Availability	Access	Quality/Usability
Eco Cost Value's Sustainability Impact Metrics	Contribution to climate change	GHG emissions	Ecocosts value provides monetization factors for six environmental impact indicators.	Open access	The website does not explicitly provide a data quality assessment. Monetization factors are globally usable for TCA of food and diets.
	Pollution of the living environment	Acidification Eutrophication Photochemical oxidant formation Ecotoxicity			
	Degradation of biodiversity and ecosystems	Land use			
True Price (2023)	Contribute to climate change	GHG emissions	True Price monetization factors are provided for various environmental impact indicators.	Open access	True Price is still working on monetization factors and recognizes limitations. Monetization factors are globally usable for TCA of food and diets.
	Pollution of the living environment	Toxic emissions to air Nitrogen deposition (NH³/NOx) Particulate matter formation Photochemical oxidation formation Acidification Ozone layer depleting emissions Toxic emissions to water Freshwater eutrophication Marine eutrophication Toxic emissions to soil			
	Degradation of biodiversity and ecosystems	Land occupation Land transformation			
	Depletion of scarce abiotic resources	Fossil fuel depletion (Other) non-renewable material depletion Scarce water use			
	Degradation of land	Soil organic carbon loss Soil loss from wind erosion Soil loss from water erosion Soil compaction			

Data source	Impact category	Impact indicator	Availability	Access	Quality/Usability
True Cost Initiative (2022)	Contribution to climate change	GHG emissions	TCA handbook provides monetization factors for nine natural capital indicators.	Open access	Data quality assessment has not applied. Monetization factors are globally usable for TCA of food and diets.
	Pollution of the living environment	Water pollution Acidification Eutrophication Eco-toxicity			
	Depletion of scarce abiotic resources	Water stress			
	Degradation of land	Carbon stock Soil erosion Soil organic matter build-up			
Rockefeller Foundation (2021)	Contribution to climate change	GHG emissions	The report outlines the true cost of food in the United States and provides monetization factors for a few environmental impacts.	Open access	The report does not specify data quality and data limitations issues. Monetization factors are the US based and usable for TCA of food and diets for the US.
	Pollution of the living environment	Soil pollution Air pollution Water pollution Eutrophication			
	Degradation of biodiversity and ecosystems	Land use			
	Depletion of scarce abiotic resources	Scarce water use			
	Degradation of land	Soil erosion			

Table A4. Summary of data availability, accessibility, and usability of social impact data

Data source	Impact category	Impact indicator	Availability	Access	Quality/Usability
Product Social Impact Life Cycle Assessment (PSILCA) database*	Child labour Forced labour Fair salary Working time Discrimination Social benefits, legal issues Workers' rights Fair competition Corruption Promoting social responsibility Contribution to economic development Prevention and mitigation of conflicts Respect for Indigenous rights Safe and healthy living conditions Migration	69 qualitative and quantitative social indicators	Comprehensive database for S-LCA that can be used to assess the social impacts of food production.	Paid	High quality data assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.
Social Hotspot Database (SHDB)*	Six categories and 30 subcategories (details behind a paywall)	160 indicators (details behind a paywall)	Collection of secondary data on social risks associated with global supply chains. It can be used to assess the social impacts of products and services.	Paid	High quality data assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.
soca*	Expected to cover the same indicators as in PSILCA.	70+ social indicators (based on the PSILCA database)	An add-on for ecoinvent LCI databases, providing information for S-LCA.	Paid	High quality data assessment. User-friendly format. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.

*No access to detailed information on impact indicators due to paywall.

Table A5. Summary of data availability, accessibility, and usability of the monetization factors for social impacts

Data source	Impact category	Monetization factor for impact indicator	Availability	Access	Usability
True Price (2023)	Discrimination	Gender discrimination	True Price provides monetization factors for various social impact indicators.	Open access	True Price is still working monetization factors and recognizes its limitations. Monetization factors are globally usable for TCA of food and diets.
	Non-guarantee of a decent living standard	Underpayment in the value chain Lack of social security Excessive and underpaid overtime Insufficient income			
	Lack of union rights	Lack of freedom of association			
True Cost Initiative (2022)		Gender pay gap Living wage gap Excessive working hours	TCA handbook provides monetization factors for three social indicators	Open access	No data quality assessment applied. Monetization factors are globally usable for TCA of food and diets.

Table A6. Summary of data availability, accessibility, and usability of health impact data

Data source	Impact category	Impact indicator	Availability	Access	Quality/Usability
AGRIBALYSE	Production-related human health impacts	Human toxicity (non-carcinogenic substances) Human toxicity (carcinogenic substances)	Offers an in-depth LCA detailing the environmental footprint of agricultural and food products for France.	Open access	High data quality assessment. Easy to use format and structure. Data is consistent and complete. LCA data is suitable for TCA of food and diets.
Agri-footprint*	Production-related human health impacts	Human toxicity (non-carcinogenic substances) Human toxicity (carcinogenic substances)	Exact content unknown due to paywall.	Paid	High data quality assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.
Ecoinvent*	Production-related human health impacts	Human toxicity (non-carcinogenic substances) Human toxicity (carcinogenic substances)	Exact content unknown due to paywall.	Paid	High data quality assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.
Idemat	Production-related human health impacts	Human toxicity (non-carcinogenic substances) Human toxicity (carcinogenic substances)	Some agricultural product-related data is available.	Open access	Includes certain assumptions and uncertainties. Data accuracy and timeliness is ensured. Easy-to-use format and structure. Data is consistent and complete. LCA data is suitable for TCA of food and diets.
PSILCA *	Health and safety	Accident rate at workplace Fatal accidents at workplace DALYs due to indoor and outdoor air and water pollution Presence of sufficient safety measures Workers affected by natural disasters	Comprehensive database for S-LCA that can be used to assess the social impacts of food production.	Paid	High data quality assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. The impact data is expected to be suitable for TCA of food and diets.

Social Hotspot Database (SHDB)*	Health and safety	Occupational toxics and hazards Occupational injuries and deaths (more detail is behind a paywall)	A collection of secondary data that provides information on social risks associated with global supply chains. It can be used to assess the social impacts of products and services.	Paid	High data quality assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. The impact data is expected to be suitable for TCA of food and diets.
soca*	Expected to cover the same indicators as in PSILCA	70+ social indicators (based on the PSILCA database)	An add-on for ecoinvent LCI databases, providing information for S-LCA.	Paid	High quality data assessment. Expected easy to use format and structure. Data is expected to be consistent and complete. LCA data is suitable for TCA of food and diets.
USEtox	Production-related human health impacts	Human toxicity (non-carcinogenic substances) Human toxicity (carcinogenic substances)	The cumulative impact results summary presents the human toxicity impacts of food contact material.	Open access	Undergoes procedures for quality assurance, transparency, and peer review. The model needs to be opened in the USEtox application. Data is consistent and complete. Impact data is suitable for TCA of food and diets.
The Global Burden of Disease Study 2019	Consumption-related human health impacts	DALYs from leading chronic diseases attributable to dietary risk factors	The study provides dietary risk exposure estimates.	Open access	High data quality assessment. Easy to use format and structure. Data is available through Global Health Data Exchange interface and be downloaded in csv format. The dietary risk data might need manipulation to use for TCA of diets.

*No access to detailed information on impact indicators due to paywall.

Table A7. Summary of data availability, accessibility, and usability of the monetization factors for human capital impacts

Data source	Impact category	Monetization factor for impact indicator	Availability	Access	Usability
True Price (2023)	Child labour	Child labour	Provides monetization factors for five human impacts.	Open access	True Price is still working on monetization factors and recognizes its limitations. Monetization factors are globally usable for TCA of food and diets.
	Forced labour	Forced labour			
	Occupational health and safety	Occurrence of harassment Negative effects of employee health and safety			
	Air/Soil/Water pollution	Human toxicity			
True Cost Initiative (2022)	Human rights	Forced labour Child labour	Monetization factors for four human indicators are provided in the handbook.	Open access	No data quality assessment applied. Monetization factors are globally usable for TCA of food and diets
	Occupational health and safety	Occupational health and safety			
	Human health	Human toxicity			

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About the project

PLAN'EAT is a Horizon Europe project that seeks to facilitate the transition towards healthy and sustainable dietary behaviour through an in-depth understanding of the underlying factors and drivers and the development of innovative, effective recommendations, tools, and interventions addressing different agri-food system actors.

PLAN'EAT aims to implement a systemic approach at the macro (food system), meso (food environment), and micro (individual) levels. Various socio-cultural and geographic contexts across Europe will be considered by implementing nine living labs in different European areas, five pan-European food value chain consultation and working groups, and national and pan-European policy labs.

As part of a consortium of 24 partners, TMG is leading work on True Cost Accounting (TCA) to analyze the environmental, socio-economic, and health impacts of European diets and their associated costs. This component of the project includes:

- analyzing the availability of TCA data

- developing a database of the impacts and true costs of 2,000+ food products consumed in Europe

- assessing the true costs of three different European dietary patterns

- providing recommendations for using TCA for holistic food systems policy and the development of national dietary guidelines

Building on this work, TMG will also be involved in developing a roadmap for the establishment of a proposed European Food Policy Council, as well as setting up a methodology framework to design easy-to-understand healthy and sustainable food-system-based dietary guidelines at the national level, for various population groups. Find out more on the TMG project page and the PLAN'EAT website.

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