True Cost Assessment Methods for Quantifying the Multi-dimensional Impacts of Food

a Three-Part Review Series

Members of the research Consortium:

NFP Netherlands Food Partnership

gain Global Alliance for Improved Nutrition

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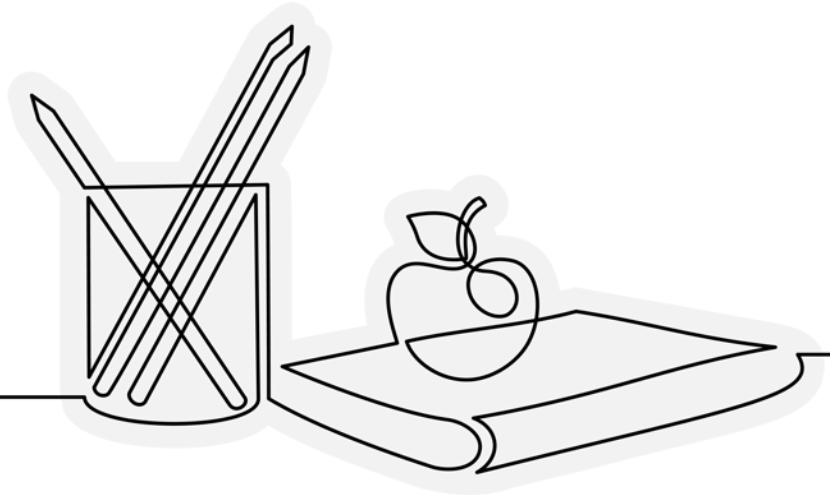
OUTLINE

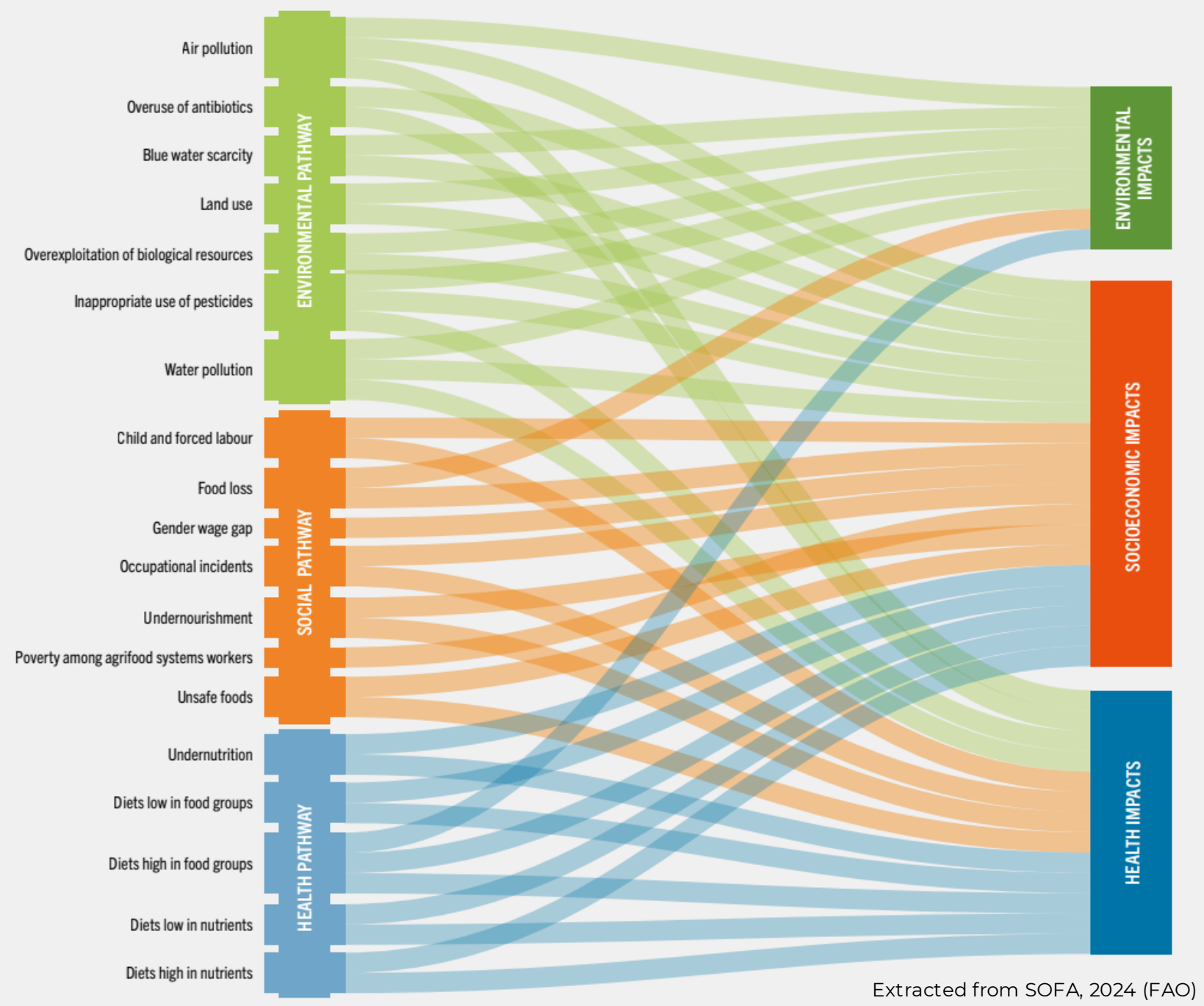
- **Background & rationale for the three-part review series**
- **Methods & findings from individual reviews:**
  - Quantifying the Health Impacts of Food: A Scoping Review of True Cost Assessment Methods
  - Quantifying the Environmental Impacts of Food: A Review of True Cost Assessment Methods
  - Quantifying the Socioeconomic Impacts of Food: A Review of True Cost Assessment Methods
- **Key cross-cutting learnings across the 3 reviews**



BACKGROUND & RATIONALE FOR THE THREE-PART REVIEW SERIES

FOOD SYSTEMS ARE COMPLEX

- **Global food systems are essential** for food and nutrition security, health and wellbeing, income generation, and cultural identity. However…
- …they generate **significant externalities** which can occur across the entire value chain.
- These impacts create **interconnected challenges** that manifest across 3 domains:



Extracted from SOFA, 2024 (FAO)

Sources: Schneider et al., 2023; FAO, 2024

INTRODUCING TRUE COST ACCOUNTING

❑ What is True Cost Accounting (TCA)?

- An econometric approach to **quantify and monetise** the large spectrum of **external costs (or externalities)** generated by food systems.
- **Monetisation =** The process of **assigning a monetary value** (e.g., US dollars) to externalities originally expressed in non-monetary units (e.g., DALYs, tons of CO2, hours of child labour).

❑ What is True Pricing?

- True Pricing builds upon TCA by attributing external costs to food products, so that externality burdens can be **compared to** and/or **incorporated into food prices**.

❑ What is the value of TCA & True Pricing?

- **Informing policy & interventions**: Economically valuing diverse impacts can inform more effective and equitable policy and programmatic design and resource allocation.
- **Promoting transparency & accountability:** Revealing the 'hidden costs' of food can increase transparency among businesses, investors, policymakers, and consumers.
- **Driving transformation:** The ultimate goal is that of incentivising the transition toward healthier, more sustainable, and equitable production and consumption patterns.

Sources: True Price Foundation, 2024; FAO, 2024

CONTEXTUALISATION: THE OVERARCHING PROJECT

- The review series is foundational to a larger, multi-component initiative, the **True Cost & True Price of Food Baskets** project:
  - **Project goal:** Determine the true cost and true price of current and recommended **food baskets** in selected countries (**one HIC and two LMICs**) and demographic groups.
  - **Overall approach:** Adapt and expand upon existing methods to quantify and monetise the **environmental, socio-economic, and health** externalities of **context-specific** food baskets.
  - **Target audience:** Policymakers, value chain actors, investors, researchers, and consumers.
- **Unique value proposition:**
  - **Focus on locally available food baskets** makes the project directly relevant to policymakers and consumers.
  - Holistic approach addressing food baskets' multi-dimensional impacts, with an additional focus on **nutritional value and affordability**.
  - Inclusion of **both HICs and LMICs** ensures the development of an **adaptable, scalable methodology**.

RATIONALE FOR THE REVIEW SERIES

- The three-part review series was conducted as part of the **inception phase** of the larger project.
- **Primary aims:**
  - Surface, categorise, and **critically analyse available methodological approaches** for quantifying and monetising the hidden costs of foods and diets.
  - Identify **knowledge gaps** and suggest an agenda for future research.
  - Generate evidence-based recommendations to **guide subsequent phases** in the larger project.
- Findings from the review series will directly **inform the core components of the main project**:
  - **Adaptation, combination, and expansion** of existing TCA and True Pricing methods.
  - Selection of **indicators/metrics, analytical tools,** and **data sources** for all three dimensions.
  - Development of new approaches for **addressing evidence gaps**.

REVIEW METHODS COMPARED: AN OVERARCHING VIEW

KEY FEATURE	HEALTH DIMENSION	ENVIRONMENTAL DIMENSION	SOCIOECONOMIC DIMENSION
Review typology	Scoping (JBI guidelines + PRISMA-ScR)	Structured (simplified PRISMA-ScR)	Structured (simplified PRISMA-ScR)
Rationale for choice	Breadth of research questions and the emerging, diverse nature of the field	Balance methodological rigor and flexibility	Nascent field with limited evidence and evolving methodologies
Time frame	2008–2025 ('modern era' of TCA)	2018–2025 (building on a foundational review by the True Price Foundation)	2008–2025 ('modern era' of TCA)
Search strategy	Developed by research librarian 3 key concepts: TCA; health externalities; foods & diets	Developed by research librarian 3 key concepts: TCA; environmental externalities; foods & diets	Developed by research librarian 3 key concepts: TCA; socio-economic externalities; foods & diets
Academic databases	5 (PubMed, Scopus, Web of Science, AGRICOLA, CAB Abstracts)	3 (Scopus, CABI, Web of Science).	3 (Scopus, EconLit, Web of Science)
Grey literature sources	11	8	8
Evidence base size	96 included records	85 included records	24 included records
Screening platform	Covidence	Covidence	Covidence
Screening process	Conducted by two independent reviewers, with a third resolving conflicts	Conducted by two independent reviewers, with a third resolving conflicts	Conducted by a single reviewer, with 15% cross-checking by a second reviewer
Extraction form	Standardised data charting form (23 variables)	Standardised data charting form (18 variables)	Standardised data charting form (18 variables)
Extraction process	Hybrid human-AI approach, with a human reviewer resolving discrepancies and merging datasets	Conducted by a single reviewer	Conducted by a single reviewer
Data analysis	Descriptive statistics Qualitative synthesis: Inductive thematic analysis to classify methods, metrics, tools, and data sources	Descriptive statistics Qualitative synthesis: Inductive/Deductive thematic analysis to classify frameworks, approaches, methods, and data sources	Descriptive statistics Qualitative synthesis: Inductive/Deductive thematic analysis to classify frameworks, approaches, methods, and data sources

METHODS & FINDINGS FROM INDIVIDUAL REVIEWS

Quantifying the Health Impacts of Food

A Scoping Review of True Cost Assessment Methods

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ACKNOWLEDGEMENTS

Core research team: This scoping review was conducted by Flaminia Ortenzi (1), Kerstin Damerau (2), Eleonora Bassetti (2), Julia Boedecker (1), Natasha Bishop (3), Estefania Marti Malvido (4), Stella Nordhagen (1), Ty Beal (1) and Wendy Gonzalez (1).

Contributors: The core research team received support and feedback by Aurélie Reynier (5), Ninja Lacey (6), Daniel Mason-D'Croz (7), Teresa Miguel (2), Lucia Dal Balcon (1), Annette Mongina Nyangaresi (1), and María Rodríguez Sánchez (4).

1. Global Alliance for Improved Nutrition

2. Independent consultant, Global Alliance for Improved Nutrition

3. Virginia Tech

4. True Price Foundation

5. Access to Nutrition Initiative

6. Netherlands Food Partnership

7. Cornell University

DECLARATION OF INTERESTS

Estefania Marti Malvido is employed by the True Price B.V (KVK number: 70048959). All other members of the core research team have no competing interests to declare.

FUNDING

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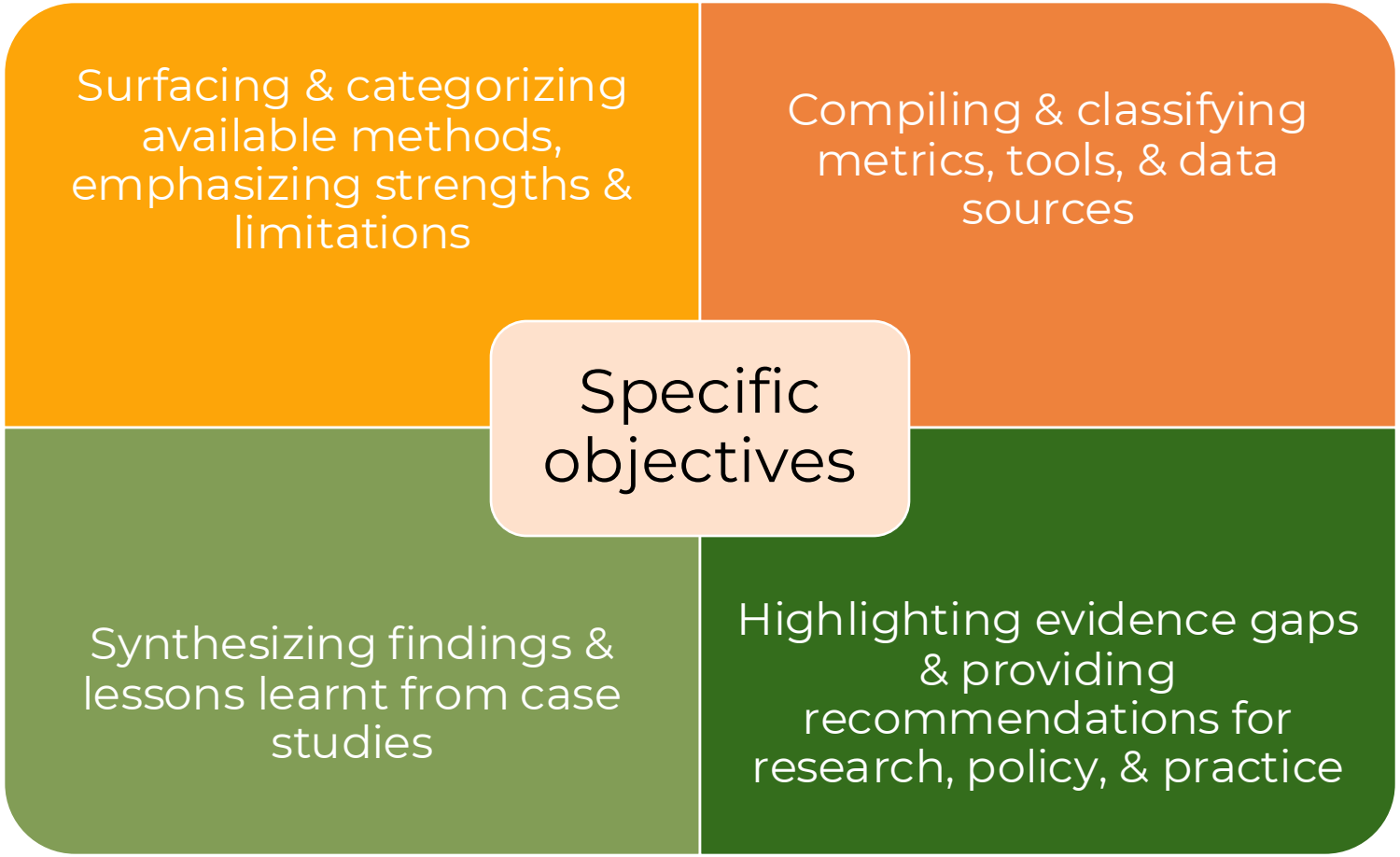
RATIONALE AND OBJECTIVES

- Health costs represent approximately **70% of the total hidden costs** of global food systems (estimated at **USD 11.6 trillion** annually).
- However, there is **no standardised economic valuation framework**. Methodologies for assessing health externalities are diverse and fragmented.
- This is the **first scoping review** mapping methods, metrics, tools, and data sources for quantifying and monetising **both positive and negative** health impacts of **foods and diets**, across the **entire value chain**.
- Aims to identify critical evidence gaps and provide recommendations for future research, policy, and practice priorities.

Sources: FAO, 2024; Çinar et al., 2024

RESEARCH QUESTIONS AND OBJECTIVES

- **Primary research question:** *What **metrics, methods, tools, and data sources** are available for quantifying and monetizing health externalities associated with the production and consumption of individual foods, food groups, meals, or whole diets?*
- We also aimed to identify **practical applications** of existing methodologies at various geographic levels.



METHODS: Process overview (1/2)

- ❑ Chose a scoping review approach given the **breadth of research questions**, the field's **emerging nature**, and the need to capture **diverse study designs** and evidence types.
- ❑ Followed a **registered protocol** based on the JBI methodology and PRISMA-ScR.

(1) SEARCH STRATEGY

- Searched for relevant records published between **January 1, 2008 & February 22, 2025**
- Comprehensive search strategy comprising 3 key concepts: **TCA; health externalities; foods & diets**
- Searched **5 academic** & **11 grey literature databases**

(2) EVIDENCE SELECTION

- Used **Covidence** systematic review software
- Assessed record eligibility against predefined **inclusion & exclusion criteria**
- **Title/abstract & full-text screening** conducted by two independent reviewers, with a third resolving conflicts

Sources: Tricco et al., 2018; Peters et al., 2024

METHODS: Process overview (2/2)

(3) DATA CHARTING

- Employed a **standardised data charting form**
- Adopted a **hybrid human-AI** approach (Claude 3.7 Sonnet)
- AI calibration via **iterative prompting**, testing, and refinement
- Human reviewer **resolved discrepancies** and merged datasets

(4) EVIDENCE SYNTHESIS

- **Descriptive statistics:** Frequencies to map the evidence distribution
- **Qualitative analysis:** Inductive thematic analysis to classify and summarise methods, metrics, tools, and data sources
- **Narrative synthesis:** Linked cross-cutting findings and lessons from case studies to actionable recommendations

Sources: Tricco et al., 2018; Peters et al., 2024

METHODS: Eligibility criteria

Aspect considered	Inclusion criteria	Exclusion criteria
Population	Any human population group	Hospitalized patients or those with medically required special diets
Concept	Records discussing quantitative methods for both assessing and monetising health externalities associated with the production or consumption of foods, food groups, meals, or whole diets	Studies focusing solely on non-health externalities, non-food sectors, single nutrients, agriculture/food systems at large, or the economic burden of diseases Records with unclear methodology, lacking monetisation, or purely qualitative approaches
Context	Any geographic setting, including specific contexts (e.g., schools, farms)	Hospitals and other medical/treatment facilities
Evidence sources	Academic manuscripts in scientific journals, working/discussion papers, reports, methodological guidelines & tools, books & book chapters from academic publishers	Publication types other than those listed under the inclusion criteria Records for which the full text is not accessible through institutional subscriptions, open-access platforms, or Interlibrary loan services
Timeframe	Records published between January 1, 2008 and February 22, 2025	Records published prior to 2008
Language	English-language records	Records published in languages other than English

Source: Peters et al., 2024

METHODS: Data charting form

Section 1: Record details											
Full citation in Harvard style	Publication type	Geographic focus	Country income group/s	Target setting/s	Target population group/s	Primary research question/s	Secondary research question/s	Assessment level/s: foods, food groups, meals, whole diets	Food/meal/ diet type/s	Positive health externalities	Negative health externalities

Section 2: Key variables of interest										
Quantification methods	Monetisation methods	Indicators/ metrics	Tools	Data sources & access	Strengths	Limitations	Application examples	Key findings	Lessons learnt and research/policy recommendations	Methodological recommendations

Source: Peters et al., 2024

METHODS: Qualitative analysis

Iterative, fully data-driven process:

Identification

1. **Reviewed the extracted information** on methods for all included records
2. Clustered similar approaches into separate **Quantification Method Typologies** (QMTs) and **Monetization Method Typologies** (MMTs)

Merging

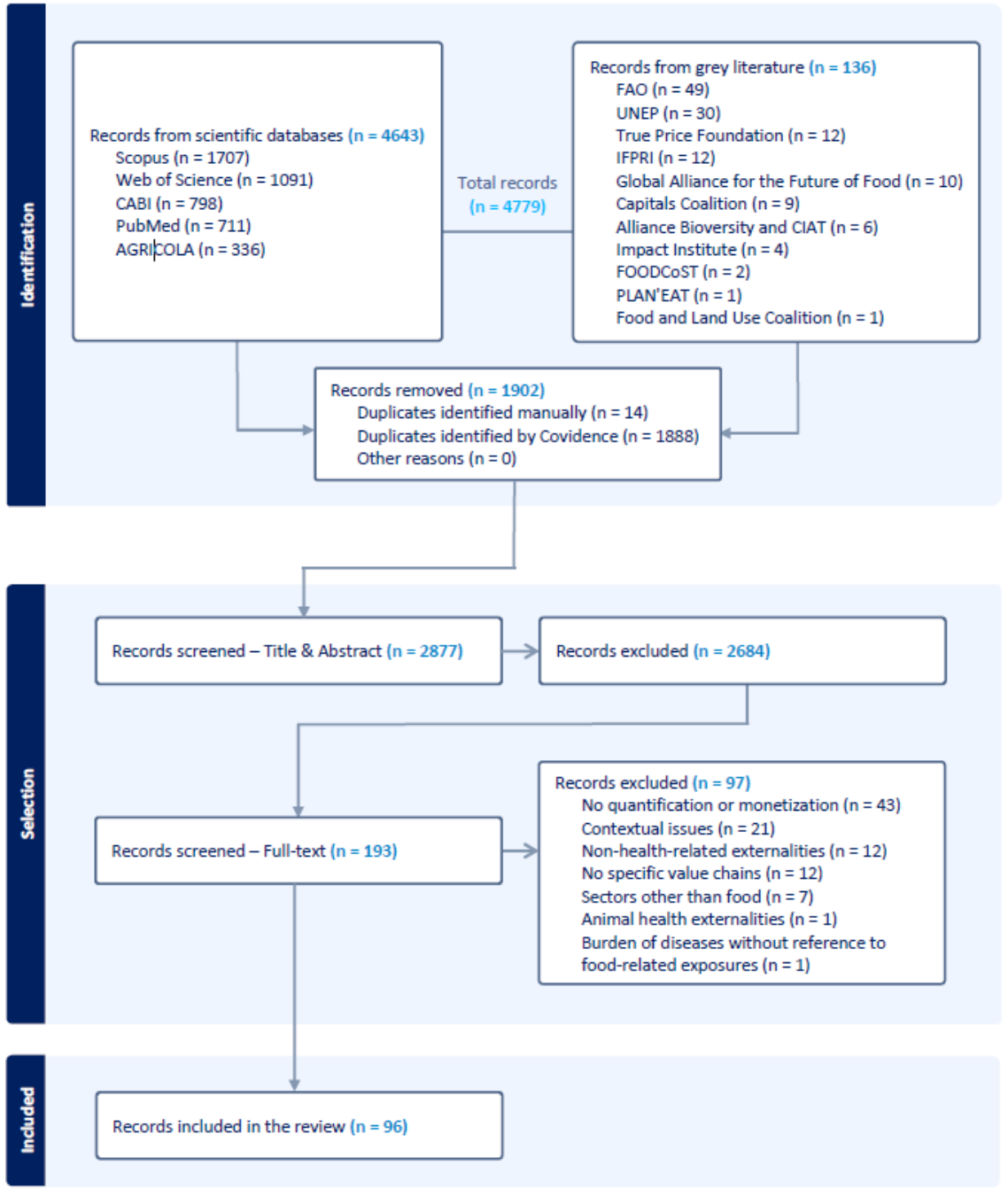
3. Merged each QMT with its matching MMT to obtain combined **Quantification and Monetization Method Typologies** (QMMTs)

Profiling & consolidation

4. Compiled a list of **unique strengths, limitations, and recommendations** for improvement for each QMMT
5. **Continuously reshaped and consolidated** QMMTs as each new record was analysed

PUBLICATION TYPES & RESEARCH FOCUS

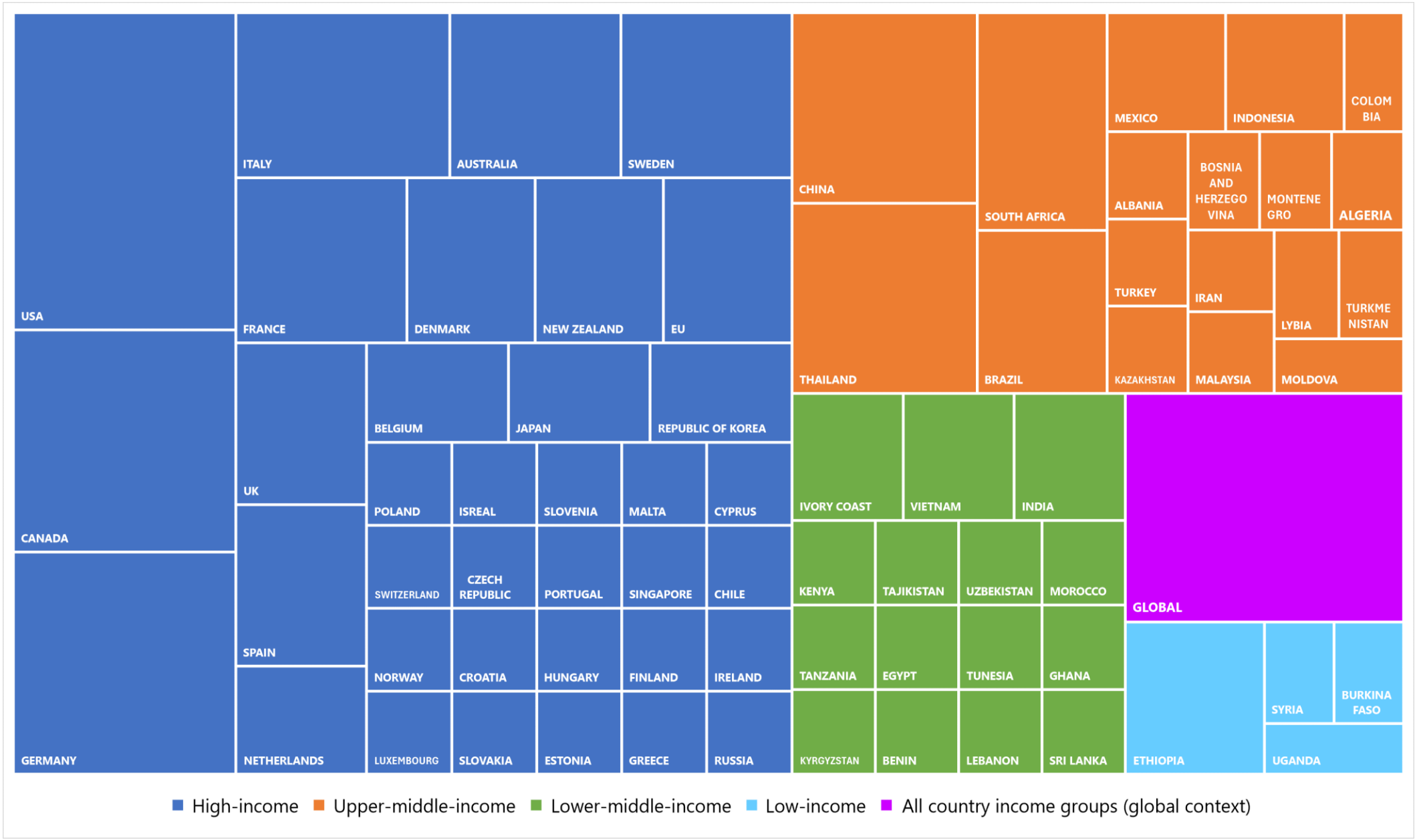
- **Large body of literature**, characterized by **high heterogeneity**.
- Health externalities were the **primary focus** of **half of records** (51%).
- **Publication types:** Most records were **academic manuscripts** (76%), followed by technical reports (11%), working papers (5%), books or book chapters (5%), and methodological guidelines (2%).



PRISMA flow diagram of the literature search and selection processes

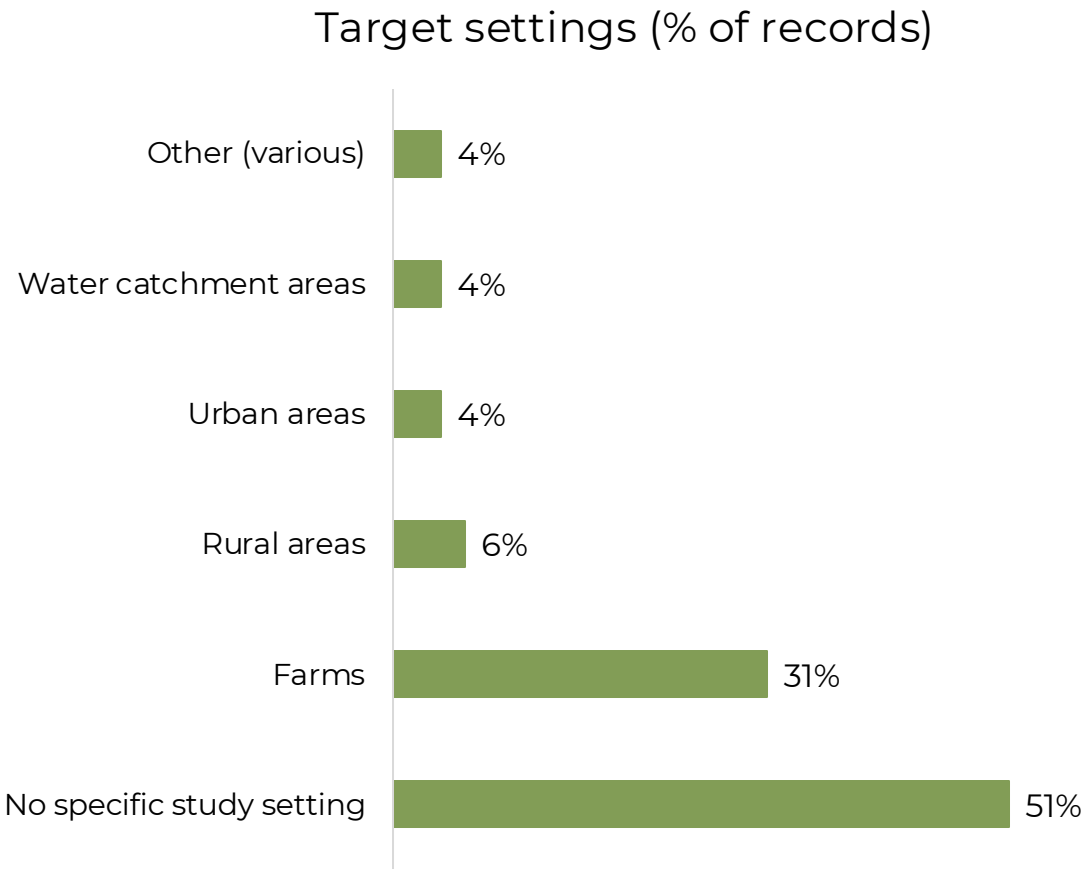
Sources: Tricco et al., 2018

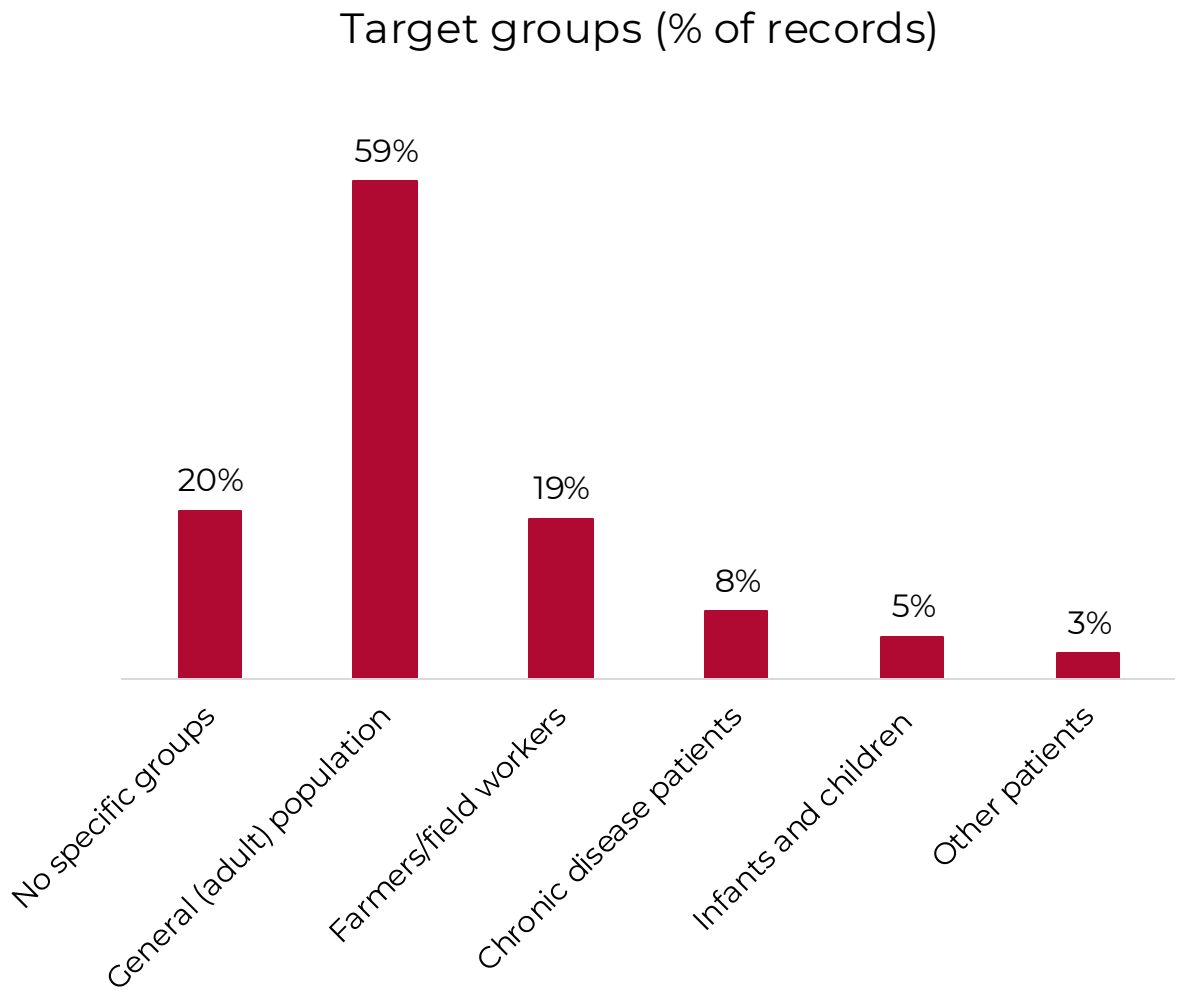
GEOGRAPHIC & INCOME DISTRIBUTION



Source: World Bank, FY 2026

TARGET SETTINGS & POPULATION GROUPS

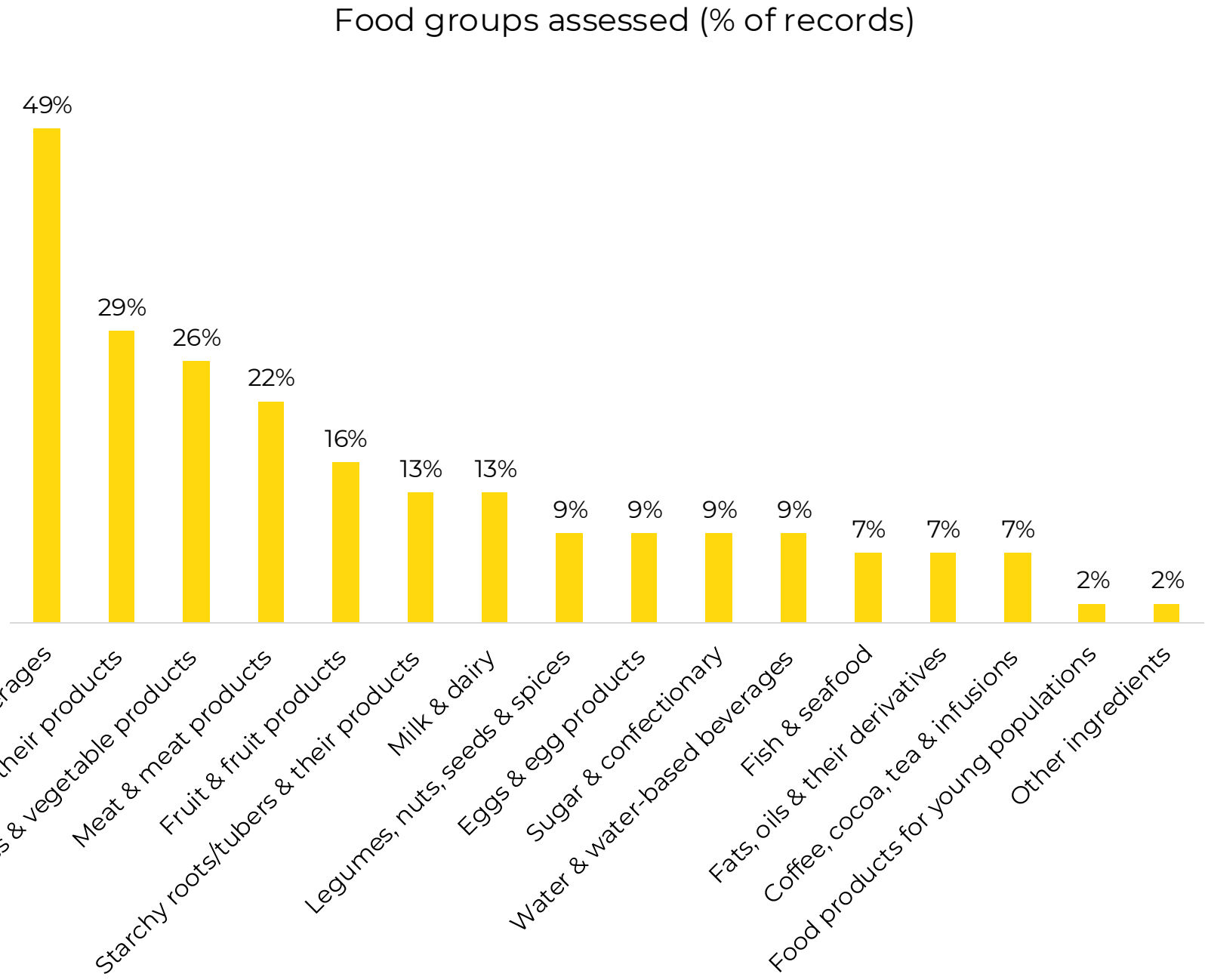




Food system roles: 57% focused exclusively on **consumers**; 13% on supply chain actors; and 14% on both.

FOOD GROUP CATEGORISATION

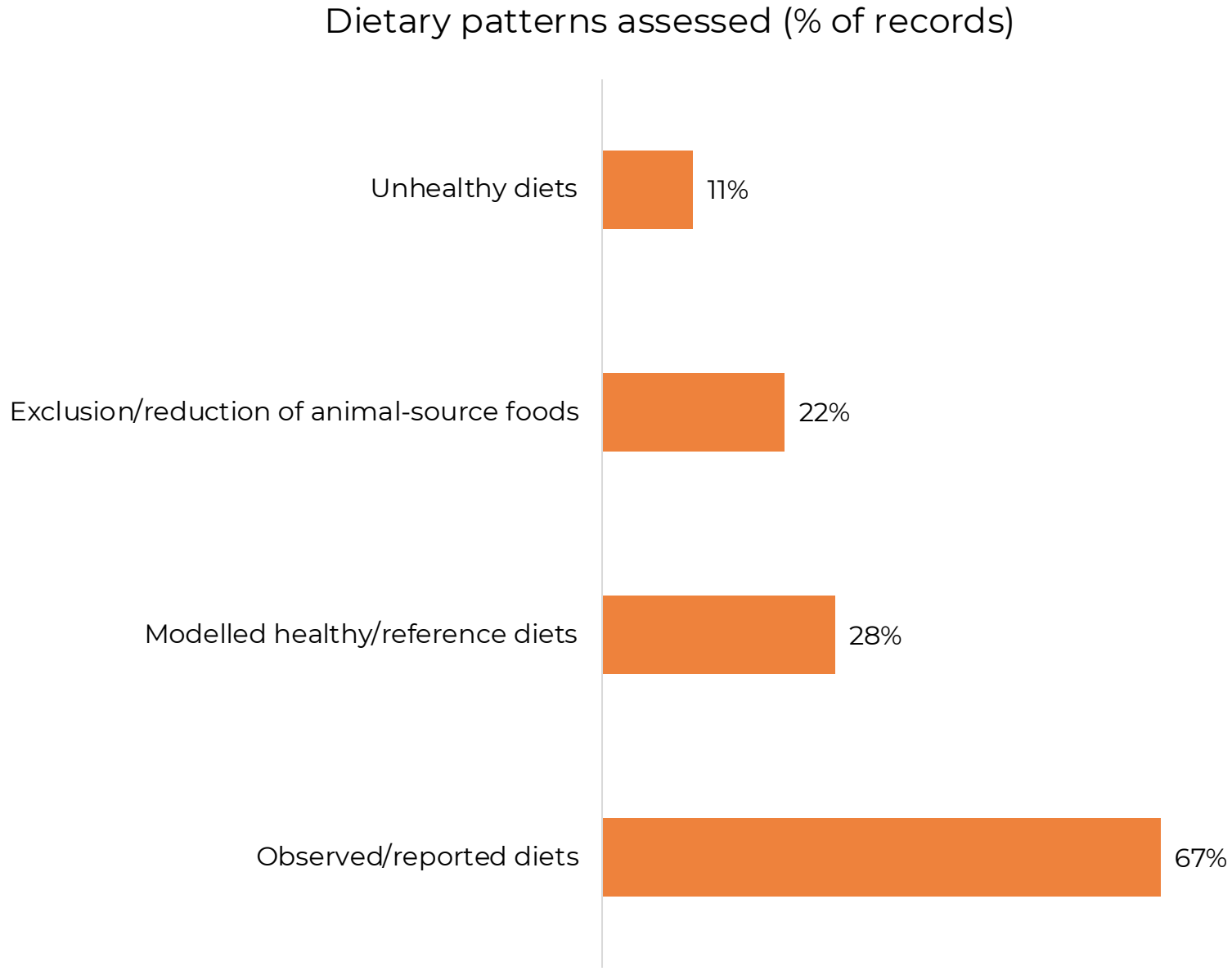
- **Assessment level:** Most records quantified externalities at the **food group (57%) or individual food (53%) levels.**
- **Most frequent: alcoholic beverages** (49%); cereals (29%); vegetables (26%); meat (22%).
- **Limited attention:** legumes/nuts/seeds and eggs (9% each); fish/seafood (7%).



Source: European Food Safety Authority (EFSA), 2015

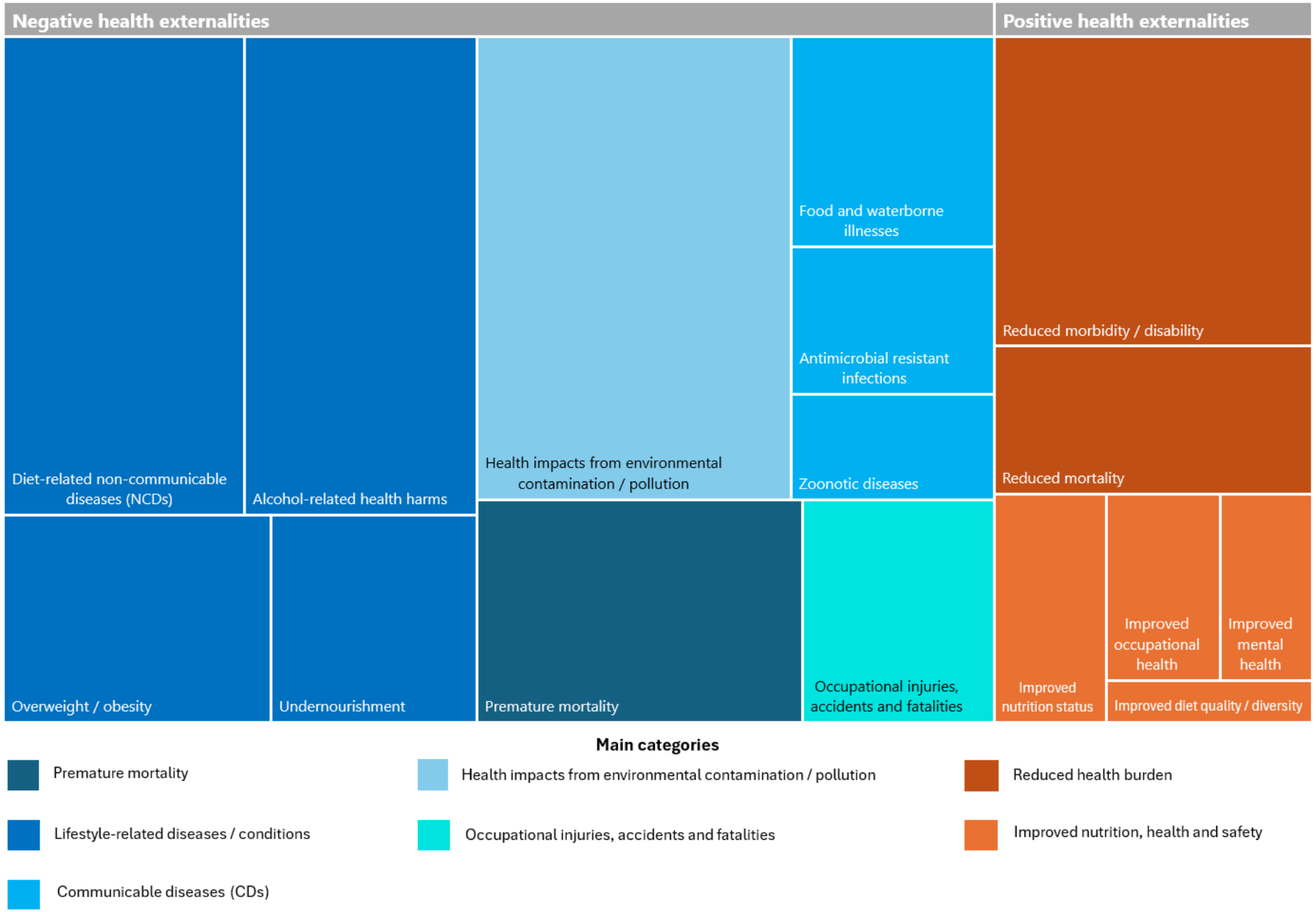
DIETARY PATTERN CATEGORISATION

- **Assessment level: 19%** quantified health costs of **whole diets**, while only 2% focused on meals.
- Breakdown of dietary patterns characterized by **exclusion or reduction of animal-source foods**:
  - Vegan (n=3)
  - Vegetarian (n=3)
  - Pescetarian (n=3)
  - Flexitarian (n=2)
  - Plant-based (n=1)
  - No-red-meat (n=1)



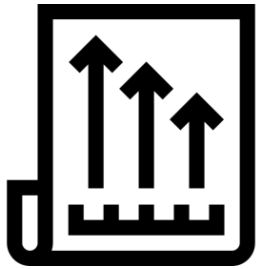
Source: European Food Safety Authority (EFSA), 2015

HEALTH EXTERNALITIES



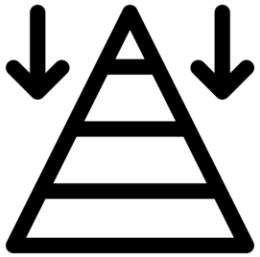
INDICATOR CATEGORIES & SPECIFIC METRICS	% OF RECORDS
1. Burden of disease	**84**
• Disability-Adjusted Life Years (DALYs)	36
• Disease incidence	21
• Mortality rate	18
• Disease prevalence	15
• Years of Life Lost (YLLs), Years of Potential Life Lost (YPLLs), Life Years Gained (LYGs)	13
• Morbidity rate	13
• Quality-Adjusted Life Years (QALYs)	9
• Accident or injury incidence / frequency / severity rates	9
• Hospitalization rate	4
• Avoidable / avoided morbidity and mortality	3
• Prevalence of food insecurity / undernourishment (e.g., protein-energy malnutrition)	3
2. Cost of health impacts	**78**
• Direct costs at individual level	54
• Indirect costs at individual level	49
• Societal costs (e.g., government / public health expenditures)	19
• Proportion of Gross Domestic Product (GDP) or Gross National Income (GNI)	15
• Avoidable / Preventable costs at individual level	15
3. Productivity losses (including from absenteeism and presenteeism)	**27**
4. Monetary value of life and health (e.g., value of DALYs; Value of a Statistical Life – VSL; Value of a Statistical Life Year – VOLY)	**23**
5. Human health impacts from environmental hazards	**22**
• Human toxicity (carcinogenic and non-carcinogenic)	14
• Pesticide exposure indices / levels	8
6. Diet quality / diversity indicators	**5**

HIGH-LEVEL APPROACH CATEGORISATION



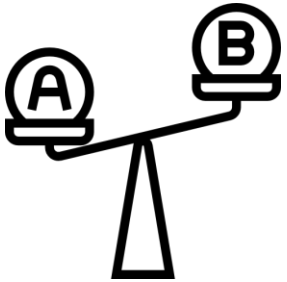
BOTTOM-UP (26%)

- **Primary collection of context-specific data** (e.g., through surveys, clinical records) or specialised local risk assessment.
- Geographic coverage: **subnational or national**.
- Top challenges: (i) risk of **bias**; (ii) **attributing impacts** and establishing **causality**; (iii) lack of **generalisability**



TOP-DOWN (63%)

- Reliance on macro-scale **secondary data** sources (e.g., GBD, FAOSTAT) and standardised value transfer.
- Geographic coverage: **national, regional, or global**.
- Top challenges: (i) reliance on **assumptions**; (ii) risk of **ecological fallacy**; (iii) failure to capture **subnational nuances**.



COMPARATIVE (10%)

- Combined use of **primary and secondary data** sources to compare different production, consumption, or policy/intervention **scenarios**.
- Geographic coverage: **from subnational to global**.
- Top challenges: (i) **input data** quality; (ii) **assumptions** in epidemiological modelling; (iii) **attributing impacts**.

PROFILING OF 7 QMMTs

Top-down approach using cost-of-illness based on relative risks and population attributable fractions (27% of records)

Definition	Core strengths	Core limitations	Main methodological recommendations
The burden of disease attributable to an exposure is quantified via a **top-down approach** which combines **population-level exposure** data with **relative risk** estimates to calculate **population attributable fractions**. This attributable burden is then monetized using a comprehensive **cost-of-illness framework** that sums direct and indirect costs from system-level data.	• Allows for the analysis of a **wide range** of risk factors, exposure levels, and health outcomes • Uses **well-established methodological approaches**, reputable secondary data sources, and internationally comparable monetary units	• Risk of **ecological fallacy** • Use of population attributable fractions **assumes a causal relationship** between exposure and outcome based on epidemiological associations	• **Disaggregate analyses** by region / province and key demographic variables • Reduce the risk of ecological fallacy by exploring alternative modelling approaches like **individual-level simulations**

PROFILING OF 7 QMMTs

Secondary data modelling & monetization via standardized value transfer for large-scale impact assessment (26% of records)

Definition	Core strengths	Core limitations	Main methodological recommendations
A wide range of health, environmental, and social impacts are quantified and monetized at a **macro level**, by synthesizing and adapting data from **large-scale international databases** (e.g., GBD, FAOSTAT) and existing **literature**. Impacts are quantified via well-established **modelling frameworks** (e.g., CRA, LCA), then monetized by applying **standardized unit values** (e.g., cost per DALY) from prior studies.	• Enables comprehensive, **large-scale assessments** (at national, regional, and global level) where primary data collection is unfeasible • Uses **well-established methodologies**; standardized data sources, metrics, and monetization factors; and internationally comparable monetary units	• Risk of **oversimplifying** complex exposure-disease causal pathways and **neglecting relevant exposures** • Heavy reliance on large-scale models and databases which (i) may lack **transparency**; (ii) fail to capture **subnational variation**; and (iii) raise **equity** concerns in cross-country comparisons	• Use **country- or region-specific** epidemiological data and monetization factors whenever available • Refine **impact attribution approaches** to link dietary risks to health outcomes

PROFILING OF 7 QMMTs

Primary data-driven impact valuation using cost-of-illness or willingness-to-pay approaches (18% of records)

Definition	Core strengths	Core limitations	Main methodological recommendations
Health and well-being impacts are assessed by collecting **primary data** on exposures, health outcomes, and associated expenditures from an affected population. The quantified externalities are then valued using either the **cost-of-illness method**, or a **willingness-to-pay approach**.	• **Relies on primary data** collected directly from the affected population • Uses **statistical and econometric modelling** to link specific exposures with health impacts and associated costs	• High **risk of bias** inherent in survey-based primary data collection from often **small, non-random samples** • Challenges in **attributing health impacts** to specific exposures, especially in cross-sectional designs	• Use **larger, more representative samples**, to improve generalizability • Supplement self-reported information with **objective data** to improve reliability and validity

PROFILING OF 7 QMMTs

Life Cycle Assessment (LCA) with monetization using transferred or contextualized unit values (10% of records)

Definition	Core strengths	Core limitations	Main methodological recommendations
Diverse environmental and associated human health impacts are quantified **across a product's life cycle** via the standardized LCA framework. The quantified externalities are then monetized by applying **unit values transferred** from existing economic valuation studies, often adjusted for the specific study context.	• Uses well-established **LCA protocols**, software and databases; common impact metrics; and standardized characterization and monetization factors • Enables the identification of **environmental and health 'hotspots'** within the value chain	• Standard LCA often **excludes** the health impacts of **food consumption** and does not account for **long-term or cumulative** health effects • Heavy reliance on **global average input data** and characterization factors	• Develop and apply more specific, validated **emission and characterization factors** for human health impacts • **Integrate LCA** with other health impact assessment methods (e.g., CRA)

PROFILING OF 7 QMMTs

Economic evaluation of policies and interventions based on health effectiveness modelling (10% of records)

Definition	Core strengths	Core limitations	Main methodological recommendations
The **economic efficiency** of a specific policy or intervention is evaluated by employing epidemiological modelling to assess its **impacts on health outcomes**. An economic evaluation framework (e.g., **Cost-Benefit, Cost-Effectiveness, or Cost-Utility Analysis**) is then applied to compare the intervention's costs with its health benefits.	• Directly **informs** policy and programmatic **decision-making** and resource allocation • Can model complex, **dynamic** behavioural and health processes and impact pathways over **long time horizons**	• Long-term health benefits of preventive policies and interventions are **inherently uncertain** • Challenges with **impact attribution** to the specific policy or intervention under study	• When possible, use health impact data from **experimental study designs** • Incorporate interactions among **concurrent interventions** and account for **confounding**

PROFILING OF 7 QMMTs

Cost-of-illness for third-party harms based on epidemiological metrics and attributable fractions (4% of records)

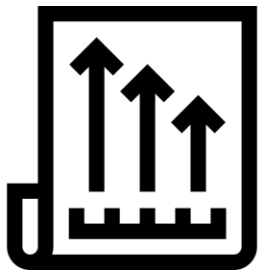
Definition	Core strengths	Core limitations	Main methodological recommendations
The health burden of harms incurred by third parties is estimated by using **epidemiological metrics** and **attributable fractions** to link an exposure to adverse outcomes. A **cost-of-illness framework** is then applied to value the associated societal costs.	• Captures societal costs **borne by third parties**, which are often excluded from standard economic analyses • Primarily relies on data from **official administrative records**	• Challenges in establishing a clear **causal link** between exposures and third-party harms • Likely to **underestimate** the total burden due to under-reporting and intangible costs	• Develop more reliable data collection techniques for **sensitive harm categories** • Use more robust, **context-specific** epidemiological data and statistical models

PROFILING OF 7 QMMTs

Pesticide risk indexing for impact assessment and monetary valuation (4% of records)

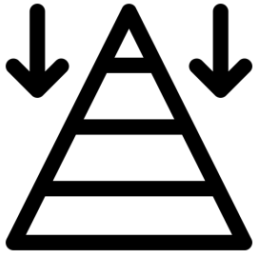
Definition	Core strengths	Core limitations	Main methodological recommendations
The potential human and environmental health risks of pesticides are quantified using a **component-based index** method. Risk levels are then monetized by applying **unit costs** for different impact indicators, often within an integrated framework like the **Pesticide Environmental Accounting (PEA)** model.	• Allows to **compare the relative risks** of different pesticides, active ingredients, and application modes • Simplifies complex toxicological data and impact pathways into a standardized, understandable **index score**	• Component-based indices provide a measure of **potential risk** rather than actual harm • Aggregation of diverse impacts into a single, weighted index involves **subjectivity** and may obscure important **trade-offs**	• Use **context-specific data** for pesticide application rates and formulation, and environmental parameters • **Disaggregate results** to show risks to different receptors and environmental compartments

MAPPING QMMTs TO APPROACH CATEGORIES



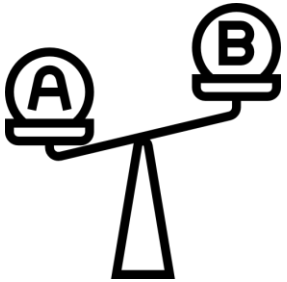
BOTTOM-UP (26%)

- **Primary data-driven impact valuation** using COI or WTP approaches (18%)
- **COI for third-party harms** based on epidemiological metrics and attributable fractions (4%)
- **Pesticide risk indexing** for impact assessment and monetary valuation (4%)



TOP-DOWN (63%)

- **Top-down approach using COI** based on relative risks and population attributable fractions (27%)
- **Secondary data modelling** & monetisation via standardized value transfer for large-scale impact assessment (26%)
- **LCA with monetisation** using transferred or contextualised unit values (10%)



COMPARATIVE (10%)

- **Economic evaluation of policies and interventions** based on health effectiveness modelling (10%)

TOOLS & DATA SOURCES CATEGORISATION

Tool category	Main purpose and use case	# of unique tools	% of records
LCA models, tools, and software	To manage Life Cycle Inventory data, conduct Life Cycle Impact Assessments, and calculate environmental and associated human health impacts.	17	19%
Health impact assessment and costing models and tools	To estimate the health and economic burden of specific diseases or conditions.	8	9%
Foresight modelling tools	To simulate future scenarios and project the potential impacts of policies or interventions on health, environmental, and/or socioeconomic outcomes.	11	8%
(Non-LCA) Environmental impact assessment and costing models and tools	To model environmental processes and quantify their associated impacts and economic costs.	6	7%
TCA and True Pricing models and tools	To apply the specific principles and frameworks of TCA and True Pricing to monetize and internalize externalities.	4	5%
Calculators and tools developed by UN agencies	To ensure international standardization and cross-country comparability in environmental and health impact assessments and costing.	4	4%
Calculators and tools developed by EU bodies	To ensure European-level standardization and cross-country comparability in environmental and health impact assessments and costing.	1	1%
Total		**51**	**54%**

DATA SOURCE CATEGORY	MAIN PURPOSE AND USE CASE	# of unique data sources	% of records
National and regional institutional databases and resources	To obtain official (sub)national or regional statistics on demographics, dietary patterns, health outcomes, economic indicators, and food systems performance.	308	89%
Academia and research institutes	To source scientific literature and published studies for parameters like relative risks, dose-response functions, emissions, characterization factors, and economic values.	100	80%
Databases and repositories by UN agencies	To access internationally standardized, multi-country or global data on demographics, nutrition, health, agriculture, environment, economics, and labour from UN agencies.	18	53%
Primary data	To collect new, context-specific information directly from target populations or entities through surveys, interviews, or direct measurement and observation.	35	35%
Technical reports, guidelines, and frameworks by UN agencies	To use methodological guidelines, conceptual frameworks, and programmatic reports from UN agencies, for obtaining reputable information and technical guidance.	13	30%
Databases and repositories by EU bodies	To access official, standardized data on demographics, nutrition, health, agriculture, environment, economics, and labour for EU member states.	26	28%
(Non-LCA) Environmental impact databases and inventories	To source specific data on environmental processes, emissions, and impacts from specialized (non-LCA) databases.	27	25%
Market data and consumer insights	To obtain data on market prices, consumer behaviour, and industry trends from market research firms and commercial data providers.	17	18%
TCA and True Pricing databases and inventories	To use pre-existing health and environmental impact data and monetization factors from established TCA and True Pricing frameworks and initiatives.	8	16%
LCA frameworks, databases, and inventories	To source Life Cycle Inventory input and output data, characterization factors, and methodological guidance for conducting LCA.	19	11%
Non-governmental and civil society organizations	To use methodological guidelines, conceptual frameworks, programmatic reports, datasets, and other resources published by NGOs and CSOs.	26	9%
Health impact assessment and costing databases and inventories	To source specialized data on the health burdens and economic costs of diseases/conditions.	1	1%
Datasets for foresight modelling and simulations	To obtain input data and parameters for running future-oriented simulation models.	1	1%
Total		599	397%

KEY FINDINGS FROM CASE STUDIES

COSTS ARE HIGH, HIDDEN, AND UNDERVALUED (64%)

- Negative externalities are consistently substantial, with **indirect costs** often outweighing direct expenses
- Current estimates likely **underrepresent** the true burden *and* value of food systems

DIET-RELATED NCDs ARE THE LARGEST CONTRIBUTOR

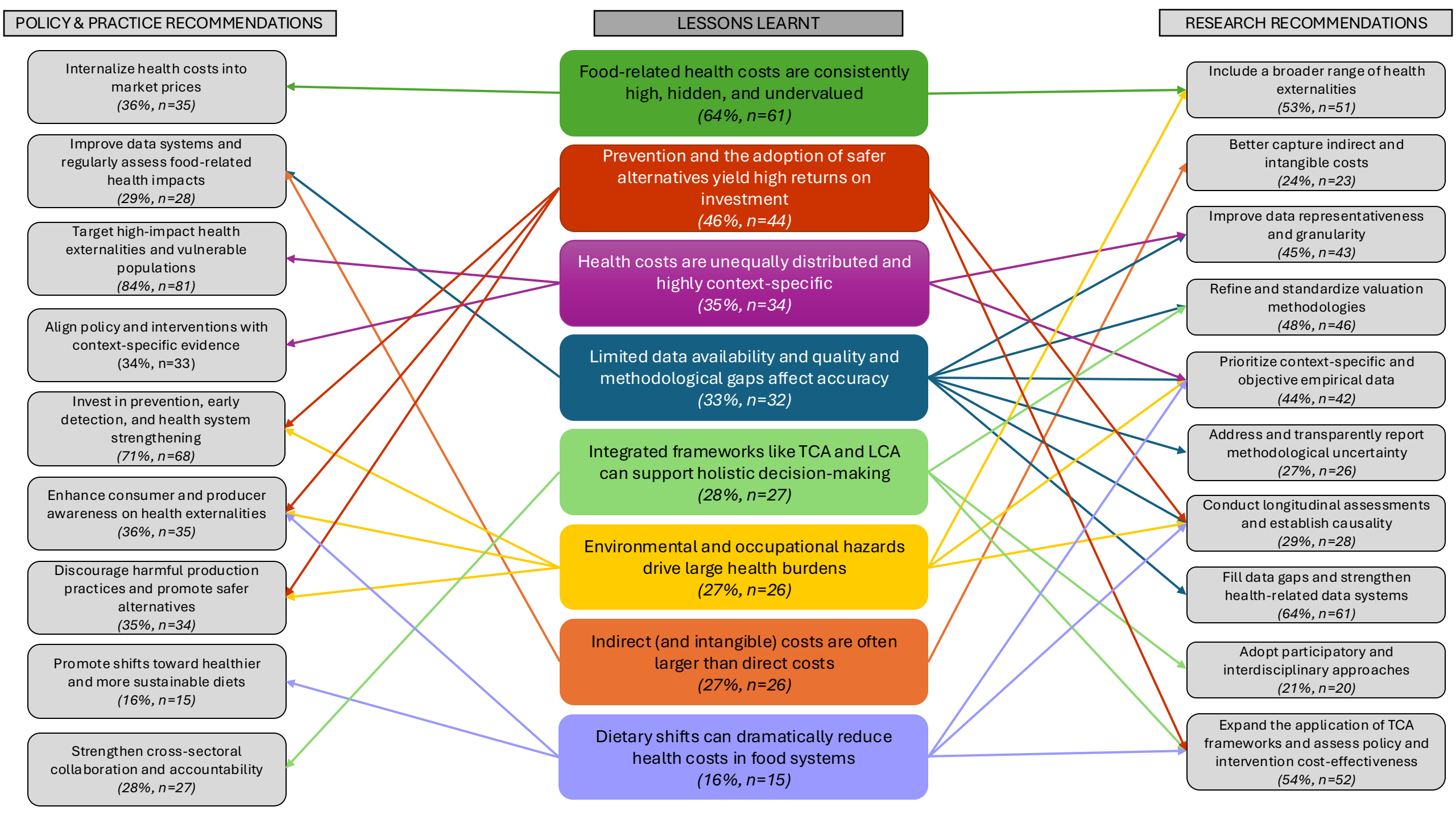
- Estimated at **USD 8.1–9.8 trillion annually** in large-scale assessments
- Primary **risk factors**: insufficient consumption of food groups beneficial to health and excessive intake of unhealthy options

ALCOHOL & ENVIRONMENTAL EXPOSURE ARE MAJOR CHALLENGES

- Alcohol-related harms impose economic burdens of **0.5–5.4% of GDP**
- Health costs from **pesticide exposure** can offset up to 64% of productivity gains from pesticide use

OCCUPATIONAL & FOODBORNE HAZARDS ARE NEGLECTED

- Food/waterborne illnesses impose high burdens, especially in LMICs – estimated at **0.9–3.0% of GNI**
- Health costs of occupational injuries/fatalities are substantial but **infrequently assessed**


POLICY & PRACTICE RECOMMENDATIONS
LESSONS LEARNT
RESEARCH RECOMMENDATIONS
Internalize health costs into market prices (36%, n=35)
Improve data systems and regularly assess food-related health impacts (29%, n=28)
Target high-impact health externalities and vulnerable populations (84%, n=81)
Align policy and interventions with context-specific evidence (34%, n=33)
Invest in prevention, early detection, and health system strengthening (71%, n=68)
Enhance consumer and producer awareness on health externalities (36%, n=35)
Discourage harmful production practices and promote safer alternatives (35%, n=34)
Promote shifts toward healthier and more sustainable diets (16%, n=15)
Strengthen cross-sectoral collaboration and accountability (28%, n=27)
Food-related health costs are consistently high, hidden, and undervalued (64%, n=61)
Prevention and the adoption of safer alternatives yield high returns on investment (46%, n=44)
Health costs are unequally distributed and highly context-specific (35%, n=34)
Limited data availability and quality and methodological gaps affect accuracy (33%, n=32)
Integrated frameworks like TCA and LCA can support holistic decision-making (28%, n=27)
Environmental and occupational hazards drive large health burdens (27%, n=26)
Indirect (and intangible) costs are often larger than direct costs (27%, n=26)
Dietary shifts can dramatically reduce health costs in food systems (16%, n=15)
Include a broader range of health externalities (53%, n=51)
Better capture indirect and intangible costs (24%, n=23)
Improve data representativeness and granularity (45%, n=43)
Refine and standardize valuation methodologies (48%, n=46)
Prioritize context-specific and objective empirical data (44%, n=42)
Address and transparently report methodological uncertainty (27%, n=26)
Conduct longitudinal assessments and establish causality (29%, n=28)
Fill data gaps and strengthen health-related data systems (64%, n=61)
Adopt participatory and interdisciplinary approaches (21%, n=20)
Expand the application of TCA frameworks and assess policy and intervention cost-effectiveness (54%, n=52)

KEY CHALLENGES: Methodological and data gaps

1. SCOPE-SPECIFICITY TRADE-OFF

- The literature is dominated by large-scale, **top-down approaches (63%)** that are comprehensive but **fail to capture local specificities** and evolving food system dynamics.
- Conversely, granular **bottom-up studies (26%)** are limited in scope and **lack standardization and generalizability**.

2. MICRONUTRIENT DEFICIENCY GAP

- Absence of studies that **monetise** malnutrition impacts from **micronutrient deficiencies** while directly linking these burdens to **underlying dietary patterns**.
- This is a crucial evidence gap leading to the **underestimation** of food-related health costs.

3. STATIC, SIMPLISTIC MODELLING

- Current epidemiological modelling oversimplifies complex **individual-diet-environment interactions**, generating large uncertainties.
- Cost-effectiveness analyses often assume an ‘average individual’, neglecting **vulnerable population sub-groups**.

KEY CHALLENGES: Ethical and implementation barriers

1. COMMODIFYING HEALTH

- Recommending the **internalisation of health costs** into food prices (36% of records) commodifies human life and health within existing, growth-oriented markets.
- No clarification on how to avoid **regressive impacts** on vulnerable population groups.

2. UNDER-RESEARCHED AREAS

- Key externalities like **food/waterborne diseases, antimicrobial resistance (AMR), and occupational hazards** remain under-researched or lack consistent evidence.

3. POLICY INERTIA

- Even where robust, consistent evidence exists (e.g., alcohol-related harms, consumption of sugar-sweetened beverages), **industry lobbying** often prevents the adoption of necessary regulatory measures.

A PATH FORWARD: Priority research directions

1. LEVERAGE METHODS COMPLEMENTARITY

- Future research must move beyond the top-down/bottom-up dichotomy.
- Prioritise designing integrative approaches that combine comprehensive, **standardised modelling** with **context-specific primary data**.

2. INTEGRATE NEGLECTED EXTERNALITIES

- Build upon existing methods to monetise malnutrition impacts from **micronutrient deficiencies** to **directly link** these burdens to underlying **dietary patterns**.
- Include other under-researched, data-scarce externalities such as **mental health impacts, AMR, occupational deaths/injuries,** and **consumer risks from pesticide residues**.

3. ADDRESS CAUSALITY

- Conduct **longitudinal assessments** in addition to cross-sectional studies, to better establish **causal relationships** between food/diet exposures and health outcomes.

A PATH FORWARD: Methodological refinement & implementation

1. EQUITY-FOCUSED ANALYSIS

- Methods must account for cross- and within-country **population heterogeneity and context specificities**.
- Quantifying the health costs of dietary shifts must consider **differential demographic impacts**.

2. STRENGTHEN DATA SYSTEMS

- Improve collection of data on productivity losses in informal labour markets and among non-working populations.
- Invest in collecting data **disaggregated by demographic and socioeconomic characteristics** and geographic location, especially in data-scarce contexts like LMICs.

3. IMPROVE TRANSPARENCY & STANDARDIZATION

- Refine and standardise valuation methodologies and transparently report **methodological uncertainty** through probabilistic modelling and sensitivity analysis.

4. POLICY & INTERVENTION EVALUATION

- Comprehensive **impact evaluations** and **cost-benefit analyses** of TCA-informed policies and programmes are critically needed to assess their effectiveness in minimizing externalities.

5. EMBRACE COLLABORATION

- Adopt **participatory and interdisciplinary approaches** that involve policymakers, value chain actors, and communities in co-developing valuation tools and research questions.

CONCLUSION:
Take-home messages

- **Magnitude of impacts & costs:**
  - Food-related health costs are overwhelmingly driven by indirect productivity losses from **diet-related diseases**.
  - Current literature likely **underestimates** the true burden and value of food systems.
- The field is defined by a **scope-specificity trade-off** between comprehensive but generalised top-down models and context-specific but non-standardised bottom-up studies.
- To serve as a robust policy tool, TCA must become more **methodologically rigorous** and **inclusive**, capturing a broader range of externalities and geographic settings, and disaggregating results for vulnerable sub-groups.

Quantifying the Environmental Impacts of Food

A Review of True Cost Assessment Methods

Members of the research Consortium:

NFP Netherlands Food Partnership

gain Global Alliance for Improved Nutrition

True Price™

ATNi NUTRITION MARKETS IMPACT

ACKNOWLEDGEMENTS

Core research team: This structured review was conducted by Flaminia Ortenzi (1),Kerstin Damerau (2), Eleonora Bassetti (2), Estefania Marti Malvido (3), Julia Boedecker (1), Natasha Bishop (4), Wendy Gonzalez (1), Ty Beal (1), and Stella Nordhagen (1).

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1. Global Alliance for Improved Nutrition

2. Independent consultant, Global Alliance for Improved Nutrition

3. True Price Foundation

4. Virginia Tech

5. Access to Nutrition Initiative

6. Netherlands Food Partnership

7. Cornell University

DECLARATION OF INTERESTS

Estefania Marti Malvido is employed by the True Price B.V (KVK number: 70048959). All other members of the core research team have no competing interests to declare.

FUNDING

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RATIONALE AND OBJECTIVES

- Several narrative reviews exist on monetisation methods for valuing environmental impacts in **non-food sectors** or within **food systems as a whole**; however…
- …This is the **first structured review** of existing frameworks, approaches, methods, and data sources for quantifying and monetising **both positive and negative** environmental externalities of **foods and diets**, across the **entire value chain**.
- Aims to identify critical evidence gaps and provide recommendations to guide future research and applications.

Sources: de Groot Ruiz et al., 2018; Markandya, 2023; Amadei et al., 2021

METHODS: Process overview (1/2)

- ❑ Chose a structured literature review to balance the need for greater **methodological rigor** than in a narrative review and more **flexibility** than in a scoping / systematic review.
- ❑ Followed a **pre-developed protocol** based on adapted versions of the PRISMA-ScR and Campbell Collaboration materials.

(1) SEARCH STRATEGY

- Searched for relevant records published between **January 1, 2018 & April 11, 2025**
- Comprehensive search strategy comprising 3 key concepts: **TCA; environmental externalities; foods & diets**
- Searched **3 academic** & **8 grey literature databases**

(2) EVIDENCE SELECTION

- Used **Covidence** systematic review software
- Assessed record eligibility against predefined **inclusion & exclusion criteria**
- **Title/abstract & full-text screening** conducted by two independent reviewers, with a third resolving conflicts

Sources: Grant and Booth, 2009; Cornell University Library, 2024; Tricco et al., 2018; Campbell Collaboration

METHODS: Process overview (2/2)

(3) DATA CHARTING

- Employed a **standardised data charting form**
- Variables captured: (1) **Study scope** & context; (2) **Assessment level** & types of foods or diets analysed; (3) **Environmental externalities**; (4) **Monetisation methods** & data sources; (5) Author-stated **strengths, limitations**, & **recommendations**

(4) EVIDENCE SYNTHESIS

- **Descriptive statistics:** Frequencies and percentages to map the evidence distribution
- **Qualitative synthesis:** Thematic analysis to classify and summarise frameworks, approaches, methods, and data sources used

Sources: Grant and Booth, 2009; Cornell University Library, 2024; Tricco et al., 2018; Campbell Collaboration

METHODS: Eligibility criteria

Aspect considered	Inclusion criteria	Exclusion criteria
Population & Context	Records on foods, food groups, meals, or whole diets in any geographical/population settings, covering any number of food system value chain stages, from primary agricultural production to household consumption and waste treatment	Records focusing solely on non-food systems/sectors, non-environmental externalities, or on oral nutritional supplements
Concept	Records discussing methods to quantify and monetise environmental externalities (positive/negative) of foods and diets	Records not including a monetisation component, or that do not explicitly report their methodology for quantifying and valuing environmental impacts
Evidence sources	Academic manuscripts in scientific journals, working/discussion papers, reports, methodological guidelines & tools, books & book chapters from academic publishers	Publication types other than those listed under the inclusion criteria Records for which the full text is not accessible through institutional subscriptions, open-access platforms, or Interlibrary loan services
Timeframe	Records published between January 1, 2018, and April 11, 2025	Records published prior to 2018
Language	English-language records	Records published in languages other than English

Source: Peters et al., 2024

METHODS: Data charting form

Section 1: Record details									
Full citation in Harvard style	Publication type	Geographic focus	Country income group(s)	Value chain stage(s)	Reference period(s) of input data	Primary research question(s)	Secondary research question(s)	Assessment level(s): foods, food groups, meals, whole diets	Food/meal/ diet type(s)

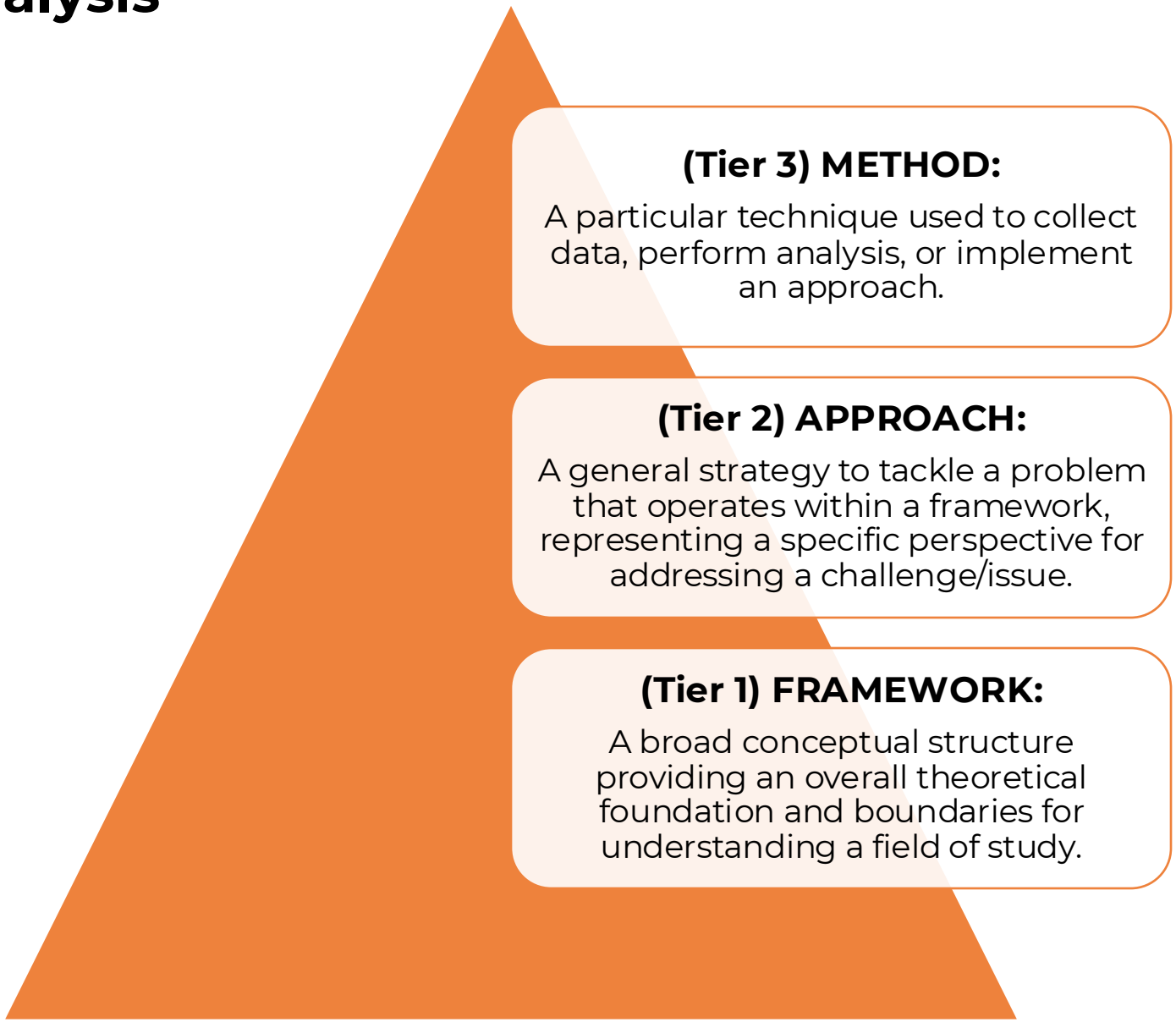
Section 2: Key variables of interest							
Positive environmental externalities	Negative environmental externalities	Monetisation methods	Data sources used (impact quantification)	Data sources used (monetisation factors)	Author-stated strengths of the approach	Author-stated limitations of the approach	Author-stated research recommendations

***Extra:** Additional areas for methodological improvement (not explicitly mentioned by the original authors)

Source: Peters et al., 2024

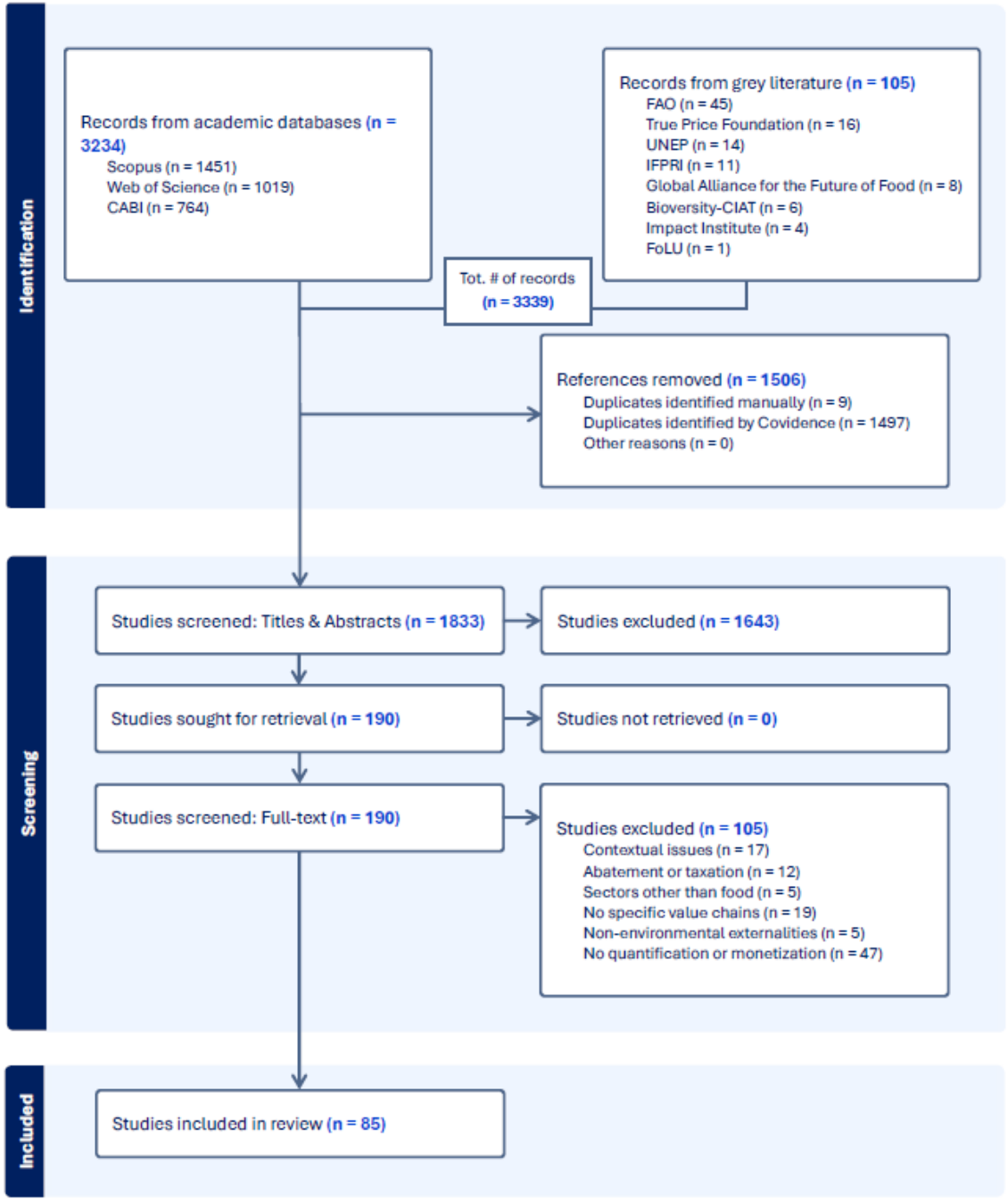
METHODS: Qualitative analysis

Each study was thematically categorised against three levels of analysis



PUBLICATION TYPES & DATA AGE

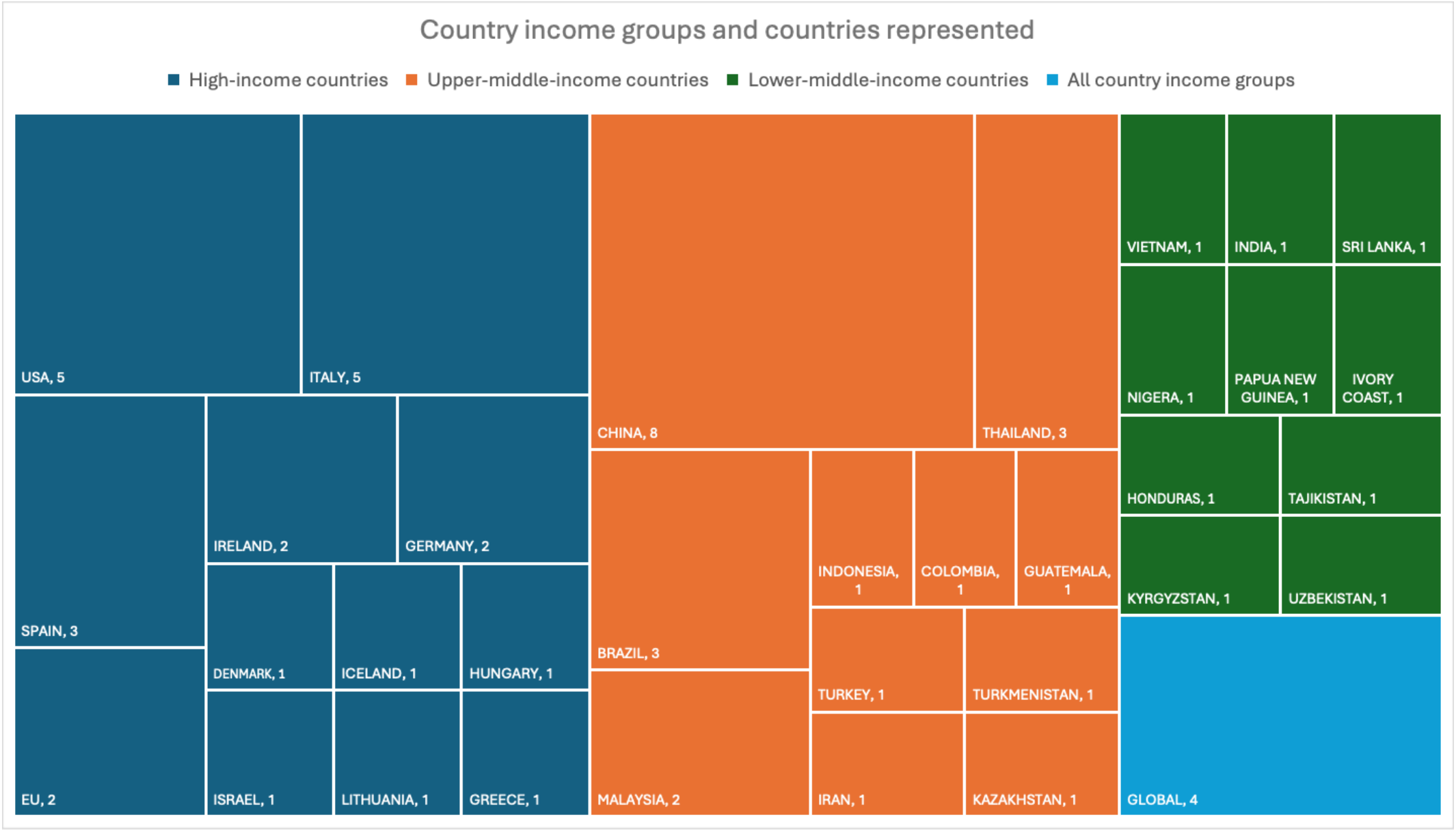
- **Large body of literature**, characterized by **high heterogeneity**.
- **Publication types:** Most records were **academic manuscripts** (83%), followed by technical reports, conference proceedings, working papers, and methodological guidelines.
- **Data age:** About **one-third** (34%) used a **mix of recent** (<10 years) **and older** (>10 years) **data or data of uncertain age**. One-fifth (20%) did not provide information on data age.



PRISMA flow diagram of the literature search and selection processes

Sources: Tricco et al., 2018

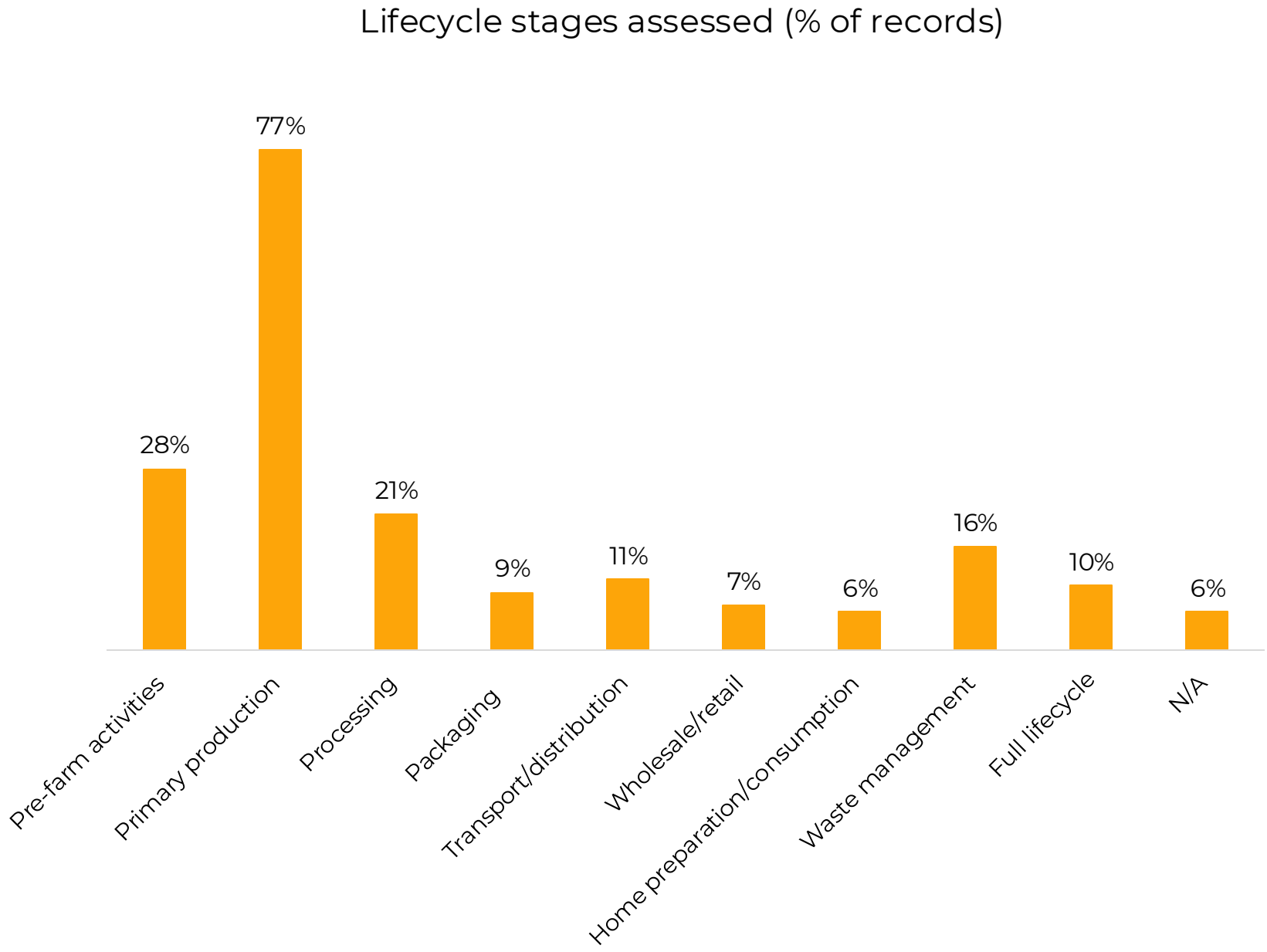
GEOGRAPHIC & INCOME DISTRIBUTION



Source: World Bank, FY 2026

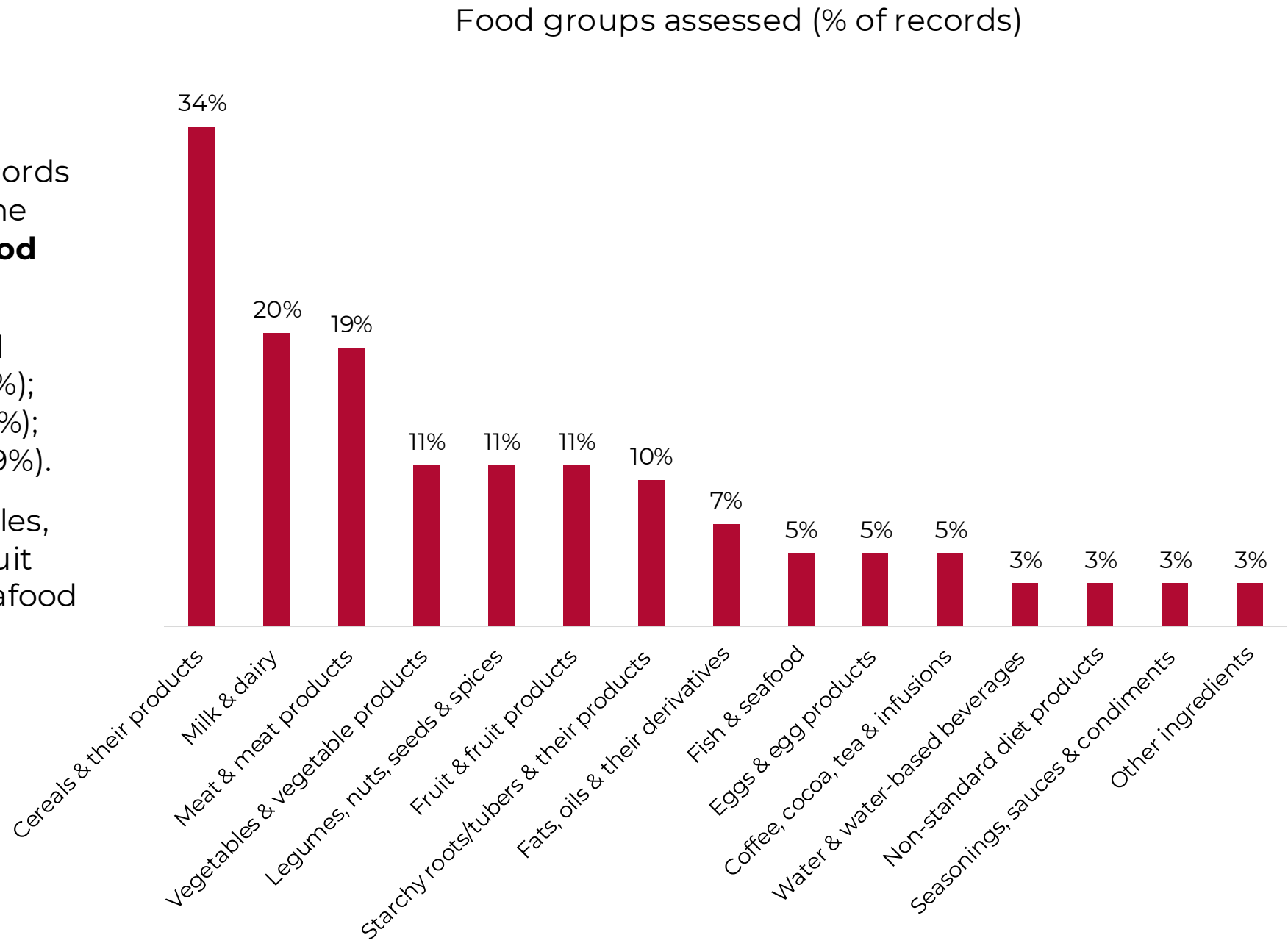
FOOD SYSTEM SEGMENTS

- **Primary production** was the most frequently analyzed lifecycle stage (77%).
- Other common lifecycle stages: **pre-farm activities** (28%) and **processing** (21%).
- **Only 10% of records considered the full lifecycle** ('cradle-to-grave'), revealing a fragmented view of food systems.



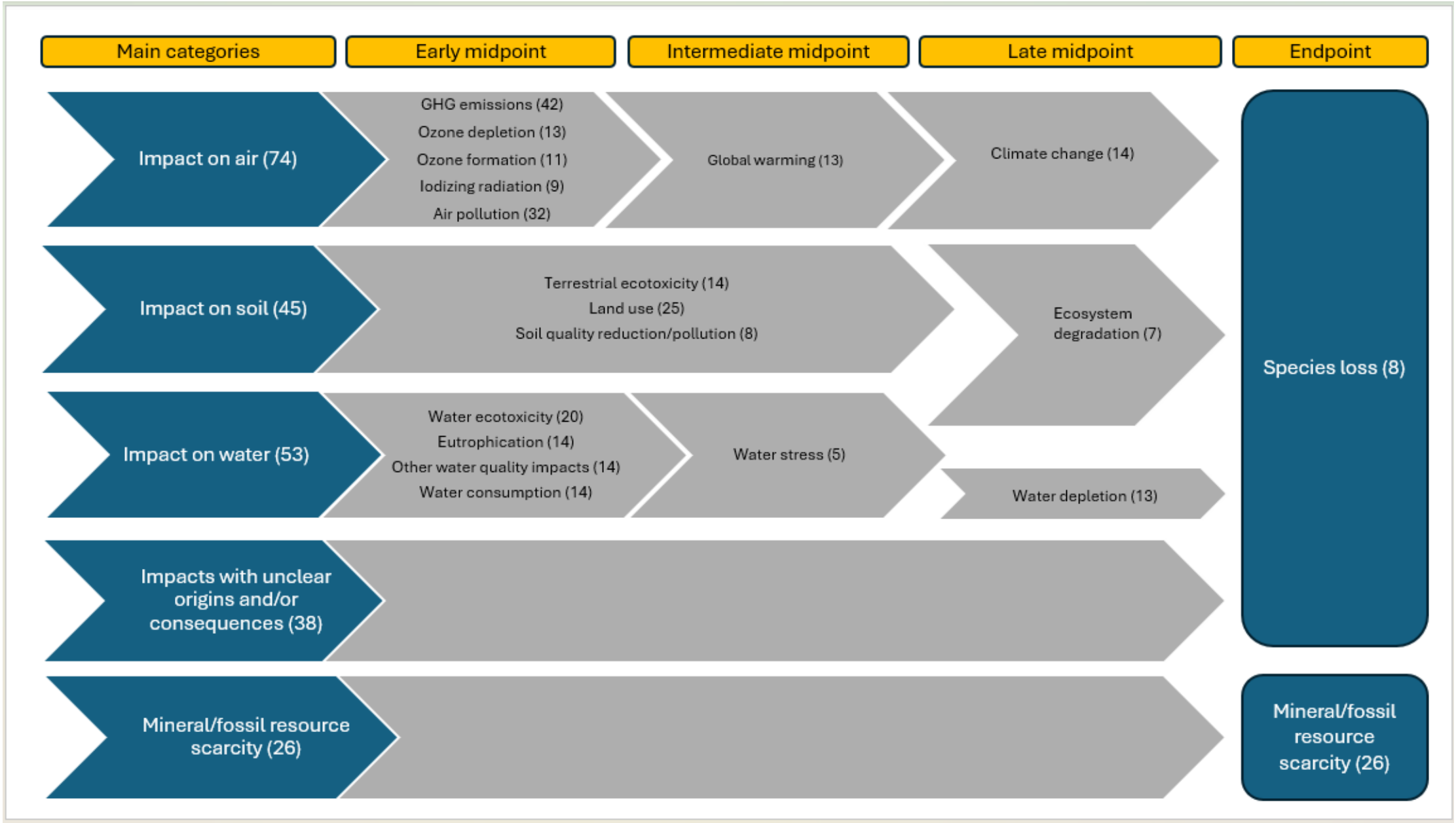
FOOD GROUP CATEGORISATION

- **Assessment level:** Most records quantified externalities at the **individual food (78%) or food group (11%) levels.**
- **Most frequent: cereals and cereal-based products** (34%); milk and dairy products (20%); meat and meat products (19%).
- **Limited attention:** vegetables, legumes/nuts/seeds, and fruit (11% each); eggs and fish/seafood (5% each).

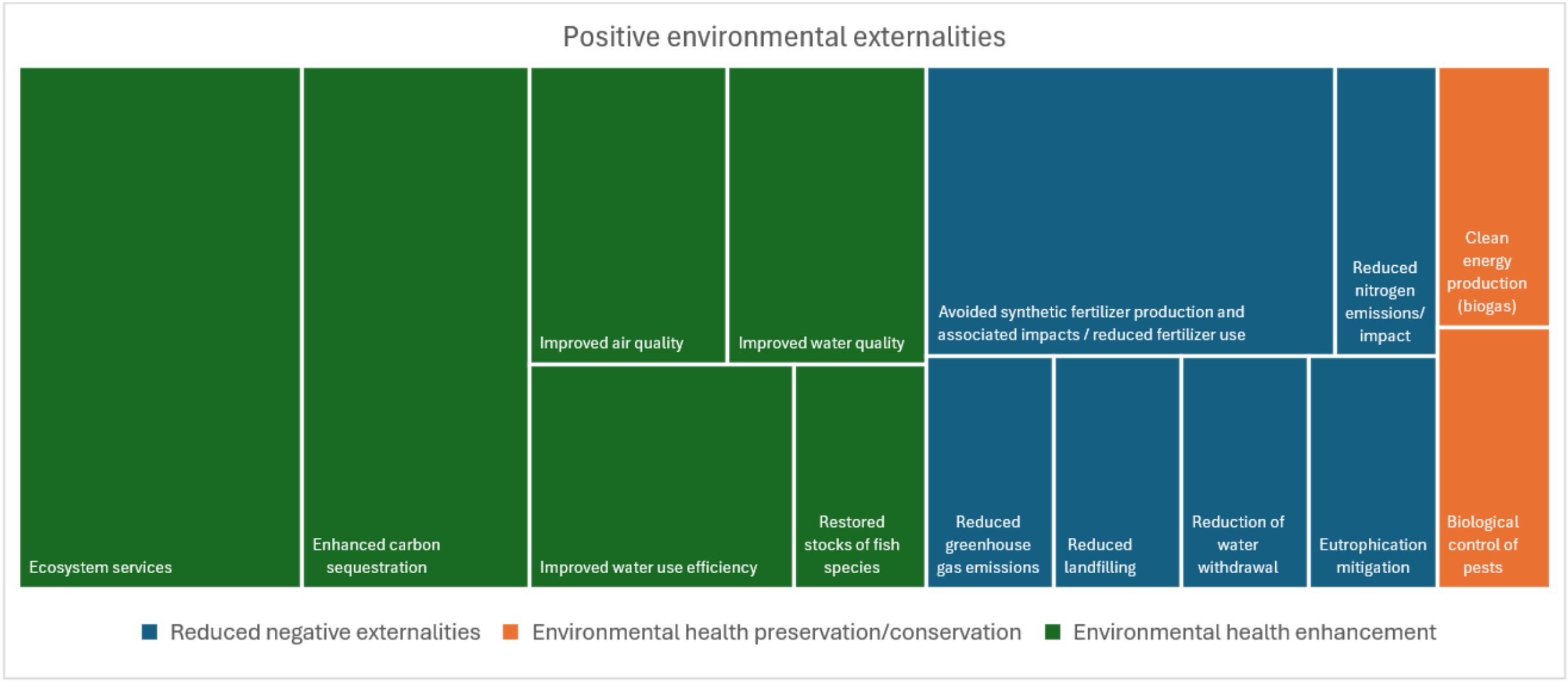


Source: European Food Safety Authority (EFSA), 2015

NEGATIVE ENVIRONMENTAL IMPACTS



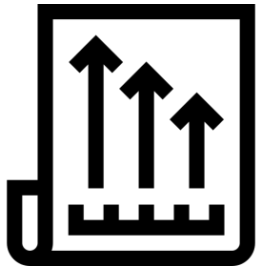
POSITIVE ENVIRONMENTAL IMPACTS



DOMINANT FRAMEWORK

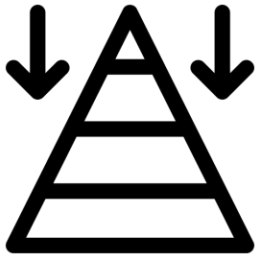
- All reviewed studies can be placed within an **environmental economics framework**.
- **Theoretical foundations:** Rooted in neoclassical economic theory.
- **Perspective:** Environmental externalities are seen as **market failures**.
- **Primary objectives:** Prioritisation of economic growth and **internalisation of externalities** into market prices for more efficient resource allocation.
- **Proposed solutions**: Policy and regulations to **adjust market prices, influence consumer behaviour**, and/or compensate for environmental degradation.

APPROACH CATEGORISATION



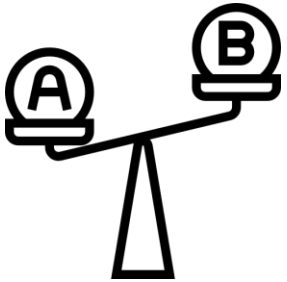
BOTTOM-UP (35%)

- **Primary collection of context-specific data** on environmental impacts.
- Geographic coverage: **subnational or national**.
- Primary input data are often **not made publicly available** due to using Life Cycle Assessment (LCA) databases with restricted access.



TOP-DOWN (31%)

- Reliance on **secondary data sources** for impact quantification, e.g., national statistics, LCA databases, published literature.
- Geographic coverage: **national, regional, or global**.
- Use of published/**pre-defined monetisation factors**, adjusted to a given country context and reference year.



COMPARATIVE (36%)

- Combined use of **primary and secondary data sources**.
- Comparison of **different production or consumption patterns**, to assess costs and benefits under various conditions/assumptions.
- Geographic coverage: **from subnational to global**.
- Includes **scenario modelling**.

METHOD TYPOLOGY	TYPOLOGY DEFINITION
Abatement cost	**Reactive expenses** to reduce/eliminate environmental harm that has already occurred. Includes both the direct costs of **pollution control measures** and any associated **opportunity costs**, such as reduced production efficiency.
Compensation/replacement cost	The monetary amount required to **compensate for or replace a lost environmental resource/service** (e.g., the cost of providing equivalent benefits).
Damage/social cost	The total economic **cost imposed on society** by environmental degradation. **Damage cost** usually includes **direct costs only** (e.g., healthcare, property damage), while **social cost** comprises **both direct and indirect costs** (e.g., lost productivity, reduced quality of life).
Ecosystem services	**Benefits** that humans derive from **functioning ecosystems**. Services included: **provisioning** (food, water, timber), **regulating** (climate regulation, water purification), **cultural** (recreation, spiritual values), and **supporting** (nutrient cycling, habitat provision).
Emission pricing/credit	Consists in assigning a price to GHG emissions or pollutants. Includes **carbon pricing**, **cap-and-trade/credit programmes**, and other financial incentives to reduce emissions.
Market price	A monetary value at which goods or services are traded in a competitive market. This also applies to the **price of natural resources** or environmental goods/services **when traded commercially**.
Prevention/Eco-cost	**Proactive expenses** to prevent environmental damage from occurring in the first place, including investments in cleaner technologies, pollution control, or sustainable practices.
Remediation cost	**Reactive expenses** to repair environmental damage that has already occurred (e.g., soil decontamination, water treatment). Can also include preliminary assessments, site investigations, feasibility studies, and remedial actions as per the True Price Principles and methodology.
Restoration cost	**Reactive expenses** required to return a degraded ecosystem to its natural or desired state, with focus on **rebuilding ecological function**.
Shadow price	The implied cost of **resources currently lacking market prices**, typically equated with marginal abatement cost (i.e., the expense of reducing one additional unit of pollution/damage).
Taxation	**Government-imposed levies** used to internalise environmental externalities and **change behaviour**, including carbon taxes or resource extraction taxes.
Willingness-to-pay	The **maximum amount** individuals or society would be willing to pay for an **environmental benefit** or to **avoid an environmental harm**, often measured through surveys.

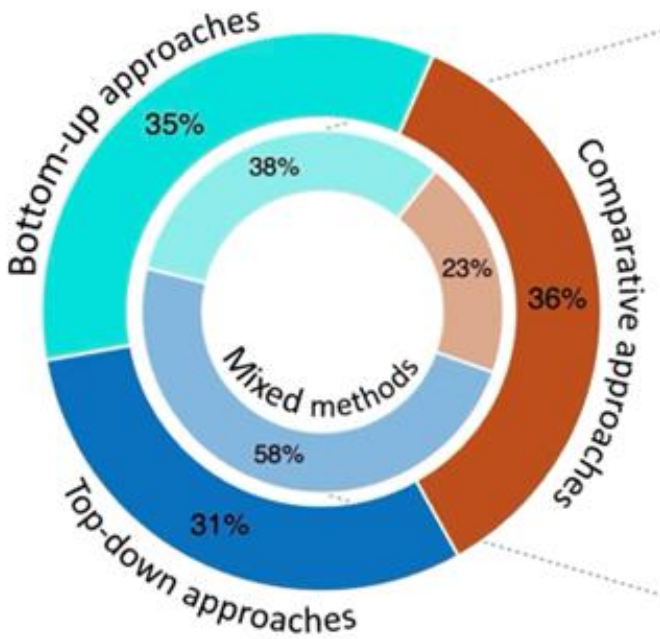
DISTRIBUTION OF APPROACHES AND METHODS

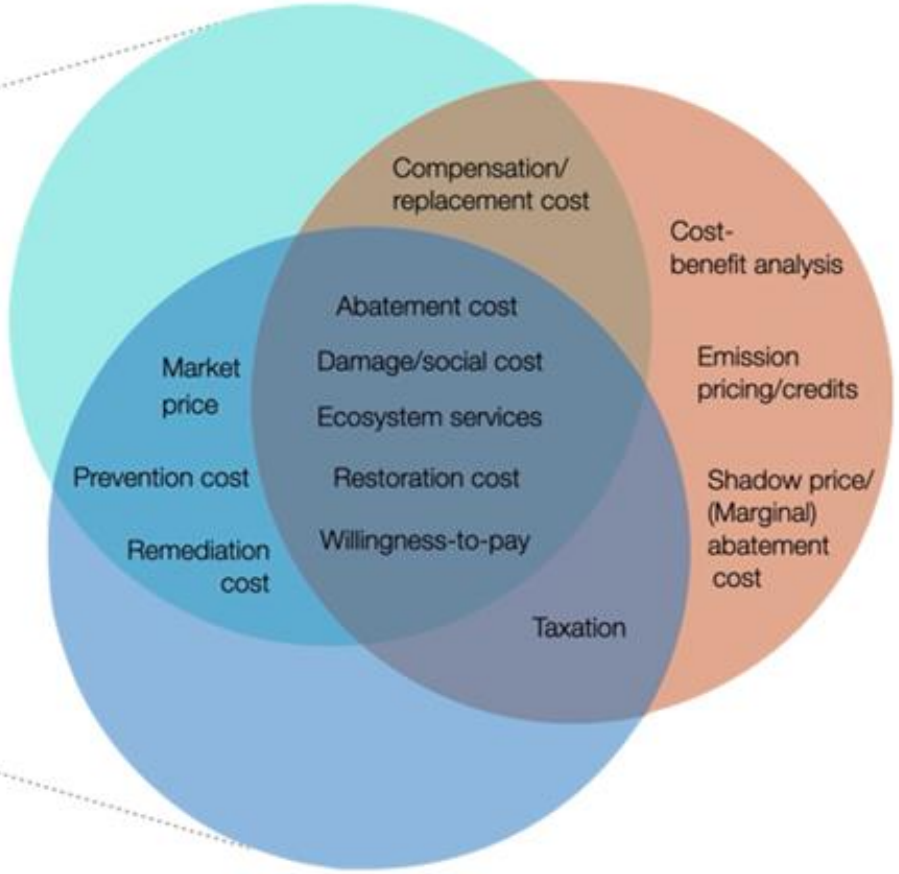
39% of records used a **combination of monetisation methods**; however, **none** of the reviewed studies **provided clear justification** for their choice of methods.

External donut: Frequency of use of approach categories

Internal donut: Frequency of use of mixed monetisation methods across approach categories

Interconnected circles: 13 monetisation methods identified, colour-coded by approach category





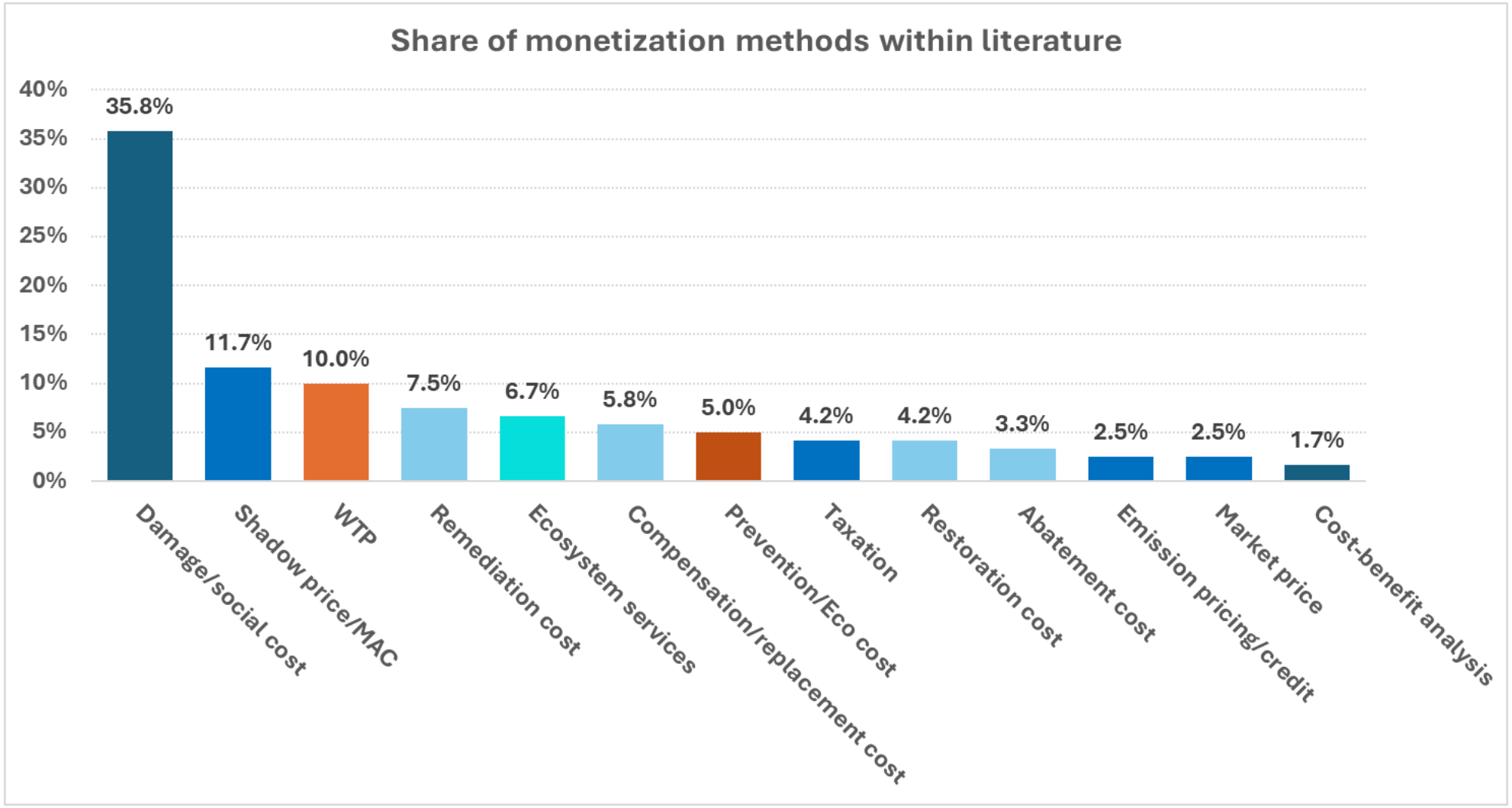
Share of approaches across literature

Share of mixed monetization methods within approaches

Use of monetization methods across approaches

DISTRIBUTION OF APPROACHES AND METHODS

- Only 2 records using damage/social cost applied **progressive cost assumptions** over time.
- While operationalised within an environmental economics framework, two methods can also reflect **ecosystems' inherent value**: prevention/eco-costs and willingness-to-pay.



DATA SOURCE CATEGORY	MAIN PURPOSE OR USE CASE	IMPACT QUANTIFICATION: % OF RECORDS	MONETISATION FACTORS: % OF RECORDS
Academia and research institutes	To obtain parameters like relative risks, dose-response functions, emissions, characterisation factors, and economic values from scientific literature, published studies and datasets.	64%	53%
National/regional institutional databases and resources	To obtain official (sub)national and/or regional statistics on demographics, dietary patterns, economic indicators, food systems performance, and environmental impacts.	59%	40%
LCA frameworks, databases, and inventories	To source Life Cycle Inventory input and output data, characterization factors, and methodological guidance for conducting LCAs.	45%	12%
Resources by UN agencies	To use technical reports, guidelines, conceptual frameworks, and standardised databases produced by UN agencies to obtain methodological guidance and internationally comparable data across sectors.	36%	9%
Primary data	To collect new, context-specific information directly from target populations or entities through surveys, interviews, or direct measurement/observation.	26%	0%
Non-LCA environmental impact databases and inventories	To source specific data on environmental processes, emissions, and impacts from specialised databases.	14%	4%
Datasets for foresight modelling	To obtain specific input data and parameters for running future-oriented simulation models.	9%	7%
Non-governmental (NGOs) and civil society (CSOs) organizations	To use methodological guidelines, conceptual/theoretical frameworks, programmatic reports, datasets, and other resources published by NGOs and CSOs, including on specific local contexts and target population groups.	6%	0%
Market data and consumer insights	To obtain data on market prices, consumer behaviour, and industry trends from market research firms and commercial data providers.	5%	9%
TCA and True Pricing databases and inventories	To use pre-existing environmental impact data and monetary values from established TCA and True Pricing frameworks and initiatives.	2%	25%

AUTHOR-STATED STRENGTHS, LIMITATIONS, & RECOMMENDATIONS

Strengths	%	Limitations	%	Research recommendations	%
Ability to calculate a 'comprehensive' true cost of food production	**28%**	Uncertainties in methodological approaches and/or data modelling	**21%**	Expanding scope/coverage, by including under-researched lifecycle stages and/or externalities	**52%**
Compatibility of methods & results with LCA and/or Life Cycle Costing approaches	**11%**	Narrow scope/coverage of externalities and lifecycle stages	**17%**	Improving research infrastructure, data availability, quality, and context specificity	**49%**
Reliance on established/reputable data sources	**11%**	Use of proxy/global data instead of (sub)national or regional inputs	**15%**	Considering a larger variety of production systems and food products (including novel foods)	**39%**
Ability to compare environmental costs and benefits	**7%**	Uncertainties in monetisation factors due to heavy reliance on assumptions	**10%**	Systematically addressing uncertainty & transparently reporting on assumptions	**38%**
Identification of lifecycle hotspots	**7%**	Limited representativeness or generalisability of assessment results	**8%**	Expanding the application of TCA to underrepresented geographic regions	**32%**
Use of empirical data	**6%**	No author-reported limitations	**11%**	Methodological standardisation to enable cross-study comparability	**16%**
Integration of farm-level data	**5%**			Capturing positive externalities and quantifying longer-term impacts	**11%**
No author-reported strengths	**17%**			No author-reported recommendations	**16%**

REVIEWER-IDENTIFIED AREAS FOR REFINEMENT OF METHODS

ENVIRONMENTAL IMPACT ASSESSMENTS

- Few records quantified **endpoint impacts** (e.g., species loss).
- **No clear rationale/justification** for indicator and impact assessment choices.
- Reliance on **outdated**, non-applicable, and/or non-public **data**, as well as outdated LCA **models**.
- **Direct conversion of methane** from ruminant enteric fermentation or flooded rice paddies **into climate change impacts**.
- Quantification of total freshwater use instead of critical, **non-renewable water use**.
- **Land use** reported as a **distinct impact category**.
- Lack of meaningful **regional findings** in global studies, like critical nitrogen and phosphorus surplus.

IMPACT MONETISATION

- Risk of **obscuring impact-specific solutions** through aggregation of externalities from multiple domains.
- **Subjective weighing** of different impacts.
- Few studies explicitly addressed the **ethical dilemma** of monetising environmental health.
- Repeated confusion around **definitions of monetisation methods** (e.g., social vs. abatement cost; abatement vs. prevention cost).
- Ecotoxicity assessments relying on **broad spatial averages** rather than detailed regional estimates, and/or monetising total freshwater use instead of **unsustainable consumption shares**.
- No accounting for **dynamic changes** in demand and availability when monetising **resource scarcity**.

DISCUSSION: Main challenges in the field

1. LACK OF GLOBAL APPLICABILITY

- Heavy concentration of research and reliance on data from high-income countries.
- A substantial proportion of the world's food is produced by informal smallholders and manufacturers.

2. METHODOLOGICAL ERRORS & INCONSISTENCIES

- The wide variety of approaches & methods, and lack of a clear rationale for selection makes cross-study comparisons difficult.
- Widespread confusion around greenhouse gas, water use, and land use change accounting.

3. INCOMPLETE, STATIC PICTURE

- Positive impacts, downstream environmental hotspots, and the dynamic & interconnected nature of food systems are largely overlooked.

4. REACTIVE OVER PROACTIVE

- The prevalence of damage/social cost assessment methods may reflect practical constraints rather than theoretical preference.

5. LACK OF EMPIRICAL EVIDENCE

- Critical literature gap on whether TCA applications can influence producer behaviour, consumer choices, and environmental outcomes in the real world.

DISCUSSION: A Path Forward

1. EXPAND GEOGRAPHIC COVERAGE

- Prioritize expanding geographic coverage with methodologies adapted to diverse production systems and locally important foods in low- and middle-income countries.

2. IMPROVE METHODS AND TRANSPARENCY

- Develop standardised protocols for method selection and implementation, while allowing for contextual flexibility.
- Increase transparency through data sharing and explicit reporting of assumptions and uncertainties.

3. BROADEN SCOPE & INTEGRATE SYSTEM DYNAMICS

- Expand the analytical scope to incorporate positive externalities & additional lifecycle stages, capture longer-term consequences, and reflect dynamic changes in food value chains.

4. EMBRACE PROACTIVE METHODS

- Move away from reactive social/damage cost assessment and invest in methods that focus on prevention and restoration.

5. VALIDATE IN REAL-WORLD SETTINGS

- Build evidence through case studies that test the effectiveness of food-related TCA in different decision contexts.

CONCLUSION:
Take-home messages

- TCA provides a **promising approach** for making environmental costs visible in food system decision-making. However…
- …its potential is currently limited by a narrow scope, **large applicability gap**, widespread **methodological inconsistencies**, fundamental technical flaws, and lack of empirical evidence.
- Future research should prioritize ongoing **methodological refinement**, expanded geographic coverage, and real-world validation.
- The path forward requires a **collaborative effort** to provide more robust evidence for a sustainable and equitable food system transformation.

Quantifying the Socioeconomic Impacts of Food

A Review of True Cost Assessment Methods

Members of the research Consortium:

NFP Netherlands Food Partnership

gain Global Alliance for Improved Nutrition

True Price™

ATNi NUTRITION MARKETS IMPACT

ACKNOWLEDGEMENTS

Core research team: This structured review was conducted by Eleonora Bassetti (1), Flaminia Ortenzi (2), Annette Mongina Nyangaresi (2), Estefania Marti Malvido (3), Julia Boedecker (2), Natasha Bishop (4), Wendy Gonzalez (2), Kerstin Damerau (1), Ty Beal (2), and Stella Nordhagen (2).

Contributors: The core research team received support and feedback by Aurélie Reynier (5), Ninja Lacey (6), Daniel Mason-D'Croz (7), Pietro Galgani (3), Teresa Miguel (1), and María Rodríguez Sánchez (3).

1. Independent consultant, Global Alliance for Improved Nutrition

2. Global Alliance for Improved Nutrition

3. True Price Foundation

4. Virginia Tech

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6. Netherlands Food Partnership

7. Cornell University

DECLARATION OF INTERESTS

Estefania Marti Malvido is employed by the True Price B.V (KVK number: 70048959). All other members of the core research team have no competing interests to declare.

FUNDING

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RATIONALE AND OBJECTIVES

- While some studies have provided methods and examples for assessing and valuing food system-related socioeconomic impacts, these have not yet been comprehensively reviewed.
- **First structured review** of existing frameworks, approaches, methods, and data sources for quantifying and monetising **both positive and negative** socioeconomic externalities of **foods and diets**, across the **entire value chain**.
- Aims to identify critical evidence gaps and provide recommendations to guide future research and applications.

Sources: Kennedy et al., 2023; Mancini et al., 2023; UNEP, 2020; PLAN'EAT, 2023

METHODS: Process overview (1/2)

- ❑ Chose a structured literature review over a scoping / systematic review because **the field is nascent** with **limited evidence**.
- ❑ Followed a **pre-developed protocol** based on adapted versions of the PRISMA Extension for Scoping Reviews and Campbell Collaboration materials.

(1) SEARCH STRATEGY

- Searched for relevant records published between **January 1, 2008 & April 30, 2025**
- Comprehensive search strategy comprising 3 key concepts: **TCA; socioeconomic externalities; foods & diets**
- Searched **3 academic** & **8 grey literature databases**

(2) EVIDENCE SELECTION

- Used **Covidence** systematic review software
- Assessed record eligibility against predefined **inclusion & exclusion criteria**
- **Title/abstract & full-text screening** conducted by a single reviewer, with 15% cross-checking by a second reviewer

Sources: Grant and Booth, 2009; Cornell University Library, 2024; Tricco et al., 2018; Campbell Collaboration

METHODS: Process overview (2/2)

(3) DATA CHARTING

- Employed a **standardised data charting form**
- Variables captured: (1) **Study scope** & context; (2) **Assessment level** & types of foods or diets analysed; (3) **Socioeconomic externalities**; (4) **Monetisation methods** & data sources; (5) Author-stated **strengths, limitations**, & **recommendations**.

(4) EVIDENCE SYNTHESIS

- **Descriptive statistics:** Frequencies and percentages to map the evidence distribution
- **Qualitative synthesis:** Thematic analysis to classify and summarise frameworks, approaches, methods, and data sources used.

Sources: Grant and Booth, 2009; Cornell University Library, 2024; Tricco et al., 2018; Campbell Collaboration

METHODS: Eligibility criteria

Aspect considered	Inclusion criteria	Exclusion criteria
Population & Context	Records on production, processing, packaging, distribution, retail, consumption, and/or waste treatment of single foods, food groups, meals, or whole diets, across any geographical/population settings	Records focusing exclusively on non-food systems/sectors, or on non-socioeconomic externalities
Concept	Records discussing methods to quantify and monetise socioeconomic externalities (positive and/or negative) of single foods, food groups, meals, or whole diets	Records not including a monetisation component, or that do not explicitly report their methodology for quantifying and valuing socioeconomic impacts
Evidence sources	Academic manuscripts in scientific journals, working/discussion papers, reports, methodological guidelines & tools, books & book chapters from academic publishers	Publication types other than those listed under the inclusion criteria Records for which the full text is not accessible through institutional subscriptions, open-access platforms, or Interlibrary loan services
Timeframe	Records published between January 1, 2008, and April 30, 2025	Records published prior to 2008
Language	English-language records	Records published in languages other than English

Source: Peters et al., 2024

METHODS: Data charting form

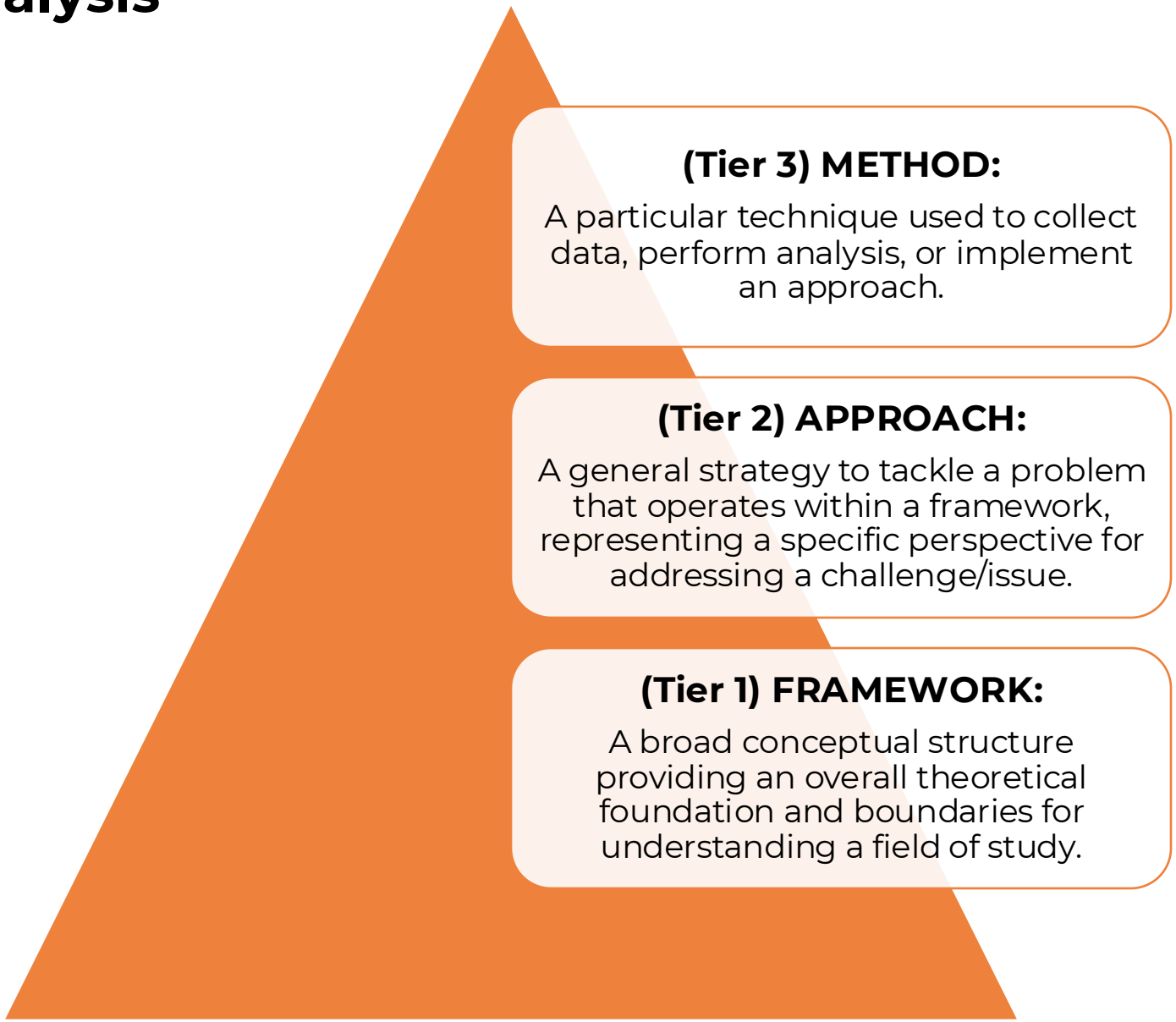
Section 1: Record details									
Full citation in Harvard style	Publication type	Geographic focus	Country income group(s)	Value chain stage(s)	Reference period(s) of input data	Primary research question(s)	Secondary research question(s)	Assessment level(s): foods, food groups, meals, whole diets	Food/meal/ diet type(s)

Section 2: Key variables of interest							
Positive socioeconomic externalities	Negative socioeconomic externalities	Monetisation methods	Data sources used (impact quantification)	Data sources used (monetisation factors)	Author-stated strengths of the approach	Author-stated limitations of the approach	Author-stated research recommendations

Source: Peters et al., 2024

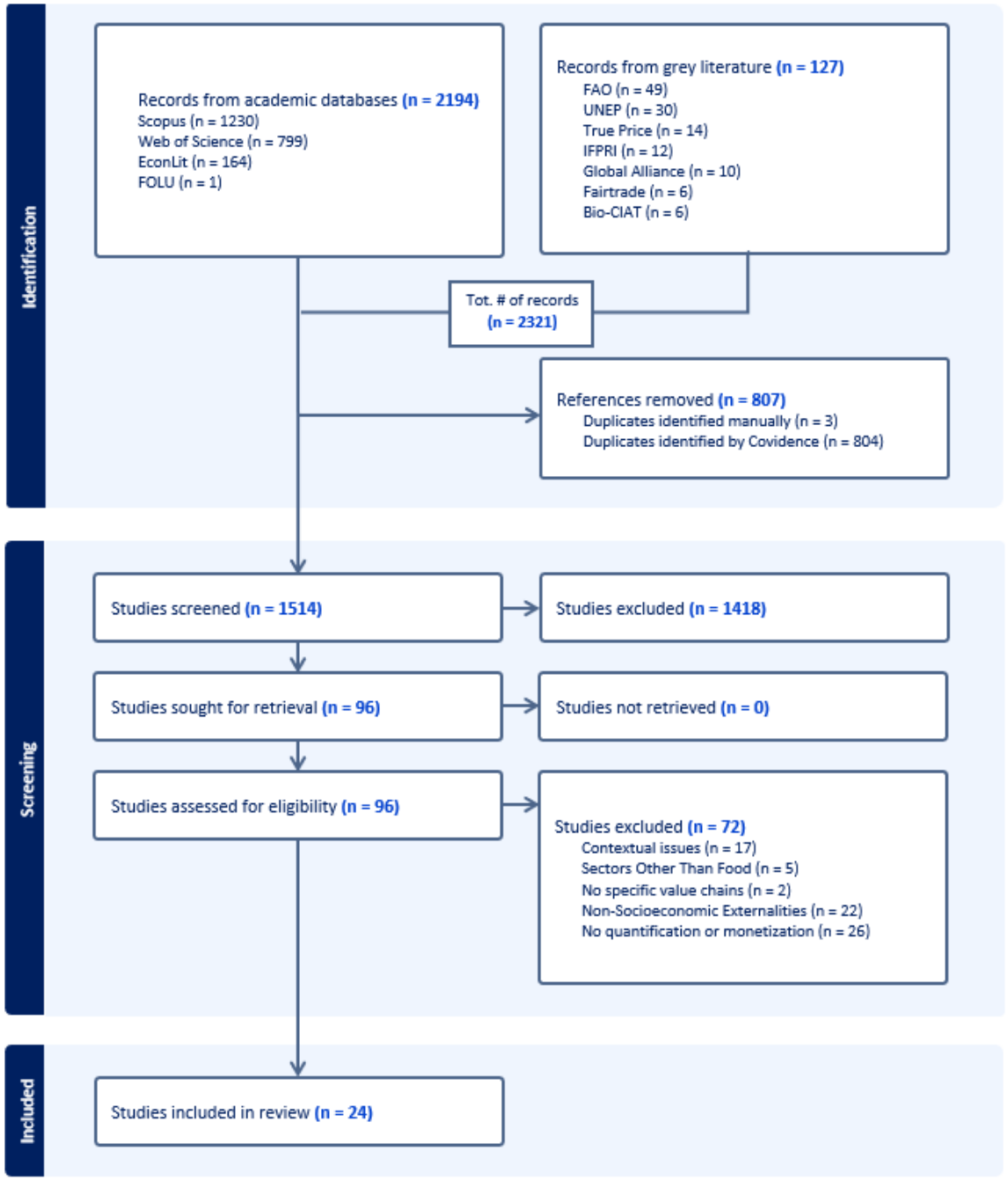
METHODS: Qualitative analysis

Each study was thematically categorised against three levels of analysis



PUBLICATION TYPES & DATA AGE

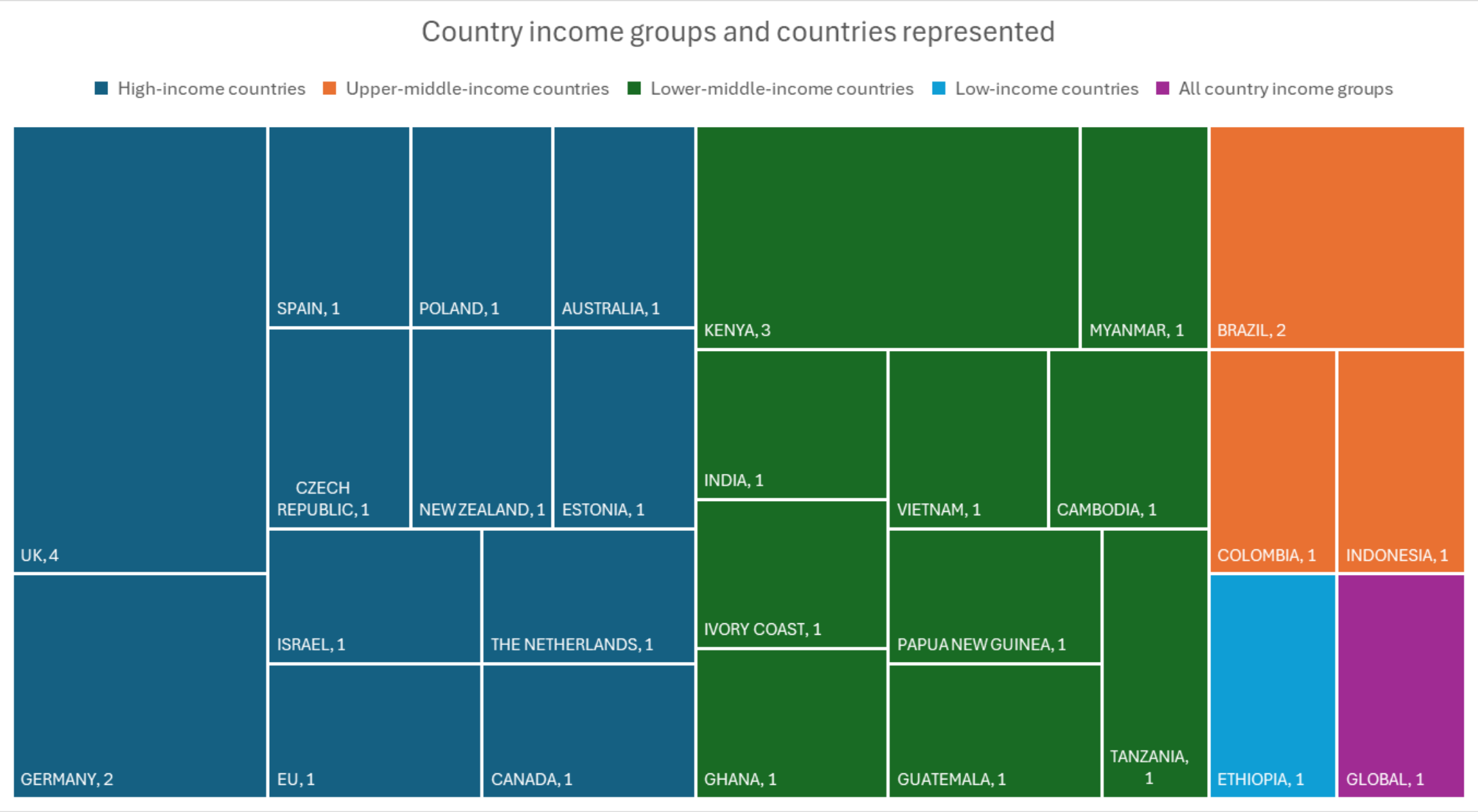
- **Small body of literature**, characterized by **high heterogeneity**.
- Socioeconomic externalities were the **primary research focus** of 79% of studies.
- **Publication types:** Most records were **peer-reviewed primary research studies** (58%), followed by reports (29%), and methodological guidelines (13%).
- **Data age:** Almost all studies (92%) relied on data from **2000–2015**. About one-third (29%) used input data collected **>10 years prior to publication**.



PRISMA flow diagram of the literature search and selection processes

Sources: Tricco et al., 2018

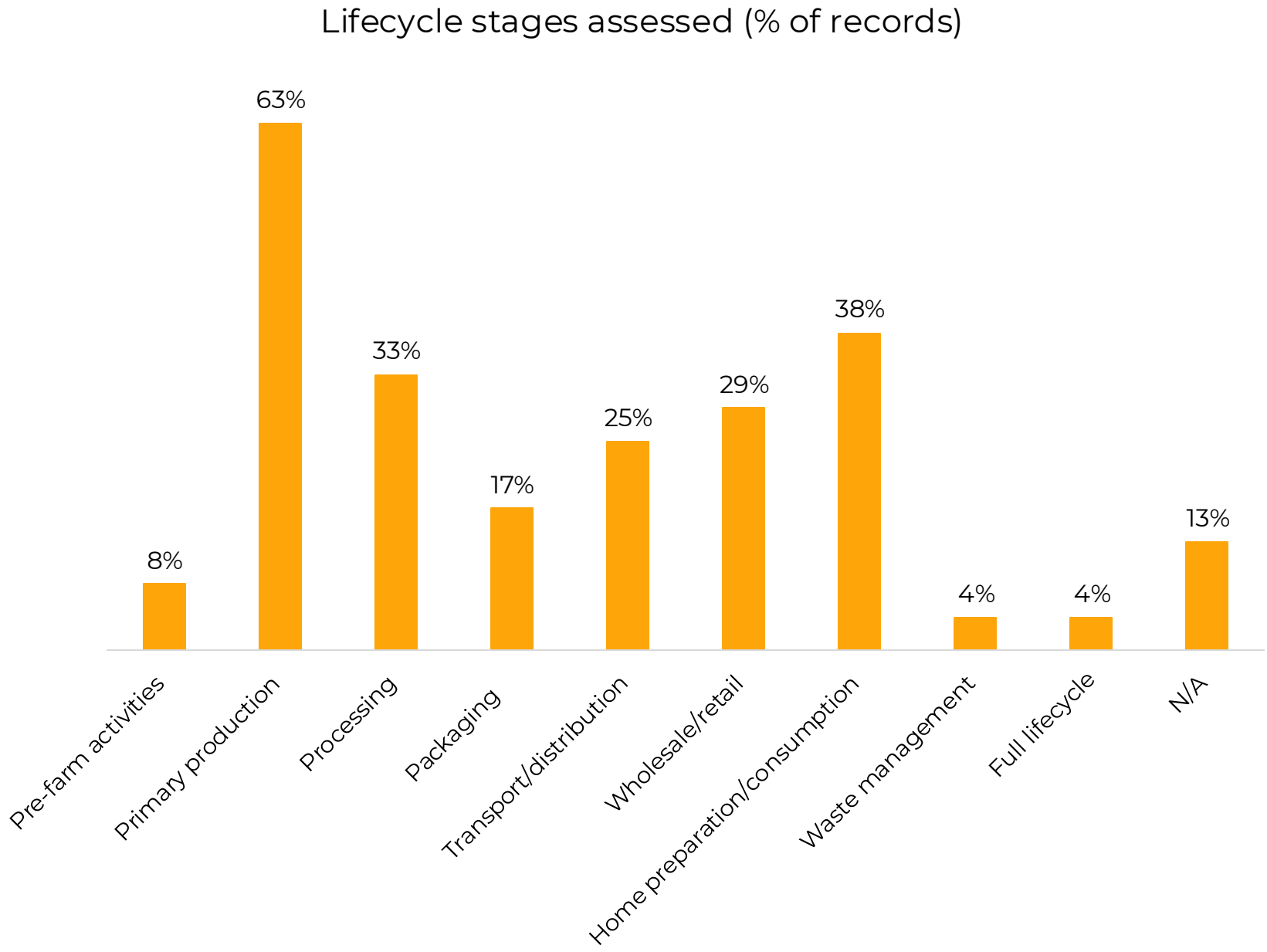
GEOGRAPHIC & INCOME DISTRIBUTION



Source: World Bank, FY 2026

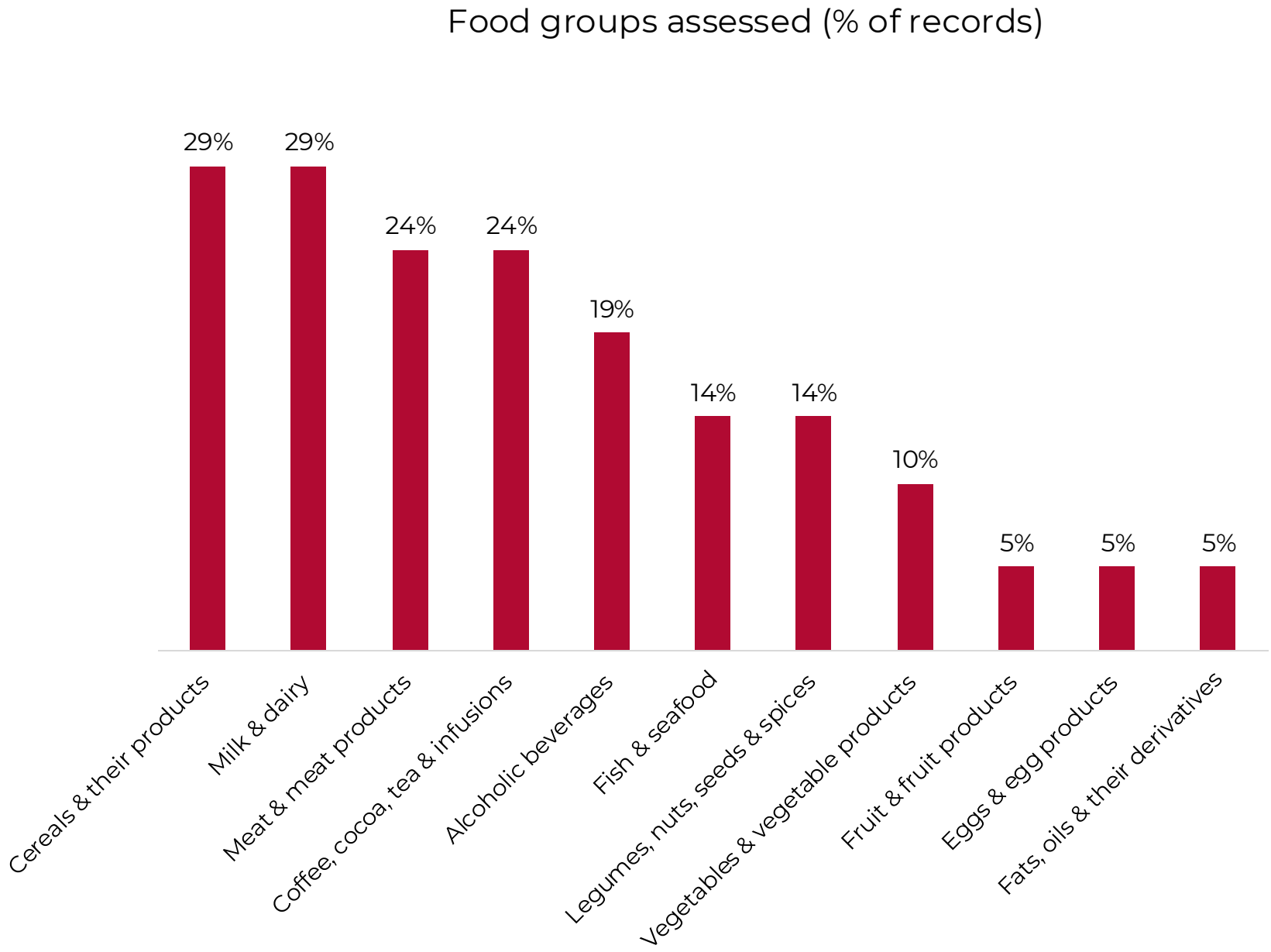
FOOD SYSTEM SEGMENTS

- **Primary production** was the most frequently analyzed lifecycle stage (63%).
- Other common lifecycle stages: **home preparation/consumption** (38%), **processing** (33%), and **retail** (29%).
- **Only one study considered the full lifecycle** ('cradle-to-grave'), revealing a fragmented view of food systems.



FOOD GROUP CATEGORISATION

- **Assessment level:** Most records quantified externalities at the **individual food (71%) or food group (17%) levels.**
- **Most frequent: cereals and cereal-based products** (29%); **milk and dairy products** (29%); meat and meat products (24%); coffee, cocoa, tea, and infusions (24%).
- **Limited attention:** vegetables (10%), fruit, eggs, fats & oils (5% each).



Source: European Food Safety Authority (EFSA), 2015

SOCIOECONOMIC COSTS & BENEFITS

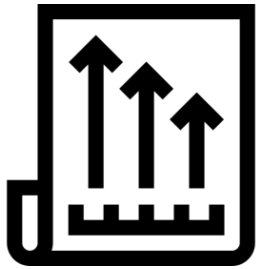
- Most studies focused on **negative socioeconomic externalities**, while positive impacts were less often investigated.
- **Inadequate working conditions** were the most frequently assessed category (42%), particularly unfair compensation practices (33%).
- Other key issues: **Rights violations** & systemic abuses, and **poverty/income-related impacts** (each at 21%).
- Among positive externalities, local **economic & community development**, and **income generation** (each at 17%) were most common.

Negative externalities			
Main categories	**%**	**Sub-categories**	**%**
Inadequate working conditions	42%	Unfair compensation practices	33%
		Lack of worker protection and health & safety risks	21%
		Work overload	17%
		Productivity loss	8%
Rights violations and systemic abuses	21%	Forced/child labour	17%
		Discrimination	17%
		Lack of union rights	17%
Poverty and income-related impacts	21%		
Animal welfare below acceptable standards	13%		
Economic losses from food waste	8%		
Reduced wellbeing	8%		
Costs to employers/public institutions	8%		
Crime and legal infractions	8%		
Positive externalities			
Main categories	**%**	**Sub-categories**	**%**
Local economic and community development	17%	Local economic development	8%
		Community development	8%
Income-related benefits	17%	Income generation	8%
		Income distribution	8%
Job creation and employment	8%		
Improved food security and reduced poverty	8%		
Animal welfare meeting acceptable standards	8%		
Social inclusion	4%		
Cultural preservation	4%		

FRAMEWORK CATEGORISATION

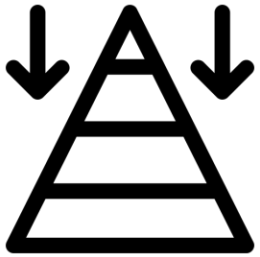
Framework typology	Theoretical foundations	Perspective	Primary objective	Proposed solutions
MARKET-ORIENTED (71%)	Neoclassical and welfare economics	**Externalities as market failures** caused by missing or distorted price signals	**Internalise externalities** into market prices, to make a product's hidden costs and benefits visible to decision-makers	Work within existing **growth-oriented economic systems**
RIGHTS-BASED (0%)	International human rights law and social justice theory	**Human rights are non-negotiable**, non-substitutable, and cannot be traded for economic gains	**Address structural inequalities**, power imbalances, and governance failures	Aim for **fundamental systemic change** to prevent rights violations at their root
HYBRID (28%)	Combination of market-oriented and rights-based frameworks	Certain rights violations are non-negotiable and must be **eradicated at their source** Other impacts can be **compensated economically** via monetisation	**Internalise externalities** into market prices and **address structural inequalities** at the same time	Work within **existing economic systems**, while simultaneously pursuing **systemic transformation**

APPROACH CATEGORISATION



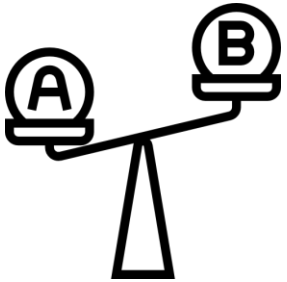
BOTTOM-UP (42%)

- **Primary collection of context-specific data** through e.g., household/farm surveys, workplace or health facility records.
- Geographic coverage: **subnational or national**.
- Primary datasets are **rarely made publicly available**, often due to confidentiality or use of proprietary data collection instruments.



TOP-DOWN (29%)

- Reliance on **secondary data sources** for impact quantification, e.g., national accounts, labour statistics, health expenditure databases.
- Geographic coverage: **national, regional, or global**.
- Use of published/**pre-defined monetisation factors**, adjusted to a given country context and reference year.



COMPARATIVE (29%)

- Combined use of **primary and secondary data sources**.
- Comparison of **different production, consumption, or policy/intervention scenarios**, to assess costs and benefits under various conditions.
- Geographic coverage: **from subnational to global**.
- Can be used for **foresight modelling**.

METHOD CATEGORISATION

Cost of socioeconomic impacts (67%)

- Estimates the **economic costs and/or benefits** associated with the occurrence of negative and/or positive externalities.
- **Impact-based methodology** that quantifies and monetises effects on individuals, communities, and/or society **after externalities have occurred**.

Cost-benefit analysis (13%)

- **Compares the total costs** of a product, policy, or intervention to its **total benefits**, both expressed in monetary terms.
- Allows to determine whether an action/measure is **economically justified**.

Restorative cost valuation (13%)

- Estimates the **cost of measures** required to **return an affected condition to its original or an acceptable state** after damage has occurred.
- Applicable to negative externalities only.

Preventive cost valuation (8%)

- Estimates the **cost of measures taken in advance** to prevent a negative externality from occurring or minimise its potential impacts.
- **Prospective methodology** that focuses on the resources required for prevention.

DATA SOURCES USED

Category	Main purpose or use case	Impact quantification: % of records	Monetisation factors: % of records
National/regional institutional databases and resources	To obtain official (sub)national and/or regional statistics on demographics, dietary patterns, economic indicators, food systems performance, and environmental impacts.	75%	33%
Academia and research institutes	To obtain parameters like relative risks, dose-response functions, emissions, characterisation factors, and economic values from scientific literature, published studies and datasets.	75%	46%
Resources by United Nations (UN) agencies	To use technical reports, guidelines, conceptual frameworks, and standardized databases produced by UN agencies to obtain methodological guidance and internationally comparable data across sectors.	33%	21%
Social impact databases (non-LCA)	To source specific data on socioeconomic externalities from specialised databases.	33%	0%
Primary data	To collect new, context-specific information directly from target populations or entities through surveys, interviews, or direct measurement/observation.	38%	21%
Datasets for foresight modelling/simulations	To obtain specific input data and parameters for running future-oriented simulation models.	33%	21%
Market data and consumer insights	To obtain data on market prices, consumer behaviour, and industry trends from market research firms and commercial data providers.	8%	4%
True Cost Accounting (TCA) and True Pricing (TP) databases and inventories	To use pre-existing socioeconomic impact data and monetary values from established TCA and TP frameworks and initiatives.	8%	25%
Non-governmental (NGOs) and civil society (CSOs) organizations	To use methodological guidelines, conceptual/theoretical frameworks, programmatic reports, datasets, and other resources published by NGOs and CSOs, including on specific local contexts and target population groups.	29%	0%

AUTHOR-STATED STRENGTHS, LIMITATIONS, & RECOMMENDATIONS

Strengths	%	Limitations	%	Research recommendations	%
Ability to compare different options/scenarios	**46%**	Limited availability and/or quality of data	**71%**	Improving data availability & quality, modelling approaches, and research infrastructure	**56%**
Conversion of externalities into monetary terms	**38%**	Narrow scope/coverage of externalities, geographic settings, lifecycle stages, reference periods, foods or diets	**63%**	Systematically conducting uncertainty/sensitivity analyses	**44%**
Disaggregation of costs by lifecycle stages	**29%**	Reliance on methodological assumptions and/or simplifications	**58%**	Expanding scope/coverage, by assessing a larger variety of foods/diets, lifecycle stages, and/or externalities	**28%**
Analysis of system-wide (inter)connections	**13%**	Absence of uncertainty/sensitivity analyses	**38%**	Methodological standardisation to enable cross-study comparability	**16%**
Assessments grounded in real-world data and contexts	**13%**	Use of non-representative samples	**29%**		
No author-reported strengths	**38%**	Challenges in converting non-market impacts into monetary terms	**21%**		

DISCUSSION: Main challenges in the field

1. METHODOLOGICAL IMMATURITY

- The TCA literature on food system-related socioeconomic externalities is in its infancy.
- Considerable heterogeneity in approaches, methods, and data sources.

2. ETHICAL CONCERNS

- The monetisation of certain social impacts, particularly human rights, raises significant ethical questions.
- Market-based frameworks suggest that these harms can be ‘offset’ by economic compensation rather than eliminated at the source.

3. PERSISTENT TECHNICAL BARRIERS

- Data and modelling constraints are the most significant challenge, reported in 71% of studies.
- These include issues with data availability/quality, reliance on proxy measures, and lack of transparency.

4. REACTIVE OVER PROACTIVE

- The prevalence of damage assessment methods over preventive ones may reflect practical constraints rather than deliberate choice.

5. STATIC MODELS

- Current methods often fail to capture the dynamic impacts of complex, adaptive food systems, which are constantly changing due to policy shifts, market dynamics, and global crises.

DISCUSSION: A Path Forward

1. PRIORITISE METHODOLOGICAL DEVELOPMENT

- Focus on strengthening existing and developing new, more robust methodologies before scaling up data collection and standardization efforts.

2. ENGAGE WITH A RIGHTS-BASED FRAMEWORK

- The field must grapple with the fundamental ethical questions of whether and how to monetise socioeconomic externalities impacting basic human rights and dignity.

3. IMPROVE DATA QUALITY AND TRANSPARENCY

- Using data of acceptable quality, preferably context-specific, and publishing it alongside analytical outputs is essential to increase confidence in the results and enable study replication and validation.

4. EMBRACE PROACTIVE METHODS

- Move away from reactive damage assessment and invest in methods that focus on prevention and restoration.

5. BROADEN SCOPE AND CONTEXT

- Future research needs to cover a wider range of value chains, lifecycle stages, externalities, and geographic/population settings.

CONCLUSION:
Take-home messages

- The field of TCA of food system-related socioeconomic impacts is in its infancy, with a **small and heterogeneous** evidence base.
- **Current methods are preliminary** and may require a fundamental reconceptualization before they can be effectively used to inform decision-making.
- Future research should prioritize methodological development, **address ethical concerns**, broaden its scope, and increase transparency.
- The path forward requires a **collaborative effort** to provide more robust evidence for a sustainable and equitable food system transformation.

KEY CROSS-CUTTING LEARNINGS ACROSS THE 3 REVIEWS

COMMON FINDINGS, CHALLENGES & RESEARCH GAPS

1. INDIRECT COSTS MAKE UP THE LARGEST SHARE

- In both Health and Socio-economic analyses, indirect costs (primarily from **productivity losses**) consistently outweigh direct expenditures.

2. BIAS TOWARDS TANGIBLE HARM

- **Intangible costs** and **positive impacts** are systematically underrepresented or entirely overlooked.

3. FRAGMENTED VIEW OF FOOD SYSTEMS

- Focus on **isolated lifecycle stages** or **single foods**/foods groups, rather than holistic assessments.

4. REACTIVE OVER PROACTIVE FOCUS

- The dominant methodological practice is reactive – documenting costs **after harm has occurred**.

5. LIMITED GLOBAL APPLICABILITY

- **Heavy concentration** of research in **HICs and UMICs** (especially Europe/North America and Asia), limiting the relevance and validity of results for LMICs.

COMMON FINDINGS, CHALLENGES & RESEARCH GAPS

6. METHODOLOGICAL HETEROGENEITY

- All domains suffer from a **lack of consensus** on definitions and metrics, and high rates of **methodological inconsistency**.

7. DATA AVAILABILITY & QUALITY CHALLENGES

- High reliance on **proxy or global/regional average data** that may not reflect local conditions.

8. SIMPLISTIC, STATIC SYSTEMS

- Current approaches treat complex food systems as **static snapshots**, failing to capture the dynamic and interconnected nature of value chains and food-related impacts.

9. THE ETHICAL DILEMMA

- The push to **internalise external costs** raises ethical concerns over **commodifying** non-negotiable values like human life and dignity, quality of life, and environmental health.

OVERARCHING RECOMMENDATIONS

1. METHODOLOGICAL RIGOR & STANDARDISATION

- **Prioritize methodological development**, refinement/adaptation, and validation across diverse contexts before scaling up data collection.
- Move towards standardisation to **reduce heterogeneity** and enable cross-study comparisons.

2. IMPROVE DATA INFRASTRUCTURE

- Fill foundational data gaps – invest in reliable, **disaggregated** data systems, especially in **LMICs**.
- Focus on collecting data for **neglected externalities, value chains,** and **population groups**.

3. EXPAND SCOPE & PROMOTE INCLUSIVITY

- Move beyond single foods and lifecycle stages to assess **whole diets and full value chains**.
- Incorporate **intangible impacts, positive externalities, missing burdens** (e.g., micronutrients, non-carbon footprints, human rights violations), and vulnerable groups.

4. ENGAGE WITH ETHICAL QUESTIONS

- Embed TCA approaches within a rights-based framework and address **ethical concerns about commodification**.
- Shift emphasis from reactive damage assessment to **proactive harm prevention**.

5. BUILD EMPIRICAL EVIDENCE

- Conduct validation through case studies that **test TCA effectiveness** in real-world policy and intervention settings.

Thank you!
Questions?

Contact: fortenzi@gainhealth.org

NFP Netherlands Food Partnership

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