

Quantifying the **Health Impacts** of Food

A Scoping Review of True Cost Assessment Methods

Members of the research Consortium:



ACKNOWLEDGEMENTS

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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.

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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.

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

(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

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

METHODS: Data charting form

Section 1: Record details

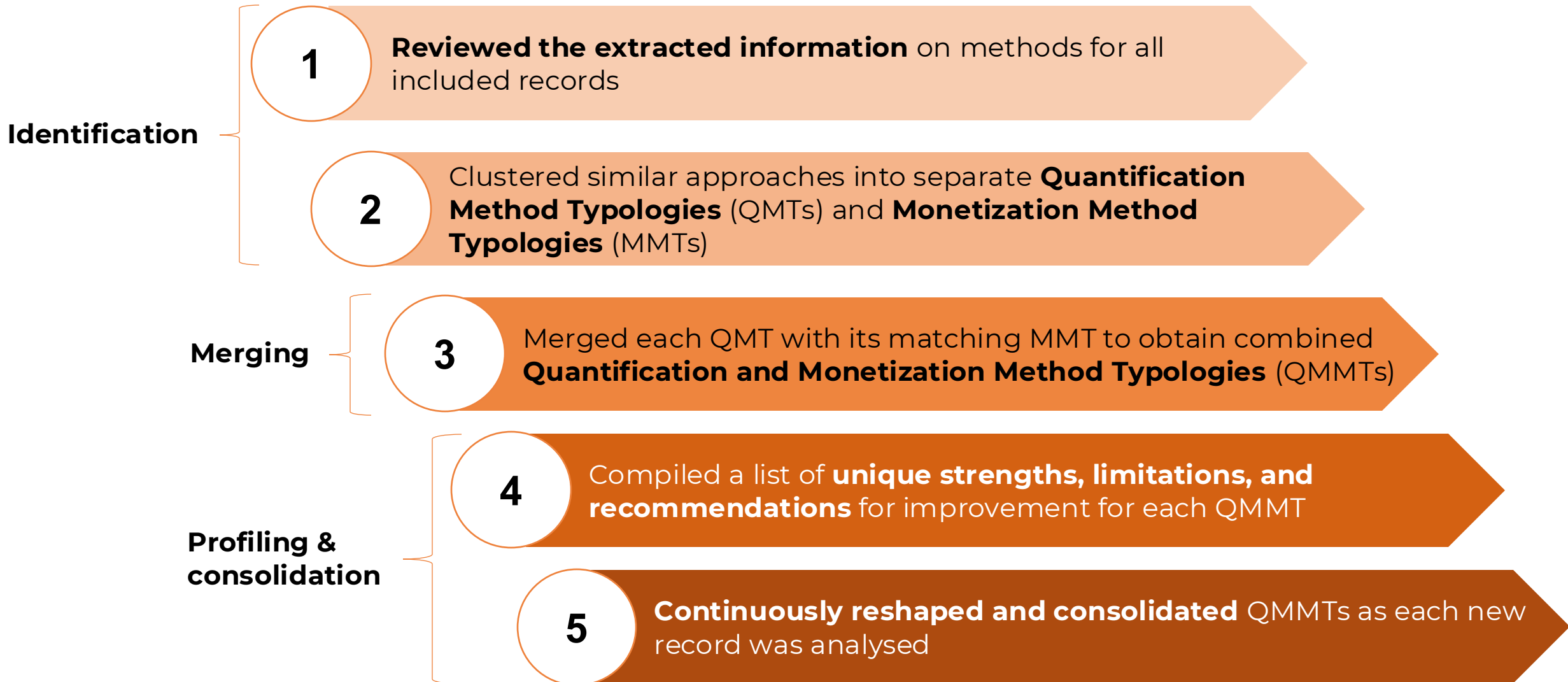
Full citation in Harvard style	Publication type	Geographic focus	Country income group/s	Target setting/s	Target population group/s	Primary research question/s	Secondary research question/s	Assessment level/s: foods, food groups, meals, whole diets	Food/meal/diet type/s	Positive health externalities	Negative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

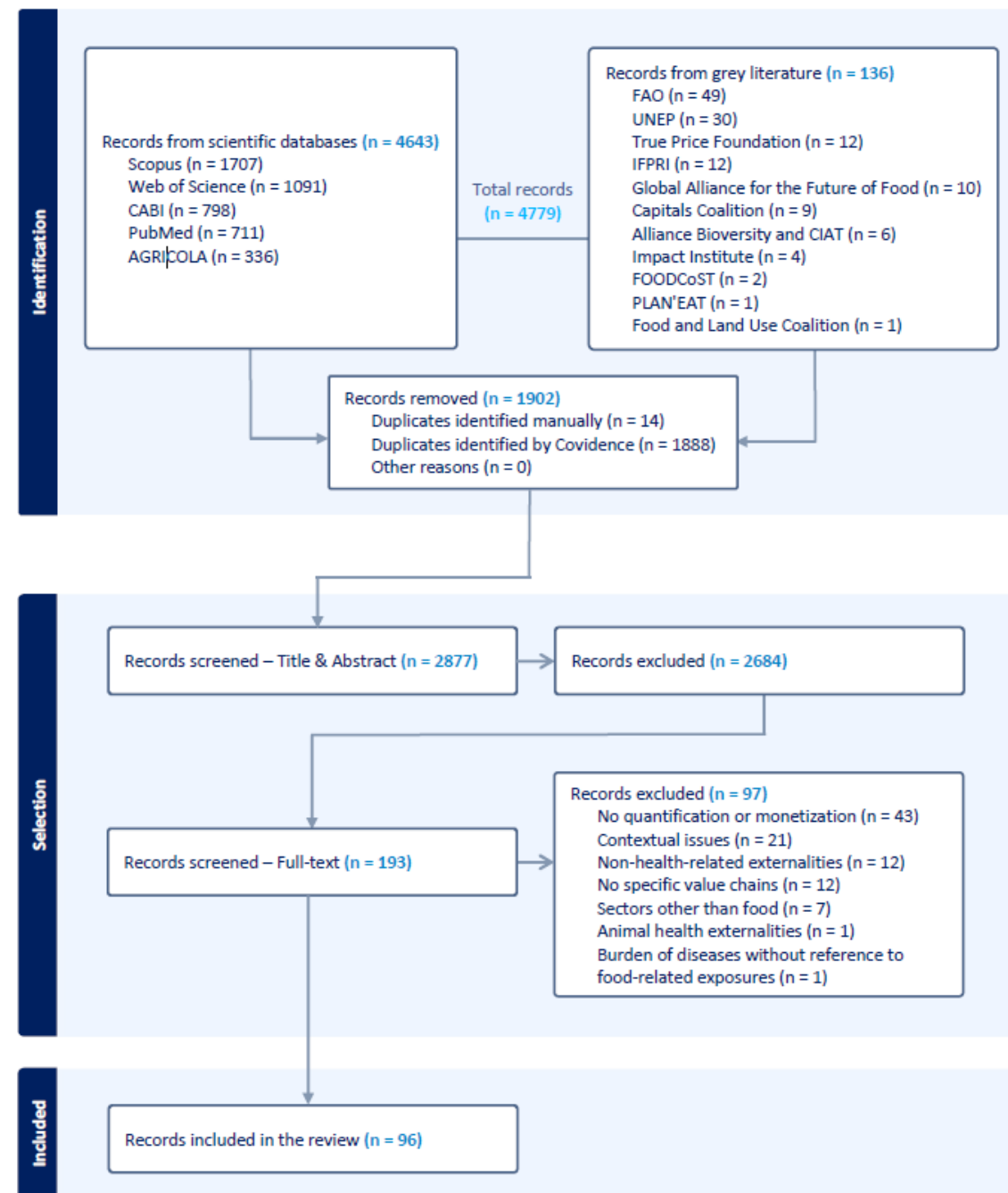
METHODS: Qualitative analysis

Iterative, fully data-driven process:

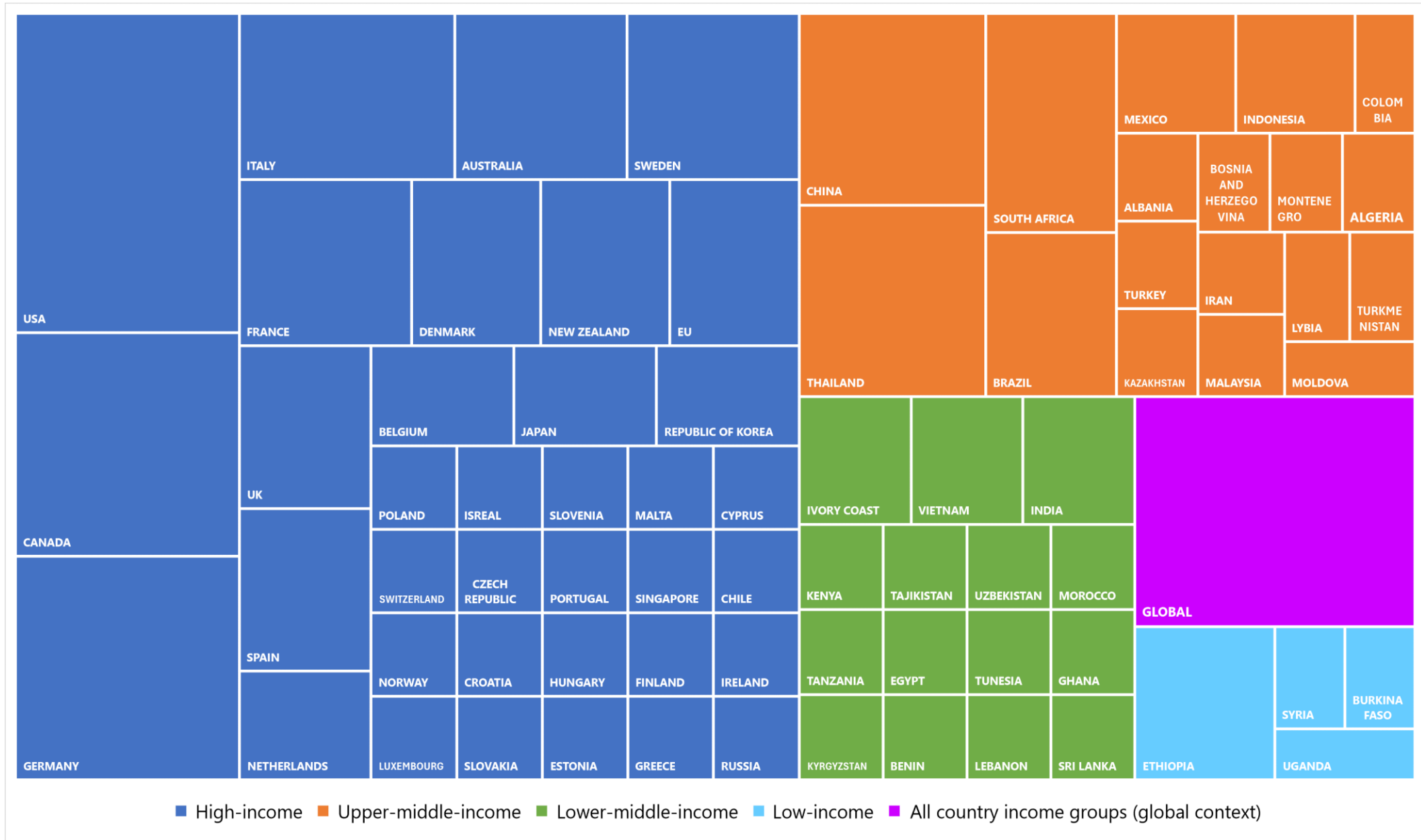


PUBLICATION TYPES & RESEARCH FOCUS

- ❑ **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%).

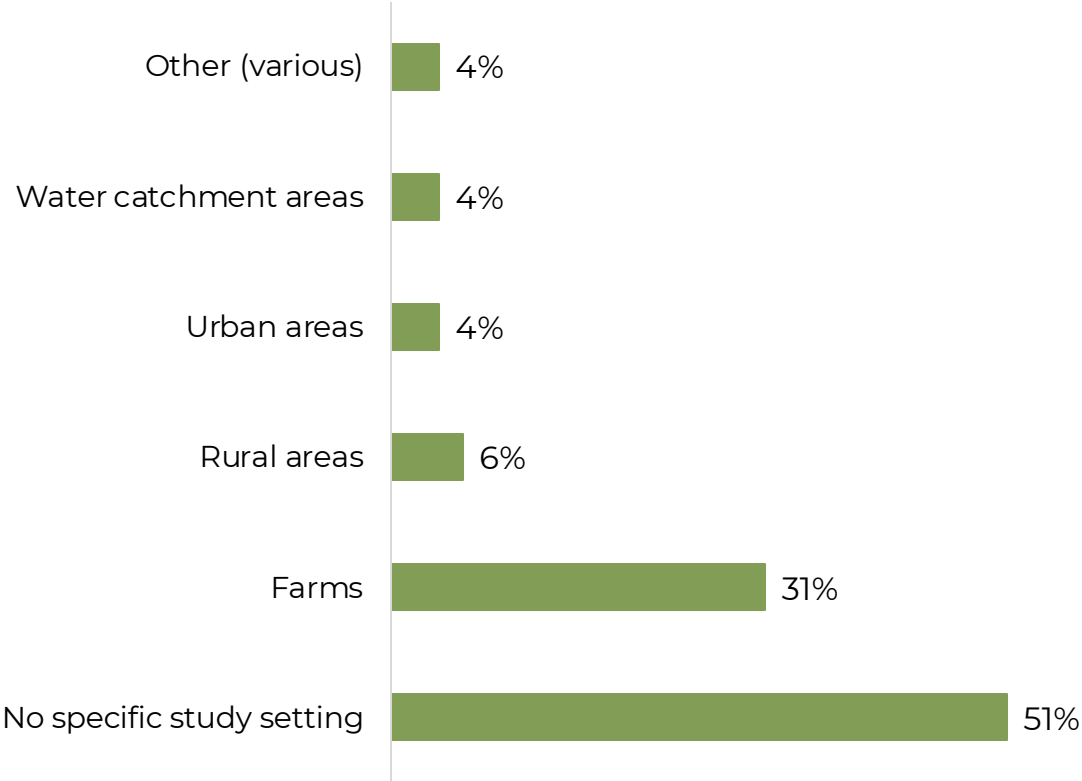


GEOGRAPHIC & INCOME DISTRIBUTION

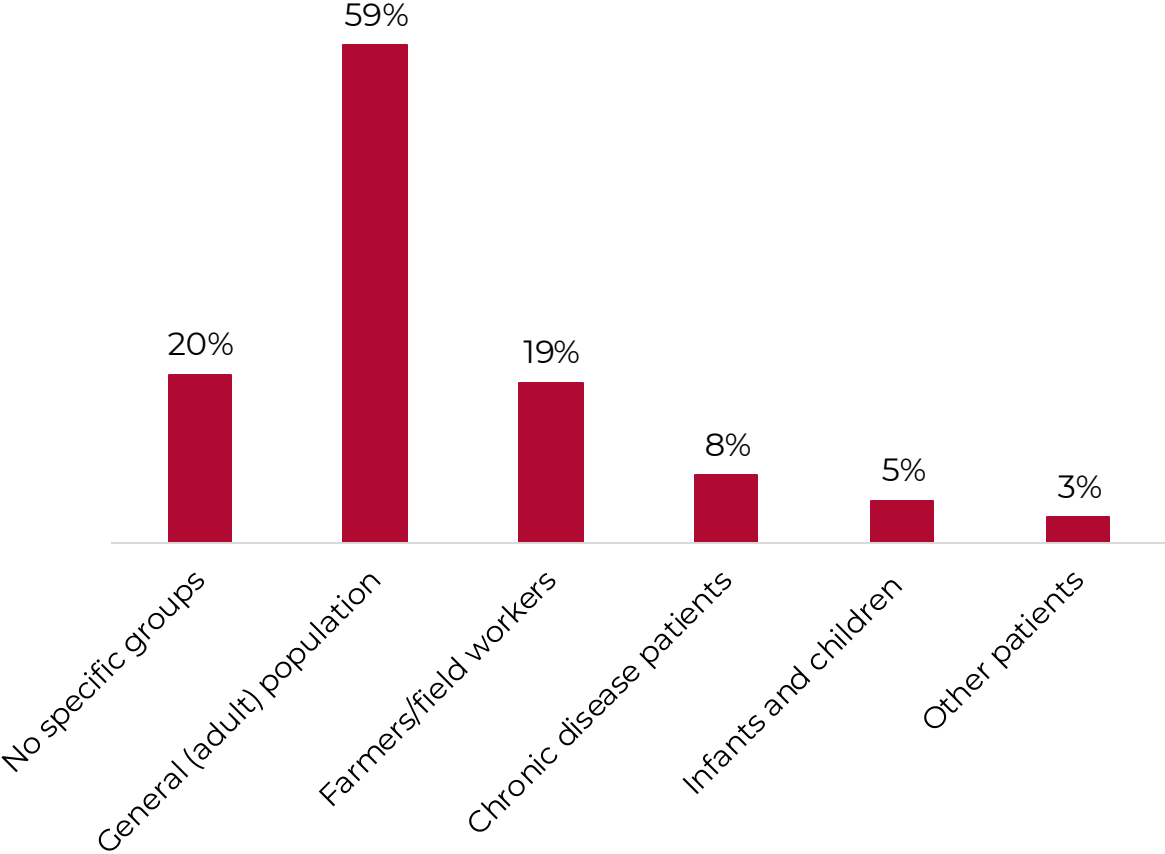


TARGET SETTINGS & POPULATION GROUPS

Target settings (% of records)



Target groups (% of records)

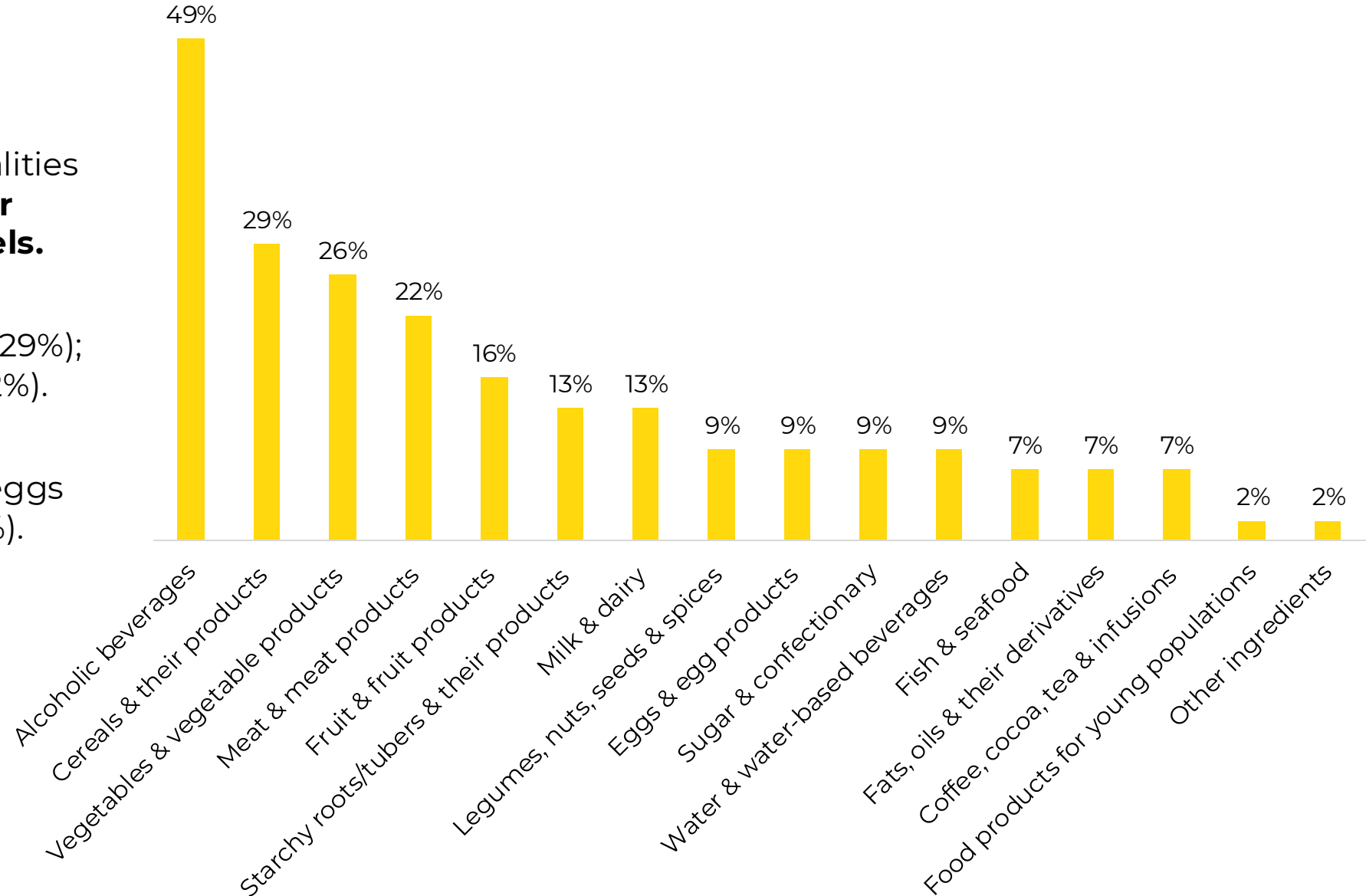


Food system roles: 57% focused exclusively on **consumers**; 13% on supply chain actors; and 14% on both.

FOOD GROUP CATEGORISATION

Food groups assessed (% of records)

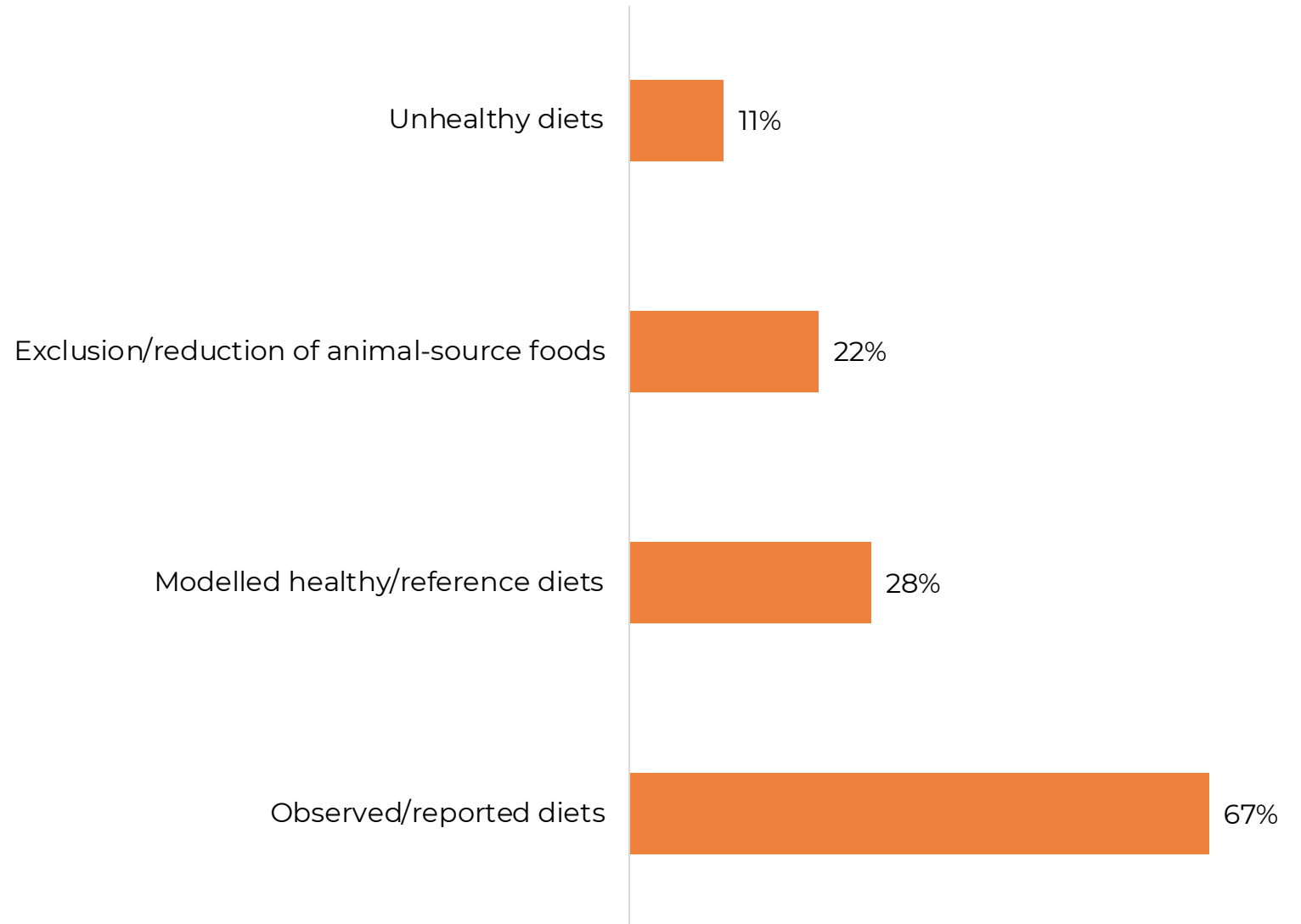
- ❑ **Assessment level:** Most records quantified externalities at the **food group (57%) or individual food (53%) levels.**
- ❑ **Most frequent: alcoholic beverages (49%); cereals (29%); vegetables (26%); meat (22%).**
- ❑ **Limited attention:** legumes/nuts/seeds and eggs (9% each); fish/seafood (7%).



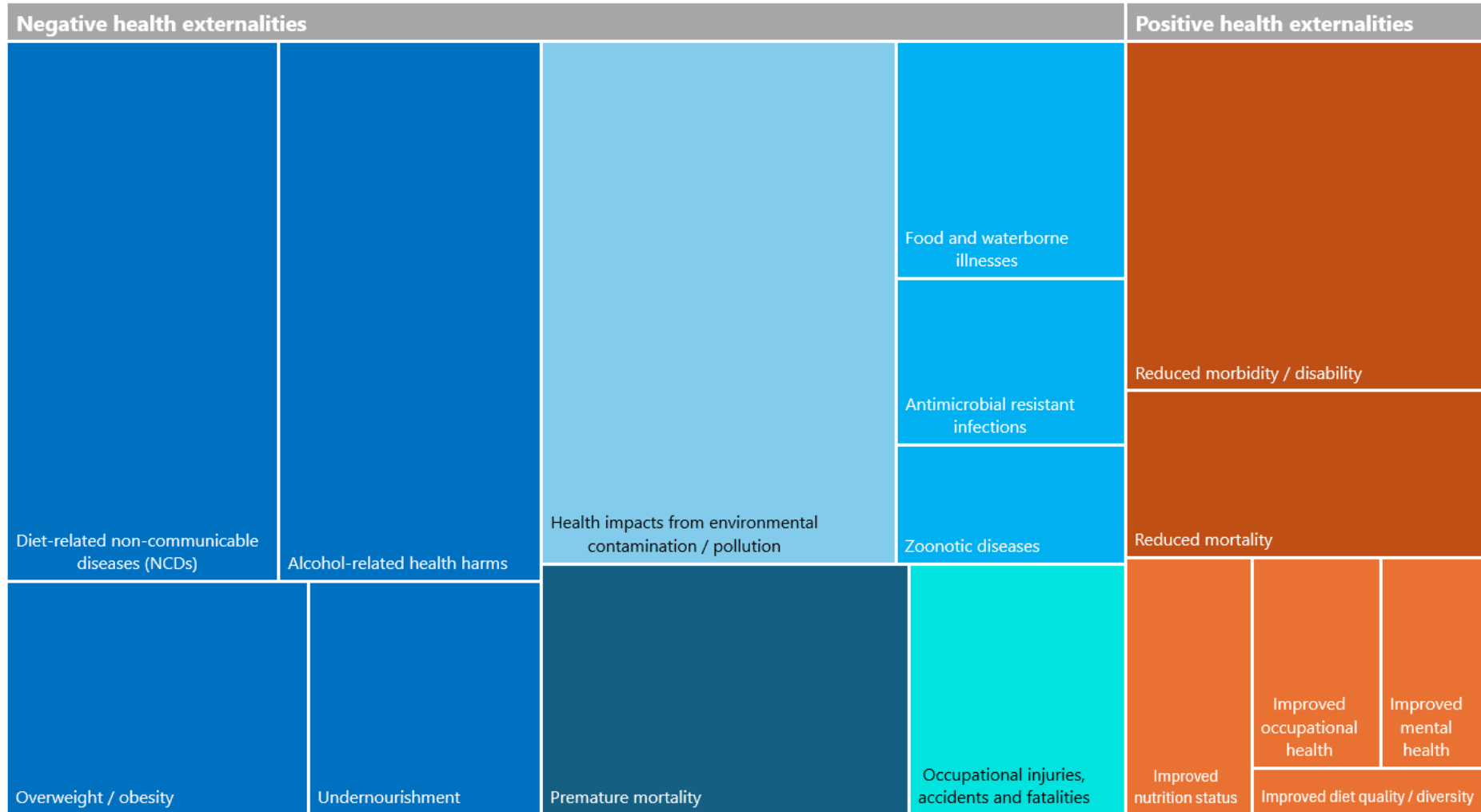
DIETARY PATTERN CATEGORISATION

- ❑ **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)

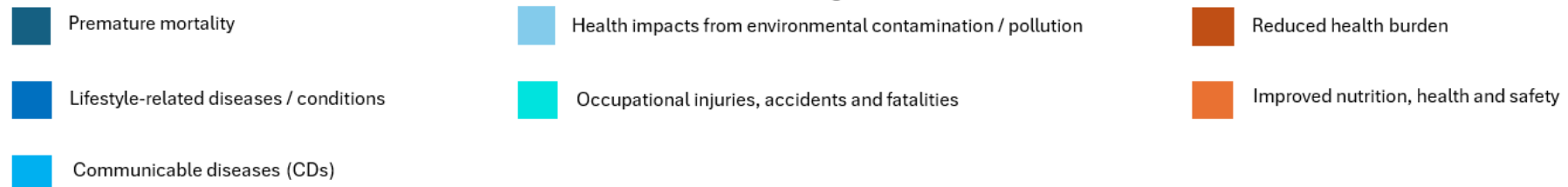
Dietary patterns assessed (% of records)



HEALTH EXTERNALITIES



Main categories



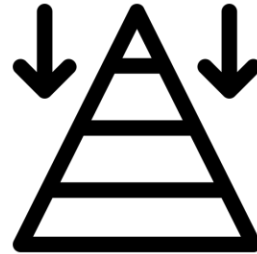
INDICATOR CATEGORIES & SPECIFIC METRICS	% OF RECORDS
1. Burden of disease	84
<ul style="list-style-type: none"> • Disability-Adjusted Life Years (DALYs) • Disease incidence • Mortality rate • Disease prevalence • Years of Life Lost (YLLs), Years of Potential Life Lost (YPLLs), Life Years Gained (LYGs) • Morbidity rate • Quality-Adjusted Life Years (QALYs) • Accident or injury incidence / frequency / severity rates • Hospitalization rate • Avoidable / avoided morbidity and mortality • Prevalence of food insecurity / undernourishment (e.g., protein-energy malnutrition) 	<p>36</p> <p>21</p> <p>18</p> <p>15</p> <p>13</p> <p>13</p> <p>9</p> <p>9</p> <p>4</p> <p>3</p> <p>3</p>
2. Cost of health impacts	78
<ul style="list-style-type: none"> • Direct costs at individual level • Indirect costs at individual level • Societal costs (e.g., government / public health expenditures) • Proportion of Gross Domestic Product (GDP) or Gross National Income (GNI) • Avoidable / Preventable costs at individual level 	<p>54</p> <p>49</p> <p>19</p> <p>15</p> <p>15</p>
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
<ul style="list-style-type: none"> • Human toxicity (carcinogenic and non-carcinogenic) • Pesticide exposure indices / levels 	<p>14</p> <p>8</p>
6. Diet quality / diversity indicators	5

HIGH-LEVEL APPROACH CATEGORISATION



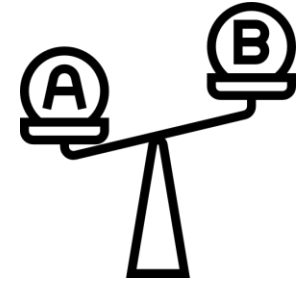
BOTTOM-UP (26%)

- **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
<p>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.</p> <p>This attributable burden is then monetized using a comprehensive cost-of-illness framework that sums direct and indirect costs from system-level data.</p>	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Risk of ecological fallacy Use of population attributable fractions assumes a causal relationship between exposure and outcome based on epidemiological associations 	<ul style="list-style-type: none"> 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
<p>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.</p> <p>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.</p>	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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
<p>Health and well-being impacts are assessed by collecting primary data on exposures, health outcomes, and associated expenditures from an affected population.</p> <p>The quantified externalities are then valued using either the cost-of-illness method, or a willingness-to-pay approach.</p>	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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
<p>Diverse environmental and associated human health impacts are quantified across a product's life cycle via the standardized LCA framework.</p> <p>The quantified externalities are then monetized by applying unit values transferred from existing economic valuation studies, often adjusted for the specific study context.</p>	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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
<p>The economic efficiency of a specific policy or intervention is evaluated by employing epidemiological modelling to assess its impacts on health outcomes.</p> <p>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.</p>	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• Long-term health benefits of preventive policies and interventions are inherently uncertain• Challenges with impact attribution to the specific policy or intervention under study	<ul style="list-style-type: none">• 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
<p>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.</p> <p>A cost-of-illness framework is then applied to value the associated societal costs.</p>	<ul style="list-style-type: none"> • Captures societal costs borne by third parties, which are often excluded from standard economic analyses • Primarily relies on data from official administrative records 	<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • 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)

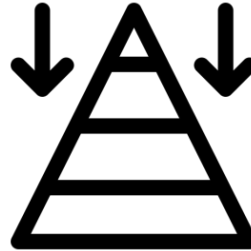
Definition	Core strengths	Core limitations	Main methodological recommendations
<p>The potential human and environmental health risks of pesticides are quantified using a component-based index method.</p> <p>Risk levels are then monetized by applying unit costs for different impact indicators, often within an integrated framework like the Pesticide Environmental Accounting (PEA) model.</p>	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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



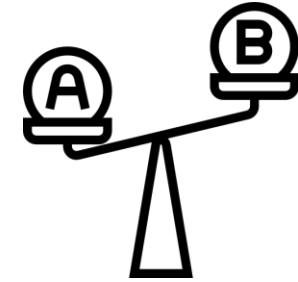
BOTTOM-UP (26%)

- **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



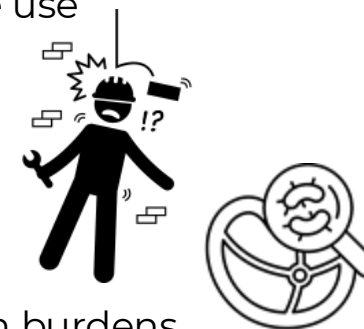
- Estimated at **USD 8.1–9.8 trillion annually** in large-scale assessments
- Primary **risk factors**: insufficient consumption of food groups beneficial to health and excessive intake of unhealthy options

ALCOHOL & ENVIRONMENTAL EXPOSURE ARE MAJOR CHALLENGES

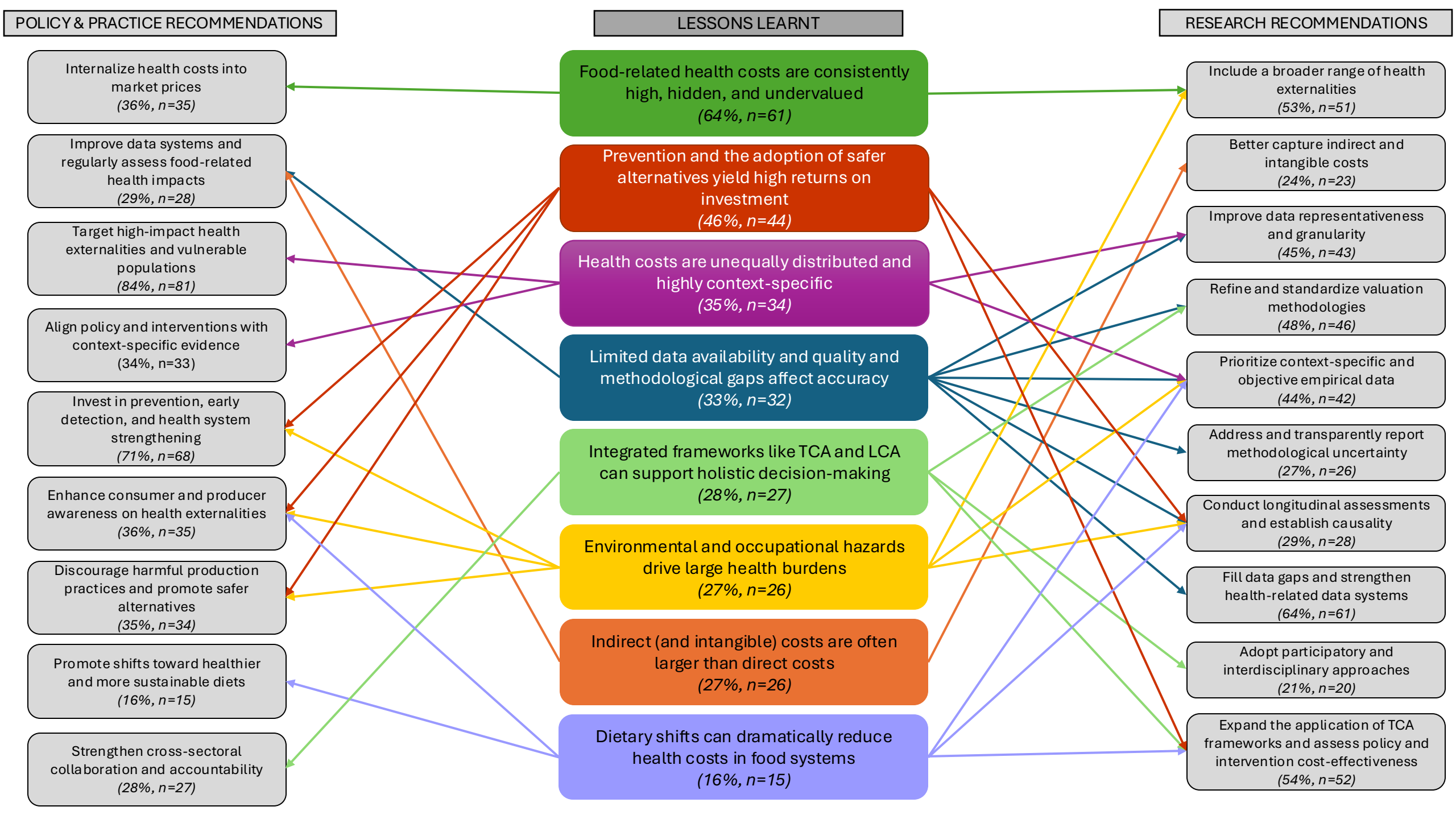


- Alcohol-related harms impose economic burdens of **0.5–5.4% of GDP**
- Health costs from **pesticide exposure** can offset up to 64% of productivity gains from pesticide use

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**



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. COMMODYING 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.

