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Food systems and nutrition

Describing the evidence
from 2000 to 2023

June 2023

Evidence
and Gap Map
Report 25

Health



International
Initiative for
Impact Evaluation

About 3ie

The International Initiative for Impact Evaluation (3ie) develops evidence on how to effectively transform the lives of the poor in low- and middle-income countries. Established in 2008, we offer comprehensive support and a diversity of approaches to achieve development goals by producing, synthesizing and promoting the uptake of impact evaluation evidence. We work closely with governments, foundations, NGOs, development institutions and research organizations to address their decision-making needs. With offices in Washington DC, New Delhi and London and a global network of leading researchers, we offer deep expertise across our extensive menu of evaluation services.

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3ie evidence and gap maps are thematic collections of information about impact evaluations and systematic reviews of impact evaluations that measure the effects of international development policies and programmes. The maps provide a visual display of completed and ongoing systematic reviews and impact evaluations in a thematic area, structured around a framework of interventions and outcomes.

Evidence and gap map reports provide supporting documentation for the maps, including the background information for the theme of the map, the methods and results, the protocol, and the analysis of results.

About this evidence and gap map report

This report presents the findings of a series of systematic searches to identify and map the evidence base of impact evaluations and systematic reviews of impact evaluations that assess the effects of food systems interventions on food security and nutrition outcomes. It updates the work by Moore and colleagues (2021). Some text of this report was copied directly from the [original report](#). 3ie, with support from Innovative Methods and Metrics for Agriculture and Nutrition Actions, has been commissioned by Germany's Federal Ministry for Economic Cooperation and Development (BMZ) through Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) through its "Knowledge for Nutrition" programme. The content of this report is the sole responsibility of the authors and does not represent the opinions of 3ie, its donors, or its board of commissioners. Any errors and omissions are also the sole responsibility of the authors. Please direct any comments or queries to Charlotte Lane at clane@3ieimpact.org.

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Evidence and Gap Map Report 25

June 2023



Executive summary

Background and rationale

Globally, we are not on track to meet the 2030 Sustainable Development Goals and the 2025 World Health Assembly nutrition targets. In fact, undernourishment increased from eight per cent in 2019 to almost 10 per cent in 2021 (FAO, 2022). Food-related shocks disproportionately affect vulnerable populations, with women being four percentage points more likely to experience food insecurity than men (FAO, 2022). The three C's (COVID, climate, and conflict) threaten global food security (Hendriks et al., 2022; FAO, 2022).

The COVID-19 pandemic increased hunger and food insecurity, with 150 million additional people affected by hunger and 112 million unable to afford a healthy diet (Global Nutrition Report, 2022). Climate change threatens the food supply chain, undermining food security. Simultaneously, food systems contribute to greenhouse gas emissions (Willette et al., 2019; Global Nutrition Report, 2020; IPCC, 2022). Effects are most severe in low-income countries, which already experience significant food insecurity (IPCC, 2022; FAO, 2022). Conflict drove 139 million people into acute food insecurity in 2020, with chronic food insecurity and protracted conflict creating a negative spiral that can be difficult to interrupt (FSIN, 2021; Hendrix & Brinkman, 2013).

To address these challenges, the global community has committed significant research efforts to understanding what works to achieve food systems transformation, who it works for, and what it costs. To be useful, this work needs accessible and future research prioritized to fill known evidence gaps. To this end, the International Initiative for Impact Evaluation (3ie), with assistance from IMMANA and support from Gesellschaft für Internationale Zusammenarbeit (GIZ), has been systematically collecting available impact evaluations and systematic reviews of impact evaluations on the effects of food systems interventions on food security and nutrition in low- and middle-income countries (L&MICs) since February 2020. 3ie presents the identified studies in an interactive [online evidence and gap map \(E&GM\)](#) and publishes periodic updates on the state of the [evidence](#). This report serves as a mid-term update on the state of the evidence regarding food systems interventions' effects on food security and nutrition in low- and middle-income countries, with the original [report](#) published in January 2021.

Study aims and research questions

By identifying, describing, and summarising the available literature in a clear and structured way, the E&GM project aims to make evidence accessible to policymakers, researchers, and the development community. By updating this E&GM regularly, we provide the community of practice with ready access to the most recent publications so that they can quickly become aware of research that fills key evidence gaps. Ultimately, this living E&GM seeks to facilitate the use of evidence to inform policy decisions.

Table 1: E&GM research questions

No.	Research question	Type
RQ1	What is the extent, range and nature of existing empirical evidence regarding the effects of food systems interventions on food security and nutrition outcomes in L&MICs?	Coverage
RQ2	How has the evidence changed over time?	Change
RQ3	What are the primary research and synthesis evidence gaps in the literature?	Gaps
RQ4	What intervention and/or outcome areas could currently be prioritised for primary research and/or evidence synthesis?	Research needs

Source: 3ie 2023; adapted from 3ie 2020

Scope

E&GMs are organized around a conceptual framework, which serves as the basis for determining the interventions and outcomes reflected in the map. This work relied on the framework from the High-Level Panel of Experts which was extended by the International Food Policy Research Institute (HLPE, 2017; de Brauw et al., 2019; Figure 1). The framework suggests three intervention domains within the food system: the food supply chain, the food environment, and consumer behaviour. The domains reflect types of actions and interventions, not a sequential flow of activities leading to one another.

Figure 1: EGM scope summary



Source: 3ie 2020; adapted from HLPE 2017 and de Brauw et al. 2019. Changes include an omission of the drivers depicted in the original framework, re-orientation of the food supply chain presentation, focus of food security and nutrition outcomes, and the addition of bi-directional arrows, which highlight that intervening at one stage in the food system may have implications for activities at another stage. The shading of the food supply chain along with the white arrow is meant to illustrate the flow of food through the supply chain.

Impact evaluations and systematic reviews of interventions considering interventions within these domains were included in the map so long as they considered outcomes related to food security and nutrition and took place in a low- or middle-income country. Studies measuring intermediate outcomes within the food system, such as food production or purchasing patterns, were also included.

Methods

In addition to the original map, this E&GM has now been updated four times. The methods for this E&GM were established *a priori* during the original map construction in 2020. Changes to the scope and methods for the updates are minimal. The search for the original E&GM was conducted in 12 academic databases and 31 sector-specific databases and completed September 2020. The search in the original 12 academic databases was repeated in July 2021, October 2021, January 2022, April 2022, and October 2022. The search of additional specialist databases and websites was repeated in January 2022. A review of included studies was conducted in October 2022 and January 2023.

During each update cycle, the same process was used: studies were imported into EPPI-reviewer, de-duplicated, screened at title and abstract, and then eligible studies were screened at full text. Data on the interventions, outcomes, country, population, and methods was extracted. Studies were added to the online map. Every four months, 3ie published an update note summarizing key developments in the evidence base and providing graphical descriptions of the types of studies that have been identified.

Results

Research question 1&2: What is the extent, range and nature of existing empirical evidence regarding the effects of food systems interventions on food security and nutrition outcomes in L&MICs? How has the evidence changed over time?

During the update period, we added 260 impact evaluations and seven systematic reviews to the E&GM. Although this is large in absolute terms, it represents a decrease in the rate of expansion in the literature base relative to pre-2019 trends. Our map currently includes 2,033 impact evaluations and 185 systematic reviews considering the effect of food systems interventions on food security and nutrition outcomes in low- and middle-income countries.

Interventions

The most studied intervention types, examined in over 250 impact evaluations and 25 systematic reviews, are *fortification*, *supplementation*, and *classes about consumer behaviour* interventions. During the update period, the focus on *fortification* and *supplementation* interventions reduced significantly, with a much smaller percentage of studies considering these interventions (10 and 14 percentage point decrease respectively). There was not a corresponding shift towards studying any single intervention.

Packaging; private food donation; use of and education regarding the use of spoiled, near spoiled or traditionally uneaten food; and advertising regulation interventions have not been examined by any identified impact evaluations.

Women's empowerment efforts, agricultural extension programs, other agricultural information and guidance, and water access and management interventions have been considered by 20 or more impact evaluations but no high- or medium-confidence systematic reviews.

Outcomes

The most studied outcomes, considered more than 400 times, are generally anthropometric, and included one micronutrient measure: *iron status*, *linear growth*, *relative weight*, and *weight*. The least studied final outcomes are *food stressed households* and *food toxins*. Twelve intermediate outcomes still never been evaluated: *advertisement topics*, *caloric requirements*, *exposure to advertisement*, *finances*, *location of foods in stores*, *movement of food*, *other regulation outcome*, *other steps taken due to non-compliance*, *tax revenue*, *time food remains unspoiled*, *violations*, and *food distribution centres*.

During the update period, there was a shift towards studying more intermediate (67% consider at least one intermediate outcome). In particular, there was an 18 percentage point increase in evaluations of agricultural outcomes and a corresponding 13 percentage point decrease in the evaluation of anthropometric outcomes. Only two per cent of studies consider five or more outcome groups.

Geography: There is focus on Sub-Saharan Africa (n = 751; 37%), with a disproportionate focus on food supply chain interventions in the region. India (n = 198, 10%), China (n = 139, 7%), and Bangladesh (n = 128, 6%) are the most commonly studied countries. These geographic trends were generally consistent over time.

Population and scale: Impact evaluations tend to consider all genders (n = 1,249; 61%) and people of all or unspecified ages (n = 662; 32%), with no meaningful difference between the original map and the update period. However, there was a slight increase in the number of national or transnational interventions evaluated, moving from 10 (n = 175) to 14 per cent (n = 36). This change was largest in the last update with 15 studies (24%) considering national or transnational interventions.

Methods: Most impact evaluations in the original map (n = 1,303; 73%) employed randomized designs. However, this decreased meaningfully, with only 58 per cent of impact evaluations in the update period using randomization. Few impact evaluations use mixed methods (n = 194, 10%) or present cost evidence (n = 163, 8%). This pattern was consistent in both the original map and the update. Systematic reviews are generally rated as low quality (n = 91, 49%) and tended to focus on *supplementation* (n = 67, 26%) and *fortification* (n = 48, 18%) across both the original map and the update.

Research question 3&4: What are the major primary and synthesis evidence gaps in the literature? What intervention and/or outcome areas could be prioritized for primary research and/or evidence synthesis?

Although there was growth in the evidence base, including in areas identified as key gaps in the original report, the evidence base in these areas was so small, that large proportionate increases did not fill the evidence gaps. Most identified research priorities remain the same as in the original report. Table 2 provides an updated, illustrative list of identified evidence gaps which could be prioritized for future research alongside a summary of the evidence that is available on these topics. These illustrative priorities were selected based on their policy relevance in reference to key ongoing activities in the field.

Table 2: Illustrative set of research priorities

	Studies and protocols added (studies in original)
<i>Illustrative list of interventions to priorities for evaluation</i>	
Government manipulations of price	6 (21)
Advertising and labelling regulations	0 (1)
On-farm, post-harvest processing	1 (4)
Interventions to support food packaging	0 (0)
Efforts to support women's empowerment within the food system	5 (18)
Innovative store design	1 (4)
Cold chain initiatives	0 (1)
Improved farm to market transport	0 (6)
Food safety regulations	2 (1)
<i>Illustrative list of outcomes to priorities for evaluation</i>	
Women's empowerment	17 (40)
Economic, social, and political stability	3 (2)
Food loss	0 (3)
Environmental impacts of the food system	6 (9)
Measures of diet insufficiency	2 (24)
<i>Illustrative list of evidence synthesis priorities</i>	
Provision of free or reduced-cost farm inputs to crop production	0 (13)
Educational approaches within the food value chain	0 (8)
Agricultural insurance products	0 (1)
Outcome related to other diet quality and adequacy measures	0 (24)
<i>Illustrative list of methods and scale priorities</i>	
Cost evidence	20 (161)
Mixed methods research	19 (175)
High-confidence systematic reviews	0 (42)
National and trans-national evaluations	36 (175)

Source: 3ie 2023

Implications for policy and practice

Although decision makers can reference high-quality systematic reviews, this evidence base has not grown and could soon be outdated. The primary evidence base increased considerably in during the update period, but only two new medium-confidence systematic reviews and no high-confidence systematic reviews were identified. Therefore, the synthesis review evidence base is quickly becoming outdated. Until additional high-confidence systematic reviews are produced, decision-makers may reference individual studies included in the map to understand barriers and facilitators to outcomes achieved in specific contexts.

The availability of evidence relating to key, policy-relevant activities is highly variable, which may leave decision makers without the evidence they need. Nonetheless, we encourage decision-makers to reference the evidence available in this E&GM and other sources as relevant.

Decision-makers may continue investing in under-researched areas. Although caution should be used when implementing under-researched interventions, these interventions should not necessarily be avoided. Decision-makers and implementers may contextualize the evidence in this E&GM with other sources to determine the likely effects of an intervention in a local context. They can design interventions with the intent to evaluate them in the future to build the evidence base.

Implications for research

Researchers are increasingly prioritizing a range of interventions, as demonstrated by the noticeable decrease in the clustering of evaluations during the update period. However, research gaps remain (Section 5.4).

There is insufficient research on key policy priorities. Many of the interventions listed as research needs in Table 2 are already widely implemented. As such, we need to quickly establish their likely impacts to ensure that the right interventions are being prioritized. This will require the production of high-quality evidence synthesis to make generalizable conclusions in addition to primary research.

Evaluations of food systems interventions do not take a systems-level approach.

Only two per cent of evaluations consider outcomes in five or more groups. Many of these do not look across the theory of change (ex. measuring production, income, diet, and anthropometrics), but instead evaluate conceptually similar outcomes (ex. micronutrient status, anthropometrics, and cognitive development). Without measurement across the causal chain, it is impossible to know how interventions affect the system as a whole. Future research may consider measuring different types of outcomes, conducting mediation analysis, and examining general equilibrium effects to understand how change echoes through the food system.

Cost evidence and mixed-methods research is still underrepresented. There was minimal change in the frequency of cost evidence or mixed methods research. This means that we still need more information to answer two key questions: are impacts worth the costs and what are the mechanisms by which impacts are achieved.

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Abbreviations and acronyms

Children's Investment Fund Foundation	CIFF
Department for International Development	DFID
Deutsche Gesellschaft für Internationale Zusammenarbeit	GIZ
European Union	EU
Evidence and gap map	E&GM
Global Food Security Strategy	GFSS
Food and Agriculture Organization	FAO
Foreign, Commonwealth, and Development Office	FCDO
Germany's Federal Ministry for Economic Cooperation and Development (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung)	BMZ
High Level Panel of Experts	HLPE
Intergovernmental Panel on Climate Change	IPCC
International Food Policy Research Institute	IFPRI
International Initiative for Impact Evaluation	3ie
Low- and middle-income countries	L&MICs
National Institutes of Health	NIH
Norwegian Agency for Development Cooperation	Norad
Population, intervention, comparator, outcome and study design	PICOS
State of Food Security and Nutrition in the World report	SOFI
United States Agency for International Development	USAID
Consultative Group for International Agricultural Research	CGIAR

1. Introduction

In February 2020, the International Initiative for Impact Evaluation (3ie) began developing an evidence and gap map (E&GM) collecting all available impact evaluations and systematic reviews of impact evaluations measuring the effects of food systems interventions on food security and nutrition in low- and middle-income countries (L&MICs). 3ie was funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) through Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) through its “Knowledge for Nutrition” programme. The Innovative Methods and Metrics for Agriculture and Nutrition Actions (IMMANA) research group supported this project by contributing significant staff time, funded by the Bill and Melinda Gates Foundation and the Foreign, Commonwealth, and Development Office (FCDO). 3ie developed the map into a living evidence product, updating it every four months with the newest literature in the field. This report represents a mid-term summary of patterns in the evidence base and changes in those patterns over time.

1.1 Study aim, objectives, and research questions

By identifying, describing, and summarising the available literature in a clear and structured way, this project aims to make evidence accessible to policymakers, researchers, and the development community. By updating this E&GM regularly, we provide the community of practice with ready access to the most recent publications so that they can quickly become aware of research that fills key evidence gaps. Ultimately, this living E&GM seeks to facilitate the use of evidence to inform policy decisions. To meet these aims, the evidence and gap map has two specific objectives:

1. To identify and describe the evidence on the effects of food systems interventions on food security and nutrition outcomes in L&MICs
2. To monitor the evolution of primary research and evidence synthesis in the field, focusing on the identification of emerging trends and the filling or persistence of knowledge gaps.

The research questions shown in Table 3 seek to address these objectives. Research questions one, three, and four are consistent with the original map. Research question two was added during the update period to allow for a deeper focus on the development of the evidence base over time.

Table 3: E&GM research questions

No.	Research question	Type
RQ1	What is the extent, range and nature of existing empirical evidence regarding the effects of food systems interventions on food security and nutrition outcomes in L&MICs?	Coverage
RQ2	How has the evidence changed over time?	Change
RQ3	What are the primary research and synthesis evidence gaps in the literature?	Gaps
RQ4	What intervention and/or outcome areas could currently be prioritised for primary research and/or evidence synthesis?	Research needs

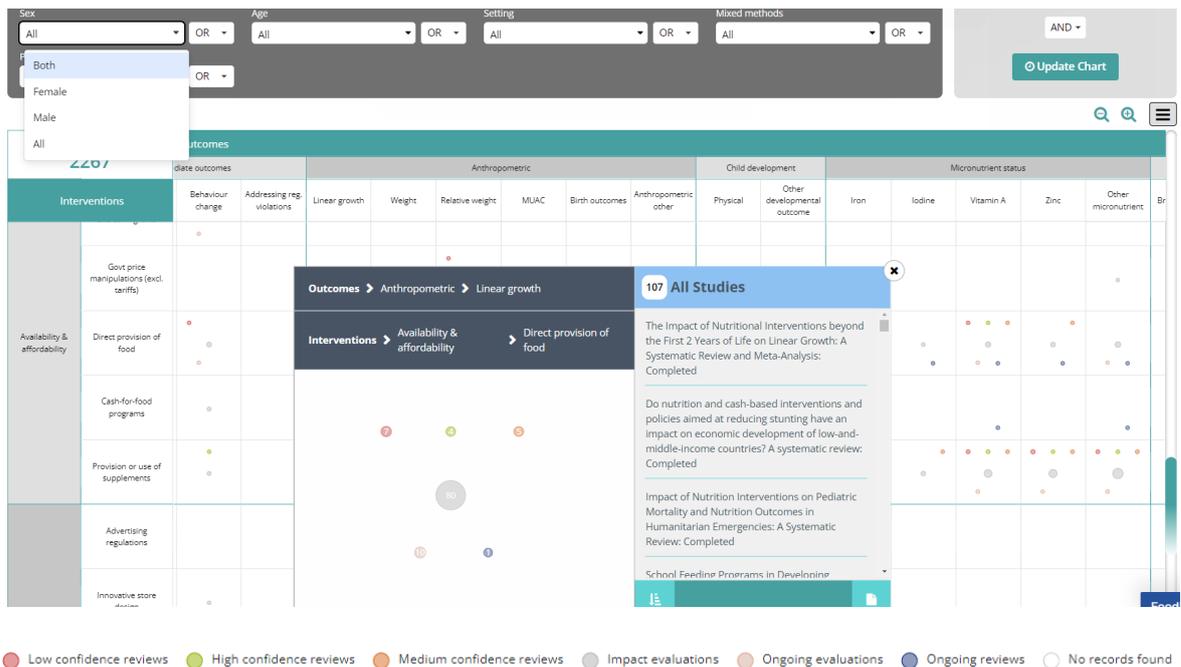
Source: 3ie 2023; adapted from 3ie 2020

1.2 What is an evidence and gap map and how is it used?

An E&GM aims to establish what is known and unknown about an evidence base in a thematic area (Snilstveit et al. 2016). The map is populated through a systematic search and screening process to identify all completed and ongoing impact evaluations and systematic reviews of impact evaluations that meet a set of pre-specified inclusion and exclusion criteria. All studies that meet these criteria are mapped onto a framework of interventions and outcomes, which provides a graphical display of the evidence in a grid-like framework. Frameworks are based on established theories of change within the sector.

The map presents the volume of evidence for all intervention–outcome combinations, the type of evidence (impact evaluation, systematic review, completed or ongoing), and a confidence rating of each systematic review. The final map is published on an [online interactive platform](#) that provides additional filters so that users can further explore the available evidence (e.g. by global region, year of publication, or population). Links to all included studies are provided in the map (Figure 2).

Figure 2: Screenshot of small portion of the interactive platform



Source: 3ie 2023

Notes: Full map can be referenced at <https://developmentevidence.3ieimpact.org/egm/food-systems-and-nutrition-evidence-gap-map>

Our living E&GM turns the search, screening, and data presentation process into a cycle that is completed approximately every four months. This keeps the map up to date and allows for the rapid identification of studies that address key evidence gaps. Through data visualisations and periodic analysis, changes in the types of studies conducted are quickly identified.

E&GMs highlight areas where evidence is concentrated and where it is noticeably absent. Absolute evidence gaps (empty cells in the framework) can be filled with new

impact evaluations. Synthesis gaps (multiple impact evaluations but no recent, high-confidence systematic reviews) can be filled with evidence synthesis. Evidence clusters may represent over-researched areas, where the effects of a particular intervention have been evaluated against a range of outcomes (or vice versa), and where additional studies may not be as necessary.

Importantly, not all evidence gaps must be filled. Gaps can occur for several reasons, including:

- Well-established effects: The impact (or lack thereof) may have been well established before the search period. In such a case, there is no need for subsequent studies investigating already established impacts.
- Limited underlying theory: There may be no theoretical reason to expect the intervention to affect the outcome. Investigating these areas might lead to incorrect conclusions due to the potential for spurious correlations.
- Methodological and practical limitations: It may be difficult to conduct impact evaluations on a given intervention. There may be other sources of information, such as qualitative research or process evaluations, that consider the topic of impact without fulfilling the inclusion criteria for this map. Implementation science is often used to investigate intervention outcomes as well. In addition, studies may also have been conducted but not published (e.g. because no significant effects were found).
- Studies not captured within this evidence map: Although a comprehensive search was undertaken, it is possible that some relevant studies are not included in this evidence map due to language or date restrictions, lack of identification through the search approach, or other potential oversights.
- Existence of meaningful knowledge gaps: Finally, there may be meaningful knowledge gaps that represent opportunities for future research. These gaps can be especially concerning when an intervention has been widely implemented without sufficient evidence.

The existence of an evidence cluster does not necessarily mean that no more research should be conducted in a given area. Because interventions and outcomes in E&GMs can reflect aggregates with disparate subgroups, it is possible that only a narrow portion of an intervention or outcome category has been investigated. For example, fortification is well researched. However, studies focus on iron, folate, and vitamin A. Less prioritized nutrients may be understudied despite the apparent saturation in the field. Additional research may be useful to consider specific contextual factors, implementation concerns, environmental interactions, or effects on specific populations. However, researchers considering working within areas known to be saturated may wish to reference the existing literature to ensure that their work builds upon and does not repeat what is already present.

3ie's evidence and gap maps are envisioned as a global public good. This allows them to be used as tools to facilitate access to high-quality research to inform development decision-making. Continually updating the evidence and gap maps ensures that these decisions are based on the most up to date evidence available.

1.3 Remainder of this report

The remainder of this report is presented as follows:

- **Section 2** presents the subject background.
- **Section 3** presents the scope and method.
- **Section 4** presents the results.
- **Section 5** concludes and provides a set of considerations for using the EGM.

2. Background and rationale

2.1 Threats to food security and nutrition

It is becoming increasingly obvious that the global food system does not work for people, our planet, and prosperity (Global Report, 2020). The world is moving further away from meeting the 2030 Sustainable Development Goals in nutrition and the 2025 World Health Assembly targets (FAO, 2022). The prevalence of undernourishment rose from eight per cent in 2019 to almost 10 per cent in 2021 (FAO, 2022). The vulnerable are always the most affected by food-related shocks and growing inequality is making this divide larger (FAO, 2022). Women are now four percentage points more likely than men to experience food insecurity (FAO, 2022). Today, the three C's (COVID, climate, and conflict) interact to threaten global food security (Hendriks et al., 2022; FAO, 2022).

Since the start of the COVID-19 pandemic, an additional 150 million people have been affected by hunger and over 112 million are now unable to afford a healthy diet (Global Nutrition Report, 2022). An additional 350 million people experienced moderate or severe food insecurity in 2021 compared to 2019 (FAO, 2022). These negative effects functioned through interruptions in the global economic, health, and food systems (Global Nutrition Report, 2021). In order to prevent the spread of COVID-19, governments reduced social services, such as important school nutrition programmes (Global Nutrition Report, 2020). Volunteers and implementing organizations did not have access to the field, causing disruptions to many interventions (GFSS, 2020). Food prices increased significantly due to supply chain and transportation challenges resulting from lockdowns and other COVID-19 response measures (FAO, 2022).

The potentially devastating effects of climate change on food security are well established (Willette et al., 2019; Global Nutrition Report, 2020). Climate events threaten the food supply chain, particularly in low-income countries (IPCC, 2022; FAO, 2022). Climate and the food system can interact in a downward spiral, with food systems being a major source of greenhouse gasses (23-42%) and climate change undermining food security (IPCC, 2022; Global Nutrition Report, 2020). Climate change is expected to reduce agricultural productivity and drastically increase food prices in the coming years (IPCC, 2022). Increased food prices are associated with lower quality diets. This can result in either obesity or undernutrition depending on the context (IPCC, 2022). Meat consumption, food imports, and land use all affect both food costs and greenhouse gas emissions (IPCC, 2022). Healthy diets, rich in locally sourced fruits and vegetables, reduce greenhouse gas emissions (IPCC, 2022). However, diets associated with more affluent populations tend to include more meat and imported foods (IPCC, 2022).

The increase in food insecurity in Sub-Saharan Africa since 2014 was largely driven by increased conflict, especially in South Sudan and Nigeria, rather than climate change, which has had a constant effect on food insecurity since 2009 (Anderson et al., 2021). Globally, conflict drove 139 million people into acute food insecurity in 2020, largely due to forced displacement (FSIN, 2021). Food insecurity can increase stress, destabilize populations, and induce conflict (Hendrix & Brinkman, 2013). This was observed during the Arab spring, when a sudden increase in food prices, related to adverse climate events, led to widespread unrest and mass uprisings (Hendriks et al., 2022; Hendrix & Brinkman, 2013). Chronic food insecurity and protracted conflict can result in a negative spiral that is difficult to interrupt, even with humanitarian aid, as the aid itself can become a source of conflict (Hendrix & Brinkman, 2013).

The full effects of the conflict in Ukraine are not yet known. However, potential effects on trade and production are significant and could cause food price increases (FAO, 2022). Already, largely attributed to the war in Ukraine, but also a result of COVID and climate change, the agricultural commodity price index was 34 per cent higher in June 2022 than January 2021 (World Bank, 2022). People in Sub-Saharan Africa, the Near East, and North Africa are likely to be most affected by the war because they spend a significant amount of their income on food and rely heavily on imported wheat and fertilizer from Ukraine and Russia (FAO, 2022).

2.2 Policy responses: transforming food systems to work for people, our planet, and prosperity

Food systems transformation is needed to develop a safe, sustainable, and equitable food system for all. Increasingly, the global community is committing to achieving this transformation. For example, the next report coming out of the Food and Agriculture Organization's (FAO) High-level Panel of Experts is expected to focus on reducing inequality within the food system.

Building on the Nutrition for Growth Summit in 2021, the Global Nutrition Report developed a Nutrition Accountability Framework to capture the SMART (specific, measurable, attainable, relevant, and time-bound) commitments from donors, monitor those commitments, and publicly report them (Global Nutrition Report, 2023a).

As of 2020, Australia, Ireland, and the Netherlands had reached their commitments and were no longer requested to report their funding to the Global Nutrition Report. The United States was the single largest donor reporting in the Global Nutrition Report in 2020, spending USD 4.2 billion, mostly on nutrition-sensitive programs (USD 4 billion; Global Nutrition Report, 2023b). The next largest donor is the United Kingdom reporting USD 1 billion, also mostly in nutrition-sensitive programming (USD 980 million). Canada, the European Union, France, Germany, and the Children's Investment Fund Foundation (CIFF) reported smaller amounts of nutrition funding, between USD 37 million and USD 907 million.

The commitment tracker reports a total of USD 42.6 billion in financial commitments made by 198 stakeholders, reflecting 897 distinct goals. Most of these commitments (96%) were made at the Nutrition for Growth Summit in 2021. These commitments focus on supporting an enabling environment for nutrition action (45%), specifically leadership

and governance (21%). They include commitments related to changing the food environment (7%), consumer knowledge (4.1%), food and nutrition security (1.6%), undernutrition (15%), and obesity (2.6%; Global Nutrition Report, 2023a).

Research, monitoring, and data is also a common commitment (9%). The High-Level Expert Group from the European Commission recently called for strengthening the science-policy-society interface by funding a series of dedicated taskforces to fill knowledge and data gaps and collectively invest in a global coordination hub (European Commission, 2022). One such coordination effort, coming out of the United Nations Food Systems Summit, is the United Nations Food Systems Coordination Hub (UNFSCH, 2022). The hub provides country-driven support, customized to help countries realize their goals and reach a sustainable food system. It highlights the importance of evidence in decision making, reaching nutrition targets, and building a sustainable food system.

2.3 Why is staying up to date on the evidence important?

The large number of commitments to research reflects the growing understanding that up-to-date evidence is needed to support decision-making which can achieve long-term food systems transformation. Decision-makers need to know what works, for whom, and at what cost. Rigorous evidence needs to be available and accessible to respond to these questions and serve as the basis of decision making. Evidence gaps need to be identified and appropriate research prioritized to fill them.

In order to be practically useful, the evidence needs to be systematically collated and presented in an easy to access manner. With over 100 new impact evaluations and systematic reviews of impact evaluations on food systems interventions published each year for the last decade, the evidence base is rapidly evolving. Therefore, any systematic search and collation process would quickly become outdated if it were not updated on a regular basis. Decision makers using the database developed through a search that was completed even just one year ago would be relying on outdated information. As such, a one-time search and collation processes would not be sufficient to respond to the evidence needs of the development community. The search and collation must be update regularly to ensure that the most up to date evidence is available to serve as the basis for decision making.

3. Scope and methods

The scope and methods for this E&GM were determined *a priori* during the original map construction in 2020. Changes to the scope and methods for the updates were minimal. We describe the original scope and methods below, specifying changes made during the update period noted.

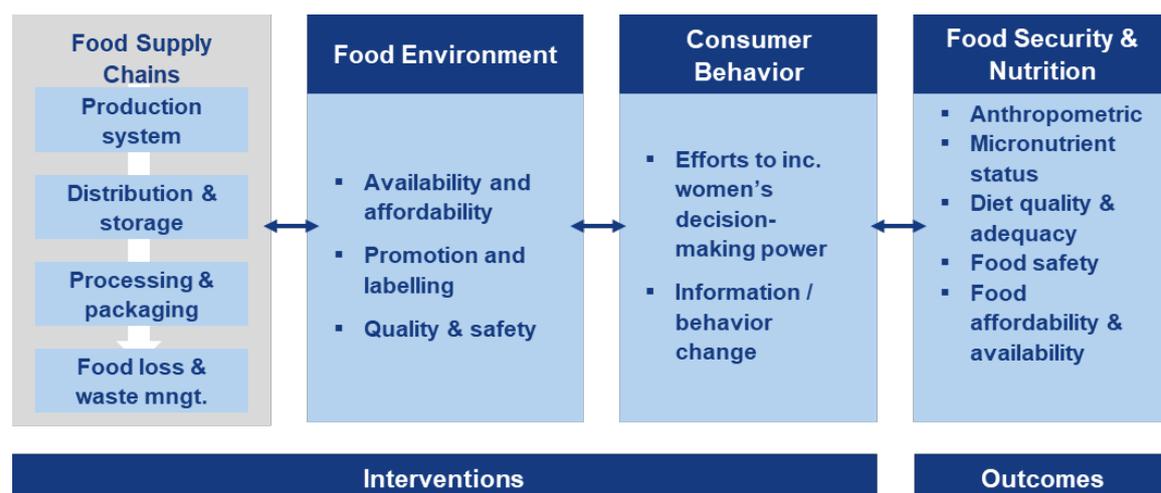
3.1 Conceptual framework

The High Level Panel of Experts established a framework to systematically map food systems (HLPE, 2017). In 2019, the International Food Policy Research Institute (IFPRI) extended this framework to include additional feedback mechanisms (de Brauw et al., 2019). This extended framework was adopted as the conceptual basis of our efforts to map the evidence relating food systems to nutrition and food security.

The framework suggests three intervention domains within the food system: the food supply chain, the food environment, and consumer behaviour. The domains reflect types of actions and interventions, not a sequential flow of activities leading to one another. The food supply chain is broken down into production activities, storage and distribution, processing and packaging, and food loss and waste management (Figure 3). The food environment is the physical, economic, political and sociocultural surroundings, opportunities, and context that create, prompt, and shape dietary preferences and choices and nutritional status (Swinburn et al., 2014; Global Panel, 2017). These include the availability, physical accessibility and provision of foods; affordability; promotion and labelling; and food quality and safety. Finally, consumer behaviour involves individual preferences related to consumption, food prices and income available for food (de Brauw et al., 2019). It includes prices, preferences, women’s empowerment in the context of the food system, and information.

The framework outlines five main drivers of change in global food systems: biophysical and environmental; innovation, technology and infrastructure; political and economic; sociocultural; and demographics (HLPE, 2017; de Braw et al., 2019). These drivers work outside the food system, but have significant impacts on food systems by altering food production and demand. The framework considers outcomes related to food security and diet, and ultimate outcomes related to nutrition; health; and social, economic and environmental well-being. For this E&GM, food security and nutrition are final outcomes. We also include intermediate outcomes which measure aspects of the food system itself. Included intermediate outcomes relate to time use; steps taken due to non-compliance; regulations; advertising and labelling women’s empowerment; intrinsic motivators; food loss; food distribution; environmental impact of the food system; economic, social, and political stability; economic outcomes; bio-nutritional outcomes; agricultural outcomes; and behaviour change.

Figure 3: EGM scope summary



Source: 3ie 2020; adapted from HLPE 2017 and de Braw et al., 2019. Changes include an omission of the drivers depicted in the original framework, re-orientation of the food supply chain presentation, focus of food security and nutrition outcomes, and the addition of bi-directional arrows, which highlight that intervening at one stage in the food system may have implications for activities at another stage. The shading of the food supply chain along with the white arrow is meant to illustrate the flow of food through the value chain.

Since the inception of this work, a revised framework was published by the HLPE (2020). The updated framework includes political and institutional drivers. As with our framework, it places the food supply chain, consumer behaviour, and diet squarely within the food system and highlights the bi-directional relationship between these concepts. However, the new HLPE framework considers the food environment to overlap with the food supply chain, consumer behaviour, and diet. In the new framework, the food environment is the backdrop against which these domains function. The updated framework also highlights the roles that other systems have in supporting the food system (e.g., ecosystems, economic systems, health systems) and the effects that the food system has on nutrition, health, the economy, equity, and the environment. It frames these as straddling the line between the food system and other key aspects of society and the planetary ecosystem. These modifications highlight the interconnectedness of the food system with other systems, drivers, and outcomes. Although we acknowledge the importance of these changes to the framework, due to practical limitations and to maintain comparability of the map over time, we have not expanded the scope of our map to include these other systems, drivers, and outcomes.

3.2 Criteria for including and excluding studies

When defining the scope of relevant interventions and outcomes, the aim was to be as comprehensive as possible whilst setting a feasible scope that was not too broad to be presented in a visually approachable and interpretable manner. Table 4 presents the detailed criteria for including and excluding studies according to the population, intervention, comparator, outcome and study design (PICOS) framework. The PICOS framework sought to identify impact evaluations and systematic reviews of impact evaluations that assessed the effects of at least one food system intervention on food security and nutrition outcomes for any population based in an L&MIC.

We define an impact evaluation as a study that uses rigorous methods to provide a quantitative estimate of the impact of an intervention ([Appendix A](#)). This is accomplished by constructing a counterfactual, which provides evidence about what would have happened in the absence of the intervention. In an impact evaluation, the outcomes of those who receive the intervention are compared with those of a comparison group that does not receive the intervention. The comparison group may be a specific population in the study area that does not receive the treatment (as in a randomised controlled trial) or may be constructed by researchers (as in propensity score matching or interrupted time series). Although simple comparisons of change over time are often used to investigate impacts, we only include these studies if they have a comparison group and account for time-invariant unobservable effects, such as through the use of fixed effect models.

We limit eligible systematic reviews to synthesis of the quantitative impact evidence on a particular topic (e.g. the effectiveness of water supply and sanitation) obtained through an exhaustive systematic literature search for all relevant studies using widely accepted scientific strategies to minimise error.

Although other forms of evidence, such as qualitative research, implementation science, and process evaluations are of critical importance, they are not reflected in this E&GM. This decision was made for practical and theoretical reasons. First, such research is much more challenging to reflect in a matrix format as outcomes can be harder to

classify. Second, the body of literature identified was already quite large. The addition of entirely new areas of inquiry would have been outside our scope and resource constraints. Which leads to a third reason to exclude these other sources of information: we want to provide an easy to navigate database of impact evaluations and systematic reviews to allow for the rapid identification evidence on causal impacts. The addition of other sources of information would make navigation more cumbersome and may reduce utility. This does not, however, mean that we do not value these other types of evidence.

Table 4: Summary of criteria for the inclusion and exclusion of studies

Criteria	Inclusion criteria	Exclusion criteria
Population	<p>Studies of interventions with programme participants that were located in a L&MIC in the first year of implementation¹</p> <p>Impact evaluations with at least one effect size for an L&MIC country population</p> <p>Studies focused on the prevention of clinical conditions</p>	<p>Studies focused on niche populations, such as athletes or the military</p> <p>Efficacy studies, unless completed in a sufficiently real-world setting</p> <p>Studies targeting participants with a clinical condition</p> <p>Studies focused on high-income country migrant populations in L&MICs and vice versa</p>
Intervention	<p>Studies of interventions that directly intervene on an aspect of the food system within its three primary domains: the food supply chain, the food environment and consumer behaviour</p> <p>Studies evaluating multiple food systems interventions</p>	<p>Interventions not in the food system or interventions targeting drivers of the food system without an explicit food system focus</p> <p>Unconditional cash transfer programmes</p> <p>Interventions focused on the financing of a food systems intervention</p>
Comparisons	<p>Studies using appropriate comparisons included: business as usual, an alternative treatment, no treatment or an early- versus-late comparison (where those that took part in earlier years are compared to those that took part in later years)</p>	<p>Studies that did not justify and make use of an appropriate comparison group</p>
Outcomes	<p>Final outcomes relating to anthropometry, physical and mental development outcomes, micronutrient status, diet quality and adequacy, food safety affordability and availability</p> <p>Intermediate outcomes were included for all interventions that were deemed relevant to the food system</p>	<p>Health and non-food-system related education outcomes</p> <p>Mortality and morbidity outcomes, unless a disease is directly linked to a specific micronutrient deficiency (e.g. anaemia or goitre)</p>
Study design	<p>Effectiveness studies, based in real- world settings, employing one of the following methods: randomised controlled trials (where treatment assignment is random); and quasi-experimental designs (where treatment is assigned as if it were random; e.g. regression discontinuity design, instrumental variables, panel methods, difference-in-difference, synthetic control groups, interrupted time series analysis and statistical matching)</p> <p>Systematic effectiveness reviews, which employ recognised search and synthesis methods (Snilstveit et al., 2016)</p>	<p>Before-after studies or cross- sectional studies that do not attempt to control for selection bias or confounding in any way</p> <p>Case-control studies</p> <p>Randomised block designs where farm field sections are the blocking unit</p> <p>Willingness-to-pay and hypothetical experiment studies</p>
Other	<p>Studies published in or after the year 2000²</p> <p>Complete or ongoing studies (i.e. protocols are included)</p> <p>Studies in any publication format</p>	<p>Studies in any language other than English</p>

Source: 3ie 2020.

1. As defined using the World Bank Atlas method. More information on this approach is available at: <https://bit.ly/3eBAWKJ>.
2. The cut-off at the year 2000 was made arbitrarily to make the volume of search results more manageable.

3.3 Search strategy

The original systematic search of 12 academic bibliographic databases was completed in May 2020 ([Appendix B](#)). Additional studies identified before the end of September 2020 were also included in the original map. To address potential publication bias issues, the following data sources were used for the original map:

- Other specialist databases and websites: In total, 31 sector-specific databases and websites were searched. Basic search terms or strings were used where search functionality was limited.
- Backward citation tracking: Citations for all included systematic reviews were reviewed for inclusion.
- Communication with researchers: Information about potential eligible studies up to the end of September 2020 was requested. This occurred through two main channels: (1) engaging with the project advisory and policy stakeholder groups and (2) publishing a call for information via a related blog post on the 3ie website and promoting it using social media.

The search in the original 12 academic databases was repeated in July 2021, October 2021, January 2022, April 2022, and October 2022. The search strings used and the databases searched were identical to those in the original EGM, with the exception of correcting a syntax error in the strings for one database (Scopus). The search of additional specialist databases and websites was repeated in January 2022. We also screened items retrieved in the searches for 3ie's [Development Evidence Portal](#)—a database of impact evaluations and systematic reviews across sectors in international development—for relevance to this evidence map. Monthly “evidence surveillance” searches are used to populate the Development Evidence Portal. As there is considerable overlap in the inclusion criteria for the Portal and this map, pooling these search strategies reduced overall workload and allowed more articles to be screened. However, no studies from the Portal search which were not also found from the E&GM search were included in the first update. Therefore, we do not expect that this pooling of the search results affected the number of studies identified. The last search of the Development Evidence Portal which is considered in this map was conducted in October 2022. Backwards citation tracking and contacting of experts was not conducted during the update period.

3.4 Screening

Screening of studies was managed using EPPI-Reviewer 4 software (Thomas et al., 2010) and was completed by implementing the following steps:

Prepare study records: All output files of the implemented search strategy were imported into EPPI-Reviewer software. Studies that were identified through the additional means specified above were added to the software manually. An automated process within the software was used to remove duplicate files. Studies which EPPI identified as having a high probability of being duplicates were removed automatically. Those which received lower scores were manually reviewed.

Title and abstract screening: The titles and abstracts of all imported and de-duplicated studies were screened by a single individual. The screener assigned one code, which

indicated that either the study should be included for full-text screening, that the study should be excluded, or that they were unsure. If a study was excluded, the reviewer coded the rationale for exclusion. Where screeners had any difficulty in applying the eligibility criteria, a study was screened by a second reviewer. Periodic meetings were held to discuss and resolve screening decisions for studies that screeners had coded as 'unsure'.

During the update period, title and abstract screening was managed within the routine screening conducted for the Development Evidence Portal. All screeners for the Development Evidence Portal were trained on the inclusion criteria for the Food Systems and Nutrition Evidence Map. Studies retrieved during searches for the Development Evidence Portal or the Food Systems and Nutrition Evidence Map were pooled and assigned for screening. As screeners worked, they indicated relevance for the Development Evidence Portal and the Food Systems and Nutrition Evidence Map at the same time.

EPPI-Reviewer 4 software's machine learning capabilities were used to streamline the process and efficiently remove clearly irrelevant studies. The same machine learning classifier was applied during the original map and the update period. An additional classifier, developed for the Development Evidence Portal, was also applied during the update period. The classifier for the Development Evidence Portal is trained to exclude studies based on country and study design but not based on intervention or outcome. Because the country and study design inclusion criteria for the Development Evidence Portal and this E&GM are the same, the application of this additional filter is not expected to have resulted in the exclusions of any studies relevant to the Food Systems and Nutrition Evidence Map.

Full text screening: The full text was retrieved for each study that met all the title and abstract inclusion criteria. Initially, two reviewers examined each full text in detail against the protocol and applied a code to indicate whether the study was included or why the study was excluded. Disagreements were reconciled periodically. From August 2020, full texts were single screened (with an option for screeners to mark items as unsure) due to time constraints. Overall, 30 per cent of studies included at the title and abstract stage were double screened during the original mapping process. Only screeners who had worked on the original map conducted full text screening during the update period. All studies identified for inclusion in the update period were screened by a second reviewer to confirm their eligibility.

Checks for linked publications: Publications were considered to be linked if the analysis was based on data related to the same study population. This typically occurred when authors followed a group of participants over time, published multiple versions of the same study in different formats (e.g. a working paper later published as a journal article), or updated a systematic review. Descriptive information was only included once for each group of linked publications, so that each study was independent. This means that the presented analysis is reported at the study level, rather than the publication level. The most recently published linked study was selected for representation in the online version of the map.

A review of included studies was conducted in October 2022 and January 2023 with studies being re-considered for eligibility in the E&GM to ensure consistent application of inclusion criteria. During this review process, we also identified 19 studies which were included, but not presented in all data counts and have now been fully coded.

3.5 Data extraction and analysis

Data were systematically extracted from all included studies using the data extraction tool described in [Appendix D](#) for the original map. Extracted data covered the following:

Study characteristics: This coding focused on capturing the general characteristics of the study, including authors, publication date and status, study location and setting, intervention type, outcomes reported, definition of outcome measures, population of interest, and study and programme funder. Methodological information was also collected, covering the type of quantitative methods employed and whether authors complemented quantitative results with qualitative inquiry and/or conducted any cost or cost-benefit analyses.

Critical appraisal: All systematic reviews were appraised following the practices adopted by the Development Evidence Portal, which draws on Lewin and colleagues (2009). This process involved appraising each review's search, screening, risk of bias assessment, data extraction and synthesis. Each systematic review was rated as low, medium or high confidence, drawing on guidance provided in Snilstveit and colleagues (2017). Initially, a five per cent sample of reviews was appraised by two researchers, then independently reconciled by a systematic review expert. Reviewers were provided with feedback, and reliability was judged to be sufficient. Subsequently, one person appraised each systematic review, and the systematic review expert independently reviewed all completed appraisals. Impact evaluations were not critically appraised, as this is typically beyond the scope of an E&GM.

For the original map, data extraction was conducted in Excel. During the update period, 3ie E&GMs were transferred to 3ie's custom, online data extraction platform. The data extracted for the original map was copied into the online platform, and all data for the updates were extracted directly into the online platform. Coding reflecting if the target of intervention was not a human (e.g. livestock targeted for veterinary intervention) and reproductive status for women was removed during the update period because it was not used in the analysis for the original map.

3.6 Presentation of the map

Results are presented graphically on 3ie's interactive [online platform](#). The main framework is a matrix of interventions and outcomes, with grey and coloured circles representing impact evaluations and systematic reviews, respectively. The systematic reviews follow a traffic-light system to indicate confidence in their findings: green for high, orange for medium, red for low. The colour blue indicates that the study is ongoing. The size of the bubble indicates the relative size of the evidence base for that intersection of intervention and outcome.

The interactive aspect of the E&GM allows users to filter the results based on key variables, thereby facilitating efficient, user-friendly identification of relevant evidence. The filters and their definitions are provided in Table 5. Users can choose to focus on specific interventions or outcomes, corresponding to the food systems domains, using additional drop-down menus.

Table 5: Study characteristics for E&GM filtering

Filter	Definition
Region	The relevant continent or region in which the intervention took place
Country	The country in which the intervention took place
Sex	The sex of the sample for which impact is estimated or the intervention broadly targets
Age	The age group of the sample for which impact is estimated or the intervention broadly targets
Study design	The quantitative experimental or quasi-experimental design implemented to estimate effects
Mixed methods	Whether qualitative evidence was analysed to complement quantitative results
Cost evidence	Whether and what cost data was reported for the intervention

Source: 3ie 2020

3.7 Study strengths and limitations

The study has the following strengths:

- **Current:** By updating the map approximately every four months, we provide the most up-to-date characterisation of the available evidence of the effects of food systems interventions on food security and nutrition outcomes (Figure 3).
- **Timely:** The original map was commissioned in response to a direct policy need and has been developed into a living product based on ongoing interest. It replies directly to the call to collect and coordinate evidence in the field by Webb and colleagues (2022).
- **Broad:** The scope of the map is broad. Outcome information was collected for a range of final and intermediate outcomes reported in studies.
- **Useful:** The map has served as the basis for two rapid evidence assessments (Berretta and colleagues, 2022; Kinzer, 2022) and a systematic review (Hammaker et al., 2022). It has also been referenced in documents from the Millennium Challenge Corporation (Laborde and colleagues, 2021); International Food Policy Research Institute (Njuki and colleagues, 2021); Foreign, Commonwealth, and Development Office (Carter and colleagues, 2021); and European Commission (European Commission, 2022).

The following limitations can be applied to this study:

- **No forward citation checking:** Due to the high volume of included studies, it was not feasible to screen records that cited included studies.
- **Focused data extraction:** Comprehensive characteristics relating to study equity considerations and research transparency were not extracted due to time constraints.
- **English language focus:** Studies only published in non-English languages were missed, which may introduce bias. Although this could induce some biases in the types of studies included, we expect these to be minimal and believe English language studies will be of the widest interest to the intended users of this map.
- **Quality of impact evaluations not assessed:** The standard analytical procedure for an EGM is to appraise the quality of systematic reviews but not impact

evaluations. While the impact evaluations included met our eligibility criteria, the quality of the evaluation specification or design (e.g. through an assessment of the theory of change or the completion of a risk of bias assessment) was not appraised. Critical appraisal of impact evaluations is very time intensive and generally considered to be outside the scope of an E&GM.

4. Results

4.1 Results of the search

During the update period, 203,244 articles were retrieved through the search of academic databases (Figures 4&5). We excluded 97,038 as duplicates and 52,775 through the classifier applied in EPPI reviewer. As a result, a total of 33,912 articles were screened on title and abstract from all update rounds. We then screened 11,820 articles at full text, including 122 articles identified through the grey literature search.

Through the reviews conducted in October 2022 and January 2023, we excluded 77 studies from the original map. Of these, 40 were protocols which no longer met eligibility criteria due to being outdated,¹ 28 were found to not meet the inclusion criteria upon additional review, and nine were identified as linked studies. We also found 19 studies that had incomplete data extraction and had been dropped from some of the original analyses, which are now included in all counts. Finally, one systematic review was identified and included through contact with the authors, but has not yet been indexed (Hammaker et al., 2022).

The process resulted in 1,951 studies (IE n = 1,773; SR n = 178) included from the original map and 267 studies (IE n = 260; SR n = 7) added during the update period. The map now contains 2,218 unique studies (IE n = 2,033; SR n = 185). We use these numbers as the denominators for all percentages reported, unless otherwise specified.

¹ Protocols are only included if they have been updated within two years or authors reply to our contact indicating that the study is still ongoing.

Figure 4: Overview of search and screening process (Original map – Update 2)

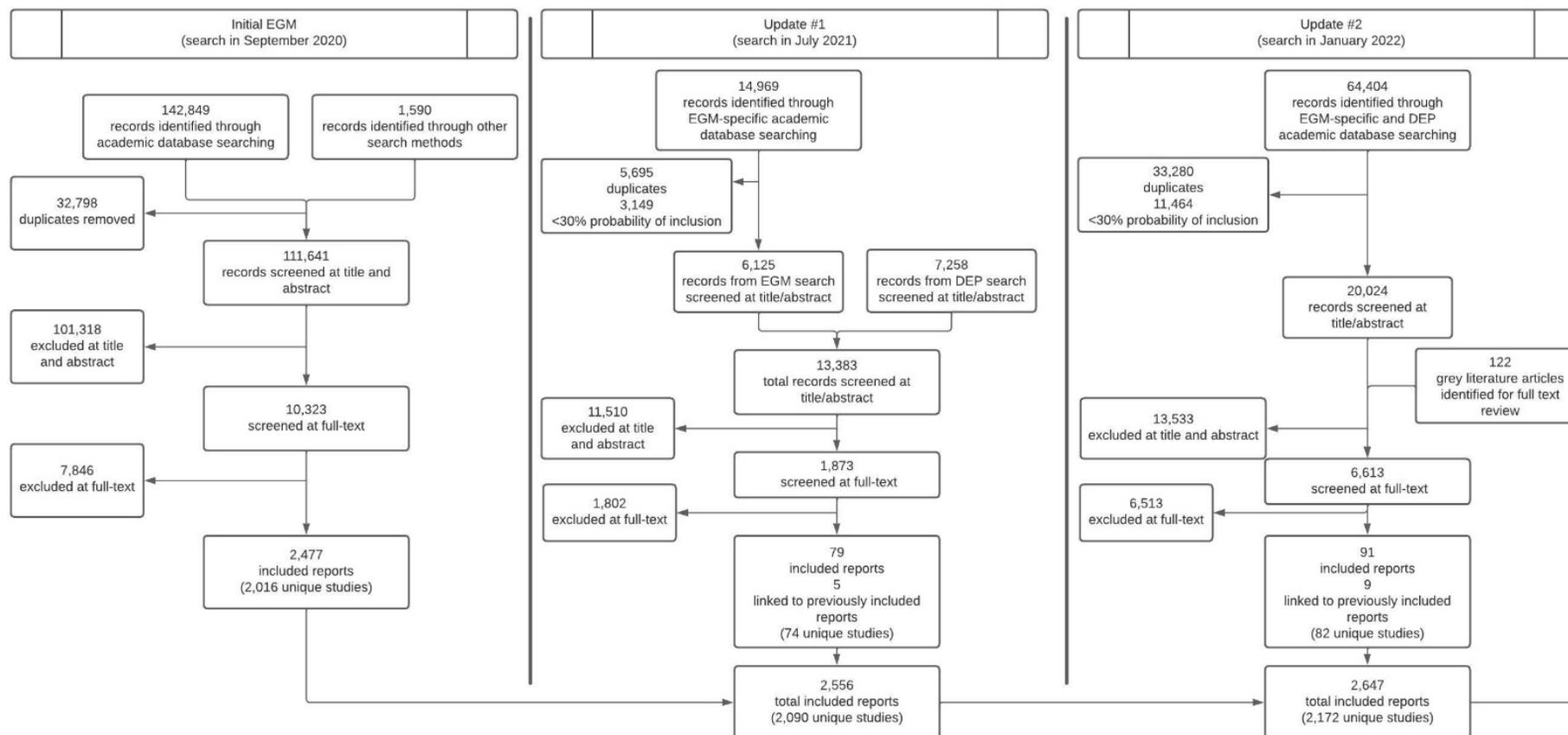
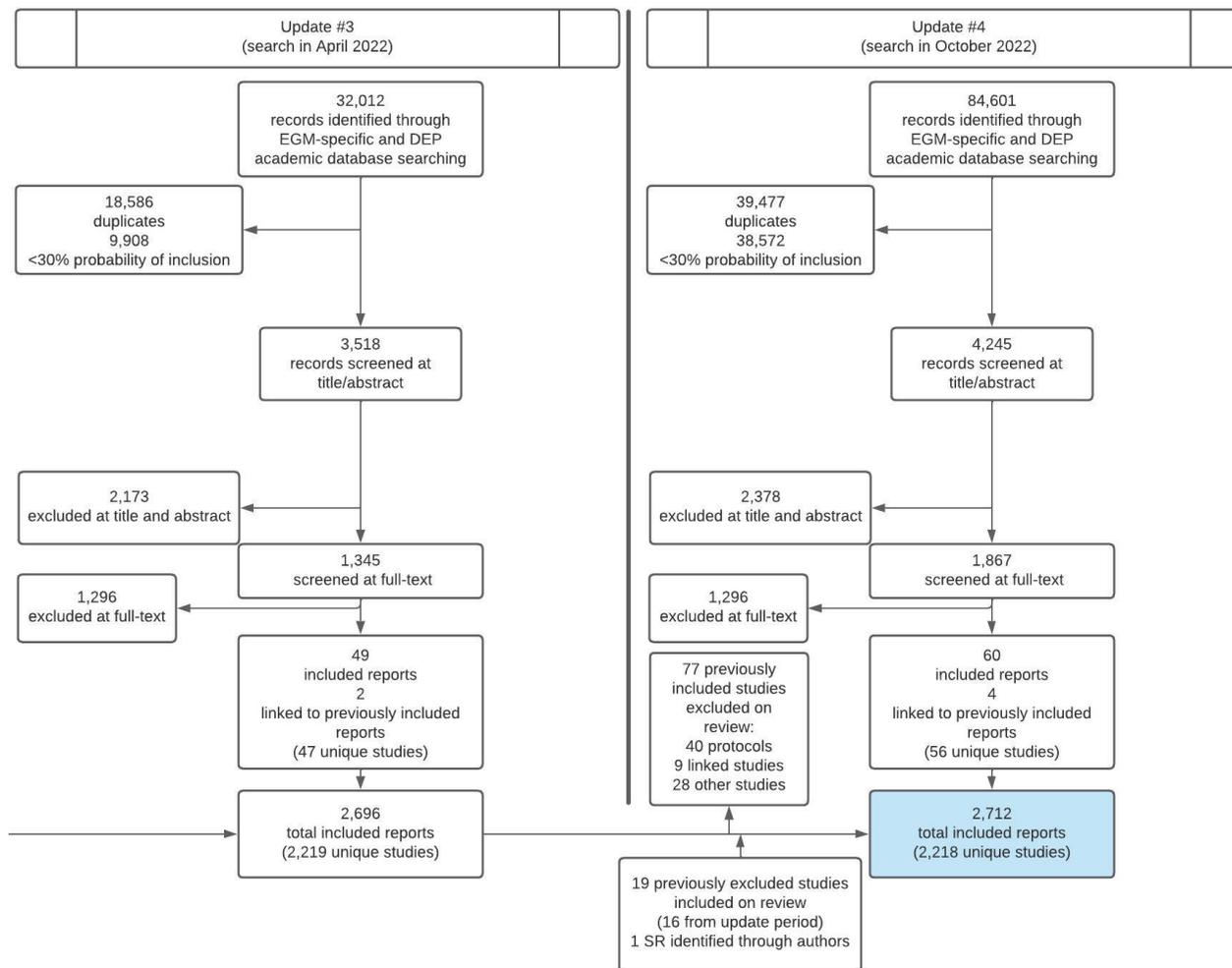


Figure 5: Overview of search and screening process (Update 3 & Update 4)



Source: 3ie 2023

Notes: Figure reflects search results and additional screening conducted over the update period.

4.2 Characteristics of the evidence base

The remainder of this section provides a descriptive overview of the distribution of studies using the PICOS characteristics described in Section 3.

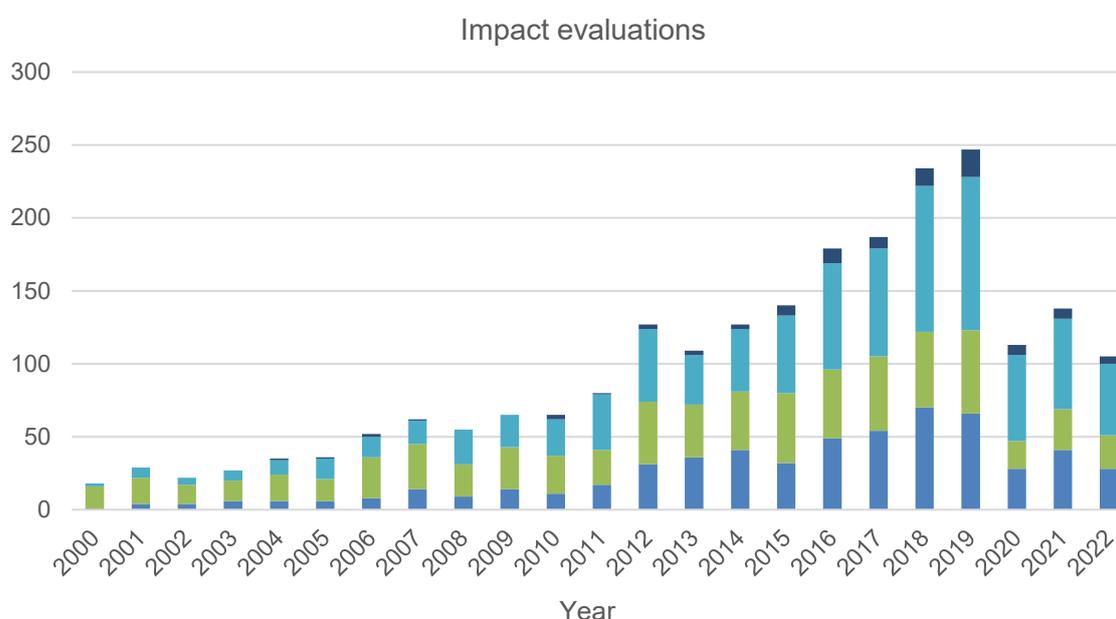
4.2.1 Growth in the evidence base

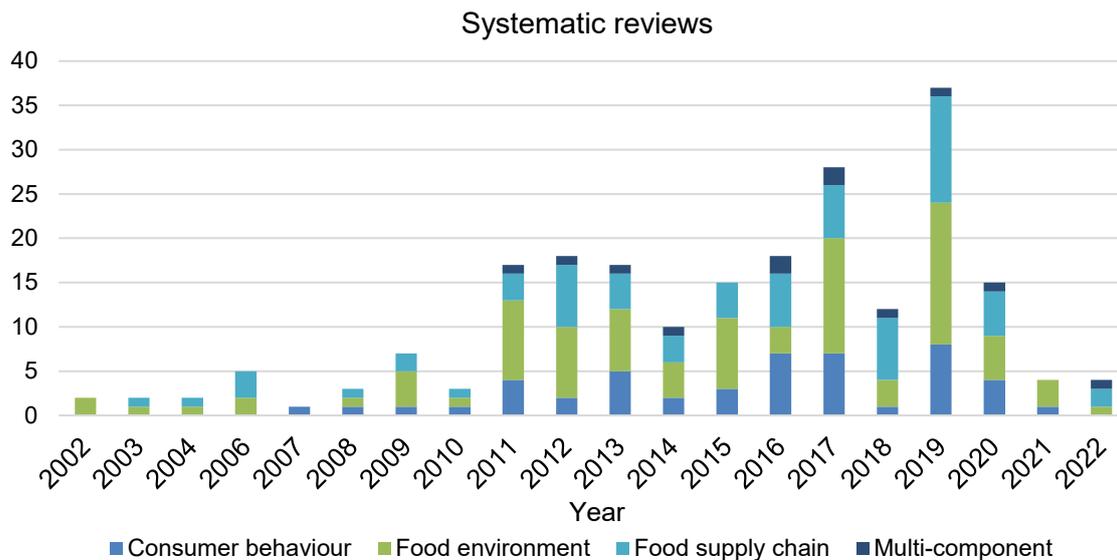
The evidence base grew by 14 per cent during the update period. While this is a large increase, it reflects a reduction in the rate of change over time.

Over 100 impact evaluations on the effects of food systems interventions on food security and nutrition have been published every year since 2012, with a maximum of 238 published in 2019 (Figure 6). The addition of 260 impact evaluations and seven systematic reviews (267 total) during the update period reflects a 14 per cent growth in the evidence base. However, there was a considerable decrease in impact evaluations published per year after 2019, possibly related to a decrease in publications during the COVID-19 pandemic resulting from interruptions in the interventions being evaluated. Since the last search was carried out in October the total number of studies for 2022 is likely higher than reflected in the map.

The proportion of food supply chain evaluations evaluated increased from 42 (IE n = 744) per cent in the original map to 54 per cent (IE n = 141, Figure 7) in the update period. There was a corresponding decrease in food environment interventions evaluated from 36 (IE n = 505) per cent to 21 (IE n = 55) per cent. The relative frequency of evaluation of common multi-component interventions and consumer behaviour interventions remained consistent.

Figure 6: Cumulative distribution of included studies by publication year

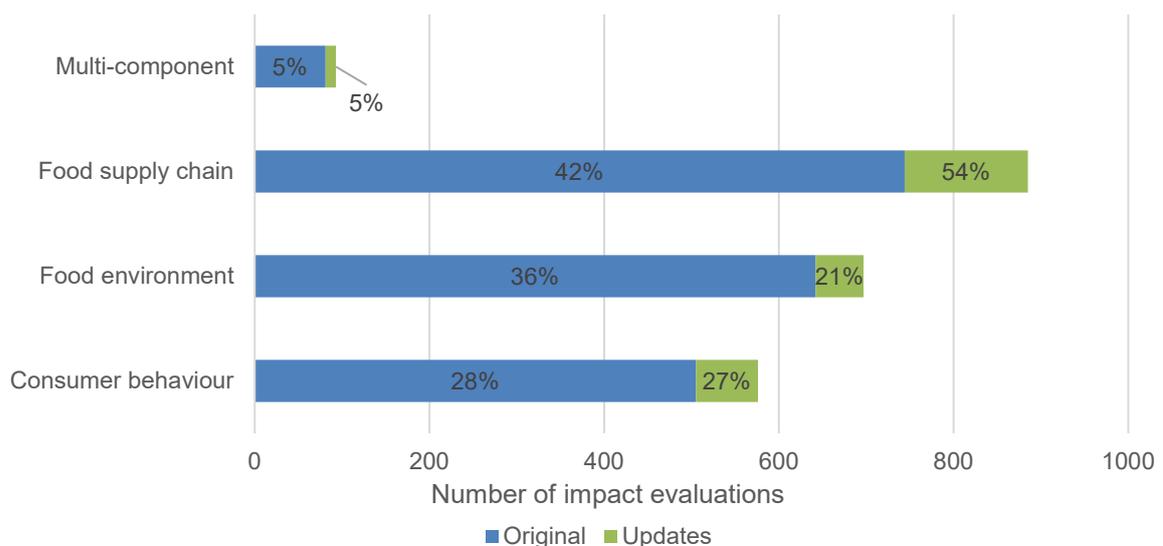




Source: 3ie 2023

Notes: 2,218 included impact evaluations and systematic reviews included.

Figure 7: Proportion of intervention domains evaluated in impact evaluations



Source: 3ie 2023

Notes: Analysis of interventions evaluated in 2,033 impact evaluations (1,773 in the original map and 260 during the update). If a study evaluated multiple interventions, the study was counted multiple times. Percentages are calculated based on the corresponding study period.

4.2.2 Intervention coverage

Although gaps regarding effects of interventions remained largely unchanged, we found a decrease in evidence clustering. There was less focus on fortification and supplementation interventions.

In our 2021 report, we commented on notable evidence clusters related to the *provision of supplements* (SR: n = 67, 38%; IE: n = 364, 21%), *fortification* (SR; n = 48, 27%; IE: n = 270, 15%), *classes in the consumer behaviour domain* (SR: n = 26, 15%; IE: n = 233, 13%), *direct provision of foods* (SR; n = 22, 12%; IE: n = 198, 11%), and *peer support*

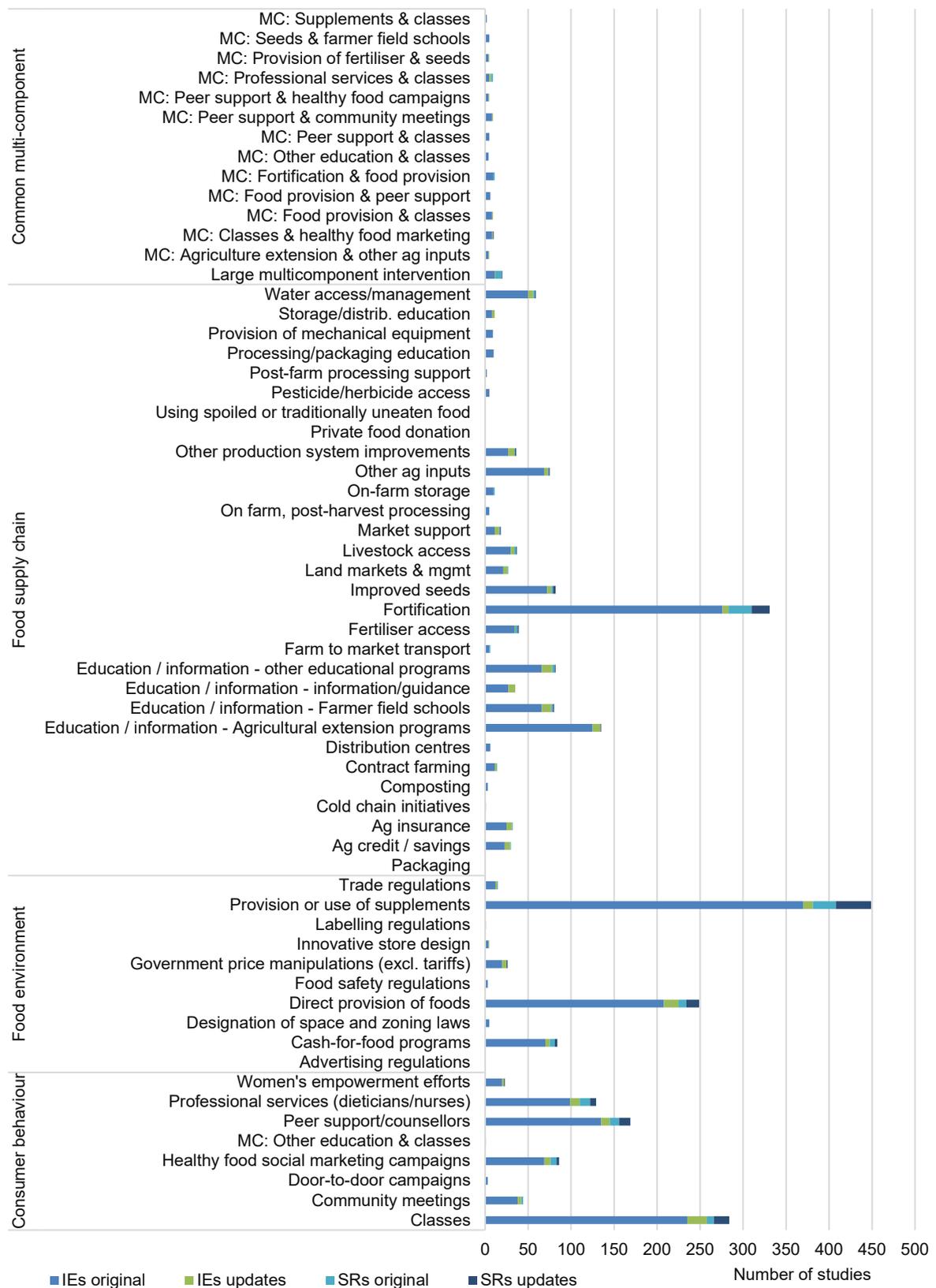
and counselling in the consumer behaviour domain (SR: n = 23, 13%; IE: n = 120, 7%; Figure 8). There has been a large reduction in the focus on the *provision of supplements* (SR n = 1, 14%; n = 17, 7%) and *fortification* (SR n = 0, 0%; n = 13, 5%) interventions in the update period. The relative frequency of impact evaluations of *classes in the consumer behaviour domain* (n = 25, 10%), *direct provision of food* (n = 27, 10%), and *peer support and counselling* (n = 25, 10%) remain largely the same.

Previously, no evaluations of interventions related to *advertising regulations, food waste education programs, private food donation, or the direct packaging of food* were identified. No new studies were identified for these interventions in the update period. We also found fewer than six studies related to *food safety regulations, cold chain initiatives, composting education, labelling regulations, door-to-door behaviour change communication campaigns, provision of goods and/or services to support food processing, designations of space and zoning, innovative store design, on-farm post-harvest processing, and access to pesticides* in the original map. During the update period we identified two new studies on *food safety regulations*, but no other additions in these areas. As such, the identified evidence gaps have not been filled over the past years.

Notable evidence synthesis gaps in the original map related to *agricultural extension, the provision of “other” agricultural inputs, agricultural information provision, government manipulation of price, and agricultural insurance*. Only one new high- or medium-confidence systematic review on these topics was identified. It was produced by 3ie, leveraging this E&GM. The review considers the effects of taxes and subsidies to support a healthy diet (Hammaker et al., 2022). No new evidence synthesis gaps, with more than 15 impact evaluations and no high- or medium-confidence systematic reviews, emerged during the update period.²

² This limit is somewhat arbitrary, but we consider interventions with at least 15 impact evaluations and no high- or medium- confidence systematic reviews to be promising areas for additional synthesis.

Figure 8: Distribution of included studies by intervention domain and intervention



Source: 3ie 2020

Note: Analysis of interventions evaluated in 2,033 impact evaluations and 185 systematic reviews. MC stands for multiple-component interventions. If a study evaluated multiple interventions, the study was counted multiple times.

In the original map, we identified eight multiple-component interventions that were evaluated five or more times, of which half were combinations of consumer behaviour interventions. During the update period three additional multi-component interventions, evaluated five or more times, emerged (Table 6). Two of these additional multiple-component interventions were focused on the food supply chain (provision of fertiliser and seeds and agricultural extension and other agricultural inputs) and the other was another consumer behaviour intervention (peer support and healthy food marketing campaigns).

Table 6: Commonly evaluated multiple-component food systems intervention.

Multiple-component interventions	No. SRs Update period (original map)	No. IEs Update period (original map)
Large multiple-component interventions	0 (8)	1 (11)
Fortification and direct provision of food	0 (1)	0 (10)
Classes and healthy food campaigns	1 (0)	1 (8)
Peer support / counselling and community meetings	0 (0)	1 (8)
Professional services and classes	0 (2)	3 (4)
Direct provision of foods and peer support	0 (0)	0 (6)
Peer support / counselling and classes	0 (0)	0 (5)
Provision of seeds and farmer field schools	0 (0)	0 (5)
Agriculture extension and other agricultural inputs	0 (0)	2 (3)
Peer support and healthy food campaigns	0 (0)	2 (3)
Provision of fertiliser and seeds	0 (0)	4 (1)

Source: 3ie 2023

Notes: Analysis of interventions evaluated in 2,033 impact evaluations and 185 systematic reviews. Large multiple-component interventions are defined as those considering 5 or more intervention categories. This threshold of five is somewhat arbitrary, but consistent with the original map.

4.2.3 Outcome coverage

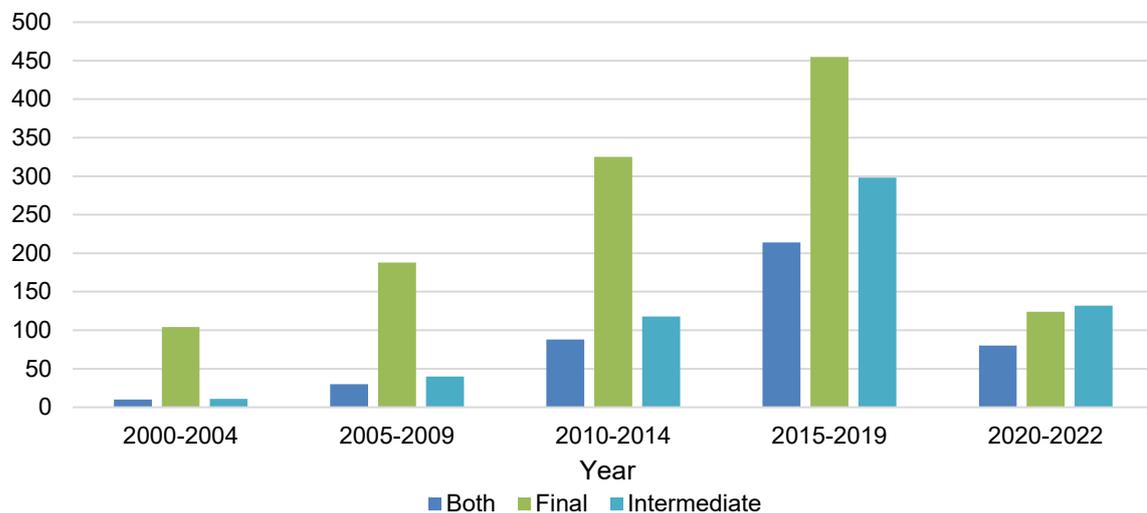
There was a shift to studying intermediate outcomes, with 63% of studies considering at least one intermediate outcome, which may be due to more research on agricultural outcomes and a reduced focus on anthropometric outcomes.

Almost half of studies in the original map (n = 942, 48%) and the update period (n = 126, 47%) considered only a single outcome group. Only 39 studies (2%) in the original map and six in the update period (3%) considered outcomes from five or more groups.³ In the original map, almost all studies considered at least one final outcome (SR: n = 170, 96%;

³ Because analysis is conducted at the study, not publication level, this accounts for the possibility that authors publish analysis on different outcomes in separate publications.

IE: n = 1,301, 73%). In the update period, there was a reduction in studies considering at least one final outcome (SR n = 5, 72%, IE n = 144, 55%, Figure 9). As with the original map (IE n = 340, 19%), a minority of studies considered both final and intermediate outcomes in the update (IE n = 57, 22%).

Figure 9: Disaggregation of outcomes by intermediate and final categories and publication year.



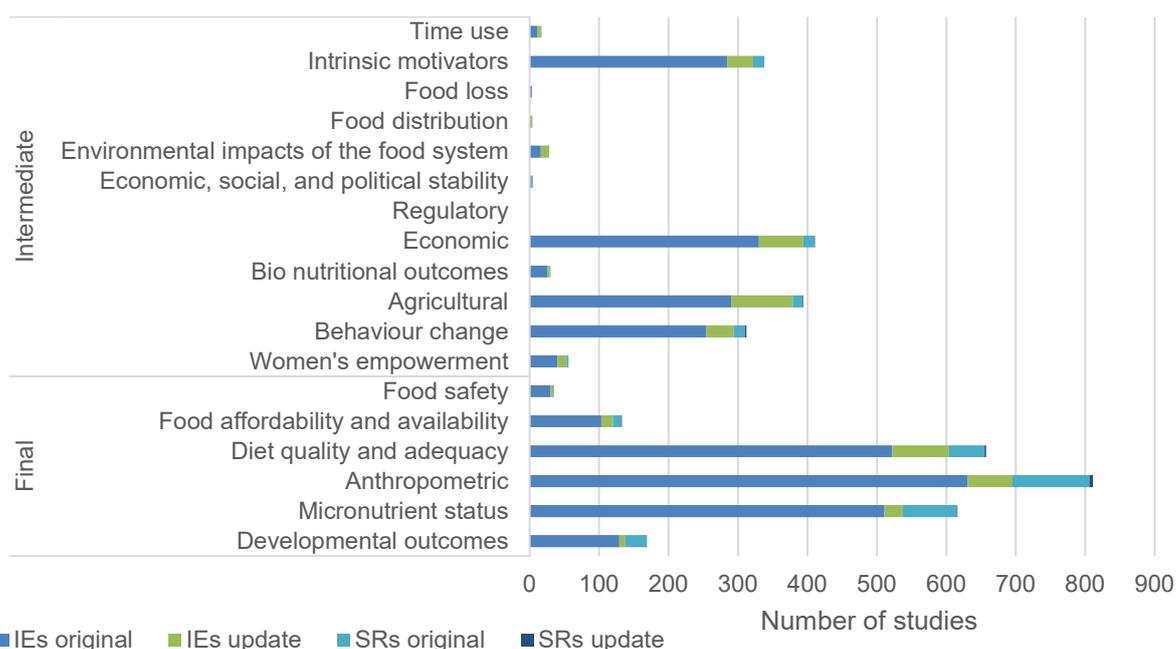
Source: 3ie 2023

Notes: Analysis of interventions evaluated in 2,033 impact evaluations and 185 systematic reviews.

Final outcome groups were mostly well researched in both the original map and the update period. All outcome groups are considered at least once (Figure 10). The top three most common outcome groups considered in the original map and update period are the same, but in a different order. In the original map *anthropometric* outcomes (IE: n = 633, 36%) were the most commonly considered, *diet quality and adequacy* (IE: n = 522, 29%) second, and *agricultural* (IE n= 292, 16%) third. In the updates *agricultural* outcomes (IE n = 88, 34%) are the most common, *diet quality and adequacy* (IE: n = 82, 32%) second, and *anthropometric* (IE: n = 64, 25%) third. *Economic* outcomes were also measured by 64 impact evaluations. The least studied final outcomes in the original map and the update period also remain consistent. The least commonly considered final outcome group is *food safety* (IE: n = 30, 1%, SR: n = 1, 1%; Figure 10; Table 7). No final outcomes were completely unevaluated.

There are more gaps in the intermediate outcomes. *Regulatory* outcomes have never been evaluated. The intermediate outcome groups evaluated in fewer than five studies are: *economic, social and political stability; regulations; food loss; food distribution; and advertising and labelling*. We found new studies considering *food safety* (IE n = 4, 2%), *environmental impacts of the food system* (IE n = 6, 2%), *food distribution* (IE n = 2, 1%) and *economic, social, and political stability* (IE n = 1, 0%). However, 12 intermediate outcomes still never been evaluated: *advertisement topics, caloric requirements, exposure to advertisement, fines, location of foods in stores, movement of food, other regulation outcome, other steps taken due to non-compliance, tax revenue, time food remains unspoiled, violations, and food distribution centres*.

Figure 10: Outcome category frequency by outcome type



Source: 3ie 2023.

Notes: Analysis of interventions evaluated in 2,033 impact evaluations and 185 systematic reviews.

Table 7: Ten least studied outcomes, among those that have been evaluated, by impact evaluations.

Final		Intermediate	
Outcome	No. update (original)	Outcome	No. update (original)
Insufficient diet	5 (24)	Water-related	10 (7)
Iodine micronutrient status	4 (24)	Women's control of resources	5 (10)
Food-borne illness	1 (23)	Climate impact	6 (8)
Food availability & supply	0 (12)	Women's ownership of assets	1 (11)
Physical development	2 (9)	Import/export	2 (2)
Food affordability	0 (9)	Economic, social & political stability	1 (3)
Food access	0 (9)	Women's self-esteem	1 (2)
Other food safety outcome	1 (5)	Agricultural cooperative performance	0 (2)
Food toxins	2 (2)	Food prices	1 (0)
Other food security outcome	1 (1)	Food spoilage or loss	0 (1)
Food stressed households	1 (0)	Non-food waste produced	0 (1)

Source: 3ie 2023.

Note: Analysis of interventions evaluated in 2,033 impact evaluations. If a study evaluated multiple outcomes, the study was counted multiple times. Twelve intermediate outcomes have never been evaluated and are not reflected here: *advertisement topics, caloric requirements, exposure to advertisement, fines, location of foods in stores, movement of food, other regulation outcome, other steps taken due to non-compliance, tax revenue, time food remains unspoiled, violations, and food distribution centres*. All final outcomes have been evaluated at least once. Bars reflect relative frequency within the corresponding outcome group.

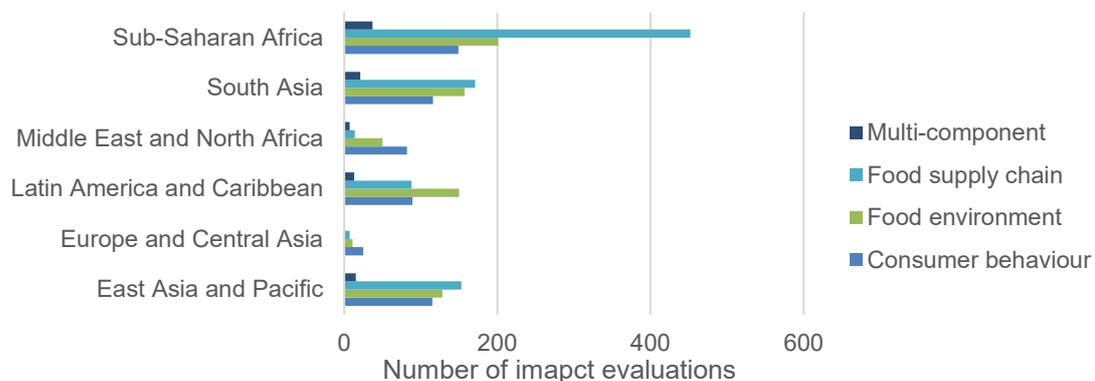
4.2.4 Country coverage

Geographic coverage remained consistent in the update, focusing on Sub-Saharan Africa and countries with large populations. However, new analysis indicated that there was meaningful variation in the types of interventions evaluated in different regions, with a focus on the food supply chain in Sub-Saharan Africa.

The geographic coverage of studies identified during the update period was similar to those in the original evidence map. Sub-Saharan Africa was the most commonly studied region in the original map (IE n = 642, 36%) and during the update period (IE n = 109; 42%). In the original map South Asia (IE n = 360, 20%) was second and East Asia and Pacific (IE n = 313, 18%) third most common. In the updates, this was reversed, with East Asia and Pacific (IE n = 65, 25%) as the second most common followed by South Asia (IE n = 44, 17%).

There are some meaningful differences in the types of interventions evaluated in each region (Figure 11). In Sub-Saharan Africa, South Asia, and East Asia and Pacific, the most commonly evaluated intervention domain is the food supply chain. However, this focus on the food supply chain is much larger in Sub-Saharan Africa compared to the other regions (n = 452, 60% of impact evaluations in Sub-Saharan Africa). In Latin America and the Caribbean, there was a focus on food environment interventions (n = 150, 48% of studies in Latin America and the Caribbean). In Middle East and North Africa (n = 82, 58% of studies in the Middle East and North Africa) and Europe and Central Asia (n = 25, 58%), consumer behaviour interventions are evaluated more than the other interventions.

Figure 11: Distribution of studies by region and intervention domain



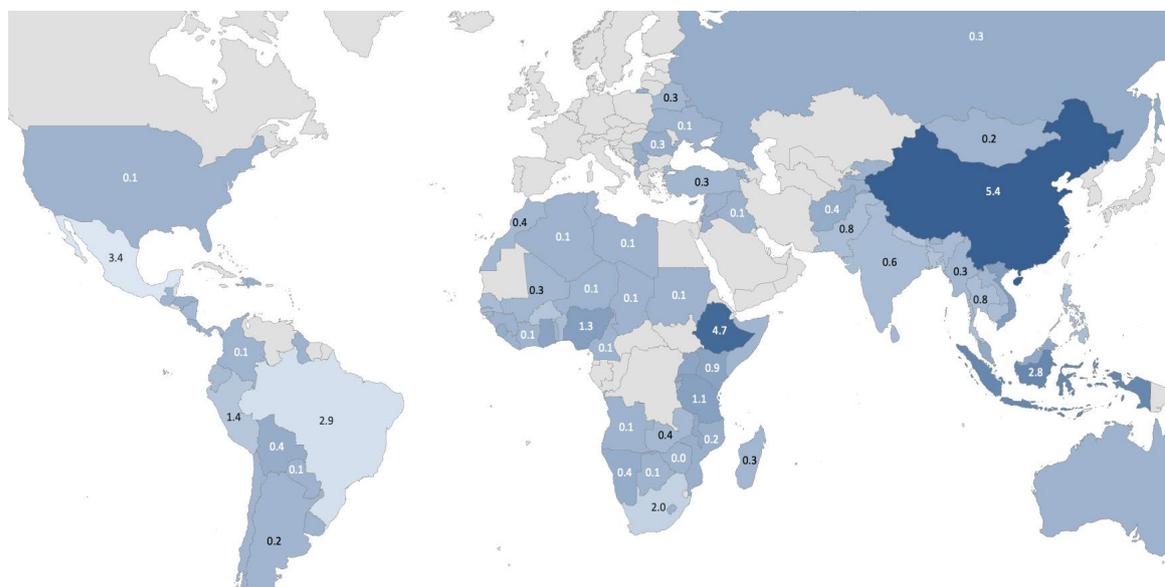
Source: 3ie 2023. Analysis of interventions evaluated in 2,033 impact evaluations.

Notes: If a study took place in multiple countries, the study was counted multiple times.

The focus on low- and lower middle-income countries remained consistent with the original map. In the original, 34 per cent (n = 605; Table 8; Figure 12) of studies took place in lower middle-income countries and 38 per cent (n = 668) took place in low-income countries, with the remainder occurring in upper middle-income countries. A few studies both took place both in high income countries and low- or middle-income countries (n = 2). Similarly, during the update period, we found that 43 per cent (n = 112) studies took place in lower middle-income countries and 30 per cent (n = 79) in low-income countries with the remainder occurring in upper middle-income countries.

Population size still seems to be a major driver of the geographic focus of included studies. Previously, India (n = 174; 10%), Bangladesh (n = 114; 7%), China (n = 109; 6%), Brazil (n = 100; 6%), and Iran (n = 94, 5%) were the most common countries. During the update, the most studied countries were China (n = 30, 12%), India (n = 24, 9%), and Ethiopia (n = 23, 9%).

Figure 12: Percentage point change in distribution of included studies by country



Source: 3ie 2023.

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations, which include 2,097 evaluations in total once multi-country studies are accounted for. Percentage point change reflects the percent of studies taking place in the country in the update period minus the percentage of studies taking place in that country in the original. As such, larger values, corresponding to darker colours, reflect a shift towards studying the country.

Table 8: Overview of the most studied countries by region

Region / rank	Country with most studies No. update (original)	Country with second most studies No. update (original)	Country with third most studies No. update (original)
Sub-Saharan Africa	Kenya: 15 (86)	Ethiopia: 23 (73)	Ghana: 11 (58)
South Asia	India: 24 (174)	Bangladesh: 14 (114)	Nepal: 2 (34)
East Asia and the Pacific	China: 30 (109)	Indonesia: 14 (46)	Vietnam: 10 (44)
Latin America and Caribbean	Brazil: 7 (100)	Mexico: 3 (80)	Peru: 0 (24)
Europe and Central Asia	Turkey: 2 (19)	Belarus: 0 (6)	Albania: 0 (3) Romania: 1 (2)
Middle East and North Africa	Iran: 10 (94)	Lebanon: 2 (6)	Egypt: 0 (7) Morocco: 0 (7)

Source: 3ie 2023

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations, which include 2,097 evaluations in total once multi-country studies are accounted for. Ranking is total across original and update period.

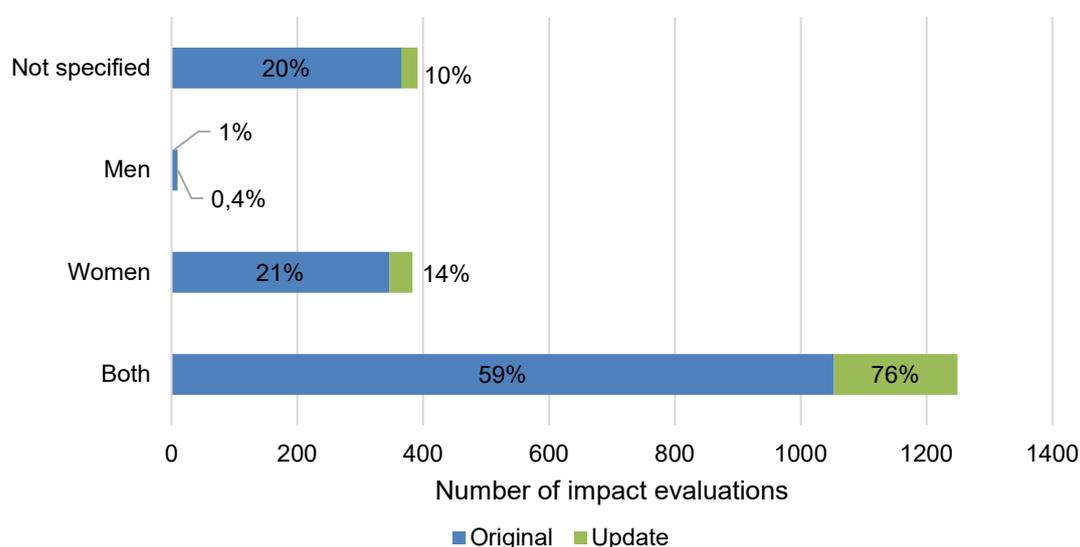
4.2.5 Population and scale

Most evaluations targeted both sexes and no specific age group. Those that did target a group tend to target women and / or infants.

As with the original map, most impact evaluations included in the update targeted both sexes (n = 196; 76%, Figure 13). If sex was targeted, women were generally the focus of the intervention (n = 37; 14%), with one study targeted exclusively men in the update. Interventions which targeted women focused on consumer behaviour with a corresponding absence to interventions targeting women within the food production interventions. Although 27 (n = 71) per cent of impact evaluations generally were on behaviour change communication interventions, 45 (n = 172) per cent of evaluations targeting women fall in this category. Conversely, 27 (n = 602) per cent of impact evaluations considered food production interventions, but only six (n = 22) per cent of studies targeting women considered these interventions.

Similarly, most often impact evaluations considered the whole population or an unspecified age group (n = 644, 34%, Figure 14). Among the impact evaluations that targeted a specific age group, the most commonly targeted group was infants under two in the original map (n = 445, 25%) closely followed by adults 20 to 60 years old (n = 451, 25%). During the update, this shifted with adults being the most studies (n = 72, 28%) followed by adolescents (n = 49, 18%). Studies which targeted infants were generally related to providing free or reduced cost food (n = 264; 53% among infants relative to n = 671; 33% across the whole map). The distribution of studies evaluating interventions targeting adults was generally similar to the distribution of evaluations in the map as a whole.

Figure 13: Distribution of impact evaluations by gender

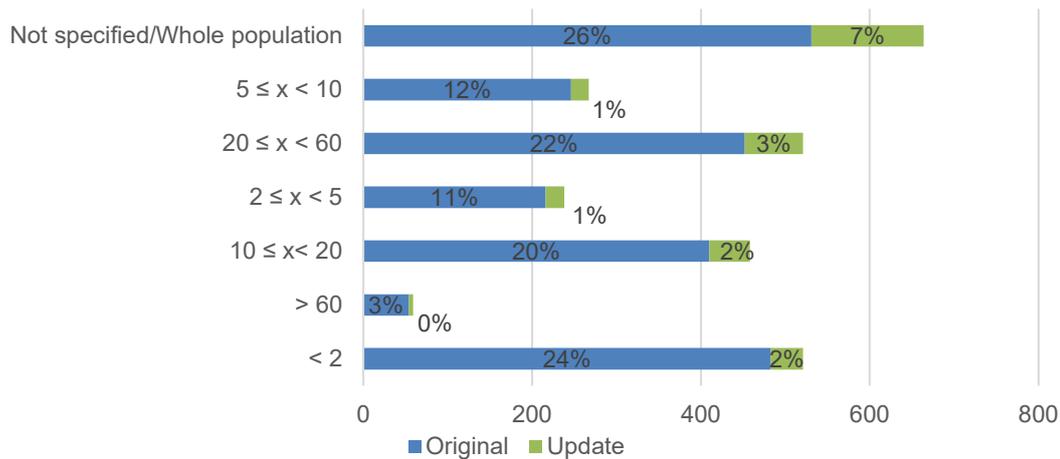


Source: 3ie 2023

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations.

Percentages are calculated based on the corresponding study period.

Figure 14: Distribution of impact evaluations by age

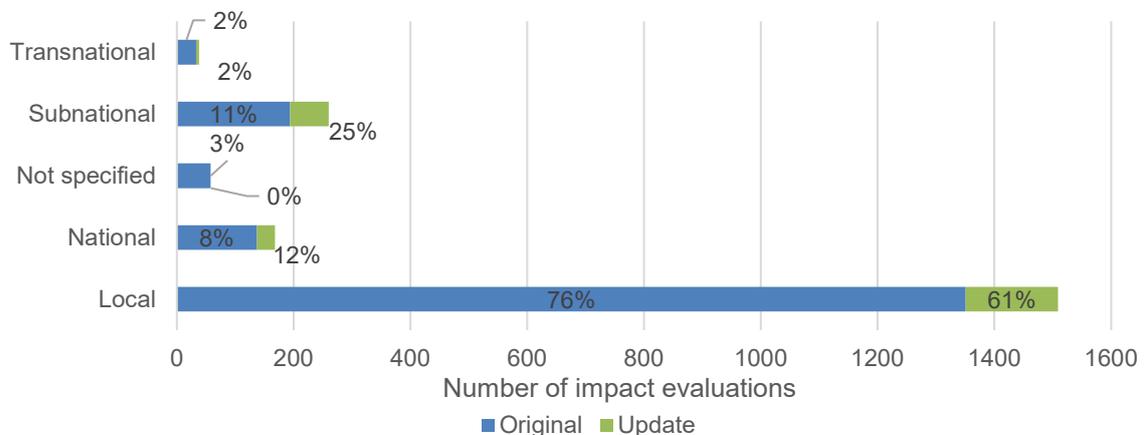


Source: Source: 3ie 2023

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations. Percentages are calculated based on the corresponding study period.

There was a slight change in the distribution of the scale of interventions considered. In the original map, evaluations were dominated by interventions which took place at the local level ($n = 1,401$, 79%, Figure 15) with few studies taking place at the national ($n = 141$, 8%) or transnational ($n = 34$, 2%) level. However, during the update period, more studies considered larger scales: 12 per cent ($n = 31$) took place at the national level and two per cent ($n = 5$) at the transnational level. Originally, these large-scale interventions focused on *cash-for-food programs* ($n = 30$, 18% of large-scale interventions), the *direct provision of food* ($n = 27$, 16%), and *classes in consumer behaviour* ($n = 22$, 13%). During the update period, there was less clustering in the types of large-scale interventions evaluated, with the *direct provision of food* ($n = 4$, 11%), *land markets and management programs* ($n = 4$, 11%), *other production systems improvements* ($n = 3$, 8%), and *governmental manipulation of price* ($n = 3$, 8%) being the most commonly evaluated.

Figure 15: Distribution of impact evaluations by scale of implementation



Source: 3ie 2023

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations. Percentages are calculated based on the corresponding study period.

4.2.6 Research and program funding

Research and program funding agencies were not often reported. However, among those that did report, governments were the most common funders.

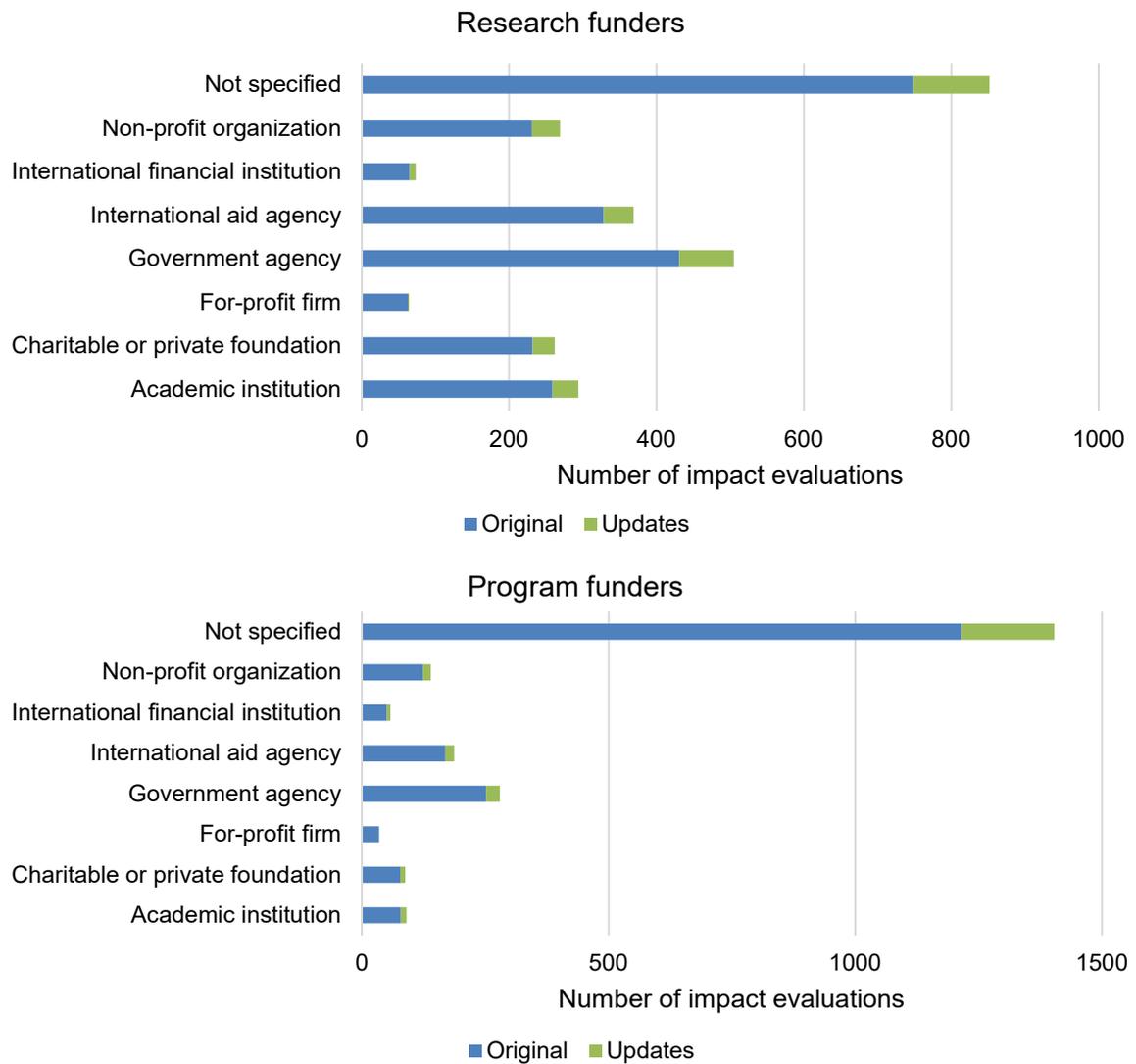
We continued to see that relatively few studies reported on implementing (n = 106, 41%) or funding agencies (n = 74, 28%) for the evaluations and underlying interventions. When funding was specified, governments were the most common program funders in both the original (n = 403; 23%) map and during the update period (n = 29; 11%, Figure 16). During the update period, we also found that non-profit organizations (n = 18, 7%) and non-governmental international aid agencies (n = 16, 6%) were commonly reported as program funders.⁴

In the original map, the United States Agency for International Development (USAID) was the most frequently reported program funding agency, followed by the World Bank and the Bill & Melinda Gates Foundation (Table 9). In the updates, the Bill & Melinda Gates Foundation are first (n = 6), followed by USAID and the World Bank both second (n = 5). Government of China, European Union, and Consultative Group for International Agricultural Research (CGIAR) were in the top 10 most common agencies during the update period, surpassing the National Institutes of Health (NIH), Government of Mexico, and Swiss Agency for Development and Cooperation.

Research funding agencies were reported more frequently than program funding agencies in the update period (IE n = 174, 67%). Government agencies are the most reported (n = 74, 28%) followed by international aid agencies (n = 47, 18%), and non-profit organizations (n = 43, 17%). The top research funders are similar for the original map and update period (Table 9). USAID (n = 18) and the Bill & Melinda Gates Foundation (n = 15) are the most commonly reported research funders. Another three agencies were identified as most common in the update period; CGIAR, Japan Society for the Promotion of Science, and Swedish International Development Agency. These surpassed the NIH, 3ie, and the National Council for Scientific and Technological Development in the list of top 10 research funders. CGIAR funded five per cent of the total studies in the update period.

⁴ For the purpose of this study governmental agencies are all agencies part of the national, federal, state and local governments where the intervention took place. These can include agencies from high-income countries involved in these interventions. The international aid agencies to bilateral agencies that provide humanitarian or development aid as official development assistance. These include all UN agencies.

Figure 16: Programme funder and research funder categories for impact evaluations



Source: 3ie 2023

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations.

Table 9: Top programme and research funders of impact evaluations

Funding agencies	No. update (original)	Per cent update (original) ⁴
Program funding		
USAID ¹	5 (51)	2 (3)
World Bank ²	5 (32)	2 (2)
Bill & Melinda Gates Foundation	6 (32)	2 (2)
DFID / FCDO	2 (27)	1 (2)
UNICEF	2 (26)	1 (1)
World Food Programme	3 (19)	1 (1)
National Institutes of Health (NIH) ³	1 (17)	0 (1)
European Union	2 (15)	1 (1)
Government of India	0 (11)	0 (1)
Government of Mexico	0 (8)	0 (0)
Swiss Agency for Development and Cooperation	1 (7)	0 (0)
Consultative Group for International Agricultural Research (CGIAR)	2 (6)	1 (0)
Government of China	3 (4)	1 (0)
Research funding		
USAID ¹	18 (114)	7 (6)
Bill & Melinda Gates Foundation	15 (95)	6 (5)
DFID / FCDO	10 (55)	4 (3)
World Bank ²	7 (47)	3 (3)
UNICEF	3 (51)	1 (3)
NIH ³	2 (48)	1 (3)
CGIAR	13 (28)	5 (2)
National Natural Science Foundation of China	10 (29)	4 (2)
3ie	2 (35)	1 (2)
International Food Policy Research Institute (IFPRI)	6 (31)	2 (2)
National Council for Scientific and Technological Development	1 (24)	0 (1)
Swedish International Development Agency	4 (16)	2 (1)
Japan Society for the Promotion of Science	6 (6)	2 (0)

Source: 3ie 2023.

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations. Only 632 studies report program funding and 1,199 studies report research funding. Some studies report more than one funder.

1. Includes sub-offices and projects of USAID
2. Includes programmes, funds, and committees associated with the World Bank
3. Includes the Fogarty International Centre and the Eunice Kennedy Shriver National Institute
4. Percentage does not include studies that do not specify funders

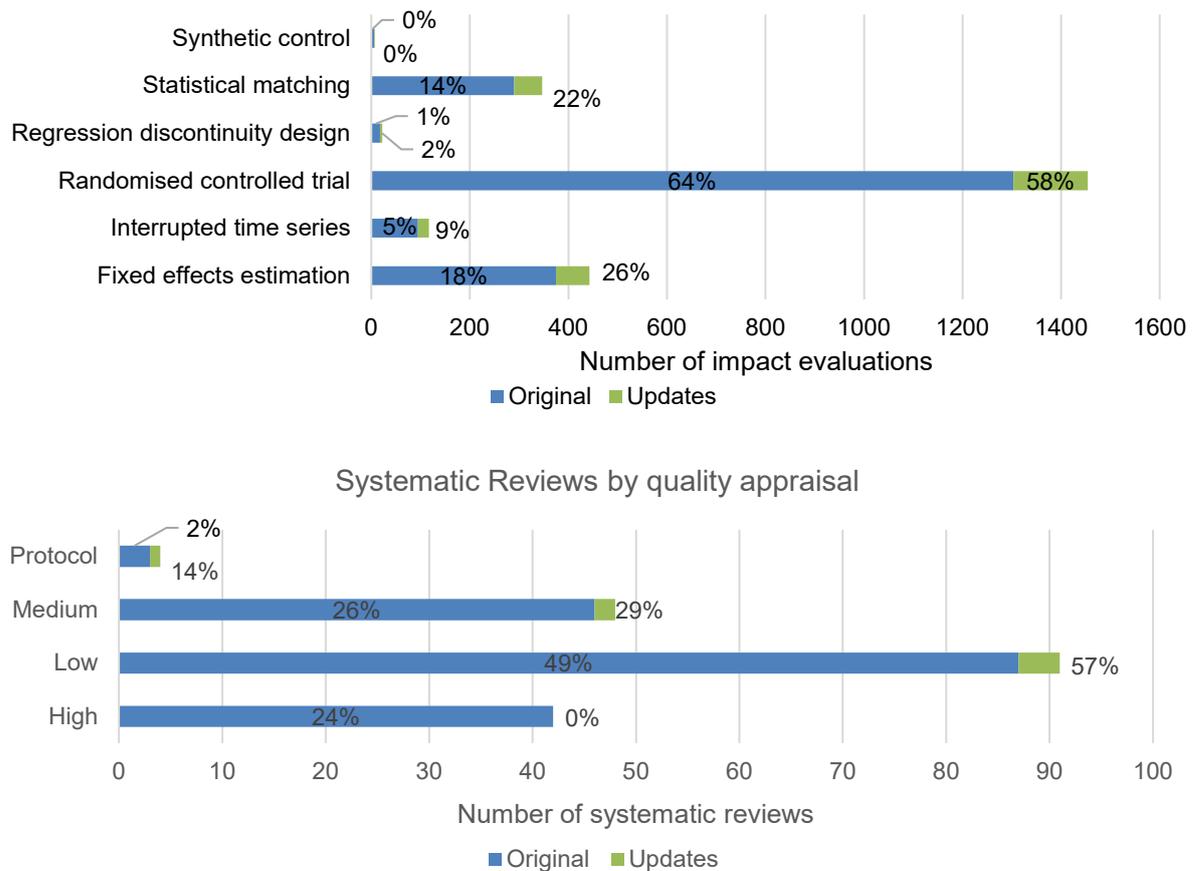
4.2.7 Impact evaluation and synthesis methods

There was a decrease in the reliance on randomized designs, but no overall change in the availability of cost evidence or mixed-methods research. The overall quality of systematic reviews decreased.

We saw a shift in the types of evaluation methods being used. In the original map, randomised controlled trials dominated the evaluation methods (n = 1,303, 73%). However, this decreased to 58 per cent (n = 151, Figure 17) during the update period. We found a stronger reliance on quasi-experimental methods, such as fixed effects (n = 68, 26%) and statistical matching (n = 57; 22%). More advanced statistical techniques such as synthetic control (n = 1; 0%) and regression discontinuity (n = 4, 2%) remained uncommon. However, the use of interrupted time series almost doubled during the update, increasing from five per cent (n = 95) to eight per cent (n = 22). Other methods, such as qualitative research, implementation science, and process evaluations were not eligible for this map and are not represented here, despite their understood, potential importance to the field (Section 3.2).

The proportion of studies considering cost evidence (n = 20; 8%) and mixed methods approaches (n = 19; 7%) in the update period was roughly similar to that of the original map (cost evidence: n = 161, 9%, mixed methods: n = 175; 10%).

Figure 17: Distribution of impact evaluation methods and systematic review quality



Source: 3ie 2023

Notes: Descriptive analysis of data extracted from 2,033 included impact evaluations and 185 systematic reviews. Percentages are calculated based on the corresponding study period.

Few systematic reviews were identified during the update period (n = 7). We previously found that the quality of systematic reviews was increasing over time. In the original map, 49 per cent (n = 87) of included systematic reviews were rated as low confidence. But, in 2019 alone, 10 high and 10 medium confidence systematic reviews were published (69% of SRs published in 2019). Since the original map, systematic review quality appears to have reduced, with only two (29%) medium confidence and zero high-confidence systematic review being published.

5. Conclusions and implications

Two years into our first project to continually update an evidence and gap map, we find that the evidence in the field of food systems and nutrition is growing quickly. We identified 267 impact evaluations and systematic reviews indexed in the period between the close of our first search in September 2020 and our most recent search in October 2022. We demonstrated the feasibility and utility of engaging in such an evidence surveillance project. The E&GM is now being used as the basis of additional work to fill key evidence gaps identified through this project. It has served to support the development of a systematic review on governmental price manipulations and a rapid evidence assessment on women's empowerment within the food system (Berretta et al., 2022; Hammaker et al., 2022).

Based on the results presented above, answers to the research questions specified in Section 1.1 are presented below.

5.1 Research question 1 – Coverage

What is the extent, range and nature of existing empirical evidence regarding the effects of food systems interventions on food security and nutrition outcomes in L&MICs?

Our map currently includes 2,033 impact evaluations and 185 systematic reviews considering the effect of food systems interventions on to food security and nutrition outcomes in low- and middle-income countries.

Interventions:

Several intervention types have been examined in over 250 impact evaluations and 25 systematic reviews: *fortification, supplementation, and classes about consumer behaviour.*

In contrast, *packaging; private food donation; use of and education regarding the use of spoiled, near spoiled or traditionally uneaten food; and advertising regulation interventions* have not been examined by any identified impact evaluations.

Women's empowerment efforts, agricultural extension programs, other agricultural information and guidance, and water access and management interventions have been considered by 20 or more impact evaluations but no high- or medium-confidence systematic reviews.

Outcomes:

Most final outcomes have been examined at least five times, with the exception of *food stressed households* and *food toxins*.

The most studied outcomes, considered more than 400 times, are generally anthropometric, but included one micronutrient measure: *iron status, linear growth, relative weight, and weight*.

Several intermediate outcomes have never been considered: *advertisement topics, caloric requirements, exposure to advertisement, fines, location of foods in stores, movement of food, other regulation outcome, other steps taken due to non-compliance, tax revenue, time food remains unspoiled, violations, and food distribution centres*

Geography: Evaluations focus on Sub-Saharan Africa (n = 751; 37%), lower middle-income countries (n = 718; 35%), and countries with large populations. India, China, and Bangladesh are the most commonly studied countries. There is a disproportionate focus on food supply chain interventions in Sub-Saharan Africa relative to other regions.

Population and scale: Impact evaluations tend to consider all genders (n = 1,249; 61%) and people of all or unspecified ages (n = 664; 33%). Most impact evaluations took place at the local level (n = 1,509; 74%), with few national or transnational evaluations (n = 211, 10%).

Methods: Most impact evaluations (n = 1,454; 72%) employed randomised designs. Among quasi-experimental evaluations, fixed effects estimation is the most common method (n = 443; 22%). Few studies use mixed methods (n = 194, 10%) or present cost evidence (n = 163, 8%). Systematic reviews are generally rated as low quality (n = 91, 49%) and tend to focus on *supplementation* (n = 68, 37%) and *fortification* (n = 48, 26%).

5.2 Research question 2 – Change

How has the evidence changed over time?

There has been a 14% increase in the evidence base between September 2020 and October 2022. Most of the new work is primary research, rather than evidence synthesis (IE n = 260, SR n = 7). However, key evidence gaps have not been filled.

Despite the expansion in the evidence base, there has been a decrease in the rate of new studies published during the update period relative to the proceeding years (Figure 7). The decrease may be related to work interruptions during the COVID-19 pandemic and may be reversed as lockdowns lift. Food supply chain (17% increase), consumer behaviour (13% increase), and multi-component interventions (14% increase) all experienced relatively similar rates of increase. There has been less of a focus on the food environment (8% increase).

Most of the newly identified work focuses on the *direct provision of foods* (n = 27, 10%, Figure 8), *peer support and counsellors* (n = 25, 10%), *consumer behaviour classes* (n = 25, 10%), and *agricultural extension programs* (n = 22, 8%). The most studied outcomes during the update period relate to *agricultural outcomes* (n = 88, 34%, Figure 10), *diet quality and adequacy* (n = 82, 32%), and *anthropometrics* (n = 64, 25%). This continues the trends we saw in the original map.

We find the largest relative reductions in the evaluations focusing on *supplementation* (n = 17, 7% in update; 14 percentage point decrease from original) and *fortification* (n = 13, 5% in update; 10 percentage point decrease from original) during the update period.

Table 10 shows the corresponding reduction in evaluations of *food processing and packaging* and *food provision / price reduction* interventions. The decreases are not offset by a disproportionate shift to studying a specific other intervention. Instead, *other agricultural education programs* (n = 23, 9% in update period; 6 percentage point increase) and *other production systems improvements* (n = 16, 6% in update; 5 percentage point increase) experienced modest relative increases in evaluation during the update period.

Table 10: High-level summary of the evidence mapping of impact evaluations and systematic reviews

Intervention / outcome	Food safety	Food affordability & availability	Micronutrient status	Diet quality & adequacy	Developmental outcomes	Anthropometric	Total
Food production	2, 1% (4, 0%)	11, 4% (60, 3%)	1, 0% (22, 1%)	20, 7% (88, 5%)	0, 0% (3, 0%)	10, 4% (49, 3%)	32, 12% (153, 8%)
Food transport / storage	0, 0% (0, 0%)	0, 0% (5, 0%)	0, 0% (0, 0%)	0, 0% (4, 0%)	0, 0% (0, 0%)	0, 0% (2, 0%)	0, 0% (10, 1%)
Processing and packaging	0, 0% (5, 0%)	1, 0% (7, 0%)	8, 3% (238, 12%)	3, 1% (53, 3%)	2, 1% (56, 3%)	4, 1% (164, 8%)	14, 5% (319, 16%)
Food loss and waste management	0, 0% (0, 0%)	0, 0% (0, 0%)	0, 0% (0, 0%)	0, 0% (1, 0%)	0, 0% (0, 0%)	0, 0% (0, 0%)	0, 0% (1, 0%)
Food provision / price reduction	0, 0% (19, 1%)	4, 1% (33, 2%)	10, 4% (319, 16%)	18, 7% (160, 8%)	5, 2% (88, 5%)	29, 11% (371, 19%)	47, 18% (655, 34%)
Promotion and labelling	0, 0% (0, 0%)	0, 0% (1, 0%)	0, 0% (0, 0%)	0, 0% (4, 0%)	0, 0% (0, 0%)	0, 0% (2, 0%)	0, 0% (4, 0%)
Women's empowerment in the food system	0, 0% (0, 0%)	0, 0% (3, 0%)	0, 0% (3, 0%)	0, 0% (5, 0%)	0, 0% (1, 0%)	1, 0% (5, 0%)	1, 0% (10, 1%)
Behaviour change communication	0, 0% (8, 0%)	1, 0% (17, 1%)	7, 3% (69, 4%)	46, 17% (310, 16%)	1, 0% (37, 2%)	32, 12% (255, 13%)	60, 22% (463, 24%)
Quality and safety	1, 0% (0, 0%)	0, 0% (0, 0%)	0, 0% (0, 0%)	1, 0% (0, 0%)	0, 0% (0, 0%)	0, 0% (0, 0%)	1, 0% (0, 0%)
Multi-component	2, 1% (0, 0%)	1, 0% (17, 1%)	3, 1% (24, 1%)	6, 2% (57, 3%)	1, 0% (10, 1%)	4, 1% (52, 3%)	10, 4% (92, 5%)
Total	4, 1% (31, 2%)	17, 6% (115, 6%)	27, 10% (589, 30%)	83, 31% (573, 29%)	9, 3% (160, 8%)	68, 25% (742, 38%)	148, 55% (1470, 75%)

Source: 3ie 2023.

Notes: Numbers in each cell reflect the number of new studies identified considering the corresponding intervention-outcome combination with the number from the original map in parentheses. Percentages are based on the corresponding period, not the total in the final map, ie the percentage for studies in the update period reflects a total of 267 studies. Colours reflect the percentage point change over time with dark colours reflecting a decrease and light colours reflecting an increase. If a study evaluated multiple interventions and outcomes across different categories, the study was counted multiple times. As a result, the total number of studies reported here is higher than the actual number of studies included in the map.

During the update period, final outcomes, particularly *anthropometrics* (n = 68, 25% in update; 13 percentage point decrease) and *micronutrient status* (n = 27, 10% in update, 20 percentage point decrease), were evaluated less often. This corresponded with a strong shift towards studying *agricultural* outcomes (n = 89, 33% in update; 18 percentage point increase from original).

There have not been significant changes in the gender or geographic distribution of targeted populations. However, the number of national or transnational interventions evaluated increased from 10 (n = 175) in the original map to 14 per cent (n = 36) in the update period. This change was largest in the last update with 14 studies (24%) considering national or transnational interventions. When geography and scale were considered together, we found a remarkable number of studies considering the impacts of national level policies in China. Although seven per cent (n = 139) of studies took place in China, 23 per cent of the national studies added during the update period took place in China.

The change in the types of interventions evaluated may have been facilitated by a shift in the methods used in impact evaluations. We saw a reduction in the reliance on experimental designs from 73 per cent (n = 1,303) to 58 per cent (n = 151). The most common quasi-experimental method remains fixed effects estimation (original: n = 375, 21%; update: n = 68, 26%). However, the use of interrupted time series almost doubled during the update, increasing from five per cent (n = 95) to eight per cent (n = 22).

In our original report, we commented that the quality of systematic reviews increased over time, with most high-confidence systematic reviews published in or after 2013. We did not see this trend continue. Five of the seven systematic reviews added during the update period were rated as low-confidence.

In our original report, we identified *women's empowerment*, *taxes on sugar-sweetened beverages*, *labelling regulation*, *support for post-harvest processing*, national interventions, cost evidence, and mixed methods research as key gaps. We also provided a longer list of potential areas for future research. We have identified new research in some of these key areas (Table 11). The largest relative increases have occurred measures of *environmental impacts of the food system* (66% increase); *women's empowerment* (33% increase); and *economic, social, and political stability* (33% increase) outcomes. We also find meaningful increases in the evaluations of *on-farm, post-harvest processing* (25% increase) and *women's empowerment* (22% increase) interventions.

Table 11: Newly identified studies addressing previously identified evidence priorities.

	Studies and protocols added (studies in original)	Percent change
<i>Illustrative list of interventions to priorities for evaluation</i>		
Government manipulations of price	3 (22)	14%
Advertising and labelling regulations	0 (0)	0%
On-farm, post-harvest processing	1 (4)	0%
Interventions to support food packaging	0 (0)	0%
Efforts to support women's empowerment within the food system	4 (18)	22%
Innovative store design	0 (5)	0%
<i>Illustrative list of outcomes to priorities for evaluation</i>		
Women's empowerment	13 (41)	32%
Economic, social, and political stability	1 (3)	33%
Food loss	0 (3)	0%
Environmental impacts of the food system	6 (9)	67%
Measures of diet insufficiency	5 (24)	21%
<i>Illustrative list of evidence synthesis priorities</i>		
Provision of free or reduced-cost farm inputs to crop production	0 (9)	0%
Educational approaches within the food value chain	0 (8)	0%
Agricultural insurance products	0 (1)	0%
Outcome related to other diet quality and adequacy measures	0 (24)	0%
<i>Illustrative list of methods and scale priorities</i>		
Cost evidence	20 (161)	12%
Mixed methods research	19 (175)	11%
High-confidence systematic reviews	0 (42)	0%
National and trans-national evaluations	36 (175)	2%

Source: 3ie 2023

Notes: Descriptive analysis of all 2,218 studies currently included in the map. Percentages are calculated independently separately for evaluation priorities (IE n = 2,033) and synthesis priorities (SR n = 185). Bars reflect percentage change.

5.3 Research question 3 – Gaps

What are the major primary and synthesis evidence gaps in the literature?

Although we note considerable increase in the evidence base, this has not meaningfully closed research gaps. Overall, the gaps identified in the original map remain.

Although there has been significant growth in the evidence base, including in areas identified as key gaps in the original report, the evidence base in these areas was so small, that large proportionate increases could not fill the evidence gaps (Table 11). For example, while there was a 32 per cent increase in the evidence on women's empowerment outcomes, this only accounted for the addition of 13 studies and an increase in the frequency of evaluating women's empowerment outcomes from two per cent (n = 41) in the original map to five per cent (n = 13) in the update. Evaluations of

women's empowerment outcomes still only represent three per cent of the included impact evaluations. We continue to see a need for more mixed methods research (n = 194, 4%), cost evidence (n = 163, 7%), and evaluation of large-scale interventions (n = 211, 10%). Below, we summarize a selected set of key papers that have responded to the identified research gaps during the update period.

5.2.1 Summary of selected new studies that address research gaps

We identified three new studies *on governmental manipulation of price*. One study found that a rice price subsidy in South India positively affected food consumption, nutrient intake and purchasing power (Malairasan et al., 2021). In another study, China's minimum grain procurement price program was found to positively affect wheat and rice prices received, land sown with wheat and rice, chemical fertilizer use, and pesticides use (Su et al., 2021). Cawley and colleagues (2021) conducted the first ever study on the impacts of a tax on sugar-sweetened beverages on BMI, and found no effect. This aligns with findings in our recent systematic review of fiscal policy interventions to support a healthy diet. We found limited impacts on purchasing behaviour and insufficient evidence on diet quality (Hammaker et al., 2022).

Another set of new studies responds to the identified gap relating to *women's empowerment*. There are four new IEs on women's empowerment interventions, and 18 IEs measuring women's empowerment outcomes.⁵ A new study investigated the impact of an agricultural capacity building intervention and an education and behavior change nutrition intervention. The nutrition intervention included gender sensitization training. This study found that the nutrition intervention improved women's empowerment outcomes - women were more likely to express their opinion to their spouses and in meetings. It also improved women's control over income from food crop farming and livestock rearing (Bonuedi et al., 2020). Another evaluation considered a gender-blind intervention that offered farmers extension training in agricultural technologies and strengthened the farmers' access to markets. The intervention reduced women's say in production and spending of income. There was weak evidence of lower empowerment in social decisions (Ntakyo and Van Den Berg, 2022). A national study considered the effects of women's empowerment through laws allowing Indian women to inherit their parents' ancestral property (Ajefu et al, 2022). The evaluation showed positive effects on child health and nutrition outcomes and found some positive effects on women's decision making. A nutrition-sensitive agroecology intervention, which provided education and seeds in Tanzania, increased decision making in income allocation but not agricultural decisions (Pamuk et al., 2021; see online map for studies on women's empowerment outcomes).

Leveraging this E&GM, 3ie recently added to this evidence base as well, through a rapid evidence assessment considering the impacts of women's empowerment interventions on food security, affordability and availability, diet quality and adequacy, anthropometrics, micronutrient intake, and wellbeing (Berretta et al., 2022). Women's empowerment interventions within the food system improved food security and food affordability and availability.

⁵ To limit scope, we only summarize the women's empowerment interventions here. Readers can find the studies looking at women's empowerment outcomes in the [online](#), interactive map.

5.4 Research needs 4 – Research needs

What intervention and/or outcome areas could be prioritised for primary research and/or evidence synthesis?

Not all evidence gaps must be filled. Interventions which are currently being widely implemented, but for which there is little impact evaluation research or insufficient evidence synthesis could be prioritized.

When considering research needs, we balance the distribution of evidence with both the theoretical strength of relationships between interventions and outcomes and policy relevance. Interventions that are currently being widely implemented or supported and those that are likely to affect a large or vulnerable population can be prioritized for additional research. Interventions which have the possibility of harm should also be prioritized for evaluation, with a measurement plan for possible or unintended outcomes.

Generally, the research priorities identified in the original report remain (Table 11). However, we recommend additional evaluations in areas that are currently being supported by key actors in the field (Table 12). Taken together, these suggest the following research needs:

Illustrative list of interventions to prioritise for evaluation

- Government manipulations of price
- Advertising and labelling regulations
- On-farm, post-harvest processing
- Interventions to support food packaging
- Efforts to support women's empowerment within the food system
- Innovative store design, designations of space, and zoning
- Cold chain initiatives
- Improved farm to market transport
- Food safety regulations

Illustrative list of outcomes to prioritise for evaluation

- Women's empowerment
- Economic, social, and political stability
- Food spoilage or loss
- Environmental impacts of the food system
- Measures of diet insufficiency

Illustrative list of evidence synthesis priorities

- Provision of free or reduced-cost farm inputs to crop production
- Educational approaches within the food value chain
- Agricultural insurance products
- Outcomes related to other diet quality and adequacy measures

Illustrative list of methods and scale priorities

- Cost evidence
- Mixed methods research
- High-confidence systematic reviews
- National and trans-national evaluations

5.5 Implications for policy and practice

Although decision makers can reference high-quality systematic reviews, this evidence base has not grown and could soon be outdated. The primary evidence base has grown considerably in recent years, but it is not being synthesized by high-quality systematic reviews. As such, decision-makers may consider commissioning high-quality systematic reviews to respond to their decision-making needs. This map can be leveraged to identify evidence and synthesis opportunities. It was the basis of rapid synthesis responding to policy relevant questions and can continue to serve in this role as long as it is maintained as a living product. Until high-confidence synthesis outputs are produced, decision-makers may reference individual studies included in the map to understand barriers and facilitators to outcomes achieved in specific contexts.

Decision-makers may continue investing in under-researched areas. Although there are potentially good explanations for many evidence gaps, such as a lack of a theoretical reason to expect a relationship, additional research to establish unknown but theoretically meaningful relationships between interventions and outcomes may be useful (Section 1.2). Caution should be used when implementing under-researched interventions; however, these interventions should not necessarily be avoided. The absence of evidence supporting an intervention does not prove the intervention does not work. Decision makers and implementers can design interventions for evaluability⁶ when implementing under-researched interventions. They may contextualize the evidence in this E&GM with other sources to determine the likely effects of an intervention in a local context.

The availability of evidence relating to key, policy-relevant activities is highly variable, which may leave decision makers without the evidence they need. Nonetheless, we encourage decision-makers to reference the evidence available in this E&GM and other sources as relevant. In Table 12, we summarize the evidence base on specific activities supported by the Food Systems Dashboard, the United Nations Food Systems Summit, and The State of Food Security and Nutrition in the World Report (Food Systems Dashboard, 2023; United Nations, 2023; FAO, 2022). Many of these are likely to be highly influenced by political will and institutional drivers, which were recently added to the HLPE's framework (HLPE 2020). We note that there is not a perfect relationship between these activities and our map. This table is meant to demonstrate the potential use of the E&GM as a database of information.

The availability of evidence is affected by program and research funding and publication decisions. However, transparent reporting of funders is limited. In addition, interventions which are not evaluated, either due to policy or research decisions, or those which are evaluated but reports not published, would not appear in the map. This can result in evidence gaps when decision-makers “know something works” and chose not to evaluate or when evaluations find negative results and are therefore not published.

⁶ Designing for evaluability can involve creating *a priori* research plans and collecting baseline data so that impact evaluations can be conducted. Often, this can be done without significantly effecting implementation plans or requiring randomization.

Careful consideration of evidence relating to unintended consequences may support positive outcomes. When prioritizing interventions, decision makers may wish to consider impacts on key global policy priorities like climate change, women's empowerment, and economic prosperity. Actions within the food system can have both positive and negative effects on these outcomes. The disproportionate focus on interventions targeting women for behaviour change communication interventions relative to women as food producers may inadvertently reinforce gender norms that view women as food preparers rather than producers. The limited consideration of interventions effects across many outcome categories may result in unintended effects being unidentified.

Table 12: Evaluations corresponding to selected implementation priorities.

Activity supported	Corresponding interventions in our evidence and gap map	IEs (SRs)
Food Systems Dashboard		
Deliver agricultural extension programmes, infrastructure, and education to support farmers to grow and market nutritious foods.	Education / information within the food supply chain	322 (8)
	Provision of goods / services for food processing and packaging	0 (0)
	Market support	16 (2)
Provide low-income households, including women, with support for animal-husbandry and training for animal rearing, safety management and processing along with nutrition education.	Improved transportation from farms to markets	5 (1)
	Cold chain initiatives	1 (1)
	Provision of livestock	34 (3)
Redirect agriculture subsidies from staple crops to increasing production of nutritious foods.	Provision of free or reduced cost agricultural inputs	156 (8)
Develop infrastructure to reduce loss and waste of nutritious foods and increase its redistribution.	Cold chain initiatives	1 (1)
	Improved transportation from farms to markets	5 (1)
Design trade policies to prioritise the supply of nutritious foods Implement taxes to decrease affordability and incentivise reformulation of sugary drinks and foods high in fats, sugars and salt food.	Governmental manipulations of price	25 (2)
	Trade regulations	14 (1)
Mandate training programmes for food producers and retailers on storage, processing and packaging to reduce spoilage and contamination of nutritious foods.	Food safety regulations	3 (0)
Provide nutritious foods and meals at lower prices at point-of-purchase by subsidising public distribution programmes, state-managed stores, public restaurants, and other forms of subsidy programmes.	Direct provision of food	225 (24)
	Implementation of distribution centres	6 (0)
Use financial incentives and planning regulations to drive the establishment of new supermarkets, fresh food markets, shops and street vendors in underserved communities. Use zoning laws to restrict numbers of “fast food” outlets and vendors in select geographic areas.	Designations of space and zoning laws	5 (0)

Activity supported	Corresponding interventions in our evidence and gap map	IEs (SRs)
<p>Require nutrition labelling on packages/menus to indicate if foods are high in calories, fats, sugars and/or salt and/or in positive nutrients.</p> <p>Restrict all forms of marketing, advertising and in-store promotions of HFSS foods, particularly to children.</p>	Advertising regulations	0 (0)
	Labelling regulations	1 (0)
<p>Deliver culturally-appropriate nutrition education, food literacy and skills training to children and adults through schools, health services, agricultural extension, social protection schemes and community settings.</p> <p>Launch engaging and compelling mass media and behaviour change communication campaigns about foods and diets.</p>	Classes within consumer behaviour	267 (27)
	Peer support / counselling	164 (24)
	Professional services	117 (21)
	Healthy food campaigns	81 (10)
	Door-to-door campaigns	3 (0)
	Community meetings	51 (2)
United Nations Food Systems Summit		
Increase farmer incomes, agricultural productivity, and equity by scaling up access to mechanisation services	Provision of mechanical equipment	9 (0)
Increase the returns to fertiliser subsidies for smallholders	Fertiliser access	40 (4)
Provide more affordable high-yielding varieties of stable crops for food-insecure farmers in fragile environments	Improved seeds	87 (5)
Buffer risks faced by livestock keepers through index-based drought risk financing solutions	Agricultural insurance	29 (1)
	Agricultural credit and savings	31 (1)
	Contract farming	13 (1)
Support systemic food systems change in rural communities through nutrition-sensitive agricultural extension services	Agricultural extension services	134 (1)
<p>Leverage women's tenure security in collectively held lands for equitable and sustainable food systems.</p> <p>Vernacularise women's land rights.</p> <p>Empowering women, smallholder farmers, and youth through school-</p>	Land markets and management	26 (1)

Activity supported	Corresponding interventions in our evidence and gap map	IEs (SRs)
based agricultural education. Women's economic empowerment for sustainable and healthy consumption patterns.	Women's empowerment efforts	22 (1)
Increase fruit and vegetable consumption through consumer-level subsidies.	Governmental price manipulations	25 (2)
Demand generation for healthy and sustainable food. Invest in better public sector marketing.	Classes within consumer behaviour	267 (27)
	Healthy food campaigns	81 (10)
	Door-to-door campaigns	3 (0)
	Community meetings	51 (2)
The State of Food Security and Nutrition in the World Report		
Market policies and fiscal policies tied to production or unconstrained use of variable production inputs. ¹ Trade and market interventions. Fiscal subsidies for agriculture.	Fertiliser access	40 (4)
	Livestock access	34 (3)
	Seed access	87 (5)
	Pesticide access	4 (1)
	Provision of other agricultural inputs	78 (2)
	Trade regulations	14 (1)
Healthy food environments and empowering consumers to choose healthy diets must be promoted through complementing agrifood systems policies.	Food environment interventions	697 (92)
Fiscal subsidies for consumers.	Governmental price manipulations	25 (2)
Enacting legislation on food marketing, and implementing nutrition labelling policies and healthy procurement policies.	Advertising regulations	0 (0)
	Labelling regulations	1 (0)
Combining land- use policies, including zoning, regulations and taxation	Designations of space and zoning laws	5 (0)

Notes: Only interventions or activities which would be directly reflected in our map are presented here. Multi-component interventions are counted under each corresponding category.

1. This activity is not supported by the SOFI report. The others in this table are generally supported by their corresponding organization.

5.6 Implications for research

Researchers are increasingly prioritizing a range of interventions. There was a noticeable decrease in the clustering of evaluations during the update period. In the original map, *fortification* studies represented 15 per cent of the available evidence and *supplementation* studies represented 21 per cent. However, during the update, this reduced to five per cent and seven per cent respectively. There were modest, proportionate increases in research in under-studied areas, such as *agricultural education* and *production systems improvements*. This indicates that a broader range of interventions are being evaluated. However, research gaps remain (Section 5.4).

More quasi-experimental research and evaluations of large-scale interventions is happening. While not always the case, quasi-experimental research can be well suited to the dynamics of complex interventions in real world settings. Evaluations of large-scale interventions often require quasi-experimental designs and can be highly influential given the number of people such interventions can affect. There may be opportunity to use big data and remote sensing in the future to allow for large-scale evaluations to be conducted.

There is insufficient research on key policy priorities. Many of the interventions listed as research needs in Section 5.4 are already widely implemented. These include governmental manipulations of price, advertising and labelling regulations, and designations of space and zoning laws. As such, we need to quickly establish their likely impacts to ensure that the right interventions are being prioritized. This will require the production of high-quality evidence synthesis to make generalizable conclusions in addition to primary research.

Evaluations of food systems interventions do not take a systems-level approach. Only two per cent of evaluations consider outcomes in five or more groups. Many of these do not look across the theory of change (ex. measuring production, income, diet, and anthropometrics), but instead evaluate conceptually similar outcomes (ex. micronutrient status, anthropometrics, and cognitive development). Without measurement across the causal chain and analysis explicitly designed to examine these linkages, it is impossible to know how interventions affect the system as a whole. Future research may consider and plan for measuring different types of outcomes, conducting mediation analysis, and examining general equilibrium effects to understand how change echoes through the entire food system (Leroy et al., 2022).

Cost evidence and mixed-methods research is still underrepresented. There was no change in the frequency of cost evidence or mixed methods research. This means that we still need more information to answer two key questions: are impacts worth the costs and what are the mechanisms by which impacts are achieved.

Research transparency could be increased by additional reporting of funders. With one third of studies failing to report research funding, it is difficult to understand the underlying motivations of the available research.

References

Reference in text

Anderson, W., Taylor, C., McDermid, S., Ilboudo-Nébié, E., Seager, R., Schlenker, W., ... & Markey, K. (2021). Violent conflict exacerbated drought-related food insecurity between 2009 and 2019 in sub-Saharan Africa. *Nature Food*, 2(8), 603-615

Berretta, M., Kupfer, M., Lane, C., & Shisler, S. (2022). Rapid Evidence Assessment on Women's Empowerment Interventions within the Food System: a meta-analysis.

Carter, B., & Kelly, L. (2021). Social Inequalities and Famine and Severe Food Insecurity Risk.

De Brauw, A., Brouwer, I.D., Snoek, H., Vignola, R., Melesse, M.B., Locketti, G., Van Wagenberg, C., Lundy, M., Maître d'Hôtel, E. and Ruben, R., (2019). Food system innovations for healthier diets in low and middle-income countries (Vol. 1816). Intl Food Policy Res Inst.

European Commission, Directorate-General for Research and Innovation, Webb, P., Sonnino, R., Fraser, E. (2022). Everyone at the table : transforming food systems by connecting science, policy and society, Publications Office of the European Union. <https://data.europa.eu/doi/10.2777/440690>

FAO, IFAD, UNICEF, WFP and WHO. (2022). The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO. <https://www.fao.org/documents/card/en/c/cc0639en>

FSIN and Global Network Against Food Crises. 2021. Global Report on Food Crises 2021. Rome.

Global Panel on Agriculture and Food Systems for Nutrition. 2020. Future Food Systems: For people, our planet, and prosperity. London, UK.

Food Systems Dashboard. (n.d.).

<https://www.foodsystemsdashboard.org/information/policies-and-actions> Accessed 23 January 2023

GFSS. 2020. "U.S. Government Global Food Security Strategy Implementation Report". FY2020.

Global Nutrition Report. (2017). Global Nutrition Report: Nourishing the SDGs. Bristol, UK; Development initiatives

Global Nutrition Report. (2020) Global Nutrition Report: Action on equity to end malnutrition. Bristol, UK; Development initiatives

Global Nutrition Report. (2021) Global Nutrition Report: The State of Global Nutrition. Bristol, UK: Development Initiatives, 2021

Global Nutrition Report. (2022) Global Nutrition Report: Stronger commitments for greater action. Bristol, UK: Development Initiatives, 2022

Global Nutrition Report. (2023a) Global Nutrition Report: The Nutrition Accountability Framework. Bristol, UK; Development initiatives

Global Nutrition Report. (2023b). Global Nutrition Report: Donor spending: Nutrition-specific and -sensitive disbursements.
<https://globalnutritionreport.org/resources/nutrition-growth-commitment-tracking/donor-spending-nutrition-specific-sensitive-disbursements/>

Global Panel. (2017). Improving nutrition through enhanced food environments. Policy Brief No. 7. London, UK: Global Panel on Agriculture and Food Systems for Nutrition.

Hammaker, J., Anda, D., Kozakiewicz, T., Bachina, V., Shisler, S., & Lane, C. (2022). Systematic review on Fiscal Policy Interventions in Nutrition. *Frontiers in Nutrition*, 2823. Available
at:https://www.frontiersin.org/articles/10.3389/fnut.2022.967494/full?utm_source=Email_to_authors&utm_medium=Email&utm_content=T1_11.5e1_author&utm_campaign=Email_publication&field=&journalName=Frontiers_in_Nutrition&id=967494

HLPE. 2020. Food security and nutrition: building a global narrative towards 2030. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.

Hendriks, S. L., Montgomery, H., Benton, T., Badiane, O., de la Mata, G. C., Fanzo, J., ... & Soussana, J. F. (2022). Global environmental climate change, covid-19, and conflict threaten food security and nutrition. *bmj*, 378.

Hendrix, C., & Brinkman, H. J. (2013). Food insecurity and conflict dynamics: Causal linkages and complex feedbacks. *Stability: International Journal of Security and Development*, 2(2).

Higgins, J.P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M.J. and Welch, V.A. eds., (2019). *Cochrane handbook for systematic reviews of interventions*. John Wiley & Sons.

High Level Panel of Experts on Food Security and Nutrition (HLPE). (2017). Nutrition and Food Systems: A Report by the High Level Panel of Experts on Food Security and Nutrition Report (HLPE)

IPCC, (2022): Summary for Policymakers. In: *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [P.R. Shukla, J. Skea, R. Slade, A. Al Khouradajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.

Kinzer, M. (2022). Land tenure formalization and regularization activities in low-income countries. Rapid evidence assessment brief. New Delhi: International Initiative for Impact Evaluation (3ie). Available from: <https://3ieimpact.org/sites/default/files/2022-06/Land-tenure-formalization-REA-brief.pdf>

Laborde Debucquet, D., Parent, M., & Piñeiro, V. (2021). Prioritization of types of investments: Operational tools for MCC agricultural investments (Vol. 4). Intl Food Policy Res Inst.

Leroy, J. L., Frongillo, E. A., Kase, B. E., Alonso, S., Chen, M., Dohoo, I., ... & Saville, N. M. (2022). Strengthening causal inference from randomised controlled trials of complex interventions. *BMJ Global Health*, 7(6), e008597

Lewin, S., Oxman, A.D., Lavis, J.N. and Fretheim, A., (2009). *SUPPORT Tools for evidence-informed health Policymaking (STP) 8: Deciding how much confidence to place in a systematic review*. *Health Research Policy and Systems*, 7(1), p.S8.

Njuki, J., Eissler, S., Malapit, H., Meinzen-Dick, R., Bryan, E., & Quisumbing, A. (2021). A review of evidence on gender equality, women's empowerment, and food systems. *Global Food Security*, 33, 100622.

Snilstveit, B., Bhatia, R., Rankin, K. and Leach, B., (2017). *3ie evidence gap maps*.

Snilstveit, B., Stevenson, J., Menon, R., Phillips, D., Gallagher, E., Geleen, M., ... & Jimenez, E. (2016). The impact of education programmes on learning and school participation in low-and middle-income countries.

Storhaug, I. G., Lane, C., Moore, N., Engelbert, M., Sparling, T. M., Franich, A., Rolker, H. & Snilstveit, B. (2022). Making the most of existing research: an evidence gap map of the effects of food systems interventions in low-income and middle-income countries. *BMJ open*, 12(6), e055062.

Swinburn, B., Dominich, C. H., Vandevjivere, S. (2014). Benchmarking food environments: experts' assessments of policy gaps and priorities for the New Zealand government. Auckland: University of Auckland.

The World Bank. (2022). Food security update. Available at: <https://thedocs.worldbank.org/en/doc/b5de315c82b1a3bb32bf30057aad9b74-0320012022/original/Food-Security-Update-LXVIII-Aug-11-2022.pdf>

Thomas J, Burton J, Graziosi S. (2010) EPPI-Reviewer 4: software for research synthesis. EPPI-Centre Software. London: Social Science Research Unit, UCL Institute of Education.

Tree, V., Lane, C., (2022). Transforming nutrition. *UN-Nutrition Journal*, Volume 1. Rome, FAO. Available from: <https://doi.org/10.4060/cc2805en>

UN Food Systems Coordination Hub. (2022). Biennial Work Plan 2022-2023. Enabling SDGs-based food systems transformations. UNFoodSystems. Available at: <https://www.unfoodsystemshub.org/about-us/mission/en>

United Nations. (n.d.). Action Tracks | United Nations. <https://www.un.org/en/food-systems-summit/action-tracks>. Accessed 23 January 2023

University of Ghent (2021). Biodiversity in the Diet in Vietnam - Full Text View - ClinicalTrials.gov. (n.d.). <https://clinicaltrials.gov/ct2/show/NCT05144919>

Willette, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., ... & Murray, C. J. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The lancet*, 393(10170), 447-492.

Newly included impact evaluations

Abdo, M., Kanyomse, E., Alirigia, R., Coffey, E. R., Piedrahita, R., Diaz-Sanchez, D., ... & Dickinson, K. L. (2021). Health impacts of a randomized biomass cookstove intervention in northern Ghana. *BMC Public Health*, 21(1), 1-17.

Abokyi, E. (2022). The impact of agricultural marketing program on farm investment: Evidence from Ghana. *Cogent Economics & Finance*, 10(1), 2111781.

Adam, L., Jin, J., & Khan, A. (2022). Does the Indonesian farmer empowerment policy enhance the professional farmer? Empirical evidence based on the difference-in-difference approach. *Technology in Society*, 68, 101924.

Adams, A., & Jumpah, E. T. (2021). Agricultural technologies adoption and smallholder farmers' welfare: Evidence from Northern Ghana. *Cogent Economics & Finance*, 9(1), 2006905.

Adong, A., Tinker, J., Levine, D., Mbowe, S., & Odokonyero, T. (2020). Encouraging fertilizer adoption through risk free sales offer: A randomized control trial in Uganda. *World Development Perspectives*, 19, 100230.

Afolami, I., Mwangi, M. N., Samuel, F., Boy, E., Ilona, P., Talsma, E. F., ... & Melse-Boonstra, A. (2021). Daily consumption of pro-vitamin A biofortified (yellow) cassava improves serum retinol concentrations in preschool children in Nigeria: a randomized controlled trial. *The American journal of clinical nutrition*, 113(1), 221-231.

Agdeppa, I. A., & Zamora, J. A. T. (2022). The Effects of Coconut Skim Milk and Coco-Dairy Milk Blend on the Nutritional Status of Schoolchildren. *Journal of Nutrition & Metabolism*.

Agler, R. A., Zivich, P. N., Kawende, B., Behets, F., & Yotebieng, M. (2021). Postpartum depressive symptoms following implementation of the 10 steps to successful breastfeeding program in Kinshasa, Democratic Republic of Congo: A cohort study. *PLoS Medicine*, 18(1), e1003465.

Agyei-Holmes, A., Buehren, N., Goldstein, M., Osei, R. D., Osei-Akoto, I., & Udry, C. (2020). The effects of land title registration on tenure security, investment and the allocation of productive resources. *Global Poverty Research Lab Working Paper*, (20-107).

Ahmed, S., McIntosh, C., & Sarris, A. (2020). The impact of commercial rainfall index insurance: experimental evidence from Ethiopia. *American Journal of Agricultural Economics*, 102(4), 1154-1176.

Ajefu, J. B., Singh, N., Ali, S., & Efobi, U. (2022). Women's Inheritance Rights and Child Health Outcomes in India. *The Journal of Development Studies*, 1-16.

- Al-Radaydah, D. (2022). The Effectiveness of a Guided Education Program on the Skill and Attitude to Breastfeeding among First-Time Mothers in Jordan. *Jordan Medical Journal*, 56(2)
- Alderman, H., Gilligan, D. O., Leight, J., Mulford, M., & Tambet, H. (2022). The role of poultry transfers in diet diversity: A cluster randomized intent to treat analysis. *Food Policy*, 107, 102212.
- Alonso, S. MoreMilk Project: Milk Safety and Child Nutrition Impacts of a Training Scheme for Dairy Vendors in Nairobi, Kenya. *Clinicaltrials*. Available at: <https://clinicaltrials.gov/ct2/show/NCT04109521> (2019).
- Anyango, G., Kagera, I., Mutua, F., Kahenya, P., Kyallo, F., Andang'o, P., ... & Lindahl, J. F. (2021). Effectiveness of Training and Use of Novasil Binder in Mitigating Aflatoxins in Cow Milk Produced in Smallholder Farms in Urban and Periurban Areas of Kenya. *Toxins*, 13(4), 281.
- Axmann, N., Fischer, T., Keller, K., Leiby, K., Stein, D., & Wang, P. (2020). Access and Adoption of Hybrid Seeds: Evidence from Uganda. *Journal of African Economies*, 29(3), 215-235.
- Ayalew, H., Chamberlin, J., & Newman, C. (2022). Site-specific agronomic information and technology adoption: A field experiment from Ethiopia. *Journal of Development Economics*, 156, 102788.
- Bari, M. A., Khan, G. D., He, B., & Yoshida, Y. (2022). The impact of unconditional cash and food assistance on contraceptive expenditure of rural households in Coastal Bangladesh: Evidence from fuzzy RDD. *Plos one*, 17(1), e0262031.
- Barrett, C. B., Islam, A., Mohammad Malek, A., Pakrashi, D., & Ruthbah, U. (2022). Experimental evidence on adoption and impact of the system of rice intensification. *American Journal of Agricultural Economics*, 104(1), 4-32.
- Bashaasha, B., Emegu, R. I., & Yamashita, M. (2021). Is Uganda's progressive refugee policy equalizing the food security of national and refugee households?. *Journal of Refugee Studies*, 34(4), 4572-4584.
- Bauchet, J., Undurraga, E., Zycherman, A., Behrman, J., Leonard, W., & Godoy, R. (2021). The effect of gender targeting of food transfers on child nutritional status: experimental evidence from the Bolivian amazon. *Journal of development effectiveness*, 13(3), 276-291.
- Beaman, L., BenYishay, A., Magruder, J., & Mobarak, A. M. (2021). Can network theory-based targeting increase technology adoption?. *American Economic Review*, 111(6), 1918-43.
- Bello, L. O., Baiyegunhi, L. J., & Danso-Abbeam, G. (2021). Productivity impact of improved rice varieties' adoption: Case of smallholder rice farmers in Nigeria. *Economics of Innovation and New Technology*, 30(7), 750-766.

- Berleze, A., & Valentini, N. C. (2022). Intervention for children with obesity and overweight and motor delays from low-income families: Fostering engagement, motor development, self-perceptions, and playtime. *International journal of environmental research and public health*, *19*(5), 2545.
- Bernedo Del Carpio, M., Alpizar, F., & Ferraro, P. J. (2021). Community-based monitoring to facilitate water management by local institutions in Costa Rica. *Proceedings of the National Academy of Sciences*, *118*(29), e2015177118.
- Bhuiyan, M. M. R., & Maharjan, K. L. (2022). Impact of farmer field school on crop income, agroecology, and Farmer's behavior in farming: A case study on Cumilla district in Bangladesh. *Sustainability*, *14*(7), 4190.
- Biggeri, M., Carraro, A., Ciani, F., & Romano, D. (2022). Disentangling the impact of a multiple-component project on SDG dimensions: The case of durum wheat value chain development in Oromia (Ethiopia). *World Development*, *153*, 105810.
- Biodiversity in the Diet in Vietnam - Full Text View - ClinicalTrials.gov. (n.d.). <https://clinicaltrials.gov/ct2/show/NCT05144919>
- Bird, S. S., Carter, M. R., Lybbert, T. J., Mathenge, M., Njagi, T., & Tjernström, E. (2022). Filling a niche? The maize productivity impacts of adaptive breeding by a local seed company in Kenya. *Journal of Development Economics*, *157*, 102885.
- Bliznashka, L., Sudfeld, C. R., Garba, S., Guindo, O., Soumana, I., Adehossi, I., ... & Isanaka, S. (2022). Prenatal supplementation with multiple micronutrient supplements or medium-quantity lipid-based nutrient supplements has limited effects on child growth up to 24 months in rural Niger: a secondary analysis of a cluster randomized trial. *The American Journal of Clinical Nutrition*, *115*(3), 738-748.
- Bonuedi I, Kornher L, and Gerber N (2020) 'Making cash crop value chains nutrition-sensitive: evidence from a quasi-experiment in rural Sierra Leone.', ZEF-Discussion Papers on Development Policy (293).
- Bragança, A., Newton, P., Cohn, A., Assunção, J., Camboim, C., de Faveri, D., ... & Searchinger, T. D. (2022). Extension services can promote pasture restoration: Evidence from Brazil's low carbon agriculture plan. *Proceedings of the National Academy of Sciences*, *119*(12), e2114913119.
- Bueno-Gutiérrez, D., Castillo, E. U. R., & Mondragón, A. E. H. (2021). Breastfeeding counseling based on formative research at primary healthcare Services in Mexico. *International journal for equity in health*, *20*, 1-11.
- Bulte, E., Cecchi, F., Lensink, R., Marr, A., & Van Asseldonk, M. (2020). Does bundling crop insurance with certified seeds crowd-in investments? Experimental evidence from Kenya. *Journal of Economic Behavior & Organization*, *180*, 744-757.
- Cai, J., Ding, F., Hong, Y., & Hu, R. (2021). An impact analysis of farmer field schools on hog productivity: Evidence from China. *Agriculture*, *11*(10), 972.

- Caifei, L. (2020). Empirical Analysis on the Effect of Agricultural Insurance on Production—Based on panel data of 31 provinces and cities in China from 2008 to 2018. In *E3S Web of Conferences* (Vol. 214, p. 01013). EDP Sciences.
- Carneiro, P., Kraftman, L., Rasul, I., & Scott, M. (2021). Do cash transfers promoting early childhood development have unintended consequences on fertility. *Unpublished Working Paper*.
- Caunedo, J., & Kala, N. (2021). Mechanizing agriculture impacts on labor and productivity.
- Cawley John, Daly Michael R, and Thornton Rebecca (2021) 'The Effect of Beverage Taxes on Youth Consumption and BMI: Evidence from Mauritius'. *NBER working paper No. W28960*. Available at: <https://www.nber.org/papers/w28960>
- Cg, K. (2021). Economic evaluation of an early childhood development center-based agriculture and nutrition intervention in Malawi. *Food Security*, 1-14.
- Channa, H., Ricker-Gilbert, J., Feleke, S., & Abdoulaye, T. (2022). Overcoming smallholder farmers' post-harvest constraints through harvest loans and storage technology: Insights from a randomized controlled trial in Tanzania. *Journal of Development Economics*, 157, 102851.
- Chehreh, R., Zahrani, S. T., Karamelahi, Z., & Baghban, A. A. (2021). Effect of peer support on breastfeeding self-efficacy in ilamian primiparous women: A single-blind randomized clinical trial. *Journal of family medicine and primary care*, 10(9), 3417.
- Chipili, G., Van Graan, A., Lombard, C. J., & Van Niekerk, E. (2022). The efficacy of fish as an early complementary food on the linear growth of infants aged 6–7 months: a randomised controlled trial. *Nutrients*, 14(11), 2191.
- Christian, P., Kondylis, F., Mueller, V., Zwager, A., & Siegfried, T. (2022). Monitoring Water for Conservation: A Proof of Concept from Mozambique. *American Journal of Agricultural Economics*, 104(1), 92-110.
- Cong, S. (2022). The Impact of Agricultural Land Rights Policy on the Pure Technical Efficiency of Farmers' Agricultural Production: Evidence from the Largest Wheat Planting Environment in China. *Journal of Environmental and Public Health*, 2022.
- Coppock, D. L., Crowley, L., Durham, S. L., Groves, D., Jamison, J. C., Karlan, D., ... & Ramsey, R. D. (2021). *Cooperation in the commons: Community-based rangeland management in Namibia* (No. w29469). National Bureau of Economic Research.
- Dagunga, G., Amoakowaa, A., Ehiakpor, D. S., Mabe, F. N., & Danso-Abbeam, G. (2020). Interceding role of village saving groups on the welfare impact of agricultural technology adoption in the Upper East Region, Ghana. *Scientific African*, 8, e00433.
- Daihawe, D. L., Lambert, D. M., Mulungu, K., & Eash, N. S. (2022). Conservation agriculture's effect on smallholder farmer wellbeing in Mozambique. *Renewable Agriculture and Food Systems*, 37(2), 155-165.

- Dar, M., De Janvry, A., Emerick, K., Sadoulet, E., & Wiseman, E. (2020). Private input suppliers as information agents for technology adoption in agriculture.
- De Silva Perera, U., & Inder, B. A. (2021). Midday meals as an early childhood nutrition intervention: evidence from plantation communities in Sri Lanka. *BMC Public Health*, 21, 1-22.
- Dean, M., & Sautmann, A. (2022). The Effects of Community Health Worker Visits and Primary Care Subsidies on Health Behavior and Health Outcomes for Children in Urban Mali.
- Debela, B. L., Shively, G. E., & Holden, S. T. (2021). Implications of food-for-work programs for consumption and production diversity: Evidence from the Tigray Region of Ethiopia. *Agricultural and Food Economics*, 9, 1-24.
- Depenbusch, L., Schreinemachers, P., Brown, S., & Roothaert, R. (2022). Impact and distributional effects of a home garden and nutrition intervention in Cambodia. *Food Security*, 14(4), 865-881.
- Desalegn, T. A., Gebremedhin, S., & Stoecker, B. J. (2022). Effect of school feeding program on the anthropometric and haemoglobin status of school children in Sidama region, Southern Ethiopia: a prospective study. *Journal of Nutritional Science*, 11, e69.
- Deutschmann, J. W., Bernard, T., & Yameogo, O. (2021). Contracting and quality upgrading: Evidence from an experiment in Senegal. *Unpublished manuscript*.
- Dickinson, K. L., Kanyomse, E., Piedrahita, R., Coffey, E., Rivera, I. J., Adoctor, J., ... & Wiedinmyer, C. (2015). Research on Emissions, Air quality, Climate, and Cooking Technologies in Northern Ghana (REACCTING): study rationale and protocol. *BMC public health*, 15(1), 1-20.
- Dillon, B., Aker, J. C., & Blumenstock, J. E. (2020). How Important is the Yellow Pages? Experimental Evidence from Tanzania.
- Djalalinia, S., Ramezani-Tehrani, F., Malekafzali, H., Hejazi, F., & Peykari, N. (2013). Development and evaluation of a nutritional health program for adolescents. *Iranian Journal of Nursing and Midwifery Research*, 18(5), 425.
- Donato, K., McConnell, M., Han, D., Gunaratna, N. S., Tessema, M., De Groote, H., & Cohen, J. (2020). Behavioural insights to support increased consumption of quality protein maize by young children: a cluster randomised trial in Ethiopia. *BMJ Global Health*, 5(12), e002705.
- Duan, Y., Liang, W., Wang, Y., Lippke, S., Lin, Z., Shang, B., & Baker, J. S. (2022). The effectiveness of sequentially delivered web-based interventions on promoting physical activity and fruit-vegetable consumption among Chinese college students: Mixed methods study. *Journal of Medical Internet Research*, 24(1), e30566.
- Dzanku, F. M., Osei, R. D., Nkegbe, P. K., & Osei-Akoto, I. (2022). Information delivery channels and agricultural technology uptake: experimental evidence from Ghana. *European Review of Agricultural Economics*, 49(1), 82-120.

- Emerick, K., & Dar, M. H. (2021). Farmer field days and demonstrator selection for increasing technology adoption. *The Review of Economics and Statistics*, 103(4), 680-693.
- Engelbrechtsen, I. M. S., Nankabirwa, V., Doherty, T., Diallo, A. H., Nankunda, J., Fadnes, L. T., ... & Tumwine, J. K. (2014). Early infant feeding practices in three African countries: the PROMISE-EBF trial promoting exclusive breastfeeding by peer counsellors. *International breastfeeding journal*, 9(1), 1-11.
- Esfarjani, F., Khalafi, M., Mohammadi, F., Mansour, A., Roustaei, R., Zamani-Nour, N., & Kelishadi, R. (2013). Family-based intervention for controlling childhood obesity: an experience among Iranian children. *International journal of preventive medicine*, 4(3), 358.
- Fafchamps, M., Islam, A., Malek, A., & Pakrashi, D. (2021). Mobilizing P2P diffusion for new agricultural practices: experimental evidence from Bangladesh. *The World Bank Economic Review*, 35(4), 1076-1101.
- Fahmida, U., Hidayat, A. T., Oka, A. A. S. I., Suciyantri, D., Pathurrahman, P., & Wangge, G. (2022). Effectiveness of an Integrated Nutrition Rehabilitation on Growth and Development of Children under Five Post 2018 Earthquake in East Lombok, Indonesia. *International Journal of Environmental Research and Public Health*, 19(5), 2814.
- Fang, G., & Zhu, Y. (2022). Long-term impacts of school nutrition: Evidence from China's school meal reform. *World Development*, 153, 105854.
- Fang, L., Fu, Y., Chen, S., & Mao, H. (2021). Can water rights trading pilot policy ensure food security in China? Based on the difference-in-differences method. *Water Policy*, 23(6), 1415-1434.
- Feyisa, M. (2021). The effect of productive safety net programme on household food consumption and dietary diversity in ethiopia.
- Fishman, R., Giné, X., & Jacoby, H. G. (2023). Efficient irrigation and water conservation: Evidence from South India. *Journal of Development Economics*, 103051.
- Flax, V. L., Ouma, E., Izerimana, L., Schreiner, M. A., Brower, A. O., Niyonzima, E., ... & Uwizeza, A. (2021). Animal Source Food Social and Behavior Change Communication Intervention Among Girinka Livestock Transfer Beneficiaries in Rwanda: A Cluster Randomized Evaluation. *Global Health: Science and Practice*, 9(3), 640-653.
- Frith, A. L., Naved, R. T., Persson, L. A., Rasmussen, K. M., & Frongillo, E. A. (2012). Early participation in a prenatal food supplementation program ameliorates the negative association of food insecurity with quality of maternal-infant interaction. *The Journal of nutrition*, 142(6), 1095-1101.
- Garcia, A., Cecchi, F., Eriksen, S., & Lensink, R. (2022). The plus in credit-plus-technical assistance: Evidence from a rural microcredit programme in Bolivia. *The Journal of Development Studies*, 58(2), 275-291.

- Gaworek-Michalczenia, M. F., Sallu, S. M., Di Gregorio, M., Doggart, N., & Mbogo, J. (2022). Evaluating the impact of adaptation interventions on vulnerability and livelihood resilience. *Climate and Development*, 14(10), 867-883.
- Ghasemi, A., Harsini, P. A., & Jeihooni, A. K. (2021). Investigating the effect of training on health behaviours of breastfeeding mothers in Iran. *British Journal of Midwifery*, 29(6), 324-329.
- Ghodsi, D., Omidvar, N., Eini-Zinab, H., Rashidian, A., & Raghfar, H. (2016). Impact of the national food supplementary program for children on household food security and maternal weight status in Iran. *International journal of preventive medicine*, 7.
- Ghosh, S., Taron, A., & Williams, F. (2019). The impact of Plant Clinics on the livelihoods of Bangladeshi farmers. *CABI Study Brief 29: Impact*, 29(8).
- Gignoux, J., Macours, K., Stein, D., & Wright, K. (2021). Agricultural input subsidies, credit constraints and expectations of future transfers: evidence from Haiti.
- Gizaw, A. T., Sopory, P., & Sudhakar, M. (2022). Effectiveness of a positive deviant intervention to improve appropriate feeding practices and nutritional outcomes in West Omo Zone, Maji District: South West Region, Ethiopia: A study protocol for a cluster randomized control trial. *medRxiv*, 2022-03
- GM, S., Ponnusamy, K., & Ramasundaram, P. (2021). Diversification and intensification in crop and dairy farming through watershed interventions. *Indian Journal of Agricultural Sciences*, 91(3), 355-8.
- Goletzke, J., Nga, H. T., Quyen, P. N., Ngu, T., & King, J. C. (2020). Effect of a Nutrient-Rich, Food-Based Supplement Given to Rural Vietnamese Mothers Prior to or during Pregnancy on the Trajectories of Nutrient Biomarkers. *Nutrients*, 12(10), 2913.
- Guan, J., Huang, K., Lan, X., Zhang, J., & Li, H. (2022). Impact of Confirmation of Farmland Rights on Farmers' Welfare: Based on the Micro-Empirical Investigation of Farmers in China. *Sustainability*, 14(15), 9710.
- Gulesci, S. (2021). Poverty alleviation and interhousehold transfers: evidence from BRAC's graduation program in Bangladesh. *The World Bank Economic Review*, 35(4), 921-949.
- Ha, T. T. T., Luoh, J. W., Sheu, A., Thuy, L. T., & Yang, R. Y. (2019). Vegetable diversity, productivity, and weekly nutrient supply from improved home gardens managed by ethnic families-a pilot study in Northwest Vietnam. *Food Ethics*, 4, 35-48.
- Haileselassie, M., Redae, G., Berhe, G., Henry, C. J., Nickerson, M. T., & Mulugeta, A. (2022). Educational intervention and livestock ownership successfully improved the intake of animal source foods in 6–23 months old children in rural communities of Northern Ethiopia: Quasi-experimental study. *Plos one*, 17(11), e0277240.
- Hailu, A. G., & Amare, Z. Y. (2022). Impact of productive safety net program on food security of beneficiary households in western Ethiopia: A matching estimator approach. *Plos one*, 17(1), e0260817.

Han, X., Xue, P., & Zhang, N. (2021). Impact of grain subsidy reform on the land Use of smallholder farms: Evidence from Huang-Huai-Hai Plain in China. *Land*, 10(9), 929.

Han, Y., Kim, H. B., & Park, S. (2021). The Roles of Nutrition Education and Food Vouchers in Improving Child Nutrition: Evidence from a Field Experiment in Ethiopia. *Journal of Health Economics*, 80, 102545.

Hando, F. H. (2021). Impact of small-scale irrigation schemes on household food security in the context of persisting droughts: Comparative quasi-experimental analysis of irrigation water users and non-users in Southwest Ethiopia. *African Journal of Agricultural Research*, 17(11), 1393-1406.

Haskell, M. J., Maleta, K., Arnold, C. D., Jorgensen, J. M., Fan, Y. M., Ashorn, U., ... & Dewey, K. G. (2022). Provision of Small-Quantity Lipid-Based Nutrient Supplements Increases Plasma Selenium Concentration in Pregnant Women in Malawi: A Secondary Outcome of a Randomized Controlled Trial. *Current developments in nutrition*, 6(3), nzac013.

He, F. J., Ma, Y., Feng, X., Zhang, W., Lin, L., Guo, X., ... & MacGregor, G. A. (2016). Effect of salt reduction on iodine status assessed by 24 hour urinary iodine excretion in children and their families in northern China: a substudy of a cluster randomised controlled trial. *BMJ open*, 6(9), e011168.

He, F. J., Zhang, P., Luo, R., Li, Y., Sun, Y., Chen, F., ... & MacGregor, G. A. (2022). App based education programme to reduce salt intake (AppSalt) in schoolchildren and their families in China: parallel, cluster randomised controlled trial. *bmj*, 376.

He, S., Le, N. A., Ramirez-Zea, M., Martorell, R., Narayan, K. V., & Stein, A. D. (2020). Leptin partially mediates the association between early-life nutritional supplementation and long-term glycemic status among women in a Guatemalan longitudinal cohort. *The American journal of clinical nutrition*, 111(4), 804-813.

Herghelegiu, A. M., Wenzel, K. M., Moser, A., Prada, G. I., Nuta, C. R., & Stuck, A. E. (2020). Effects of health risk assessment and counselling on fruit and vegetable intake in older people: a pragmatic randomised controlled trial. *The journal of nutrition, health & aging*, 24, 591-597.

Hidayat, S., Muawanah, U., Pabuayon, I. M., & Ridwansyah, M. (2021). Benefits Of Marine Conservation Program: An Impact Evaluation Approach. *International Journal of Conservation Science*, 12(2), 545-558.

Hoffmann, V., & Jones, K. (2021). Improving food safety on the farm: Experimental evidence from Kenya on incentives and subsidies for technology adoption. *World Development*, 143, 105406.

Hörner, D., Bouguen, A., Frölich, M., & Wollni, M. (2022). Knowledge and adoption of Complex agricultural technologies: Evidence from an extension experiment. *The World Bank Economic Review*, 36(1), 68-90.

Hua, W., Chen, Z., & Luo, L. (2022). The Effect of the Major-Grain-Producing-Areas Oriented Policy on Crop Production: Evidence from China. *Land*, 11(9), 1375.

- Huss, M., Brander, M., Kassie, M., Ehlert, U., & Bernauer, T. (2021). Improved storage mitigates vulnerability to food-supply shocks in smallholder agriculture during the COVID-19 pandemic. *Global Food Security*, 28, 100468.
- Ibrahim, H., Umar Garba, S., & Wahab Munir, J. (2021). Impact of a Contract Farming Scheme on Income, Food Security, and Nutrition among Maize Farmers in North Western, Nigeria. *Journal of Nutrition and Food Security*, 6(2), 101-106
- Iddrisu, M., Aidoo, R., & Wongnaa, C. A. (2020). Participation in UTZ-RA voluntary cocoa certification scheme and its impact on smallholder welfare: Evidence from Ghana. *World Development Perspectives*, 20, 100244.
- Jabbar, A., Liu, W., Wang, Y., Zhang, J., Wu, Q., & Peng, J. (2022). Exploring the Impact of Farmer Field Schools on the Adoption of Sustainable Agricultural Practices and Farm Production: A Case of Pakistani Citrus Growers. *Agronomy*, 12(9), 2054.
- Jamaluddine, Z., Akik, C., Safadi, G., Abou Fakher, S., El-Helou, N., Moussa, S., ... & Ghattas, H. (2022). Does a school snack make a difference? An evaluation of the World Food Programme emergency school feeding programme in Lebanon among Lebanese and Syrian refugee children. *Public Health Nutrition*, 25(6), 1678-1690.
- Jansen, L., Outwater, A. H., Lowery Wilson, M., Iseselo, M. K., & Bärnighausen, T. (2022). A controlled pilot intervention on community violence prevention, financial and social capital generation in Dar Es Salaam, Tanzania. *BMC public health*, 22(1), 335.
- Joyce, C. M., Hou, S. S. Y., Ta, B. T., Vu, D. H., Mathisen, R., Vincent, I., ... & Nandi, A. (2021). The association between a novel baby-friendly hospital program and equitable support for breastfeeding in Vietnam. *International Journal of Environmental Research and Public Health*, 18(13), 6706.
- Jumrani, J., & Meenakshi, J. V. (2022). How effective is a fat subsidy? Evidence from edible oil consumption in India. *Journal of Agricultural Economics*.
- Kafle, K., Songsermsawas, T., & Winters, P. Impacts of agricultural value chain development in a mountainous region.
- Kanchanachitra, M., & Angeles, G. (2023). Impact of a School-Based Nutrition Intervention in Preventing Overweight and Obesity in Children in Thailand. *Journal of School Health*, 93(2), 140-147.
- Kansanga, M. M., Kangmennaang, J., Kerr, R. B., Lupafya, E., Dakishoni, L., & Luginaah, I. (2021). Agroecology and household production diversity and dietary diversity: Evidence from a five-year agroecological intervention in rural Malawi. *Social Science & Medicine*, 288, 113550.
- Kansiime, E., Kabahenda, M. K., & Bonsi, E. A. (2021). Improving caregivers' infant and young child-feeding practices using a three-group food guide: A randomized intervention study in central Uganda. *African Journal of Food, Agriculture, Nutrition and Development*, 21(4), 17834-17853.

Kariuki, S. W., & Hoffmann, V. (2022). Can information drive demand for safer food? Impact of brand-specific recommendations and test results on product choice. *Agricultural Economics*, 53(3), 454-467.

Kassie, K. E., & Alemu, B. A. (2021). Does irrigation improve household's food security? The case of Koga irrigation development project in northern Ethiopia. *Food Security*, 13, 291-307.

Kemeze, F. H. (2018). The impact of agricultural insurance on the demand for supplemental irrigation: A randomized controlled trial experimental evidence in Northern Ghana. *Building a Resilient and Sustainable Agriculture in Sub-Saharan Africa*, 181-206.

Khan, A. I. (2013). Effects of pre-and postnatal nutrition interventions on child growth and body composition: the MINIMat trial in rural Bangladesh. *Global health action*, 6(1), 22476.

Khan, N., Ray, R. L., Kassem, H. S., Ihtisham, M., Asongu, S. A., Ansah, S., & Zhang, S. (2021). Toward cleaner production: Can mobile phone technology help reduce inorganic fertilizer application? Evidence using a national level dataset. *Land*, 10(10), 1023.

Khani Jeihooni, A., Layeghiasi, M., Yari, A., & Rakhshani, T. (2022). The effect of educational intervention based on the theory of planned behavior on improving physical and nutrition status of obese and overweight women. *BMC Women's Health*, 22(1), 13.

Khanna, D., Yalawar, M., Saibaba, P. V., Bhatnagar, S., Ghosh, A., Jog, P., ... & Huynh, D. T. (2021). Oral nutritional supplementation improves growth in children at malnutrition risk and with picky eating behaviors. *Nutrients*, 13(10), 3590.

Kilic, T., Moylan, H., Ilukor, J., Mtengula, C., & Pangapanga-Phiri, I. (2021). Root for the tubers: Extended-harvest crop production and productivity measurement in surveys. *Food Policy*, 102, 102033.

Kimani-Murage, E. W., Kimiywe, J., Mutoro, A. N., Wilunda, C., Wekesah, F. M., Muriuki, P., ... & Griffiths, P. L. (2021). Effectiveness of the baby-friendly community initiative on exclusive breastfeeding in Kenya. *Maternal & child nutrition*, 17(3), e13142

Kimwele, A. M., Ochola, S. A., & Mugambi, M. N. (2021). Influence of Homegrown School Feeding Programme on Dietary Diversity Among School Children 6-13 Years of Age in Makueni County, Kenya.

Kinuthia, B. K. (2020). *Agricultural input subsidy and farmers outcomes in Tanzania* (No. wp-2020-149). World Institute for Development Economic Research (UNU-WIDER).

Kirkwood, E. K., Dibley, M. J., Hoddinott, J. F., Huda, T., Laba, T. L., Tahsina, T., ... & Alam, A. (2021). Assessing the impact of a combined nutrition counselling and cash transfer intervention on women's empowerment in rural Bangladesh: a randomised control trial protocol. *BMJ open*, 11(6), e044263.

Knauer, H. A., Balasanyan, S., Bakhshinyan, E., & Alderman, H. (2021). *Promoting school readiness through a preschool feeding program: A nutritional nudge to improve at-risk preschooler's cognitive development in Armenia* (Vol. 2046). Intl Food Policy Res Inst.

- Kondal, D., Jeemon, P., Manimunda, S., Narayanan, G., Purty, A. J., Negi, P. C., ... & Prabhakaran, D. (2022). Structured Lifestyle Modification Interventions Involving Frontline Health Workers for Population-Level Blood Pressure Reduction: Results of a Cluster Randomized Controlled Trial in India (DISHA Study). *Journal of the American Heart Association*, 11(6), e023526.
- Kumar, K. N. R., & Babu, S. C. (2021). Can a Weather-Based Crop Insurance Scheme Increase the Technical Efficiency of Smallholders? A Case Study of Groundnut Farmers in India. *Sustainability*, 13(16), 9327.
- Kumar, M. V., & Erhardt, J. (2020). Improving the iron status of school children through a school noon meal programme with meals prepared using a multiple micronutrient-fortified salt in Tamil Nadu, India. *Asia Pacific Journal of Clinical Nutrition*, 29(3), 577-583.
- Kurzawa, Z., Cotton, C. S., Mazurkewich, N., Verney, A., Busch-Hallen, J., & Kashi, B. (2021). Training healthcare workers increases IFA use and adherence: Evidence and cost-effectiveness analysis from Bangladesh. *Maternal & Child Nutrition*, 17(2), e13124.
- Ladino, J. F., Saavedra, S., & Wiesner, D. (2021). One step ahead of the law: The net effect of anticipation and implementation of colombia's illegal crops substitution program. *Journal of Public Economics*, 202, 104498.
- Laguna-Camacho, A., & de Jesús Serrano-Plata, M. (2021). Effect on Weight of a Homemade Diet in Women with Overweight or Obesity: A Randomized Controlled Trial. *Psicología Conductual*, 29(3), 743-762.
- Lazzeri, B., Leotti, V. B., Soldateli, B., Giugliani, E. R., Monteiro, C. A., Steele, E. M., ... & Drehmer, M. (2021). Effect of a healthy eating intervention in the first months of life on ultraprocessed food consumption at the age of 4–7 years: A randomised clinical trial with adolescent mothers and their infants. *British Journal of Nutrition*, 126(7), 1048-1055.
- Le, T. Q. A., Shimamura, Y., & Yamada, H. (2020). Information acquisition and the adoption of a new rice variety towards the development of sustainable agriculture in rural villages in Central Vietnam. *World Development Perspectives*, 20, 100262.
- Lecoutere, E., & Van Campenhout, B. (2018). Joint forces: the impact of intrahousehold cooperation on welfare in East African agricultural households. *Working papers/University of Antwerp. Institute of Development Policy and Management; Université d'Anvers. Institut de politique et de gestion du développement.-Antwerp*.
- Leroy, J. L., Olney, D. K., Nduwabike, N., & Ruel, M. T. (2021). Tubaramure, a food-assisted integrated health and nutrition program, reduces child wasting in Burundi: a cluster-randomized controlled intervention trial. *The Journal of Nutrition*, 151(1), 197-205.
- Li, C. L., Wang, Y. H., Wang, J. L., Zhang, P., & Sun, Y. (2021). Effect of individualized medical nutrition guidance on pregnancy outcomes in older pregnant women. *Journal of International Medical Research*, 49(8), 03000605211033193.
- Li, Y., & Wang, Z. (2022). Analysis on the effect of farmer income of policy-based agricultural insurance. *Acta Agriculturae Scandinavica, Section B—Soil & Plant Science*, 72(1), 386-400.

- Lignou, S., Das, S., Mistry, J., Alcock, G., More, N. S., Osrin, D., & Edwards, S. J. (2016). Reconstructing communities in cluster trials?. *Trials*, *17*, 1-11.
- Likhitweerawong, N., Boonchooduang, N., Kittisakmontri, K., Chonchaiya, W., & Louthrenoo, O. (2021). Effectiveness of mobile application on changing weight, healthy eating habits, and quality of life in children and adolescents with obesity: a randomized controlled trial. *BMC pediatrics*, *21*(1), 1-9.
- Liu, Y., Wang, M., Qian, Z., Hou, B., Chen, X., Lei, Q., ... & Zhao, L. (2022). Effect of Farmland Transfer on Poverty Reduction under Different Targeted Poverty Alleviation Patterns Based on PSM-DID Model in Karst Area of China. *Mathematical Problems in Engineering*.
- Loginova, D. (2022). Assessing the Short-term Effect of Exchange Rate Liberalisation on Food Import Prices: The Regression Discontinuity in Time Employed for Russian Food Markets in 2014. *Research on World Agricultural Economy*, *3*(2455-2022-811), 52-67.
- Luna, S. V., Pompano, L. M., Lung'aho, M., Gahutu, J. B., & Haas, J. D. (2020). Increased iron status during a feeding trial of iron-biofortified beans increases physical work efficiency in Rwandan women. *The Journal of Nutrition*, *150*(5), 1093-1099.
- Lungu, E., Auger, J., Piano, A., & Dahl, W. J. (2021). Higher fiber complementary food alters fecal microbiota composition and normalizes stool form in Malawian children: a randomized trial. *African Journal of Food, Agriculture, Nutrition and Development*, *21*(4), 17854-17875.
- Luo, C., Sun, S., & Wan, G. (2021). The impact of political relations on international trade: China–Philippines island dispute as a quasi-natural experiment. *The World Economy*, *44*(11), 3422-3441.
- Lyu, J. L., Liu, Z., Zhou, S., Feng, X. X., Lin, Y., Gao, A. Y., ... & Wang, H. J. (2022). The Effect of a Multifaceted Intervention on Dietary Quality in Schoolchildren and the Mediating Effect of Dietary Quality between Intervention and Changes in Adiposity Indicators: A Cluster Randomized Controlled Trial. *Nutrients*, *14*(16), 3272.
- M'liria, J. K., & Kimiywe, J. (2020). Impact of mother-to-mother support groups in promoting exclusive breastfeeding in a low-resource rural community in kenya: A randomized controlled trial. *Current Research in Nutrition and Food Science*, *8*(2), 609.
- Mahmudiono, T., Loh, S. P., Atmaka, D. R., Rachmah, Q., Mahmudah, M., Arini, S. Y., ... & Dewi, N. U. (2021). Nutrition Education 4.0 to Prevent Overweight and Obesity through Social Media. *Open Access Macedonian Journal of Medical Sciences*, *9*(E), 1475-1479.
- Malaiarasan, U., Paramasivam, R. and Felix, K.T. (2021) 'Does Food Price Subsidy Affect Dietary Diversity? Evidence from South India', *Margin: The Journal of Applied Economic Research*, *15*(2), pp. 268–290. doi:10.1177/0973801021990397.
- Manea, R. E. (2021). School feeding programmes, education and food security in rural Malawi (No. 63-2020). Centre for International Environmental Studies, The Graduate Institute.

- Manjusree, R. V., Maiti, S., Garai, S., Manjunath, K. V., Bhakat, M., Dixit, A. K., ... & Kadian, K. S. (2022). Impact of Agromet Advisory Services on Farmers' Operational Decisions Related to Crop Cultivation in Thiruvananthapuram District of Kerala.
- Maredia, M. K., Farris, J. G., Mason, N. M., & Morgan, S. N. (2022). Effectiveness of farmer-led extension that combines demonstration plots and free trial packs: A field experiment in Tanzania.
- Mariyono, J., Dewi, H. A., Daroini, P. B., Latifah, E., Hakim, A. L., & Luther, G. C. (2022). Farmer field schools for improving economic sustainability performance of Indonesian vegetable production. *International Journal of Productivity and Performance Management*, 71(4), 1188-1211.
- Maryati, S., Yunitasari, P., & Punjastuti, B. (2022). The Effect of Interactive Education Program in Preventing Stunting for Mothers with Children under 5 Years of Age in Indonesia: A Randomized Controlled Trial. *Open Access Macedonian Journal of Medical Sciences*, 10(G), 260-264.
- Mehta, S., Huey, S. L., Ghugre, P. S., Potdar, R. D., Venkatramanan, S., Krisher, J. T., ... & Kalogi, V. D. (2022). A randomized trial of iron-and zinc-biofortified pearl millet-based complementary feeding in children aged 12 to 18 months living in urban slums. *Clinical Nutrition*, 41(4), 937-947.
- Mekonnen, D. K., Choufani, J., Bryan, E., Haile, B., & Ringler, C. (2022). Irrigation improves weight-for-height z-scores of children under five, and Women's and Household Dietary Diversity Scores in Ethiopia and Tanzania. *Maternal & Child Nutrition*, 18(4), e13395.
- Mendonça, R., Mingoti, S. A., Bethony, M. F. G., Martinez-Gonzalez, M. A., Bes-Rastrollo, M., & Lopes, A. C. S. (2022). Intervention for promoting intake of fruits and vegetables in Brazilians: a randomised controlled trial. *Public Health Nutrition*, 25(3), 781-793
- Mihrshahi, S., Ara, G., Khanam, M., Rasheed, S., Agho, K. E., Kabir, A. I., ... & Dibley, M. J. (2022). The Shishu Pushti Trial—Extended Peer Counseling for Improving Feeding Practices and Reducing Undernutrition in Children Aged 0-48 Months in Urban Bangladesh: Protocol for a Cluster-Randomized Controlled Trial. *JMIR Research Protocols*, 11(2), e31475.
- Mikulic, N., Uyoga, M. A., Paganini, D., Mwasi, E., Stoffel, N. U., Zeder, C., ... & Zimmermann, M. B. (2021). Consumption of a single dose of prebiotic galacto-oligosaccharides does not enhance iron absorption from micronutrient powders in Kenyan infants: a stable iron isotope study. *The Journal of Nutrition*, 151(5), 1205-1212.
- Mishra, K., Gallenstein, R. A., Miranda, M. J., Sam, A. G., Toledo, P., & Mulangu, F. (2021). Insured loans and credit access: Evidence from a randomized field experiment in northern Ghana. *American Journal of Agricultural Economics*, 103(3), 923-943.
- Monoto, E. M. M., Hamzah, Z., Alwi, N. K. M., & Wahab, A. A. (2020). Breastfeeding Peer Counselor Program in Malaysia: Impact on Breastfeeding Duration and Exclusivity. *Bali Medical Journal*, 9(3), 876-883.

- Montenegro-Bethancourt, G., Wallace, T., Rohloff, P., Jimenez, E. Y., Proaño, G., McCabe, G., & Steiber, A. (2021). The Saqmolo'Project: Protocol for a Randomized Controlled Trial Examining the Impact of Daily Complementary Feeding of Eggs on Infant Development and Growth in Guatemala. *Current Developments in Nutrition*, 5, 5140162.
- Moore, S. E., Fulford, A. J., Darboe, M. K., Jobarteh, M. L., Jarjou, L. M., & Prentice, A. M. (2012). A randomized trial to investigate the effects of pre-natal and infant nutritional supplementation on infant immune development in rural Gambia: the ENID trial: Early Nutrition and Immune Development. *BMC pregnancy and childbirth*, 12(1), 1-8.
- More, N., Das, S., Bapat, U., Rajguru, M., Alcock, G., Joshi, W., ... & Osrin, D. (2013). Community resource centres to improve the health of women and children in Mumbai slums: study protocol for a cluster randomized controlled trial. *Trials*, 14(1), 1-10.
- Mortazavi, Z., Dorosty, A. R., Eshraghian, M. R., Ghaffari, M., & Ansari-Moghaddam, A. (2021). Nutritional education and its effects on household food insecurity in Southeastern Iran. *Iranian Journal of Public Health*, 50(4), 798.
- Muhammad, A., Fazal, Z. Z., Baloch, B., Nisar, I., Jehan, F., & Shafiq, Y. (2022). Nutritional support and prophylaxis of azithromycin for pregnant women to improve birth outcomes in peri-urban slums of Karachi, Pakistan—a protocol of multi-arm assessor-blinded randomized controlled trial (Mumta PW trial). *Trials*, 23, 1-13.
- Mwale, M. L., Kamninga, T. M., & Cassim, L. (2022). The effects of the Malawi Farm Input Subsidy Program on household per-capita consumption convergence. *Development in Practice*, 32(3), 336-348.
- Narayan, T. A., & Geyer, J. (2022). Can results-based prizes to private sector incentivize technology adoption by farmers? Evidence from the AgResults Nigeria project that uses prizes to incentivize adoption of Aflasafe™. *Agriculture & Food Security*, 11(1), 37.
- Ndegwa, M. K., Shee, A., Turvey, C. G., & You, L. (2020). Uptake of insurance-embedded credit in presence of credit rationing: evidence from a randomized controlled trial in Kenya. *Agricultural Finance Review*.
- Ng, C. M., Kaur, S., Koo, H. C., Mukhtar, F., & Yim, H. S. (2022). Experiential healthy meal preparation: A randomized-controlled trial to improve food group consumption and weight status among children. *Human Nutrition & Metabolism*, 28, 200151.
- Nguyen-Anh, T. (2021). Market-oriented extension and farming efficiency in small-scale maize farmers: evidence from Northern Vietnam. *Journal of Agribusiness in Developing and Emerging Economies*.
- Nguyen, T., De Brauw, A., Van den Berg, M., & Do, H. T. P. (2021). Testing methods to increase consumption of healthy foods evidence from a school-based field experiment in Viet Nam. *Food Policy*, 101, 102047.
- Niu, Z., Yi, F., & Chen, C. (2022). Agricultural insurance and agricultural fertilizer non-point source pollution: evidence from China's policy-based agricultural insurance pilot. *Sustainability*, 14(5), 2800.

- Ntakyo P R and Van Den Berg M (2022) 'The Unintended Side-Effects of a Major Development Strategy: Commercialization of Smallholder Production and Women Empowerment in Uganda', *Journal of Development Studies* [Preprint]. doi:10.1080/00220388.2022.2032671.
- Nunes, L. M., Führ, J., Belin, C. H. S., Moreira, P. R., Neves, R. O., de Brito, M. L., ... & Bernardi, J. R. (2021). Complementary feeding methods in the first year of life: a study protocol for a randomized clinical trial. *Trials*, 22, 1-13.
- Okello, J. J., Just, D. R., Jogo, W., Kwikiriza, N., & Tesfaye, H. (2022). Do Behavioral Interventions Increase the Intake of Biofortified Foods in School Lunch Meals? Evidence from a Field Experiment with Elementary School Children in Ethiopia. *Current Developments in Nutrition*, 6(2), nzac008.
- Okolo-Obasi, N. E., & Uduji, J. I. (2022). The impact of national home grown school feeding programme (NHGSFP) on rural communities in Nigeria. *Journal of Economic and Administrative Sciences*.
- Okoyo, E. N., Wordofa, M. G., Hassen, J. Y., & Bezabih, M. (2021). Welfare impacts of rural credit and saving program in Kurfa Chele district, eastern Ethiopia: a propensity score matching estimation. *Agricultural Finance Review*, 81(4), 596-613.
- Otiang, E., Yoder, J., Manian, S., Campbell, Z. A., Thumbi, S. M., Njagi, L. W., ... & Palmer, G. H. (2022). Vaccination of household chickens results in a shift in young children's diet and improves child growth in rural Kenya. *Proceedings of the National Academy of Sciences*, 119(24), e2122389119.
- Otieno, G., Ogola, R. J. O., Recha, T., Mohammed, J. N., & Fadda, C. (2022). Climate change and seed system interventions impact on food security and incomes in East Africa. *Sustainability*, 14(11), 6519.
- Oyinbo, O., Chamberlin, J., Abdoulaye, T., & Maertens, M. (2022). Digital extension, price risk, and farm performance: experimental evidence from Nigeria. *American Journal of Agricultural Economics*, 104(2), 831-852.
- Palmer, A. C., Jobarteh, M. L., Chipili, M., Greene, M. D., Oxley, A., Lietz, G., ... & Haskell, M. J. (2021). Biofortified and fortified maize consumption reduces prevalence of low milk retinol, but does not increase vitamin A stores of breastfeeding Zambian infants with adequate reserves: a randomized controlled trial. *The American Journal of Clinical Nutrition*, 113(5), 1209-1220.
- Pamuk, H., Asseldonk, M. V., Wattel, C., Ng'ang'a, S. K., Hella, J. P., & Ruben, R. (2021). Farmer Field Business Schools and Village Savings and Loan Associations for promoting climate-smart agriculture practices: Evidence from rural Tanzania. *CGIAR Research Program on Climate Change, Agriculture and Food Security Working Paper*.
- Pant, I., Rimal, R., Yilma, H., Bingenheimer, J., Sedlander, E., & Behera, S. (2021). mHealth for anemia reduction: protocol for an entertainment education-based dual intervention. *JMIR Research Protocols*, 10(11), e26252.

- Parkkali, S., Abacassamo, F., Nwaru, B. I., Salomé, G., Augusto, O., Regushevskaya, E., ... & Hemminki, E. (2013). Comparison of routine prenatal iron prophylaxis and screening and treatment for anaemia: pregnancy results and preliminary birth results from a pragmatic randomised controlled trial (PROFEG) in Maputo, Mozambique. *BMJ open*, 3(2), e001948.
- Peng, J., Zhao, Z., & Chen, L. (2022). The Impact of High-Standard Farmland Construction Policy on Rural Poverty in China. *Land*, 11(9), 1578.
- Pfluger, B. A., Smith, H. V., Weber, A. M., Ibrahim, H., Doumbia, L., Bore, A., ... & Ryan, E. P. (2022). Non-targeted dried blood spot-based metabolomics analysis showed rice bran supplementation effects multiple metabolic pathways during infant weaning and growth in Mali. *Nutrients*, 14(3), 609
- Pimmer, C., Zahnd, A., & Gröhbiel, U. (2019). Participatory videos to teach the use of renewable energy systems. A case study from rural Nepal.
- Pompano, L. M., Luna, S. V., Udipi, S. A., Ghugre, P. S., Przybyszewski, E. M., & Haas, J. (2022). Iron-biofortified pearl millet consumption increases physical activity in Indian adolescent schoolchildren after a 6-month randomised feeding trial. *British Journal of Nutrition*, 127(7), 1018-1025.
- Pragya, PhD, P., Yadav, MD, R. K., Khadgawat, DM, R., & Pandey, PhD, R. M. (2021). Effect of Vitamin D Supplementation on Disposition Index in Non-Diabetic Indians with Obesity: A Double-Blind Randomized Placebo-Controlled Trial. *Journal of Dietary Supplements*, 18(6), 630-645.
- Pretari, A. (2021). Resilience in the West Bank: Impact evaluation of the 'From Emergency Food Security to Durable Livelihoods: Building Resilience in the Occupied Palestinian Territory' project.
- Proscovia, N. R., Johnny, M., Robert, B., Diana, N., & Robert, K. (2021). Influence of informal financial literacy training on financial knowledge and behavior of rural farmers: Evidence from Uganda.
- Quisumbing, A., Ahmed, A., Hoddinott, J., Pereira, A., & Roy, S. (2021). Designing for empowerment impact in agricultural development projects: Experimental evidence from the Agriculture, Nutrition, and Gender Linkages (ANGeL) project in Bangladesh. *World Development*, 146, 105622.
- Reeves, S., Poh, B. K., Cheah, W. L., Essau, C., Summerbell, C., Koh, D., ... & Gibson, L. (2020). ToyBox Study Malaysia: a feasibility study to improve healthy energy balance and obesity-related behaviour. *Proceedings of the Nutrition Society*, 79(OCE2).
- Rimal, R. N., Yilma, H., Sedlander, E., Mohanty, S., Patro, L., Pant, I., ... & Behera, S. (2021). Iron and folic acid consumption and changing social norms: cluster randomized field trial, Odisha, India. *Bulletin of the World Health Organization*, 99(11), 773.
- Rokhani, R., Asrofi, A., Adi, A. H., Khasan, A. F., & Rondhi, M. (2021). The Effect of Agricultural Extension Access on The Performance of Smallholder Sugarcane Farmers in Indonesia. *AGRARIS: Journal of Agribusiness and Rural Development Research*, 7(2), 142-159.

- Romero, P., & Melo, O. (2021). Can a Territorial Use Right for Fisheries management make a difference for fishing communities?. *Marine Policy*, 124, 104359.
- Rondini, K. A., Xu, W., Chai, Y., Pachón, H., & Kancherla, V. (2022). National Mandatory Grain Fortification Legislation Decreases Anemia Prevalence among Nonpregnant Women of Reproductive Age: Findings from Multiple Demographic and Health Surveys. *The Journal of Nutrition*, 152(12), 2922-2930.
- Roosita, K., Ma'rifah, B., Nurdin, N. M., & Anwar, F. (2022). Effects of Galohgor Nutraceutical Lactation Cookies on Breast Milk Volume and Lactose Concentration. *Korean Journal of Family Medicine*, 43(1), 56.
- Rosato, M., Lewycka, S., Mwansambo, C., Kazembe, P., Phiri, T., Chapota, H., ... & Costello, A. (2012). Volunteer infant feeding and care counselors: a health education intervention to improve mother and child health and reduce mortality in rural Malawi. *Malawi Medical Journal*, 24(2), 39-42.
- Rotheram-Borus, M. J., Le Roux, I. M., Tomlinson, M., Mbewu, N., Comulada, W. S., Le Roux, K., ... & Swendeman, D. (2011). Philani Plus (+): a Mentor Mother community health worker home visiting program to improve maternal and infants' outcomes. *Prevention Science*, 12, 372-388.
- Rubio-Jovel, K. (2021). Gender Empowerment in Agriculture Interventions: What Are We Still Missing? Evidence From a Randomized-Controlled Trial Among Coffee Producers in Honduras. *Frontiers in Sustainable Food Systems*, 5, 695390.
- Ruml, A., & Qaim, M. (2020). Effects of marketing contracts and resource-providing contracts in the African small farm sector: Insights from oil palm production in Ghana. *World Development*, 136, 105110.
- Sabogal, I. M. U., Nariño, C. C. D., & Monsalve, M. A. M. (2021). Lactation counseling for maintaining exclusive breastfeeding in adolescent mothers: a trial protocol. *Pilot and Feasibility Studies*, 7, 1-9.
- Sadiq, M. S., Singh, I. P., & Ahmad, M. M. (2021). INCOME DISCRIMINATION-A MANIFESTATION OF INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT (IFAD) RICE PROGRAMME IN NIGERIA'S NIGER STATE: INVISIBLE OR INVINCIBLE. *Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences*, 37(1), 56-70.
- Saffari, M., Amini, N., Ardebili, H. E., Sanaeinasab, H., Mahmoudi, M., & Piper, C. N. (2013). Educational intervention on health related lifestyle changes among Iranian adolescents. *Iranian journal of public health*, 42(2), 172.
- Sağlık, M., & Karaçam, Z. (2021). Effectiveness of structured education and follow-up in the management of perceived breastmilk insufficiency: a randomized control trial. *Health Care for Women International*, 1-19.
- Said, L., Gubbels, J. S., & Kremers, S. P. (2022). Effect Evaluation of Sahtak bi Sahnak, a Lebanese Secondary School-Based Nutrition Intervention: A Cluster Randomised Trial. *Frontiers in nutrition*, 9, 428.

Salazar, L., Palacios, A. C., Selvaraj, M., & Montenegro, F. (2021). *Using satellite images to measure crop productivity: Long-term impact assessment of a randomized technology adoption program in the Dominican Republic* (No. IDB-WP-01234). IDB Working Paper Series.

Samson, K. L., Loh, S. P., Lee, S. S., Sulistyoningrum, D. C., Khor, G. L., Mohd Shariff, Z. B., ... & Karakochuk, C. D. (2021). The Inclusion of Folic Acid in Weekly Iron–Folic Acid Supplements Confers no Additional Benefit on Anemia Reduction in Nonpregnant Women: A Randomized Controlled Trial in Malaysia. *The Journal of nutrition*, *151*(8), 2264-2270

Santaweasuk, S., & Siriwong, W. (2021). The effects of a pesticide application program on improving knowledge and attitude related to pesticide use: A quasi-experimental study among rice farmers in Thailand.

Santoso M.V. et al. A Nutrition-Sensitive Agroecology Intervention in Rural Tanzania Increases Children's Dietary Diversity and Household Food Security But Does Not Change Child Anthropometry: Results from a Cluster-Randomized Trial. *The Journal of Nutrition*. *151*(7), 2010-2021. (2021).

Sarrafadegan, N., Kelishadi, R., Esmailzadeh, A., Mohammadifard, N., Rabiei, K., Roohafza, H., ... & Malekafzali, H. (2009). Do lifestyle interventions work in developing countries? Findings from the Isfahan Healthy Heart Program in the Islamic Republic of Iran. *Bulletin of the World Health Organization*, *87*, 39-50.

Sartorelli, D. S., Crivellenti, L. C., Baroni, N. F., de Andrade Miranda, D. E. G., da Silva Santos, I., Carvalho, M. R., ... & Diez-Garcia, R. W. (2022). Effectiveness of a minimally processed food-based nutritional counselling intervention on weight gain in overweight pregnant women: A randomized controlled trial. *European Journal of Nutrition*, 1-12.

Scopel, E., Affholder, F., Da Silva, F. A. M., Wery, J., & Corbeels, M. (2020). Maize relay intercropping with fodder crops for small-scale farmers in central Brazil. *Experimental Agriculture*, *56*(4), 561-573.

Scott, S., Gupta, S., Menon, P., Raghunathan, K., Thai, G., Quisumbing, A., ... & Kumar, N. (2022). A Quasi-Experimental Evaluation of a Nutrition Behavior Change Intervention Delivered Through Women's Self-Help Groups in Rural India: Impacts on Maternal and Young Child Diets, Anthropometry, and Intermediate Outcomes. *Current Developments in Nutrition*, *6*(6), nzac079.

Seidu, M. M., & Tanko, M. (2022). Maize productivity amidst northern rural growth credit programme in Ghana. *Heliyon*, *8*(9), e10420.

Selamat, R., Raib, J., Aziz, N. A. A., Zulkafly, N., Ismail, A. N., Mohamad, W. N. A. W., ... & Mokhtar, A. H. (2021). Fruit and vegetable intake among overweight and obese school children: A cluster randomised control trial. *Malaysian Journal of Nutrition*, *27*(1).

Shukla, P., Pullabhotla, H. K., & Baylis, K. (2022). Trouble with zero: The limits of subsidizing technology adoption. *Journal of Development Economics*, *158*, 102920.

- Siagian, A., Siagian, A., & Lubis, N. L. (2021). The Influence Of Android-Based Educational Game Media On The Knowledge Of Selecting Food Snacks In Children Basic Schools In Binjai City. *International Journal of Public Health and Clinical Sciences*, 8(1), 30-38.
- Sibanda, L. O. V. E. M. O. R. E., Johnson, P. J., van der Meer, E., Hughes, C., Dlodlo, B., Mathe, L. J., ... & Loveridge, A. J. (2022). Effectiveness of community-based livestock protection strategies: a case study of human–lion conflict mitigation. *Oryx*, 56(4), 537-545.
- Siddiqua, T. J., Roy, A. K., Akhtar, E., Haq, M. A., Wagatsuma, Y., Ekström, E. C., ... & Raqib, R. (2022). Prenatal nutrition supplementation and growth biomarkers in preadolescent Bangladeshi children: A birth cohort study. *Maternal & Child Nutrition*, 18(1), e13266.
- Siegel, K. (2022). *A Good Egg: An Evaluation of a Social Behavior Change Campaign to Increase Egg Consumption Among Children in Rwanda* (Doctoral dissertation, The George Washington University).
- Siswati, T., Iskandar, S., Pramestuti, N., Raharjo, J., Rubaya, A. K., & Wiratama, B. S. (2022). Impact of an Integrative Nutrition Package through Home Visit on Maternal and Children Outcome: Finding from Locus Stunting in Yogyakarta, Indonesia. *Nutrients*, 14(16), 3448.
- Smith, L. C., & Frankenberger, T. R. (2022). Recovering from severe drought in the drylands of Ethiopia: Impact of Comprehensive Resilience Programming. *World Development*, 156, 105829.
- Stark, H., Omer, A., Wereme N'Diaye, A., Sapp, A. C., Moore, E. V., & McKune, S. L. (2021). The Un Oeuf study: Design, methods and baseline data from a cluster randomised controlled trial to increase child egg consumption in Burkina Faso. *Maternal & Child Nutrition*, 17(1), e13069.
- Su, M., Heerink, N., Oosterveer, P., Tan, T., & Feng, S. (2021). Impacts of china's minimum grain procurement price program on agrochemical use: A household-level analysis. *Agriculture*, 11(10), 910.
- Subramanian, A. (2021). Harnessing digital technology to improve agricultural productivity?. *Plos one*, 16(6), e0253377
- Sudfeld, C. R., Bliznashka, L., Salifou, A., Guindo, O., Soumana, I., Akehossi, I., ... & Isanaka, S. (2022). Evaluation of multiple micronutrient supplementation and medium-quantity lipid-based nutrient supplementation in pregnancy on child development in rural Niger: A secondary analysis of a cluster randomized controlled trial. *PLoS Medicine*, 19(5), e1003984.
- Sullivan, J. A., Brown, D. G., Moyo, F., Jain, M., & Agrawal, A. (2022). Impacts of large-scale land acquisitions on smallholder agriculture and livelihoods in Tanzania. *Environmental Research Letters*, 17(8), 084019.

- Šumonja, S., & Jevtić, M. (2021). Impact of the Cross-Curricular Education Program on Food Intake, Physical Activity, and Body Mass Index of School Children in a Local Community in Northern Serbia. *Children*, 8(11), 947.
- Sun, D., Liu, Y., Grant, J., Long, Y., Wang, X., & Xie, C. (2021). Impact of food safety regulations on agricultural trade: Evidence from China's import refusal data. *Food Policy*, 105, 102185.
- Sun, X., Zhu, W., Chen, A., & Yang, G. (2022). Land Certificated Program and Farmland "Stickiness" of Rural Labor: Based on the Perspective of Land Production Function. *Land*, 11(9), 1469.
- Syakur, R., Syam, A., Hadju, V., Palutturi, S., Hadi, A. J., Hafid, R., & Musaidah, M. (2022). The Effect of Pumpkin Seed Biscuits on Nutritional and Zinc Status: A Randomized Controlled Trial in Pregnant Women. *Open Access Macedonian Journal of Medical Sciences*, 10(E), 1161-1168.
- Tambo, J. A., Romney, D., Mugambi, I., Mbugua, F., Bundi, M., Uzayisenga, B., ... & Ndhlovu, M. (2021). Can plant clinics enhance judicious use of pesticides? Evidence from Rwanda and Zambia. *Food Policy*, 101, 102073.
- Taneja, S., Upadhyay, R. P., Chowdhury, R., Kurpad, A. V., Bhardwaj, H., Kumar, T., ... & Bhandari, N. (2022). Impact of supplementation with milk–cereal mix during 6–12 months of age on growth at 12 months: a 3-arm randomized controlled trial in Delhi, India. *The American Journal of Clinical Nutrition*, 115(1), 83-93.
- The Effect of Maternal Dadiah Supplementation During Pregnancy on Child Growth and Gastrointestinal Health Outcomes - Full Text View - ClinicalTrials.gov. (n.d.). <https://clinicaltrials.gov/ct2/show/NCT05140928>
- Theriault, V., Smale, M., & Haider, H. (2018). Economic incentives to use fertilizer on maize under differing agro-ecological conditions in Burkina Faso. *Food Security*, 10, 1263-1277.
- Titaley, C. R., Dibley, M. J., Ariawan, I., Mu'asyaroh, A., Paramashanti, B. A., Alam, A., ... & Fahmida, U. (2022). The impact of a package of behaviour change interventions on breastfeeding practices in East Java Province, Indonesia. *Maternal & Child Nutrition*, 18(3), e13362.
- Todd, J. E., Winters, P. C., & Hertz, T. (2020). Conditional cash transfers and agricultural production: Lessons from the Oportunidades experience in Mexico. In *Migration, Transfers and Economic Decision Making among Agricultural Households* (pp. 39-67). Routledge.
- Tong, L. A., Ulubaşoğlu, M. A., & Guven, C. (2022). Growing more Rice with less water: the System of Rice Intensification and water productivity in Vietnam. *Australian Journal of Agricultural and Resource Economics*, 66(3), 581-611.
- Utami, A., Margawati, A., Pramono, D., Julianti, H. P., Adespin, D. A., & Wulandari, D. R. (2022). The Effectiveness of Iron-folic Acid Supplementation and Education Intervention to Hemoglobin Level, Knowledge, and Compliance among Adolescent Girls in Islamic Boarding School. *Open Access Macedonian Journal of Medical Sciences*, 10(E), 1141-1146.

- Vaiknoras, K., & Larochele, C. (2021). The impact of iron-biofortified bean adoption on bean productivity, consumption, purchases and sales. *World Development*, 139, 105260.
- Vandeveldel, S., Van Campenhout, B., & Walukano, W. (2021). Accounting for spillovers in assessing the effectiveness of video messages to improve potato seed quality: evidence from Uganda. *The Journal of Agricultural Education and Extension*, 27(4), 503-534.
- Vu, H. T., & Goto, D. (2020). Does awareness about land tenure security (LTS) increase investments in agriculture? Evidence from rural households in Vietnam. *Land Use Policy*, 97, 104721.
- Vu, H. T., Tran, D., Goto, D., & Kawata, K. (2020). Does experience sharing affect farmers' pro-environmental behavior? A randomized controlled trial in Vietnam. *World Development*, 136, 105062.
- Wang, X., Liu, J., Gao, D., Li, Y., Ma, Q., Chen, L., ... & Ma, J. (2022). Effectiveness of national multicentric school-based health lifestyles intervention among chinese children and adolescents on knowledge, belief, and practice toward obesity at individual, family and schools' levels. *Frontiers in Pediatrics*, 10.
- Wegmüller, R., Musau, K., Vergari, L., Custer, E., Anyango, H., Donkor, W. E., ... & Rohner, F. (2022). Effectiveness of an integrated agriculture, nutrition-specific, and nutrition-sensitive program on child growth in Western Kenya: a cluster-randomized controlled trial. *The American Journal of Clinical Nutrition*, 116(2), 446-459.
- West, K. P., Christian, P., Labrique, A. B., Rashid, M., Shamim, A. A., Klemm, R. D., ... & Sommer, A. (2011). Effects of vitamin A or beta carotene supplementation on pregnancy-related mortality and infant mortality in rural Bangladesh: a cluster randomized trial. *Jama*, 305(19), 1986-1995.
- Wonde, K. M., Tsehay, A. S., & Lemma, S. E. (2022). Training at farmers training centers and its impact on crop productivity and households' income in Ethiopia: A propensity score matching (PSM) analysis. *Heliyon*, 8(7), e09837.
- Workneh, W. A., Takada, J., & Matsushita, S. (2020). The Impact of Using Small-Scale Irrigation Motor Pumps on Farmers' Household Incomes in Ethiopia: A Quasi-Experimental Approach. *Sustainability*, 12(19), 8142.
- Xie, L., Liao, J., Chen, H., Yan, X., & Hu, X. (2021). Is Futurization the Culprit for the Violent Fluctuation in China's Apple Spot Price?. *Agriculture*, 11(4), 342.
- Yang, R., & Gao, Q. (2021). Water-Saving Irrigation Promotion and Food Security: A Study for China. *Sustainability*, 13(21), 12212.
- Yang, Y., Li, G., Li, F., Xu, F., Hu, P., Xie, Z., ... & Wang, Z. (2022). Impact of DHA from Algal Oil on the Breast Milk DHA Levels of Lactating Women: A Randomized Controlled Trial in China. *Nutrients*, 14(16), 3410.
- Yitayew, A., Abdulai, A., Yigezu, Y. A., Deneke, T. T., & Kassie, G. T. (2021). Impact of agricultural extension services on the adoption of improved wheat variety in Ethiopia: A cluster randomized controlled trial. *World Development*, 146, 105605.

Yıldırım, Ç., Türkten, H., Ceyhan, V., Atış, E., Hasdemir, M., Salalı, H. E., ... & Güngör, F. (2021). Exploring opportunity cost of conversion to eco-friendly farming system: the case of Samsun and Adana provinces of Turkey. *Environment, Development and Sustainability*, 23, 1447-1460.

Young, M. F., Mehta, R. V., Gosdin, L., Kekre, P., Verma, P., Larson, L. M., ... & Martorell, R. (2021). Home Fortification of Complementary Foods Reduces Anemia and Diarrhea among Children Aged 6–18 Months in Bihar, India: A Large-Scale Effectiveness Trial. *The Journal of Nutrition*, 151(7), 1983-1992.

Zhang, Z. Q., Chen, Y. M., Wang, R. Q., Huang, Z. W., Yang, X. G., & Su, Y. X. (2016). The effects of different levels of calcium supplementation on the bone mineral status of postpartum lactating Chinese women: a 12-month randomised, double-blinded, controlled trial. *British Journal of Nutrition*, 115(1), 24-31.

Zhang, Z., Chen, Y. H., & Wu, L. H. (2021). Effects of governmental intervention on foodborne disease events: evidence from China. *International Journal of Environmental Research and Public Health*, 18(24), 13311.

Zhao, C., Ma, L., Gao, L., Wu, Y., Yan, Y., Peng, W., & Wang, Y. (2022). Effectiveness of a multifaceted intervention for the improvement of nutritional status and nutrition knowledge of children in poverty-stricken areas in Shaanxi Province, China. *Global Health Journal*, 6(3), 156-163.

Zhao, M., & Guo, W. (2022). Does Land Certification Stimulate Farmers' Entrepreneurial Enthusiasm? Evidence from Rural China. *Sustainability*, 14(18), 11453.

Zhu, B., Zhang, J., Qiu, L., Binns, C., Shao, J., Zhao, Y., & Zhao, Z. (2015). Breastfeeding rates and growth charts—the Zhejiang Infant Feeding Trial. *International journal of environmental research and public health*, 12(7), 7337-7347.

Newly included systematic reviews

Csölle, I., Felső, R., Szabó, É., Metzendorf, M. I., Schwingshackl, L., Ferenci, T., & Lohner, S. (2022). Health outcomes associated with micronutrient-fortified complementary foods in infants and young children aged 6–23 months: A systematic review and meta-analysis. *The Lancet Child & Adolescent Health*.

Dewidar, O., Saad, A., Baqar, A., John, J. C., Riddle, A., Ota, E., ... & Welch, V. (2021). PROTOCOL: Effectiveness of nutrition counselling for pregnant women in low-and middle-income countries to improve maternal, infant and child behavioural, nutritional and health outcomes: A systematic review. *Campbell Systematic Reviews*, 17(4), e1202.

Hammaker, J., Anda, D., Kozakiewicz, T., Bachina, V., Shisler, S., & Lane, C. (2022). Systematic review on Fiscal Policy Interventions in Nutrition. *Frontiers in Nutrition*, 2823. Available

at:https://www.frontiersin.org/articles/10.3389/fnut.2022.967494/full?utm_source=Email_to_authors&utm_medium=Email&utm_content=T1_11.5e1_author&utm_campaign=Email_publication&field=journalName=Frontiers_in_Nutrition&id=967494

Heuven, L. A., Pyle, S., Greyling, A., Melse-Boonstra, A., & Eilander, A. (2021). Gut microbiota-targeted nutritional interventions improving child growth in low-and middle-income countries: a systematic review. *Current Developments in Nutrition*, 5(11), nzab124.

Leroy, J. L., Koch, B., Roy, S., Gilligan, D., & Ruel, M. (2021). Social assistance programs and birth outcomes: a systematic review and assessment of nutrition and health pathways. *The Journal of Nutrition*, 151(12), 3841-3855.

Nuvey, F. S., Arkoazi, J., Hattendorf, J., Mensah, G. I., Addo, K. K., Fink, G., ... & Bonfoh, B. (2022). Effectiveness and profitability of preventive veterinary interventions in controlling infectious diseases of ruminant livestock in sub-Saharan Africa: a scoping review. *BMC Veterinary Research*, 18(1), 1-19.

Wall, C., Tolar-Peterson, T., Reeder, N., Roberts, M., Reynolds, A., & Rico Mendez, G. (2022). The impact of school meal programs on educational outcomes in African schoolchildren: A systematic review. *International Journal of Environmental Research and Public Health*, 19(6), 3666.

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