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About this report

This report provides a summary of the evidence available on the effects of development cooperation in the area of food and nutrition security. It presents new insights into the findings of the living Food systems and nutrition (FSN) Evidence and Gap Map (EGM) that was initially commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) through Deutsche Gesellschaft für Internationale Zusammenarbeit's (GIZ) "Knowledge for Nutrition" Programme. It also presents a protocol for a Rapid Evidence Assessment (REA) that aims to synthesise and appraise the evidence available on the effects of Information, Capacity Strengthening, and Behaviour Change interventions (ICSBC) on food security, nutrition, and environmental food system resilience in Sub-Sahara Africa. This report was commissioned by the German Institute for Development Evaluation (DEval) in the framework of an evaluation on the effects of development cooperation on food security and nutrition envisaged in its multi-annual evaluation programme 2024-2026.

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Development cooperation in the area of food security and nutrition: Protocol for a Rapid Evidence Assessment on the effects of Information, Capacity Strengthening, and Behaviour Change interventions on food security, nutrition, and environmental food system resilience in Sub-Sahara Africa

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Rapid Evidence Assessment Protocol

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Abstract

Food system and nutrition (FSN) challenges are exacerbated by climate change and environmental risks and crises affecting all the actors of the food system (e.g., food supply, consumer behaviour, and food environment). Due to its high vulnerability to climate change and environmental risks and crises, food security and nutrition in Sub-Saharan Africa are particularly at risk. Information, Capacity Strengthening, and Behaviour Change (ICSBC) interventions are some of the numerous approaches with the potential to enhance food security and nutrition and build food system resilience in environmentally vulnerable and shock-prone settings.

This protocol outlines the methodology for a Rapid Evidence Assessment (REA) aimed at synthesising evidence on the effects of Information, Capacity Strengthening, and Behaviour Change interventions (ICSBC) on food security, nutrition, and environmental food system resilience in Sub-Sahara Africa. This REA can be compared to a Rapid Systematic Review that will leverage data from the Food Systems and Nutrition Evidence and Gap Map (FSN EGM) and will systematically identify and appraise studies that examine the impact of these interventions on food security and nutrition and their relation to food system resilience. This rapid review will include rigorous evidence and utilise a rigorous and systematic mixed-methods synthesis approach to assess intervention effectiveness across diverse contexts and explore factors influencing variability in outcomes.

The findings will provide policy-relevant evidence for designing and implementing FSN interventions, contributing to evidence-informed development strategies. By enhancing understanding of what works in FSN programming, this research seeks to support efforts to mitigate food insecurity and malnutrition, promote sustainable food systems, and inform development cooperation policies in Sub-Saharan African affected by climate change and environmental risks and crises.

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List of Abbreviations

BMZ	German Federal Ministry for Economic Cooperation and Development
CASP	Critical Appraisal Skills Programme
EGM	Evidence and Gap Map
FSN	Food System and Nutrition
GHI	Global Hunger Index
GII	Gender Inequality Index
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HKI	Helen Keller International
ICSBC	Information, Capacity Strengthening, Behaviour Change
IFPRI	International Food Policy Research Institute
ITS	Interrupted Time Series
IV	Instrumental Variable
L&MICs	Low- & Middle-Income Countries
PICOS	Population, Intervention, Comparison, Outcome, Study Design
QEX	Quantitative Data Extraction
REA	Rapid Evidence Assessment
Rob	Risk of Bias
SDG	Sustainable Development Goal
SMS	Short Message Service

1. Introduction

Food security encompasses six key dimensions: availability, access, utilisation, stability, agency, and sustainability (Clapp et al. 2022; Termine 2024; NJ Office of the Food Security Advocate 2024; Mockshell and Nielsen Ritter 2024; HLPE 2020). *Availability* refers to the production and supply of food, while access focuses on individuals' ability to obtain food, influenced by income, prices, and distribution networks. *Utilisation* emphasises proper dietary intake and food safety, ensuring nutritional adequacy. *Stability* underscores the need for reliable food access over time, minimising the impact of shocks such as climate disasters or economic downturns. *Agency* highlights the ability of individuals and communities to make informed decisions about food production and consumption. *Sustainability* ensures that food systems (the complex web of activities involving food production, processing, transport, and consumption) operate within ecological and resource limits to support long-term food security. This concept of food security is connected to the concept of nutrition, which involves the intake, digestion, absorption, metabolism, and utilisation of nutrients essential for energy production, immune function, and disease prevention. Malnutrition specifically refers to the deficiencies, excesses, or imbalances in a person's intake of energy and nutrients (WHO 2024).

Food insecurity and malnutrition remain pressing global challenges. According to the latest estimates from the World Health Organisation (WHO), one in 11 people worldwide faced hunger[1] in 2023 or approximately 733 million people. Despite global food insecurity indicators showing signs of improvement between 2000 and 2010, recent crises, conflicts, and economic disruptions led to a deterioration of those indicators: In 2005, about 793 million people experienced chronic hunger, decreasing to 598 million in 2010 and 589 million in 2015 before increasing to 735 million in 2022. These trends highlight the urgent need for sustainable solutions to improve food security and nutritional outcomes, particularly in regions most vulnerable to these challenges.

In the global context of the food security and nutrition crisis, Sub-Saharan Africa (SSA) is disproportionately affected: recent data indicate a deterioration in food security indicators between 2019 and 2022. In 2022, an estimated 282 million people were undernourished, and 868 million people across Africa suffered from moderate to severe food insecurity, with more than two-thirds of populations in Central, Eastern, and Western Africa experiencing these conditions (FAO, AUC, et al. 2023). In a region where 96% of the food production relies on rain-fed agriculture, climate change and environmental risks and crises are a key driver of the food security crisis and exacerbates food shortages through extreme weather events, rising temperatures, erratic precipitation patterns, and land degradation (Wudil et al. 2022). Food shortages can then cause price increases, disproportionately affecting vulnerable population groups (e.g. women, rural population, children and youth), reducing their access to diverse and nutrition diets and heightening the risk of food insecurity and malnutrition. In order to secure the food and nutritional

[1] FAO defines hunger, an indicator of food insecurity, as "an uncomfortable or painful sensation caused by insufficient consumption of dietary energy that becomes chronic when the person does not consume a sufficient amount of calories on a regular basis to live a normal, active and healthy life". Chronic hunger designates the lack of sufficient amount of calories on a regular basis (FAO 2024).

needs of the Sub-Saharan African population, capacity needs to be strengthened to anticipate, absorb, and adapt to climate change and environmental stressors and to ultimately strengthen the food system's resilience (Ensor 2023).

In the face of vulnerability to climate change and environmental risks and shocks in Sub-Saharan Africa, Information, Capacity Strengthening, and Behaviour Change (ICSBC) interventions have the potential to play a significant role in enhancing food security and nutrition (FAO 2022). These interventions equip the stakeholders of the food system with the necessary knowledge, skills, and resources to adapt to climate change and environmental risks and crises (FAO 2022). Nonetheless, despite their potential for improving food security and nutrition, no recent rigorous synthesis has analysed the effects of ICSBC interventions in Sub-Saharan Africa.

Our Rapid Evidence Assessment (REA) can be compared to a Rapid Systematic Review and complies with the best practices of systematic review while building on the existing 3ie FSN EGM to rigorously fill this evidence synthesis gap by answering the following research questions:

- What are the effects of Information, Capacity Strengthening, and Behaviour Change (ICSBC) interventions on food and nutrition security outcomes in Sub-Saharan Africa?
- How do these interventions enhance the resilience of African food systems against climate change and environmental risks and crises?
- Do effects systematically vary by moderators such as context, intervention features, group vulnerability, or others?

To address these questions, our rigorous and systematic mixed-method REA will synthesise the evidence available in 3ie's living Food Systems and Nutrition (FSN) Evidence and Gap Map (EGM). This approach will systematically assess relevant studies to provide timely and rigorous evidence on the effects of ICSBC interventions following the best practices of systematic reviews.

Our protocol outlines our methodology for the REA. Our background section presents the key concepts and relevance of our study and presents the characteristics and relevance of the analysis of Information, Capacity Strengthening, and Behaviour change interventions in SSA. Our methodology section presents the approach for selecting, extracting, and analysing the data of our REA.

2. Background

In this section, we provide the definition of the core concepts and an overview of the current trends and indicators of food security and nutrition in Sub-Saharan. We then highlight the potential of Information, Capacity Strengthening and Behaviour Change (ICSBC) intervention in addressing some of the key challenges of the Sub-Saharan Africa food systems. We finally present the current evidence synthesis gap on the effect of these interventions and the opportunity it raises for evidence synthesis to inform policy, intervention design and research.

2.1 The problem, condition, or issue

2.1.1 Definition of key concepts

Food security

According to the FAO definition, “food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meet their dietary needs and food preferences for an active and healthy life” (FAO 1996). Our review’s definition applies the six-dimensional food security framework proposed by Clapp et al. (2022) and building on the 2020 report of the High-Level Panel of Experts on Food Security and Nutrition (HLPE) that highlights the core pillars of food security (Clapp et al. 2022; Termine 2024; NJ Office of the Food Security Advocate 2024; Mockshell and Nielsen Ritter 2024; HLPE 2020):

- *Availability*: the physical presence of food. This refers to individuals having enough quantity, sufficient quality, and nutritional food physically present in a person’s environment.
- *Access*: the resources and means to obtain food. It refers to the economic and physical resources and means needed to obtain appropriate and nutritious food without compromising satisfactory access to other basic needs.
- *Utilisation*: the intake of sufficient and safe food. This refers to the intake of sufficient, adequate, and safe food to meet nutritional needs. This includes both the knowledge, skills, and confidence in accessing, preparing, and consuming food and the proper consumption of nutrition essentials for energy production, immune function, and disease prevention.
- *Stability*: reliable supply of food over time. This refers to maintaining adequacy in food availability, access, and utilisation over time and the ability to maintain these dimensions in the face of risks and crises.
- *Agency*: the power to make decisions about food eaten and produced. It refers to the capacity to make decisions and take actions to shape individuals' or communities' relationships with food and food systems. This includes making choices about what to eat, what to produce, and how to produce, process, or distribute it.
- *Sustainability*: the food system’s ability to provide long-term food security. This refers to food system practices that contribute to the long-term regeneration of natural, social, and economic systems, ensuring the ability to meet long-term food needs.

Nutrition

Nutrition examines how nutrients and other food-based substances interact with the body to support growth, reproduction, health, disease prevention and support essential body functions. Among others, it encompasses the processes of food intake, absorption, assimilation, biosynthesis, catabolism, and excretion, which is defined as the process by which organisms physiologically absorb and utilise food to ensure growth, energy, and immune function (Alex 2020; Pilipenko 2023; Krause et al. 2016). Alternatively, WHO defines malnutrition as “deficiencies, excesses, or imbalances in a person’s intake of energy or nutrients” and categorises it under three categories (WHO 2024):

- Undernutrition: wasting (low weight for height), stunting (low height for age) and underweight (low weight for age)
- Micronutrient-related malnutrition: micronutrient deficiencies or excess
- Overweight, obesity and diet-related non-communicable diseases

Food system
According to the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (HPLE 2017, p.23), the food system "gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the output of these activities including socio-economic and environmental outcomes".

The HLPE also structures the food systems under three main constituents (HLPE 2017; 2020):

- *The food supply chain* domain covers activities targeting the entire process from production through consumption and waste management.
- *The food environment* domain examines how consumers interact with the food system, influencing dietary preferences, choices, and nutritional status within various physical, economic, political, and socio-cultural contexts.
- *The consumer behaviour* domain involves activities shaping individual preferences regarding food consumption, household food allocation, food prices, and available food income.

Resilience
We apply a definition of resilience that builds on multiple sources of literature that broadly define it as the capacity of systems and their actors to prepare for, absorb, adapt to, and recover from shocks and stressors while maintaining long-term functionality and sustainability (Constas, Frankenberger, and Hoddinott 2014; Berretta et al. 2023; OECD 2014).

Our REA will follow the definition of the German Federal Ministry for Economic Cooperation and Development (BMZ), which defines resilience as the capacity of people and local structures to withstand the impact and consequences of crises (BMZ 2021; Abbentheren and Weigartner 2019). It encompasses four key elements: the ability to cope with crises independently, prepare for recurring stresses, mitigate negative effects, and gradually overcome crises through structural changes.

This approach emphasises promoting participation and self-help to strengthen the development capacity of individuals and structures, ensuring sustainability and adaptability over time. It is categorised into four principal capabilities:

1. Stabilisation Capacities: enabling people and systems to meet basic needs during and after crises, maintaining functionality and ensuring survival.
2. Adaptation Capacities: empowering people and structures to adapt to long-term changes, cope with negative impacts, and minimise their effects.
3. Transformation Capacities: addressing the root causes of problems and promoting structural changes to ensure sustainable livelihoods.
4. Anticipation Capacities: enabling people and systems to be better prepared for the eventuality of a specific shock through proactive action. This includes the ability to plan, set up contingency plans, and to improve preparedness.

Food system resilience
Food system resilience refers to the capacity of food systems and their actors to anticipate, absorb, adapt to, and recover from stressors while ensuring stable food

security and nutrition (Ensor, 2023). It focuses on maintaining food security, supply chain stability, equitable access, and participation of all food system actors during crises such as climate change, pandemics, or economic disruptions (BMZ 2021; Tendall et al. 2015).

2.1.2 The issue: the impact of climate change and environmental crises on food security and nutrition in Sub-Saharan Africa

The global food security and nutrition crisis

Hunger and malnutrition remain critical global health challenges and significant barriers to sustainable development. Despite progress in combating food insecurity, large portions of the global population, particularly in Low and Middle-Income Countries (L&MICs), continue to struggle with access to a diverse, adequate, and healthy diet. Following a decade of improvement of food security and nutrition indicators between 2000 and 2010, the latest reports from the Food and Agriculture Organisation of the United Nations (FAO; FAO et al. 2024) highlight that the number of people affected by moderate to severe food insecurity in L&MICs rose from 25.0 per cent in 2019 to 28.9 per cent in 2023, affecting over 2 billion people (FAO, IFAD, et al. 2023).

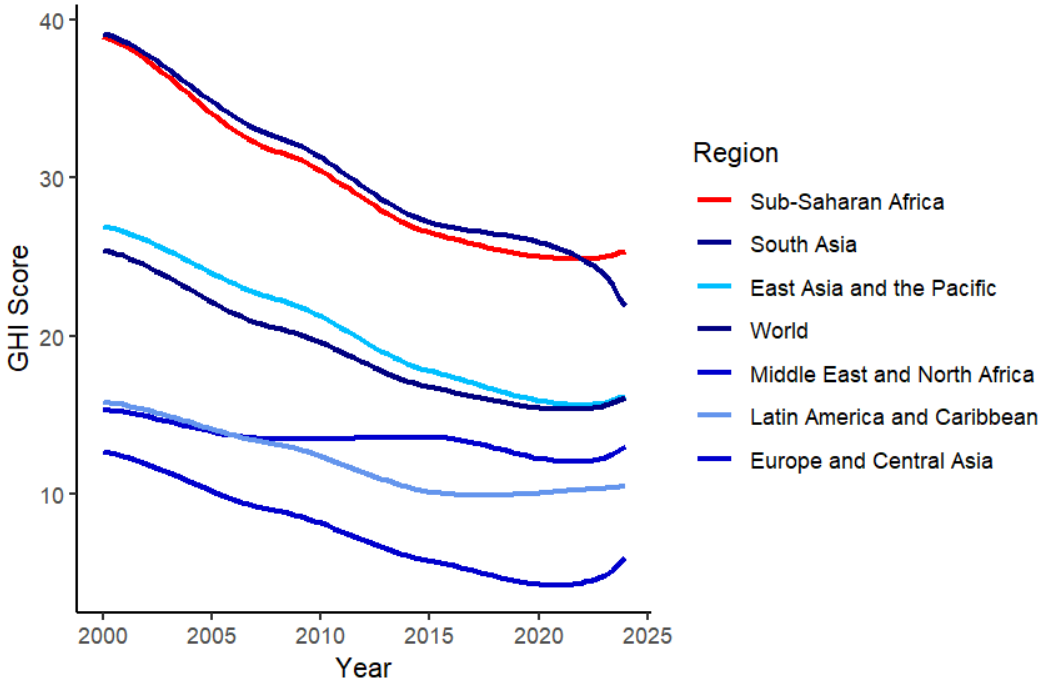
In 2021, global Official Development Assistance (ODA) and Other Official Flows (OOF) in food security and nutrition represented USD 76 billion (FAO et al. 2024). Despite these investments, the world is not on track to meet the Sustainable Development Goal (SDG) 2 and its target of ending hunger by achieving food security, improving nutrition and promoting sustainable agriculture by 2030. Progress towards this goal has been severely hampered by the combined effects of the COVID-19 pandemic, conflict, climate change, and economic downturn (UNDESA 2023). To achieve this goal, FAO estimates that an additional USD 176 billion in investment is required, representing an increase of 131.58% over current funding levels (FAO et al. 2024). Some estimates suggest that achieving this goal will need considerably more additional funding, in the order of USD 3,799 billion or more than 2,100%, by 2030 (FAO et al. 2024).

The disproportionate impact of the food security and nutrition crisis in Sub-Saharan Africa

In this global food security and nutrition crisis, Sub-Saharan Africa (SSA) appears as a particularly vulnerable region. SSA remains one of the most food-insecure regions globally, with the highest average Global Hunger Index[2] (GHI) scores in the 21st century and the highest current GHI score of 25.33 (almost 10 points above the world average score.(Figure 1). While some progress was made between 2000 and 2010, hunger has worsened significantly, particularly between 2019 and 2022. In 2022, 282 million people in Africa were undernourished, and 868 million faced moderate or severe food insecurity, with over 342 million experiencing severe food insecurity. Malnutrition remains widespread, with 30% of children under five stunted and high levels of wasting observed in most subregions except Southern Africa. Meanwhile, anaemia among adult women is above the global average, especially in Western and Central Africa. These alarming trends highlight the urgent need for comprehensive interventions to improve food security, nutrition, and resilience across the region (FAO et al. 2023).

[2] The GHI measures and tracks hunger globally as well as by region. It is calculated through four indicators: undernourishment, child stunting, child wasting, and child mortality. The lower the score, the better the situation. For more information: https://www.globalhungerindex.org/

Figure 1: Trends in Global Hunger Index Score 2000-2024, by region



The analysis of food security and nutrition in SSA shows some intra-continental disparities (WFP 2024):

- Eastern Africa is grappling with crises driven by conflict, displacement, and climate shocks, leaving nearly 62 million people acutely food insecure and 834,000 facing famine — accounting for 40% of the global population experiencing famine.
- Southern and Central Africa[3] are similarly impacted by climatic shocks, conflict, disease outbreaks, and economic challenges, pushing 55 million people into acute food insecurity. In 2024, the region was particularly affected by an El Niño-induced drought, prompting Lesotho, Malawi, Namibia, Zambia, and Zimbabwe to declare national drought disasters.
- Western Africa faces mounting food insecurity, with 57 million people affected, primarily due to economic instability, conflict, and climate change threats. While conflict remains the dominant driver of food insecurity, building long-term resilience to climate and other shocks is a pressing priority for the region.

The food security and nutrition indicators in Sub-Saharan Africa confirm that the region is off track to meet 2030 Sustainable Development Goal 2 and the Malabo targets of the African Union (AU) of ending hunger and malnutrition by 2025[4]. To achieve these goals,

[3] Data is based on WFP regions, including Southern and most of Central Africa countries in one region, with the exception of Chad and the Central African Republic (usually categorised as Central Africa), which are included in WFP's Western Africa region.

[4] The Malabo Declaration, adopted by the African Union in 2014, set out agricultural development goals known as the Malabo targets. They aim to transform Africa's agriculture for inclusive growth, food security, nutrition and sustainable development by 2025. Key targets include doubling agricultural productivity, halving poverty through agriculture, ending hunger, boosting intra-African trade in agricultural commodities, and enhancing resilience to climate variability among others.

the FAO has identified four regional priorities: sustainable agrifood production systems, efficient and equitable food and nutrition systems, climate action and sustainable natural resources management, and building resilience and ending poverty (FAO 2025). In addition, the World Food Programme in Sub-Saharan Africa foresees an operational requirement for 2025 of up to 9 billion USD to address the region's pressing food security needs (including 3.9 billion USD in Eastern Africa, 2.7 billion USD in Western Africa, and 1.8 billion USD in Southern and Central Africa; WFP 2024).

Climate change and environmental risks and crises: a core driver of food insecurity and malnutrition crisis in Sub-Saharan Africa

When analysing the main drivers of food insecurity and malnutrition in Sub-Saharan Africa, climate change (the long-term shifts in temperatures and weather patterns) and environmental risks and crises appear as one of the most significant. African food systems are particularly vulnerable to climate extremes and shifts in weather patterns due to their high dependence on rainfed agriculture and pastoralism (Global Centre on Adaptation 2022). In addition, future warming may affect food systems by shortening growing seasons, affecting yields and productivity, increasing water stress, threatening livestock production, and affecting marine and freshwater fisheries (Intergovernmental Panel On Climate Change 2023).

The region has also been substantially impacted by climate change and environmental crises (e.g., East Africa's 2023 Locust Swarm, West Africa’s 2013 Ebola outbreak, the 2019 Tanzania earthquake, the 2019 Idai cyclone in Mozambique, Zimbabwe, and Malawi, etc.), which are projected to increase in severity and frequency. In 2022, over 54 million people were affected by droughts or floods in Sub-Saharan Africa, some of the most prevalent climate-related risks in the region (Global Centre on Adaptation 2022).

By exacerbating vulnerability in the food system through its impact on all the pillars of food security, climate change and environmental risks and crises are a core driver of risks and crises in the region and acts as a threat multiplier (Mbow et al. 2020; Ingram, Ericksen, and Liverman 2012; Ogwuche, Christopher, and Muhammed 2018; Gitz et al. 2016; Olayide and Alabi 2018; Asuamah Yeboah 2024; Assan 2023; Hertel et al. 2023; OECD 2023; Stehfest et al. 2019; Schmitz et al. 2014; Nelson et al. 2016; 2018; Springmann et al. 2016; Table 1):

Table 1: The impact of environmental vulnerability on food security pillars

Food security pillars	Environmental vulnerability impact
Availability	• Altered rainfall patterns, increasing temperatures, and extreme weather events may impact agricultural yields • Climate may affect food stock and spoilage in the absence of reliable storage and distribution processes • Water scarcity and soil degradation may further compromise agricultural productivity
Access	• Extreme weather may lead to price volatility (particularly affecting low-income households) and reduce purchasing power • Food producers may also be affected by lower income due to the impact of climate change on food production

Food security pillars	Environmental vulnerability impact
Utilisation	• Climate change may affect the nutritional quality of food • Elevated CO2 may reduce protein, iron, and zinc concentrations in staple crops • Disruption in the food supply chain may lead to lower food safety standards and increased risk of contamination • Disruption in the production system may lead to a shortage of some food resources, reducing dietary diversity
Stability	• Climate shocks may disrupt production and distribution systems • Prolonged crises may lead to resource scarcity or generate cyclical food crises
Agency	• Climate change disproportionately affects marginalised populations (e.g. women, smallholder farmers, rural groups), limiting their agency across the food system
Sustainability	• Unsustainable agricultural practices may contribute to environmental degradation, deforestation, and biodiversity loss • Overreliance on monoculture farming, soil depletion, and water resources depletion may further threaten the long-term sustainability of food systems

2.1.3 A solution: Building the capacities of food system actors to strengthen food system resilience to climate change and environmental risks and crises in Sub-Saharan Africa

Building resilient food systems in SSA to withstand shocks such as climate change and environmental risks and crises is essential for mitigating its impacts and ensuring food security and nutrition. The literature on food system resilience highlights several strategies, including diversifying crop and livestock populations, developing and adopting climate-resilient crop varieties, implementing sustainable agricultural practices, improving resource management, investing in agricultural infrastructure, fostering local engagement, and enacting policy reforms (Mekonnen, Jalata, and Onyeaka 2024; Braimoh 2020).

Various interventions within the food system may contribute to improved food security and nutrition by improving food availability, access, utilisation, stability, agency and sustainability. The High-Level Panel of Experts on Food Security and Nutrition (HLPE 2017; 2020) highlighted the three entry points to the food system interventions targeting food security and nutrition: the food supply chain, the food environment, and consumer behaviour. The International Initiative for Impact Evaluation's (3ie) living Food System and Nutrition (FSN) Evidence Gap Map (EGM) mapped the interventions covered by those entry points to identify their effect on food security and nutrition outcomes (Moore et al. 2021; see Appendix A for more information about the FSN EGM):

- The *food supply chain* domain covers activities starting with production and subsequent activities leading to consumption (e.g., production, storage, distribution, processing, packaging, retailing, market, etc.). Intervention under the food supply chain targets the production systems to contribute to better water access, improved seed varieties, fertilisers, and livestock support, along with

capacity-strengthening programmes to enhance farming techniques. Distribution and storage initiatives focus on improving transportation, storage structures, and cold chain systems. Processing and packaging interventions ensure food preservation and quality, while food loss and waste management include programmes for donation, repurposing spoiled food, and composting.

- The *food environment* domain covers the physical, economic, and socio-cultural context where food is acquired, prepared, or consumed, as well as the norms that underlie the relations in the food system. Strategies like food subsidies, direct food provision, and cash transfers are implemented to improve food availability and affordability. Promotion and labelling regulations, along with food safety standards, encourage healthier food choices, while empowerment programmes target enhanced decision-making in food production and consumption.
- The *consumer behaviour* domain covers consumers' choices regarding how to acquire, store, prepare, or eat food. Interventions include information and behaviour change communication through peer support, professional services, community meetings, and campaigns that foster healthy eating habits and improved practices, all of which collectively support food security and nutrition.

The successful implementation of food system resilience interventions and strategies depends on the ability of food system actors to effectively utilise resources, adopt new practices, and implement processes that enhance resilience to climate change and environmental risks and crises. Targeted capacity-strengthening programmes, training initiatives, knowledge exchange platforms, and community empowerment with sustainable practices are crucial for improving food security and nutrition in SSA. Strengthening the capacities of food system actors has the potential to increase productivity, enhance human resource capabilities, reinforce collaboration, and promote sustainable practices (Tendall et al. 2015; Constas et al. 2021; OECD 2020; Ingram et al. 2023; Mekonnen, Jalata, and Onyeaka 2024).

2.2 The interventions

Our review will focus on a specific subset of interventions of the FSN EGM: the effects of Information, Capacity Strengthening, and Behaviour Change (ICSBC) interventions on food security and nutrition outcomes in Sub-Saharan Africa. By drawing on the latest update of the 3ie living FSN EGM (Storhaug et al. 2024), the rich body of rigorous primary evidence available on ICSBC (Murphy et al. 2024), and focusing on food systems' resilience to climate change and environmental risks and crises, our research will contribute to the synthesis of evidence on the role of these interventions in strengthening food security and nutrition.

2.2.1 Increasing food system resilience through Information, Capacity Strengthening, and Behaviour change interventions

Our definition of ICSBC interventions draws on FAO's definition as "an interactive process with the community to develop tailored messages and approaches using a variety of communication channels to develop positive behaviours, promote and sustain individual, community, and societal behaviour change, and maintain appropriate behaviours" (FAO 2022; p.vii). ICSBC interventions target farmers, community resources, agricultural extension officers, public officials, and consumers to train and sensitise them to produce and consume nutritious, diverse, sufficient, and quality food

(FAO, 2022), ultimately contributing to food security and nutrition. This training and sensitisation process includes a range of interventions under the three domains of the food system (HLPE 2017; 2020):

- The food supply chain ICSBC interventions include interventions targeting farmers and food producers through the provision of information and guidance (e.g., SMS-based information, online or application-based information provision), agricultural extension services (e.g., training, cooperative organisation, support services), farmer field schools, or other information channels (e.g., certification schemes, discussion groups, media-driven information systems).
- The food environment ICSBC interventions include interventions targeting the other actors of the food system to provide guidance, information and skills on the availability of food resources, promotion, and labelling, or quality and safety of food resources through storage and distribution, waste or spoiled food management, composting, processing marketing campaigns or counselling.
- The consumer behaviour ICSBC interventions include interventions targeting food consumers to inform them about good practices, build their nutrition knowledge and skills, or share information through classes, peer support, counselling, community meetings, professional services and advice, marketing, or door-to-door campaigns.

ICSBC interventions have the potential to increase food system resilience by equipping food system actors with the technical resources and capacities they need to cope with climate change and environmental risks and shocks. As highlighted by FAO, the promotion of behaviour change through nutrition capacity strengthening and information within a supportive environment can contribute to the sustainable production and use of resources and strengthen food security and nutrition (FAO 2013). By enhancing the adaptive and transformative capacities of food system actors, ICSBC interventions may contribute not only to recovering from food system shocks but also to implementing structural transformations to withstand future challenges better (Ingram et al. 2023; Meyer 2020; Doherty et al. 2023). The body of evidence of the living FSN EGM highlights a number of potential effects of ICSBC interventions across the six pillars of food security (Table 2).

Table 2: The potential effects of ICSBC intervention food security pillars

Food security pillars	Examples of potential effects
Availability	• Acquisition of new skills and knowledge may lead to increased agricultural productivity and efficiency • Adoption of climate-smart agriculture (e.g., drought-resistant crops, agroforestry) reduces vulnerability to climate-related risks and enhances production stability • Improved post-harvest handling, storage, and distribution techniques may help reduce food loss and waste, increasing the quantity of food available • Strengthening extension services and knowledge-sharing platforms could improve farmers' access to inputs and innovative farming techniques.

Food security pillars	Examples of potential effects
Access	• Increased farm productivity may lead to higher household incomes, which could improve purchasing power and access to diverse foods • Strengthened local markets and value chains could improve smallholder farmers' market access, potentially stabilising food prices and improving affordability • Access to information may enable households to make more informed food-purchasing decisions
Utilisation	• Nutrition information and knowledge may improve food preparation, storage, and consumption practices, potentially reducing foodborne illnesses and malnutrition • Awareness campaigns on dietary diversity could encourage the consumption of locally available, nutrient-rich foods, possibly improving overall diet quality • Increased availability and access may lead to a reduction of malnutrition (particularly among vulnerable population groups)
Stability	• Diversification of production systems (e.g., integrating livestock, crops, and fisheries) may enhance resilience to market and climate shocks • Improved practices for storage or distribution may improve the producer's and consumer’s ability to respond to shocks • Adaptive risk management training (e.g., crop insurance, early warning systems) may enhance food system stability by improving preparedness for disruptions
Agency	• Increased knowledge and skills may increase the demand for climate-resilience food production practices • Participation in cooperatives and advocacy groups could strengthen farmers’ bargaining power and influence over policies • Vulnerable groups provided with additional skills and knowledge may increase their participation and influence in decision-making processes within the household or community
Sustainability	• Increased awareness of sustainable agricultural practices (e.g., agroecology, regenerative farming) may promote environmentally friendly production methods • Consumer capacity strengthening on sustainable diets and responsible sourcing may drive demand for more environmentally sustainable food choices. • Increased capacities, motivation and opportunities of food system actors may increase the demand for policy and governance support towards sustainable food systems

2.3 Expected theory of change

2.3.1 Overarching principles

Our Theory of Change (ToC) for ICSBC interventions on food security and nutrition outcomes in Sub-Saharan Africa builds directly on the FSN EGM ToC, incorporating its core principles and multi-layered approach while tailoring it to the specifics of ICSBC interventions (Figure **2**):

1. The food system is situated within a contextual setting that includes a series of drivers that enable, alter, or influence its functionality (Nguyen 2018; HLPE 2017).
2. This food system encompasses the interactions among all system actors (e.g., farmers, consumers, firms, and institutions) in a dynamic and complex network (Nguyen 2018; HLPE 2017). Through this holistic approach, and in alignment with international priorities, our theory of change emphasises the importance of linking the actors of the food supply chain, food environment and consumer behaviour. This linkage is essential for analysing their combined effects on food security and nutrition outcomes and for building resilient food systems (WFP 2022).
3. Within this food system, ICSBC interventions have the potential to enhance food security and nutrition by enhancing knowledge, attitudes, and behaviours related to food and nutrition among target groups (FAO 2022). These changes in knowledge, attitudes, and behaviours will then act as leverage towards the six pillars of food security (availability, access, utilisation, stability, agency, and sustainability).

2.3.2 Pathways to change

As discussed in the previous section, climate change and environmental crises are a critical biophysical and environmental driver that shapes the food system's functionality (HLPE 2017). In response to the challenges posed by environmental changes, ICSBC interventions may employ three key pathways to improve food security and nutrition outcomes: the food supply pathway, the food environment pathway, and the consumer behaviour pathway. Building on Michie et al. (2011) *Behaviour Change Wheel*, each pathway follows a similar mechanism — empowering food system actors with opportunities (the norms and enabling environment that influences the change of practices), capabilities (the ability to perform the change of practices), and motivation (the deliberative process to enact the change of practices), ultimately leading to longer-term behavioural change (Watson et al. 2023; FAO 2022):

- The *Food Supply Pathway* focuses on interventions targeting food producers through agricultural extension programmes, farmer field schools, training, and capacity-strengthening initiatives. These interventions aim to build knowledge and skills on climate-resilient food practices while fostering the motivation and opportunities needed to adopt them. As food producers integrate these practices, they enhance their capacity to meet the food demands emerging within the system and directly contribute to improving food availability, access, stability, agency, and sustainability.
- The *Food Environment Pathway* targets actors involved in food storage, distribution, packaging, labelling, and resource management. Capacity-strengthening programmes equip these actors with the necessary skills and knowledge to improve food handling, preservation, and promotion. In addition, these interventions create opportunities and incentives for adopting improved food environment practices, ultimately leading to more efficient food storage,

distribution, and processing. This pathway directly contributes to improving food availability, access, stability, and sustainability.

- The *Consumer Behaviour Pathway* focuses on food consumers, employing interventions such as capacity-strengthening programmes, peer support initiatives, professional services, and awareness campaigns. These interventions enhance knowledge of food provision, preparation, and consumption while fostering positive attitudes and behaviours. As a result, consumers are better equipped and more motivated to adopt healthier and more sustainable food practices and increase their demand for such practices across the food system. This pathway thus directly contributes to improving food access, utilisation, agency, and sustainability.

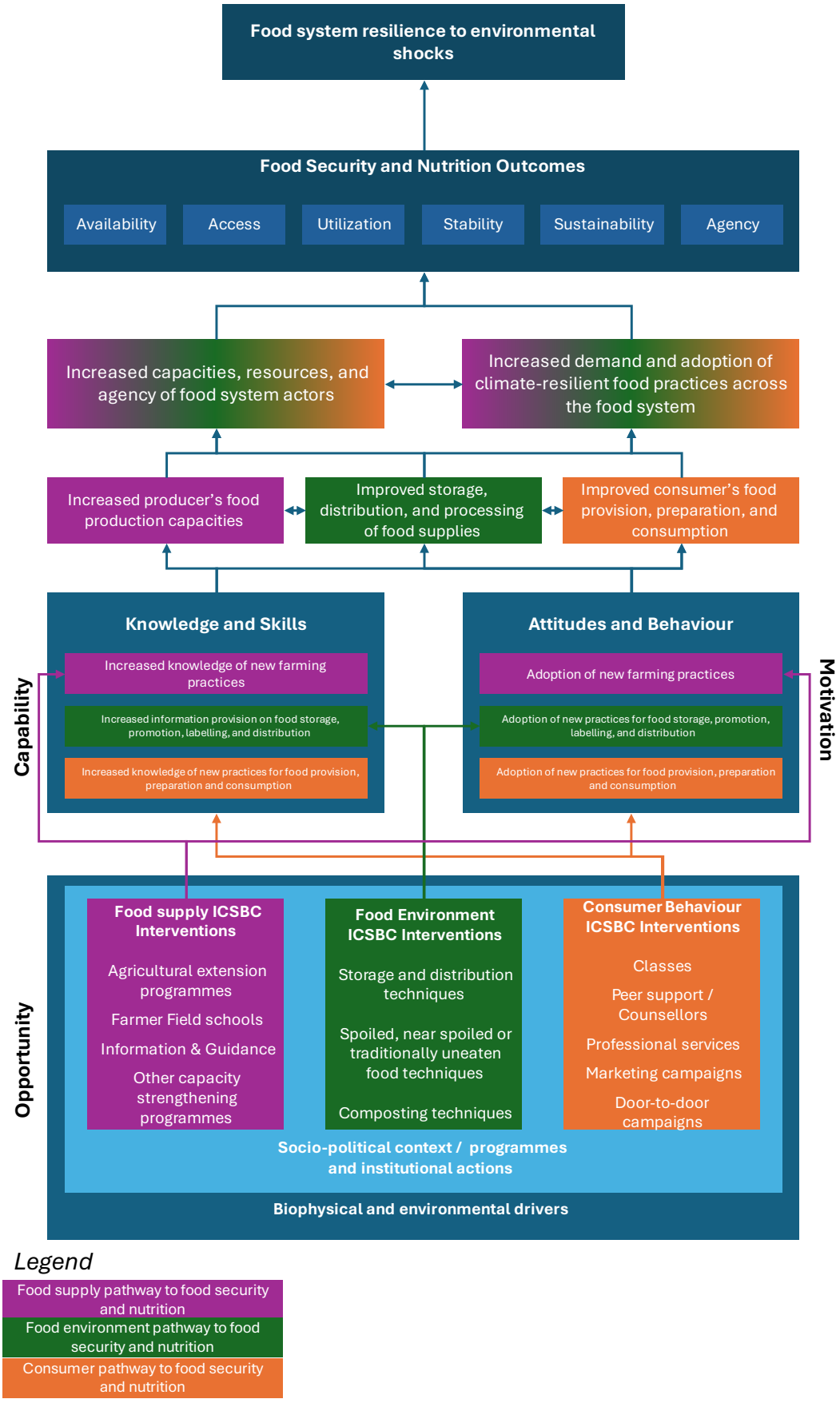
It is through the combination of the effects of interventions across the three pathways that ICSBC interventions may lead to improved food security and nutrition outcomes. This is enabled by the complementarity and interconnection of the three pathways leading to increased capacities, resources, and agency of all actors of the food system and the increased demand and adoption of climate-resilient food practices by those same actors. By building the capacities of the actors and changing their behaviour towards climate-resilient food practices, ICSBC can then be an enabler of change across the six pillars of food security.

2.3.3 Assumptions

To ensure the clarity and coherence of our ToC, we highlight some assumptions affecting the pathway to impact:

- Climate change risks and shocks: Our ToC assumes that climate change risks and shocks will continue to pose significant threats to food systems in Sub-Saharan Africa and that the food system is sufficiently flexible to integrate environmental resilience measures, allowing the system to better withstand and recover from environmental shocks over time.
- Interventions: Our ToC assumes that ICSBC interventions will have the necessary financial and technical capacity and resources to implement interventions at a scale allowing to influence food security and nutrition outcomes by improving knowledge, attitudes, and practices at various levels (e.g., farmers, processors, consumers). Similarly, it assumes the scalability and adaptability of the interventions to the respective contexts of interventions.
- Pathways: Our ToC assumes that food systems actors' enhanced capabilities will lead to increased productivity across the food system domains and contribute to an increase in income and other economic resources. This potential increase in economic resources could also be used to provide food resources.
- Stakeholders and resources: The ToC assumes that the involvement of local stakeholders, such as communities, governments, and the private sector, will be supportive of the implementation of the intervention. In addition, it assumes that sufficient local technical expertise, training materials, and knowledge dissemination channels will be available to support the delivery of the interventions effectively.

Figure 2: Theory of change of ICSBC interventions in environmentally vulnerable and shock-prone settings in Sub-Saharan Africa



2.4 Rationale for the review

The evidence base collated in the 3ie living FSN EGM (Moore et al. 2021) includes 1,838 impact evaluations and 178 systematic reviews across the three domains of the food system[5]: the food supply chain, food environment, and consumer behaviour. The review of this evidence base allows us to identify both an evidence synthesis gap on ICSBC interventions in SSA and the availability of primary evidence to fill this evidence synthesis gap (more information about the scope of the FSN EGM is available in Appendix A). The goal of our REA will be to contribute to expanding the evidence synthesis base on this topic to inform research, policy and intervention designs on *what works.*

2.4.1 Review of existing literature: an evidence synthesis gap on ICSBC interventions in Sub-Saharan Africa

The review of existing evidence in the FSN EGM highlights a small and ageing body of high-confidence[6] evidence synthesis on ICSBC interventions on food security and nutrition outcomes, and food system resilience. This gap calls for additional and updated evidence synthesis. Out of the 53 high-confidence systematic reviews of FSN EGM's evidence base focusing on L&MICs, only 10 analysed the effects of an aspect of ICSBC interventions (Waddington et al. 2014; Oya et al. 2017; Ota et al. 2015; Jolly et al. 2012; Curran and MacLehose 2006; Visser et al. 2020; Dewidar et al. 2023; Menon et al. 2018; Stewart et al. 2015; Watson et al. 2023). For example, Waddington et al. (2014) analysed the effects of farmer field schools on farming practices and farmer outcomes and highlighted their beneficial effects in improving intermediate outcomes related to knowledge and adoption of practices as well as farmer incomes. Dewidar et al. (2023) focused on the effects of setting, intensity, and timing of peer support on breastfeeding practices and observed the statistically significant and positive effect of peer support intervention in L&MICs.

We observe similar levels of evidence synthesis gaps when specifically focusing on Sub-Saharan Africa ICSBC high-confidence evidence synthesis. The evidence base for the FSN EGM indicates only two high-confidence reviews focusing on the effects of ICSBC interventions in Sub-Saharan Africa. None of them cover all types of ICSBC interventions. Similarly, they do not integrate a focus on food system resilience in environmentally vulnerable and shock-prone settings:

- Watson et al. (2023) focused on behaviour change interventions, including both agricultural and nutritional capacity-strengthening initiatives aimed at improving maternal and child nutrition in Sub-Saharan Africa. The findings were mostly inconclusive. However, for many interventions that included behaviour change theory, there were significant improvements in infant stunting, wasting, household dietary intake, and maternal psychosocial measures. Interventions that included more than two behaviour change functions were the most effective overall.

[5] Six updates have been undertaken since the initial map was published in 2021. More information about the FSN EGM is available on the project page: https://www.3ieimpact.org/research/food-systems-and-nutrition-evidence-and-gap-map

[6] The confidence rating is based on 3ie's evidence synthesis critical appraisal tool that assesses the rigour of the methods used to identify, include and critically appraise studies, the methods used to analyse the findings, and the overall reliability of the review. More information is available at: https://www.3ieimpact.org/sites/default/files/2019-04/quality-appraisal-checklist-srdatabase.pdf

Although this review does not focus on a similar set of outcomes to ours, we will build on its framework for the analysis of behaviour change functions and their effect on food security, nutrition and food system resilience.

- Stewart et al. (2015) focused on training programmes for farmers on new products and farming techniques and their effects on food security and economic outcomes. They notably observed the promising effect of agricultural input innovations on food security but did not observe a statistically significant effect of training interventions on farming households' income. Nonetheless, the ageing publication of this review calls for updated research using newly provided evidence.

Other reviews with lower confidence levels or other regional focus may complement the findings of these two reviews. For example, a review by Nugent et al. (2021) found that multi-component behaviour change interventions had the largest impact, particularly among high-risk populations such as individuals with non-communicable diseases (NCDs) or clinically measured risk factors. Messaging and information campaigns also showed positive outcomes, although evidence from L&MICs remains sparse and concentrated in a few countries, including China, Mexico, Iran, and India. Litvin et al. (2024) examined social and behavioural change interventions targeting women's dietary practices in L&MICs. These interventions often sought to shift harmful norms or build positive ones, acknowledging the role of family and community power structures. To address these dynamics, interventions frequently engaged participants alongside influencers and reference groups. However, inconsistencies emerged in how social norms were tackled, with many interventions lacking clear theories or pathways of change. The review also found that health messages and nutrition knowledge alone were insufficient to alter behaviour without the support of additional activities.

The FSN EGM evidence base does not include any synthesis of the ICSBC intervention's effectiveness with a specific focus on resilience in SSA. Some evidence syntheses cover aspects of food systems resilience in SSA and other contexts and may inform our approach but do not meet the inclusion criteria for the FSN EGM[7]. Additionally, none of them provides a rigorous evidence synthesis of the effectiveness of interventions on food security and nutrition outcomes and on SSA food system resilience:

[7] Systematic effectiveness reviews were included if they described the search, data collection, and synthesis methods according to the 3ie database of systematic reviews protocols (Snilstveit et al. 2016). Any evidence reviews, such as literature reviews that did not adopt these methods were excluded. Systematic reviews that were not effectiveness reviews (i.e., those which did not aim to synthesise the evidence of the effects of a relevant intervention on priority outcomes of interest), such as systematic reviews of driving factors of nutrition-sensitive methods, were excluded. Reviews that included a mixture of evidence from both high-income and L&MICs were included if they presented disaggregated evidence for L&MICs or if more than 50 per cent of the evidence of non-disaggregated results was from L&MICs. Reviews that did not have disaggregated results for L&MICs and had more than 50 per cent of the evidence for consolidated findings from high-income countries or where it was impossible to ascertain the composition of evidence by income level were excluded. Reviews that included multiple research methods were included if over at least 50 per cent of studies included at least one of the included impact evaluation designs (Moore et al. 2021)

- Meyer (2020) conducted a systematic review on the role of resilience in food systems research in L&MICs. The study examines how different research efforts have jointly analysed agricultural food system resilience and associated social-ecological systems, the conceptualisation of resilience in food systems, and gaps in its application to food security research.
- Ujjwal et al. (2024) explored the evolution of food system resilience assessment, summarising how these assessments have changed over time, identifying key drivers of this evolution, and discussing their implications for policies aimed at ensuring food security.
- Murphy et al. (2024) reviewed 600 peer-reviewed studies on food security, nutrition, and climate resilience interventions, emphasising rigorous causal designs such as randomised control trials, high-quality quasi-experimental studies, and meta-analyses conducted in L&MICs. The review highlights various intervention strategies, including behaviour change and nutrition capacity strengthening programmes, agricultural training, cooking demonstrations, and complementary feeding guidance. Community-led and participatory approaches — especially peer capacity strengthening and positive deviance strategies — were found to improve dietary diversity and reduce childhood malnutrition in contexts like Ethiopia, Kenya, and Vietnam. The study also noted the underexplored potential of digital and remote learning for nutrition capacity strengthening. While Murphy et al. (2024) illustrate the relevance of ICSBC interventions for food security and nutrition, their study does not employ a meta-analysis approach to assess intervention effectiveness. Instead, it reports the number of publications that found a positive and significant effect on food security, nutrition, and climate resilience.

In conclusion, the review of the body of synthesis evidence shows the existence of an evidence gap on the effectiveness of ICSBC interventions on food security and nutrition outcomes in Sub-Saharan Africa. A key contribution of our research will then be to contribute to filling the evidence gap through a mixed-method rapid evidence assessment, including both experimental and quasi-experimental impact evaluation and qualitative evaluations.

2.4.2 The primary evidence base on ICSBC intervention's effectiveness in Sub-Saharan Africa

We identified 96 quantitative impact evaluations across 35 countries on the effects of ICSBC interventions on food security and nutrition outcomes (Table 3). This amounts to 3 per cent of the quantitative impact evaluations identified across the FSN EGM. We observed a significant increase in the number of studies between 2019 and 2023 and about 47 per cent of the studies analysed the effects of interventions through experimental design. Out of these 96 studies, the FSN EGM highlights 64 studies implemented in SSA, providing an opportunity for evidence synthesis on the effectiveness of ICSBC interventions in this region.

Table 3: FSN EGM Distribution of quantitative impact evaluations on the effects of ICSBC interventions on food security and nutrition outcomes[8]

		Food insecurity measures
Food supply chain	Other capacity strengthening programmes	25
	Agricultural extension programmes	24
	Farmer field schools	15
	Information/guidance	4
Consumer behaviour	Classes	22
	Peer support/counsellors	18
	Community meetings	11
	Professional services (dieticians/nurses)	6
	Healthy food social marketing campaigns	4
	Door-to-door campaigns	1
Food environment	Storage/distribution capacity strengthening	3
	Processing/packaging capacity strengthening	1
Grand Total		**96**

2.4.3 Defining goals and contribution of the REA

By building on this primary evidence from the FSN EGM, our REA will present a unique synthesis of available evidence on the effects of ICSBC interventions on food security and nutrition outcomes in Sub-Saharan Africa and their contribution to food system resilience in the face of environmental vulnerability. Our mixed-method REA will contribute to filling the identified evidence synthesis gap on the effect of these interventions in SSA to expand the body of evidence on their effectiveness on food security and nutrition outcomes building on quantitative impact evaluation evidence and a meta-analysis. It will also explore how these interventions can contribute to enhanced food system resilience building on a qualitative synthesis of qualitative evaluation and evidence.

It will also provide practical and policy-relevant implications for designing, implementing, and evaluating food system interventions. By providing more evidence on *what works,* policymakers and implementers will be able to prioritise and adapt the design of interventions to maximise their effect on the targeted population. Finally, our research will support the achievement of the Sustainable Development Goals (SDGs), especially SDG 2 (Zero hunger) and SDG 17 (Partnerships for the Goals), by providing evidence on the resilience of food systems.

[8] The figure reports the number of quantitative impact evaluations in the 3ie FSN EGM (Storhaug et al. 2024). It aggregates the number of studies under the *food insecurity measures* and *other food security outcomes* categories.

3. Protocol for the rapid evidence assessment

The REA is a form of evidence synthesis that has been developed to address policy-relevant questions in less time and with fewer resources than what is typically required for systematic reviews (Ganann, Ciliska, and Thomas 2010; Khangura et al. 2012; Collins et al. 2015; Barends, Rousseau, and Briner 2017; Snilstveit et al. 2018). There is no single definition of a rapid review, and recent analysis of study methods has highlighted the variation in rapid review methods (Hartling et al. 2015; Khangura et al. 2012; Tricco et al. 2015; Fenton Villar 2022). However, such approaches typically involve adjusting traditional systematic review methods and adopting one or more shortcuts to answer urgent questions more promptly (Schünemann and Moja 2015). The approach and methodology described below are developed in line with other types of rigorous evidence synthesis methodologies (Barends, Rousseau, and Briner 2017; Fenton Villar 2022) and can be compared to a Rapid Systematic Review building on the evidence of the 3ie FSN EGM. We adopt a rigorous and systematic mixed-method approach, building on the best practices and principles of systematic reviews while building on the FSN EGM existing evidence and some data extraction shortcuts (e.g. single independent data extraction and full data extraction quality assessment and reconciliation).

In this section, we present our approach for a mixed methods REA that will synthesise and appraise existing quantitative and qualitative evidence on the effects of ICSBC interventions on food security and nutrition outcomes in Sub-Saharan Africa. We will utilise existing evidence from 3ie's living FSN EGM, starting with publications from 2000 onwards and ending with the last FSN EGM update in July 2024, to analyse the effect of interventions through a meta-analysis (when evidence allows). We will complement this evidence through an additional search for qualitative evidence to explore how ICSBC intervention can contribute to enhanced resilience of food systems in Sub-Saharan Africa. We outline here our research questions, the criteria determining the inclusion of studies in this review, and the methods to be used to describe and analyse both the quantitative and qualitative evidence.

3.1 Research questions

This research aims to promote wider use and understanding of evidence on effective ICSBC intervention strategies to strengthen food systems' resilience in SSA. To support this aim, we will address the following research questions:

- What are the effects of ICSBC interventions on food and nutrition security outcomes in Sub-Saharan Africa?
- How do these interventions enhance the resilience of African food systems against climate change risks and crises?
- Do effects systematically vary by moderator, such as context, intervention features, group vulnerability, or others?

3.2 Inclusion criteria and overview of the body of evidence

3.2.1 Criteria for including and excluding studies

The inclusion criteria for the REA have been established in collaboration with DEval and

an Advisory Group[9]. They are based on the predefined scope and criteria of the FSN EGM. Most of the criteria align with the EGM described in the previous section to cover the 64 studies focusing on ICSBC interventions and their effects on food security and nutrition outcomes in SSA. We have applied some additional restrictions to limit the scope of the study to be feasible within the allocated time and resources. Table 4 summarises the type of participants, interventions, comparison, outcomes, and study designs (PICOS) considered in this REA, along with other inclusion and exclusion criteria (see Appendices 2 and 3 for updated data per intervention and outcome).

Table 4: Summary of criteria (PICOS) determining study eligibility for the REA

CRITERIA	DESCRIPTION
Participants	People of any age and gender residing in Sub-Saharan Africa
Interventions	Information, capacity strengthening, and behaviour change interventions under FSN EGM Descriptions of included interventions are available in Appendix B
Comparison	Business as usual, including pipeline and waitlist controls and alternative intervention
Outcome	Measures of food security and nutrition. Descriptions of included outcomes are available in Appendix C
Study designs	We include quantitative impact evaluations and qualitative evaluations: - For quantitative impact evaluations, we include studies using an experimental or quasi-experimental design. - For qualitative evaluations, we include qualitative studies collecting primary data using mixed-method or qualitative methods, descriptive quantitative studies, and process evaluations focusing on interventions included in the quantitative impact evaluations. It is important to note that the original FSN EGM did not include qualitative evaluations. Descriptions of included study designs are available in Appendix D
Language	Studies in English
Publication date	Studies published from 2000 onwards
Status of studies	We include completed quantitative impact evaluations and qualitative evaluations.
Publication status	We include studies published in any outlet, including peer-reviewed journals, working paper series, organisational reports, and unpublished author manuscripts.

Participants and population

The review will cover individuals of any age and gender residing in Sub-Saharan Africa. Studies focusing on other regions will not be included in our analysis.

[9] The advisory group provides expert input throughout the research process to ensure policy relevance and broad dissemination of findings. Members, including policymakers, practitioners, and researchers, help refine the research scope, suggest literature, review drafts, and support stakeholder engagement. The role is voluntary, with a limited time commitment.

Interventions

We define interventions as an activity or a set of activities implemented in real-life settings by individuals or institutions with the aim of creating change for the people exposed to them. This definition encompasses both internal and external, national and international programmes and policies implemented at the international, regional, national, or subnational level. The term is used synonymously with treatment, initiative, programme, project, policy, or activity, among others.

The focus is on ICSBC interventions under the FSN EGM framework. These interventions fall into three broad categories (detailed descriptions of these interventions are available in Appendix B):

- Food Supply Interventions: Approaches that improve agricultural knowledge and practices, such as farmer field schools, agricultural extension programmes, capacity-strengthening initiatives on agricultural techniques, and phone-based agricultural guidance.
- Food Environment Interventions: Programmes that enhance food storage, distribution, processing, and packaging through capacity-strengthening initiatives.
- Consumer Behaviour Interventions: Strategies aimed at influencing dietary habits and nutritional choices. These include structured classes, peer support programmes, community meetings, professional nutrition services, and social marketing campaigns promoting healthy eating.

Our review will not include studies specifically focusing on women's empowerment, as this scope was already covered in our recent rapid evidence assessments (Basak et al. 2024; Berretta et al. 2023).

Comparison

Interventions are compared to business-as-usual conditions, including pipeline and waitlist controls or alternative intervention approaches:

- Business-as-Usual: The standard conditions in which no additional intervention is introduced, representing existing policies or practices.
- Pipeline Control: A comparison group that is scheduled to receive the intervention at a later stage, allowing for an assessment of short-term effects before full implementation.
- Waitlist Control: A group that is assigned to receive the intervention after the study period, ensuring that all participants eventually benefit while providing a valid comparison during the evaluation.

Outcomes

The primary outcome is food security and nutrition, assessed through various dimensions and indicators (further description of the food security and nutrition outcomes measures are available in Appendix C):

- Aggregated Food Security and Nutrition Measures: Composite indicators reflecting multiple aspects of food security and nutrition. Example indicators include: Food Insecurity Experience Scale (FIES); Household Food Insecurity Index; aggregation of Household Food Insecurity Access Scale (HFIAS), Household Hunger Scale (HHS), and minimum dietary diversity (MDD).
- Food Availability: The consistent supply of sufficient food through domestic

production, imports, food aid, and stock levels. Example indicators include: Domestic food production index, per capita food supply, food stock levels, crop yields.

- Food Access: Economic and physical ability to obtain nutritious food, influenced by income, prices, and distribution systems. Example indicators include: Household Food Insecurity Access Scale (HFIAS), Household Hunger Scale (HHS), food expenditure share, food consumption score (FCS).
- Utilisation (including nutrition and adequacy): The proper biological use of food, dependent on dietary diversity, food quality, and sanitation. Example indicators include: Underweight prevalence, body mass index (BMI), household dietary diversity score (HDDS), and minimum dietary diversity (MDD).
- Stability: The capacity to sustain food security over time without disruptions from economic, climatic, or political factors. Example indicators included: Coping Strategies Index (CSI), Food availability and access over time, Food Security and Nutrition Resilience Index.
- Agency: The ability of individuals or communities to make informed choices about food production, consumption, and governance. Example indicators include: Participation in food governance, engagement in cooperatives and support groups, and bargaining power in food-related decision-making.
- Sustainability: The long-term viability of food systems, incorporating environmental conservation, fair labour, and resilient food supply chains. Example indicators include: Climate resilience, biodiversity conservation, sustainable farming practices adoption, supply chain transparency.

Study designs

This review includes quantitative impact evaluations and qualitative evaluations with the following criteria (further descriptions of the included study designs are available in Appendix D):

- Quantitative Impact Evaluations: Studies using experimental or quasi-experimental designs to assess intervention effects on outcomes using quantitative analyses. Before-after studies without a comparison group or cross-sectional studies that do not attempt to control for selection bias or confounding are excluded. Studies that only examine willingness-to-pay for goods, services, process, and business models are excluded. Experiments conducted in tightly-controlled settings, like those in a laboratory, lab-in-the-field studies, and studies that measure immediate reactions to a short-term exposure (i.e., studies where implementation and data collection is started and completed within a single day) are also excluded. All these quantitative IEs will be directly drawn from the FSN EGM as in its last update of July 2024 and no additional search for quantitative evidence will be conducted.
- Qualitative Evaluations: Studies collecting primary data using mixed-methods, qualitative approaches, descriptive quantitative studies, or process evaluations aligned with quantitative impact evaluations. The original FSN EGM did not include qualitative evaluations, and an additional search will be conducted based on the programmes covered in the included quantitative impact evaluations.

Other inclusion criteria

This review includes only English-language studies published from 2000 onwards which are included in the FSN EGM as per its last update (July 2024). It considers completed

quantitative impact evaluations and qualitative evaluations (protocol, pre-analysis plans, and ongoing studies will not be included in the analysis). Studies from any outlet are included, such as peer-reviewed journals, working paper series, organisational reports, and unpublished manuscripts.

3.2.2 Selecting studies for the REA

One of the main REA shortcuts facilitated by the living FSN EGM is leveraging its systematic search and selection process to bypass the search and screening of evidence while keeping the same level of rigour as a standard systematic review, and directly selecting relevant studies according to the PICOS criteria within the EGM's body of evidence (Moore et al. 2021; see Appendix A for more information about the FSN EGM search strategy and screening process). This methodology allows to provide a more timely answer to the research question by skipping the screening and descriptive data extraction process (representing about 2 months of work in a comparable EGM) while building on the recent evidence within the body of evidence and following the principles of systematic reviews. Nonetheless this shortcut has the limitation of not covering the evidence published between August and December 2024.

Our rapid review builds on a systematic search process: the FSN EGM authors adopted a systematic search strategy following the guidelines for systematic literature search by Kugley et al. (2017) and aimed to minimise publication bias by extensively searching academic databases and incorporating grey literature from specialised organisational websites, bilateral and multilateral agencies, and repositories of impact evaluations in international development. This broad approach acknowledged the diverse nature of interventions, anticipating outcome changes across sectors such as agriculture and health. Electronic searches were conducted across a range of bibliographic databases, including MEDLINE, EMBASE, and the Cochrane Controlled Trials Register, among others specified in the protocol. Grey literature was sourced from platforms like Google Scholar, EconLit, and WHO Global Index Medicus, ensuring a thorough examination of unpublished and less accessible research. Additionally, websites of relevant organisations were reviewed, and backward and forward citation tracking via Google Scholar supplemented database searches to identify additional eligible studies.

The screening process, managed using EPPI Reviewer 4 software, involved several rigorous steps. Initially, imported study records underwent automated duplicate removal before trained screeners assessed titles and abstracts for inclusion against predefined criteria. Machine learning support aided in this initial screening phase. Studies that passed this stage proceeded to full-text evaluation by core team reviewers, with decisions documented using a systematic coding system. Regular meetings were held to resolve discrepancies and refine screening procedures, ensuring consistency and accuracy throughout the selection process.

This structured approach, detailed in the EGM protocol (Moore et al. 2021), ultimately produced a reliable set of studies for data extraction, presented in a detailed flowchart within the EGM report to facilitate transparency and reproducibility of the review methodology. By adhering to these rigorous protocols, the FSN EGM provided a robust evidence base for our REA to inform policy and practice in food security and nutrition.

3.3 Method for quantitative data extraction and analysis

3.3.1 Data extraction and coding procedures

We will extract the following data from each study: the context, methods, and findings, along with information about the cost and implementation of the intervention. This data will be used for both quantitative and qualitative analysis notably regarding their relationship with the context of intervention and climate change vulnerability (see Appendix E for details on the use of climate vulnerability indices and Appendix F for provisional data extraction forms):

- Descriptive data includes authors, publication date, status, and other information to characterise the study, including country, category of intervention and outcome, and intervention design.
- Methodological information on study design, analysis method, and type of comparison (if relevant).
- Quantitative data for outcome measures, including descriptions of outcome measures, sample sizes in each intervention and comparison group, the outcome means, SDs, and test statistics (e.g., *t*-test, F test, *p*-values, 95 per cent confidence intervals, if available).
- Qualitative data for the analysis of the resilience context, challenges, capabilities, and opportunities.
- Cost data for the cost associated with the implementation of the intervention.

Descriptive data, methodological information, and cost data will be single-coded by a trained reviewer and checked by another second reviewer. Trained reviewers will independently code the quantitative data, and any disagreement will be resolved through discussion with a reviewer (who must be a core team member). Before proceeding with independent data extraction, all coders will receive training on quantitative data extraction (QEX) and Risk of Bias assessment (RoB). Only coders meeting the minimum similarity threshold (inter-rater reliability of at least 85%) with the research team will be selected for single data extraction. Additionally, all QEX and RoB will be reviewed for consistency by the research team, and each coding will be reviewed in detail by the research team to ensure the quality and accuracy of the data extraction process.

3.3.2 Measures of treatment effects

An effect size (or treatment effect) expresses the direction and magnitude of the difference in outcomes between groups of observations, such as the difference in outcomes between observations in the intervention and comparison groups (Borenstein et al. 2009; Valentine, Aloe, and Lau 2015).

Effect sizes presented in empirical studies are rarely independent of the scale or unit of the outcome in the study, and the scale or unit of the outcome is generally not directly comparable across studies. To facilitate cross-study comparisons of the magnitudes of studies' effects in our analysis, we will extract data from each study to calculate standardised effect sizes (i.e., Cohen's d adjusted to Hedges *g*). We will choose the appropriate formulae for standardised effect size calculations about, and dependent upon, the data provided in the included studies and the outcome category (see Appendix G for the effect size formulae list) (Borenstein et al. 2009).

If different outcome categories exist under the same outcome construct, we will convert estimates to the most common standardised metric for comparability of estimated effect sizes. We will use common transformations outlined by Borenstein et al. (2009) for converting between different measures of standardised effects. When studies provide multiple estimates for the same effect (e.g., using different model specifications), we will extract the authors' preferred specifications if they have identified one. Otherwise, we will select the most precise estimate (i.e., the estimate with the smallest standard error).

3.3.3 Criteria for determination of independent findings

Our analysis must accurately capture and account for dependencies between study estimates. Standard meta-analytic methods assume effect size estimates are independent and fail to qualitatively recognise that estimates derived from the same intervention or study can distort (inflate) our perceptions of the availability of evidence. Estimating average effect sizes without properly accounting for dependent effects will give too much weight to studies with multiple dependent measures and can lead to an increase in false positives (e.g., finding a significant effect when there is none).

Dependent effect sizes can arise in several circumstances. For example, dependencies between estimates can arise when several publications stem from one study or several studies are based on the same data set. Some studies might have multiple treatment arms that are all compared to a single control group. Other studies may report outcome measurements from several time points or use multiple outcome measures to assess related outcome constructs. All such cases yield a set of statistically dependent effect size estimates (Borenstein et al. 2009).

We will assess the extent to which relationships exist across the studies included in the review. We will avoid double-counting identical evidence by linking papers prior to data analysis, using the information provided in the studies, such as sample sizes, programme characteristics, and key implementing and/or funding partners, to help support these assessments. Where we have several publications reporting on the exact same effect in the same underlying sample, one main study will be used for data extraction, and the linked studies will be stored to help any required search for further or missing information. To identify the main study, priority will be given to the most recent journal article, and, in the case of multiple reports/working papers, the most recent one will be selected.

We will extract effects reported across different interventions, outcomes, and subgroups within a study. We will address dependent effect sizes using data processing and selection techniques to select one effect estimate per outcome per study (further details of the criteria determining effect estimate selection are available in Appendix H). Alternatively, we may use robust variance estimation analyses (RVE; (L. V. Hedges, Tipton, and Johnson 2010; Fisher and Tipton 2015) to include all available data, even when it is statistically dependent. We may consider this approach when substantively relevant and when we reach the minimum degrees of freedom required to provide valid inferences.

3.3.4 Unit of analysis issues

Unit of analysis errors can arise when the unit of allocation of treatment is different from the unit of analysis of effect size estimate, and this is not accounted for in the analysis

(e.g., by clustering standard errors at the level of allocation). We will assess included studies for the prevalence of these issues and, where they exist, account for them by adjusting the reported standard errors (*SE*s) according to the following formula (Higgins et al. 2022; Hedges 2009):

$$(d)' = (d) \cdot 1 + (m-1)c$$

Where *d* is the effect size, m is the average number of observations per cluster, and c is the intra-cluster correlation coefficient. If the included studies use robust Huber-White *SE*s to correct for clustering, we will calculate the *SE* of *d* by dividing *d* by the t-statistic on the coefficient of interest. We will search the literature for an appropriate ICC value. If no such value is available, we will assume an ICC of 0.05, as described by Waddington et al. (2014).

3.3.5 Dealing with missing data

In instances where there is missing or incomplete data, we will make every effort to contact study authors to obtain the required information. Suppose we are unable to obtain the necessary data. In that case, we will report the characteristics of the study but state that it could not be included in the meta-analysis or reporting of effect sizes due to missing data. In line with recommendations on collating data in systematic reviews from study authors (see Mullan et al. 2009), we will report the number of studies for which authors were contacted, the information requested, any important details of the method of eliciting information, and the response of authors to the request. When relevant, we will also report the impact of the information obtained from authors on the results, including sensitivity analyses.

3.3.6 Critical appraisals

We will assess the risk of bias in included studies using 3ie's risk of bias tool, which is amended to account for time and resource limitations (Barends et al. 2017; see Appendix I). This examines both the internal validity and statistical conclusion validity of experimental and quasi-experimental impact evaluation designs (Waddington et al. 2012). Two reviewers will undertake the risk of bias assessment independently. If there are disagreements, we will resolve them by discussion and the involvement of a third reviewer (who must be a member of the core team). We will compile a risk of bias assessment for each estimate we extract. This is to account for the fact that estimates for different outcomes in the same study may score differently in the assessment (for example, based on the use of different statistical models or different outcome measurements).

We will assess the risk of bias based on the following criteria by answering whether the estimate is *free from* each bias, with a response set of "Yes," "Probably Yes," "Probably No," "No," and "No Information" for each domain:

- Factors relating to baseline confounding and biases arising from differential selection into and out of the study (e.g., assignment mechanism).
- Factors relating to bias due to missing outcome data (e.g., assessment of attrition).
- Factors relating to biases due to spillovers, crossovers, and contamination.
- Factors relating to biases in outcome measurement (e.g., social desirability or courtesy bias, recall bias).
- Factors relating to biases in reporting of analysis.

We will report the results of the assessment for each of the assessed criteria for each estimate. In addition, we will use the results of the risk of bias assessments to produce an overall rating for each study as either "High risk of bias," "Some concerns," or "Low risk of bias," drawing on the decision rules in RoB2.0 (Sterne et al. 2019), rating studies as follows:

- "High risk of bias": if any of the bias domains were assessed as "No" or "Probably No."
- “Some concerns”: if one or several domains were assessed as “No Information," and none were "No" or "Probably No."
- "Low risk of bias": if all of the bias domains were assessed as "Yes" or "Probably Yes."

We will describe the reliability of included studies and explore whether there are systematic differences in estimated effects between primary studies with different risks of bias. We will conduct a sensitivity analysis to assess the robustness of the results to the risk of bias associated with included studies.

3.3.7 Data synthesis

To synthesise the effects of interventions, we will combine a narrative synthesis of study findings with a meta-analysis of intervention effects. Our narrative synthesis will examine the range of intervention effects and the study settings. We will include studies in the same meta-analysis when we identify two or more effect sizes using a similar outcome construct, the same intervention type, and where the type of comparison group is judged to be similar across the studies. Suppose there are too few studies, or the included studies are considered too heterogeneous in terms of interventions or outcomes. In that case, we will present a narrative discussion of individual effect sizes alone (Wilson, Weisburd, and McClure 2011). Additionally, we will highlight gaps in the evidence and explain why these gaps exist.

Because heterogeneity exists in theory due to the variety of interventions and contexts that could be included in the review, we will use inverse-variance weighted, random effects meta-analytic models to synthesise the effect estimates (Higgins et al. 2020). Meta-analyses will be conducted using R software (R Core Team 2022), specifically the *metafor* package (Viechtbauer 2010) for independent effects and the *robumeta* package (Fisher, Tipton, and Zhipeng 2023) for RVE analyses (for dependent effects).

3.3.8 Sub-group analysis and investigation of heterogeneity

Standard approach

In our analysis, we will examine and discuss the distribution of estimated effects across intervention and outcome types. We will also statistically assess heterogeneity by calculating the Q statistic, I^2, and τ^2 to provide an estimate of the amount of variability in the distribution of study effect sizes (Borenstein et al. 2009). We will complement this assessment with a graphical analysis using forest plots to illustrate the range of the standardised effects by intervention. This approach provides a summary effect estimate with studies weighted by the precision of the estimate using the inverse of the variance. Whenever feasible, we will conduct moderator analyses using meta-regression to investigate potential sources of heterogeneity.

Following the PROGRESS-PLUS approach (Oliver et al. 2017), we will assess moderators falling into three broad categories of extrinsic, methodological, and substantive characteristics. Examples of these categories include:

- Extrinsic characteristics: E.g., funder of the study (e.g., NGO vs private sector vs government investments), publication type, publication date.
- Methodological characteristics: E.g., study design, risk of bias, length of follow-up, categories of outcome measures.
- Substantive characteristics: For example, participant characteristics (gender, age, socio-economic status, education, vulnerability), context (geographical setting; democratic setting), environmental and/or hunger-related indicators (GHI, GDL, etc.), intervention type, intervention features, and type of implementing agency.

We intend to use random effects meta-regression to investigate the association between moderator variables and heterogeneity of treatment effects (Borenstein et al. 2009) and subgroup analyses to investigate heterogeneity by treatment subgroups (e.g., men and women, poor and non-poor, and so on). If these strategies are not possible (e.g., if we do not have a sufficient number of studies or data), we will discuss and explore the factors that may be driving the heterogeneity of results narratively by conducting cross-case comparisons (Miles and Huberman 1994).

Additional heterogeneity analyses for ICSBC intervention, resilience, and environmental vulnerability

We intend to explore factors driving heterogeneity across specific aspects of our set of interventions and outcomes.

Environmental vulnerability

To analyse the heterogeneity of effects of interventions based on the countries' environmental vulnerabilities, the team scoped available relevant indices on resilience and climate change. There was a four-step inclusion criterion for shortlisting the indices. First if the index had quantifiable country rankings. Second, if it focused on resilience and climate vulnerability. Therefore, we excluded rankings that looked at environmental sustainability levels, just transition indices, energy transition rankings, etc. Third, if it included the time period that covers the range of interventions. Fourth, if it was based on a sound, transparent methodology.

Based on the framework, the team identified 12 indices (a detailed description of each index is presented in 5), of which six were assessed to be appropriate for our research aims. These vulnerability and readiness indices directly looked at the extent to which countries were affected by climate change. The included indices are:

1. Global Climate Risk Index
2. ND-Gain Country Index and its IMF derivative
3. GDL Vulnerability Index
4. World Risk Index
5. INFORM Climate Change and INFORM risk index
6. Climate Vulnerability Monitor

For these shortlisted indices, we will match countries with their environmental vulnerability status during the reported interventions and the projected environmental vulnerability.

In addition, we will collect reported data on the type of risk or crisis experienced by the intervention context to analyse their prevalence in the body of evidence and identify potential heterogeneity of intervention effects according to the type of risk or crisis.

Information, Capacity Strengthening, and Behaviour Change intervention functions

Building on the existing body of evidence and approaches, we will follow the approach by Watson et al. (2023) using the Michie et al. (2011) Behaviour Change Wheel, categorising the features applicable to intervention design and implementation. The wheel outlines nine behavioural intervention functions across three categories:

- Capability (physical and psychological): the physical and mental ability to perform the behaviour and engage in the necessary thought processes (e.g., capacity strengthening, training, enablement)
- Opportunity (physical and social): the environmental and social norms that influence the behaviour or make the behaviour possible (e.g., environmental restructuring, restriction, enablement)
- Motivation (automatic and reflective): the deliberative processes, impulses, habits, and emotional response (e.g., persuasion, incentivisation, coercion, modelling, enablement).

Each intervention will be mapped against the three categories to analyse the heterogeneity of effect according to the behavioural intervention function targeted by the ICSBC intervention.

Food system resilience

Resilience will be incorporated as a moderator in the meta-analysis by examining whether interventions explicitly aim to enhance beneficiaries' ability to adapt to, absorb, anticipate or transform in response to environmental and other shocks. Our data extraction process will report whether resilience is a stated objective of the intervention, distinguishing between treatments designed to increase resilience and those that may achieve it incidentally. This enables subgroup analyses to compare effect sizes and determine if explicitly targeting resilience leads to better outcomes. Additionally, our data extraction process assesses whether resilience is part of the intervention's theoretical framework or conceptual design, allowing an exploration of whether theoretically grounded resilience strategies are more effective.

The template also categorises the specific aspects of resilience targeted, including coping with crises, preparing for recurring stresses, mitigating negative effects, and achieving structural changes for long-term recovery. By coding these dimensions, the meta-analysis can explore which resilience aspects contribute most to intervention effectiveness. This approach provides a nuanced understanding of how and why certain interventions are effective, revealing the mechanisms through which resilience-building strategies impact beneficiaries' ability to withstand and recover from shocks.

3.3.9 Sensitivity analysis

We will conduct a sensitivity analysis to assess whether the results of the meta-analysis are sensitive to the removal of any single study. We will do this by excluding studies from the meta-analysis one by one and assessing changes in results. We will also assess the sensitivity of our results to the inclusion of studies with a high risk of bias by removing

these studies from the meta-analysis and comparing results to the main meta-analysis results. Furthermore, we will assess the sensitivity of our results to outliers. We will use studentised residuals to examine whether studies' estimated effects may be outliers (Viechtbauer and Cheung 2010), and studies with a studentised residual larger than the $100 \times (1 - 0.05/(2 \times k))$th percentile of a standard normal distribution will be considered potential outliers.

3.3.10 Assessment of reporting biases

To reduce the possibility of publication bias, we identified and included unpublished studies in the review. We will visually inspect funnel plots for each outcome, with at least 10 studies reporting such measures (Higgins et al. 2020). In addition, if a meta-analysis is feasible, we will test for the presence of publication bias through the use of contour-enhanced funnel graphs (Peters et al. 2008) and statistical tests (Egger et al. 1997) for outcomes for which we identified at least 10 studies, as suggested by Sterne et al. (2019).

3.4 Qualitative search and appraisal

3.4.1 Purpose of the qualitative analysis

For the review to be more beneficial for policymakers and practitioners, we will collect and analyse qualitative evidence to assess the resilience factors that affect the implementation and effects of the interventions. We will investigate the context configuration of different conditions of the intervention and how the interventions enhance the resilience of food systems against climate change risks and crises according to the BMZ resilience analytic framework categories (Thomas, O'Mara-Eves, and Brunton 2014; BMZ 2021):

- *Context:* Any element related to external factors beyond the programme's control that affects programme impact. This can refer to, e.g., political factors such as type of governance, societal factors such as norms, economic factors such as a recession, and cultural factors such as beliefs.
- *Resilience capacities:* Any element related to the responsible actors and structure affected, along with knowledge of their strengths, potentials, and skills for coping with environmental shocks.
- *Needs and opportunities:* Any element related to the needs and opportunities for further strengthening these crisis management capacities (including prevention) on a cross-sectoral basis.

3.4.2 Source and eligibility of qualitative evidence

Qualitative evidence is not included in the FSN EGM. Thus, we will undertake an additional search for qualitative evidence. Qualitative evidence will be gathered from two sources:

- Descriptive and qualitative data from the included experimental and quasi-experimental studies from the included studies.
- A targeted search for additional papers on the interventions covered by the included impact evaluations to provide additional detail on these factors.

To be included, these papers must be related to the interventions in the included quantitative impact evaluations and be one or more of the following types of studies:

- A *qualitative study* collects primary data using qualitative or quantitative methods and reports some information on the research question, data collection

procedures, data analysis procedures, and information on sampling and recruitment, including at least two sample characteristics.

- A *process evaluation* assesses whether an intervention is being implemented as intended, what is felt to be working more or less well, and why. Process evaluations may include collecting qualitative and quantitative data from different stakeholders to cover subjective issues, such as perceptions of intervention success, or more objective issues, such as how an intervention was operationalised. They might also be used to collect organisational information.
- A *descriptive quantitative* study collects primary data using quantitative methods of data collection and descriptive quantitative analysis and reports some information on the research question, data collection procedures, data analysis procedures, and information on sampling and recruitment, including at least two sample characteristics. The purpose of including them in our review is to ensure we will have sufficient information about the evaluation features and process.
- A *project document* providing information about planned, ongoing, or completed interventions. Such documents may describe the background and design of an intervention or the resources available for a project. As such, these documents do not typically include much analysis of primary evidence, but they provide information about interventions. The purpose of including them in our review is to ensure we will have sufficient information about the context and interventions in the included studies.

3.4.3 Search process

Search will begin by identifying the programme names from included quantitative studies, followed by a citation search and searching in the web browser and the implementer, funder, or project websites and publications for linked qualitative evaluations. Relevant hits include, but are not limited to, reports, project documents, and web pages, as listed below. Key documents should fall within our inclusion criteria and PICOS:

- Project websites, including those hosted by the implementer and donor.
- Qualitative research reports on the relevant project.
- Additional grey literature or reports.

3.4.4 Appraisal of qualitative evidence

We will assess the quality of included qualitative studies, process evaluations, and descriptive quantitative studies using a mixed-methods appraisal tool developed by Langer et al. (2016) and applied by Snilstveit et al. (2017; see Appendix J). This tool builds on the Critical Appraisal Skills Programme checklist (CASP 2011) and Pluye et al. (2011) mixed-methods appraisal tool. Using our appraisal tool, we will make judgments on the adequacy of reporting, data collection, presentation, analysis, and conclusions drawn. We will assess the quality of the included qualitative studies and descriptive quantitative studies using six appraisal domains (more information about each domain is provided in our critical appraisal tool in Appendix J):

- The defensibility of the applied research design to answer the research question under investigation.
- The defensibility of the selected research sample and the process of selecting research participants.
- The rigour of the technical research conducted, including the transparency of reporting.

- The rigour of the applied analysis and credibility of the study's claims given the nature of the presented data.
- The consideration of the study's context (for qualitative studies only).
- The reflexivity of the reported research (for qualitative studies only).

We will not undertake a critical appraisal of the included project documents. They typically provide information about planned, ongoing, or completed programmes, providing information about the design or resources available for a project, for instance. As such, these documents do not typically include much analysis of primary evidence, but they provide information about interventions. The purpose of including them in the REA is to ensure we have sufficient information about the context and interventions included in our review.

For the rest of the qualitative studies, we will filter out studies of particularly low quality at this stage, using a fatal flaw approach following Dixon-Woods et al. (2005). Studies that do not meet either criterion of appraisal domains 1–4 above will be excluded from the synthesis. That is, they will be included in the review, and we will report on the studies' descriptive data, for example the applied intervention. However, no research findings will be extracted from these studies to feed into the review's synthesis. Each appraisal domain will be assessed on a scale of critical trustworthiness to low, medium, and high trustworthiness. We will allocate an overall critical appraisal judgment per study using a numerical threshold of the appraised quality domains.

We will, therefore, focus the appraisal on assessing the relevance of the documents against the interventions assessed in our review. Before extracting any data, we will ensure that the name of the intervention, the implementing agency, the context, and the timeline of the intervention described in the project document correspond to the intervention assessed in the impact evaluation included in our review. Finally, collecting data from a range of sources, especially if used for triangulation, can enhance confidence in the trustworthiness of the information included. If several sources are available, we will extract data from all sources for purposes of triangulation.

3.4.5 Data extraction and thematic coding

We will use computer-aided qualitative data extraction and analysis tools for thematic synthesis. Data extraction will be single-coded using the line-by-line extraction function of EPPI Reviewer and codes will be allocate to themes. Themes will closely follow these domains:

- *Context:* Any element related to external factors beyond the programme's control that affects programme impact. This can refer to, e.g., political factors such as type of governance, societal factors such as norms, economic factors such as a recession, and cultural factors such as beliefs.
- *Intervention design:* Any variable related to the design and planning of the applied intervention. The design and planning of an intervention refers to the blueprint or schedule of the intervention and typically outlines what components the intervention consists of and in what sequence they will be applied. Examples of design variables refer to the size or type of cash transfer and outreach strategy, e.g., posters, reminders, and type of training.
- *Intervention implementation:* Any variable related to the implementation of the intervention in practice. This refers to variables that emerge while the intervention

is applied and are usually not known in advance. Examples of implementation variables include the lack of attendance or uptake, payment difficulties, corruption, and elite capture.

- *Population characteristics:* Any variable that is related to the population targeted by the intervention or the population in which the effects are measured (in cases where these differ). This can refer to, e.g., the socio-economic status of the population, its educational status, and asset ownership. It is important not to confuse this with sample characteristics, where these variables might be reported to describe the composition of the study sample and only to look for data on how these characteristics might have influenced the programme effects.

3.4.6 Synthesis of qualitative information

The process of synthesis involves generating descriptive and analytic themes derived from the line-by-line coding for each of the four sections (population, design, implementation, and contextual interplay with effects).

The first data point of interest is the frequency reports. These are important to get an overall idea of the most common child codes and those related to each other, as well as those that are bounded by one study (unlikely to make it into the descriptive and thematic analysis) and themes across every four categories per intervention.

For each intervention, we will generate coding reports and compare and compile codes that can be merged based on their thematic proximity.

3.4.7 Data presentation

A thematic synthesis will complement the meta-analysis conducted with the quantitative data. We will provide a narrative summary of the papers identified. This will include an overall description of the available literature and a general synthesis of findings. Key information from each study, such as intervention type, study design, country, outcomes, measurement type, effect sizes, and confidence rating, will be summarised in a table. Along with results from meta-analyses, we will narratively summarise qualitative information focusing on informing project design and implementation.

Appendix A: About the FSN EGM

The following appendix provides the basic information about the methodology followed by the FSN EGM and its subsequent updates that form the evidence base of our REA. More information about the methodology and findings of the living FSN EGM are available on 3ie's dedicated webpage.

Overview

The initial literature search included 12 academic databases and was originally completed in September 2020. Since then, it has been repeated for the updates every four months from July 2021 until November 2023. Additionally, a grey literature search of 31 sector-specific databases has been searched twice, once during the original EGM in September 2020 and once in January 2022. For each search, studies were uploaded to EPPI Reviewer, de-duplicated, and screened independently in duplicate. We extracted interventions, outcomes, population, country, and methods data. All studies meeting the eligibility criteria established in the initial protocol (Moore et al. 2021) are published on the online map. The International Initiative for Impact Evaluation also publish a regular summary of the new evidence added and the overall evidence distribution.

About 75 percent of the impact evaluations (IEs) in the original EGM used randomized designs. The updates have shifted to include more quasi-experimental studies (i.e. 44% of the studies identified from updates 1-6 are quasi-experimental). Since the original EGM, we also observed a reduction in published systematic reviews and an increase in low-confidence systematic reviews. In the first report, 54% of the SRs were rated as low confidence and 19% as high confidence. Over 75% of the high-confidence SRs were published between 2015 and 2020. During the update period, 25 systematic reviews were identified, and 80% were low confidence.

We observed evidence clusters in the original EGM. For example, India, China, and Bangladesh gather higher numbers of studies. The most common interventions were *fortification*, *supplementation*, and *classes related to consumer behaviour.* They have remained the most evaluated interventions, but the studies identified in the update period show a reduction in studies evaluating *supplementation* and *fortification* interventions. Overall, most interventions have been evaluated by a minimum of one IE, and interventions with 50 or more IEs have been synthesized by at least one SR. Outcome clusters have remained the same from the original report to the most recent update: *anthropometric*, *diet quality and adequacy,* and *micronutrient status*.

Search strategy and screening

The search strategy and screening process for the FSN EGM followed a systematic approach in line with guidelines for systematic literature searching (Kugley et al., 2017). The strategy was designed to address potential publication bias by conducting comprehensive searches across both academic bibliographic databases and unpublished literature. Additionally, searches for grey literature were implemented on specialist organisational websites, websites of bilateral and multilateral agencies, and repositories of impact evaluations relevant to international development.

Given the varied nature of the interventions within the scope of the EGM, it was anticipated that reported outcome changes would span multiple development sectors, such as agriculture and health. Consequently, sector-specific databases were included where relevant. The review team also contacted key experts and organisations through an advisory group to identify additional studies meeting the inclusion criteria.

Search strings were tailored for each database, using appropriate index terms and truncation operators. Appendix A of the protocol presented examples of these strings as well as sensitivity analyses to evaluate the impact of variations in the search scope on the volume of results. These analyses included comparisons of search results from the MEDLINE database with and without terms for cardiometabolic diseases and publication date filters. Stakeholder engagement helped determine the costs and benefits of an expanded search scope, influencing the final search strategy.

Electronic searches were conducted across multiple bibliographic databases, including:

- MEDLINE
- EMBASE
- Cochrane Controlled Trials Register (CENTRAL)
- CINAHL
- CAB Global Health
- CAB Abstracts
- Agricola
- PsychINFO
- Africa-Wide Information
- Academic Search Complete
- Scopus
- Campbell Library

Grey literature was identified using databases containing both published and unpublished sources, including:

- Google Scholar
- EconLit
- ENN-Network
- IDEAS/RePEc
- IMMANA grantee database
- WHO Global Index Medicus
- Grey Literature Report
- Social Science Research Network (SSRN)
- Eldis
- Epistemonikos
- 3ie Development Evidence Portal
- Registry of International Development Impact Evaluations (RIDIE)
- Oxfam Policy & Practice

Relevant organisational websites, as listed in Appendix A, were also searched. These websites typically offered limited search functionality, necessitating adaptations of the review's search strings to suit each platform.

Backward and forward citation tracking was conducted using Google Scholar to review all citations by included studies and all studies citing at least one included study. The review team also engaged with the research community by contacting experts recommended by the advisory group and publishing a call for information on the 3ie website, supplemented with social media promotion.

The screening process was managed using EPPI Reviewer 4 software and involved several systematic steps:

- Import and De-duplication: Study records from all search outputs were imported into EPPI, where duplicate entries were automatically removed.
- Training of Screeners: Consultants were trained to ensure a consistent understanding of the subject matter and screening criteria. Screeners practiced on the same set of studies until a 95% consistency level was achieved in inclusion/exclusion decisions.
- Title and Abstract Screening: Titles and abstracts were single-screened with machine learning support, following a safety-first approach. Studies were coded to indicate inclusion or reasons for exclusion. Regular meetings were held to resolve disagreements and refine the screening approach.
- Full-Text Screening: Studies meeting all title and abstract inclusion criteria were subjected to full-text screening by two reviewers from the core team. Each study was coded to indicate inclusion or provide a reason for exclusion.
- Linked Publications Checks: The team grouped linked publications reporting on the same intervention and population. Descriptive data were extracted once for each group to ensure comprehensive coverage.

Search strings

1 (random* or experiment* or (match* adj2 (propensity or coarsened or covariate)) or "propensity score" or ("difference in difference*" or "difference-in-difference*" or "differences in difference*" or "differences-in-difference*" or "double difference*") or ("quasi-experimental" or "quasi experimental" or "quasi-experiment" or "quasi experiment") or ((estimator or counterfactual) and evaluation*) or "instrumental variable*" or (IV adj2 (estimation or approach)) or regression discontinuity or time series or segment* regression).ti,ab,kw. (3158100)

2 Randomized Controlled Trial/ or Random Allocation/ or Evaluation Studies/ or Propensity Score/ or Interrupted Time Series Analysis/ or Controlled Before-After Studies/ or Controlled Clinical Trial/ or Non-Randomized Controlled Trials as Topic/ (931395)

3 1 or 2 (3600883)

4 (review or meta-analysis).pt. (2687667)

5 cochrane database of systematic reviews.jn. (14735)

6 (systematic review or literature review).ti. (154171)

7 4 or 5 or 6 (2731803)

8 3 or 7 (6034861)

9 developing countries.sh,kf. (85389)

10 (Africa or Asia or Caribbean or West Indies or South America or Latin America or Central America).ti,ab,kw. (216058)

11 Africa/ or Asia/ or Caribbean/ or West Indies/ or South America/ or Latin America/ or Central America/ (76022)

12 (Afghanistan or Albania or Algeria or Angola or Argentina or Armenia or Armenian or Azerbaijan or Bangladesh or Benin or Byelarus or Byelorussian or Belarus or Belorussian or Belorussia or Belize or Bhutan or Bolivia or Bosnia or Herzegovina or Hercegovina or Botswana or Brazil or Bulgaria or Burkina Faso or Burkina Fasso or Upper Volta or Burundi or Urundi or Cambodia or Khmer Republic or Kampuchea or Cameroon or Cameroons or Cameron or Camerons or Cape Verde or Central African Republic or Chad or China or Colombia or Comoros or Comoro Islands or Comores or Mayotte or Congo or Zaire or Costa Rica or Cote d'Ivoire or Ivory Coast or Cuba or Djibouti or French Somaliland or Dominica or Dominican Republic or East Timor or East Timur or Timor Leste or Ecuador or Egypt or United Arab Republic or El Salvador or Eritrea or Ethiopia or Fiji or Gabon or Gabonese Republic or Gambia or Gaza or Georgia Republic or Georgian Republic or Ghana or Grenada or Guatemala or Guinea or Guiana or Guyana or Haiti or Honduras or India or Maldives or Indonesia or Iran or Iraq or Jamaica or Jordan or Kazakhstan or Kazakh or Kenya or Kiribati or Korea or Kosovo or Kyrgyzstan or Kirghizia or Kyrgyz Republic or Kirghiz or Kirgizstan or Lao PDR or Laos or Lebanon or Lesotho or Basutoland or Liberia or Libya or Macedonia or Madagascar or Malagasy Republic or Malaysia or Malaya or Malay or Sabah or Sarawak or Malawi or Mali or Marshall Islands or Mauritania or Mauritius or Agalega Islands or Mexico or Micronesia or Middle East or Moldova or Moldovia or Moldovian or Mongolia or Montenegro or Morocco or Ifni or Mozambique or Myanmar or Myanma or Burma or Namibia or Nepal or Netherlands Antilles or Nicaragua or Niger or Nigeria or Muscat or Pakistan or Palau or Palestine or Panama or Paraguay or Peru or Philippines or Philipines or Phillipines or Phillippines or Papua New Guinea or Romania or Rumania or Roumania or Rwanda or Ruanda or Saint Lucia or St Lucia or Saint Vincent or St Vincent or Grenadines or Samoa or Samoan Islands or Navigator Island or Navigator Islands or Sao Tome or Senegal or Serbia or Montenegro or Seychelles or Sierra Leone or Sri Lanka or Solomon Islands or Somalia or Sudan or Suriname or Surinam or Swaziland or South Africa or Syria or Tajikistan or Tadzhikistan or Tadjikistan or Tadzhik or Tanzania or Thailand or Togo or Togolese Republic or Tonga or Tunisia or Turkey or Turkmenistan or Turkmen or Uganda or Ukraine or Uzbekistan or Uzbek or Vanuatu or New Hebrides or Venezuela or Vietnam or Viet Nam or West Bank or Yemen or Zambia or Zimbabwe).ti,ab,kw,sh. (1423829)

13 ((developing or less* developed or under developed or underdeveloped or middle income or low* income or underserved or under served or deprived or poor*) adj (countr* or nation? or population? or world or state*)).ti,ab,kw. (98986)

14 ((developing or less* developed or under developed or underdeveloped or middle income or low* income) adj (economy or economies)).ti,ab,kw. (535)

15 (low* adj (gdp or gnp or gross domestic or gross national)).ti,ab,kw. (243)

16 (low adj3 middle adj3 countr*).ti,ab,kw. (15731)

17 (L&MIC or L&MICs or third world or lami countr*).ti,ab,kw. (7551)

18 (transitional countr* or emerging econom* or global south).ti,ab,kw. (1010)

19 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 (1594007)

20 8 and 19 (255764)

21 exp Agriculture/ or Food Assistance/ or exp Food Packaging/ or Food Preservation/ or Food Storage/ or Food-Processing Industry/ or exp Meat-Packing Industry/ or exp Food Quality/ or exp Nutrition Policy/ or exp Nutrition Therapy/ (311574)

22 (((agricultur* or aquacultur*) adj3 input*) or (improv* adj3 (seed* or variet* crop*)) or (genetic* adj3 modif* adj3 (food* or organism*)) or GMO or fertili* or pesticid* or insecticid* or compost* or manure* or mulch* or ((drought* or pest* or insect*) adj3 (toleran* or resist*)) or (rotat* adj3 crop*) or (land adj3 manage*) or "fixed distance planting" or (plant* adj3 row?) or ((farm* or crop or agricultur* or aquacultur*) adj6 subsid*) or (price* adj6 purchas* adj6 guarantee*) or ((crop* or rain* or weather or index) adj6 insurance) or (irrigat* adj6 (project* or program* or access* or improv*)) or "water meter*" or (rain* adj3 (fed or feed*)) or (trench* adj3 hill*) or hilling or "water break" or terrac* or ((farm* or agricultur* or aquacultur*) adj3 (mechani#e* or mechani#ation*)) or intercrop* or (companion adj3 (plant* or variet* or species))).ti,ab,kw. (274307)

23 (((grain* or crop* or agricultur* or aquacultur* or farm* or produce) adj6 (silo* or stor* or shed* or warehous*)) or ((agricultur* or aquacultur* or farm*) adj3 (collection or distribution) adj3 (centre* or center*)) or ((farm* or produce or food* or agricultur* or aquacultur*) adj6 ("cold chain*" or ((refrigerat* or cold) adj3 (truck* or transport* or transit))))).ti,ab,kw. (4047)

24 (((food* or crop* or staple*) adj3 (fortif* or biofortif*)) or ((recycl* or compost* or biodegrad* or plastic*) adj3 (pack* or sache*)) or (post-harvest adj6 (clean* or winnow* or cann* or mill* or thresh* or hull*)) or ((food* or crop* or grain*) adj3 dry*) or ((food* or grocer* or soup) adj6 (donat* or pantr* or bank* or kitchen or transfer*)) or (food* adj6 near* adj6 spoil*)).ti,ab,kw. (9156)

25 ("food environment*" or (zoning and (food* adj3 (security or access*))) or "farmers market" or "food desert" or (school adj6 (meal* or feed* or food* or lunch*)) or (food* adj6 (cash or "social assistance" or "social safety net")) or (food* adj6 ((advertis* or label* or market*) adj3 (ban* or restrict* or regulat* or polic* or law*))) or ((supermarket or ((food* or grocer* or convenience or corner) adj (store* or market*))) adj6 (design* or redesign* or re-design* or layout*)) or (front adj3 pack* adj3 label*) or (food* adj3 (safe* or quality) adj3 (regulat* or restrict* or polic* or law* or inspect*)) or (food* adj3 certif*)).ti,ab,kw. (8820)

26 (((sugar* or SSB) adj3 tax*) or ((food* or consumer*) adj6 subsid*) or nudg* or ((food* or eat* or feed* or meal* or diet*) adj6 (deci* or ((cultur* or social) adj3 (norm* or preferen*)))) or (wom#n adj6 (food* or eat* or feed* or meal* or diet*) adj6 (empower* or

deci*)) or ((food* or eat* or feed* or meal* or diet*) adj3 (inform* or educat* or promot* or campaign* or media or initiative*))).ti,ab,kw. (33515)

27 or/21-26 (608240)

28 Breast Feeding/ or Child Nutritional Physiological Phenomena/ or Adolescent Nutritional Physiological Phenomena/ or Infant Nutritional Physiological Phenomena/ or Weaning/ or Energy Intake/ or Diet, Healthy/ or Eating/ or Elder Nutritional Physiological Phenomena/ or Food Preferences/ or exp Maternal Nutritional Physiological Phenomena/ or exp Nutritional Requirements/ or Nutritional Status/ or exp Nutritive Value/ or exp Nutrition Disorders/ or Nutrition Assessment/ or exp Food Supply/ (548239)

29 (height? or length? or length-for-age or LAZ or "short stature" or stunt* or weight? or weight-for-age or WAZ or "elevated weight" or underweight or "low weight" or "body mass index*" or "weight-for-length" or WLZ or BMI or BMIz or wasted or wasting or obes* or overweight or "mid-upper arm circumference" or MUAC or "low birth weight" or LBW or ((small or large) adj3 "gestational age*") or "head circumference*" or adiposity or (lean adj3 ("muscle mass" or "body mass")) or DEXA or "dual-energy x-ray" or absorptiometry or electroimpedence or "whole body air displacement" or plethysmography or "skin fold*" or "arm fat" or ((hip-to-waist or hip-to-shoulder) adj ratio*)).ti,ab,kw. (1939806)

30 (((iron or fe or iodine or "vitamin a" or b12 or cobalamin or calcium or ca or zinc or zn or folate or "folic acid") adj3 deficien*) or h?emoglobin or an?emia or ferritin or transferrin or "urinary iodine concentration*" or goitre* or goiter* or "serum thyroid stimulating hormone" or TSH or (serum adj (thyroglobulin or tg))).ti,ab,kw. (388485)

31 ((food adj (consumption or variety) adj score*) or (diet* adj6 divers*) or DDS or "food groups consumed" or ((meal or "food consumption") adj frequency) or "minimal acceptable diet*" or "estimated average requirement" or "reference daily intake" or RDI or "recommended daily allowance" or RDA or (diet* adj6 (adequa* or sufficien*)) or ((fruit* or vegetable*) adj6 consum*) or "healthy eating index" or HEI or "nutrient rich food index" or "Mediterranean diet score" or "nova food groups" or "dietary pattern score*" or (probability adj3 adequa*)).ti,ab,kw. (38256)

32 ((breastfeed* adj3 (exclusive* or early or extend* or initiat* or frequen*)) or "mixed feeding" or weaning or ((food* or feed*) adj6 complement* adj6 introduc*) or (index adj3 feed* adj3 (infant or child)) or IYCF).ti,ab,kw. (38042)

33 ((food adj (security or insecurity)) or "household food insecurity access scale" or HFIAS or "poverty index" or "poverty line" or ((income or wealth) adj3 (inequality or relative)) or (access* adj3 market*) or "food desert*" or (food* adj3 basket*) or (index adj3 "food consumer price*") or FCPI or (Shannon adj (measure or metric or score)) or (modified adj3 functional adj3 attribute adj3 diversity) or (stress* adj3 food) or hunger or hungry or ((meal* or food* or feed*) adj3 (skip* or miss*)) or "coping strategy index" or (food* adj6 afford*)).ti,ab,kw. (25766)

34 or/28-33 (2604578)

35 exp Animals/ (23074750)

36 Humans/ (18388397)

37 35 not (35 and 36) (4686353)

38 34 not 37 (2088346)

39 20 and 27 and 38 (4339)

Appendix B: List of interventions

CATEGORY	INTERVENTION	DESCRIPTION	NUMBER OF STUDIES
Consumer behaviour	Classes	The use of a classroom structure to provide messages regarding healthy eating. This includes classrooms outside of school.	10
	Peer support / counsellors	The use of peer support or counsellors to increase healthy eating.	11
	Community meetings	The use of community meetings to provide messages regarding healthy eating. Education provided to a specific group would be a class, not a community meeting. A community meeting must be a public engagement for discussion and mobilisation, not simply education. Education within established groups (such as women's self-help groups or microfinance groups) does not count as these are not open to the public.	5
	Professional services (dieticians / nurses)	The use of professional services such as dieticians or nurses to provide messages regarding healthy eating. Can be provided one-on-one or in a group. However, the service provided must be related to their direct training, and not simply general information. The provision of general information to a group is a class (ex. they must be acting as a dietician and not a teacher, "group counselling" and not "group education").	2
	Healthy food social marketing campaigns	Healthy food social marketing campaigns. This includes campaigns on social media, radio, and TV. Also includes provision of media, e.g. magazines and newsletters to promote healthy eating. Including e and m-health, movies and multimedia, text messages, newsletters, posters, games.	3

CATEGORY	INTERVENTION	DESCRIPTION	NUMBER OF STUDIES
Food supply chain	Farmer field schools	Farmer field schools bring together a group of farmers to learn agricultural techniques. They meet regularly during a production cycle, setting up experimentation and engaging in hands-on learning to improve skills and knowledge that will help adapt practices to their specific context. Demonstration farms may be used in farmer field schools or separately to show the use of certain agricultural techniques.	13
	Agricultural extension programmes	Trained agents visit communities to teach current practices, organise cooperatives, and engage in other secondary activities.	21
	Other capacity strengthening programmes	Other educational programmes supporting the adoption of new agricultural techniques. All mediums of education are included here so long as the information being exchanged is related to agricultural techniques / animal husbandry. Programmes related to other educational topics (eg. literacy) would not be included.	16
	Information and guidance	If information/reminders is provided over the phone, such as via voice messages or SMS.	4
Food environment	Storage and distribution education and capacity strengthening	Educational programmes to support storage and distribution techniques. This reflects education itself, without necessarily providing additional services.	3
	Process and packaging education and capacity strengthening	Educational programmes to support processing and packaging	1

Appendix C: List of outcomes, descriptions, and corresponding indicators

OUTCOME	DESCRIPTION	OUTCOME LABELS[10]	NUMBER OF STUDIES
Food security and nutrition	Following the 1996 World Food Summit (FAO, 1996) we define food security as having physical and economic access to sufficient safe and nutritious food at all times that meets one's dietary needs and food preferences for an active and healthy life. We will include composite measures of food security / insecurity, typically reflecting a household's reported food security	*Food security* – Aggregated: Aggregated measures of all or multiple pillars of food security. Example indicators: food security score, food insecurity in the last 7 days, food insecurity experience scale. Food availability refers to the consistent supply of sufficient quantities of food through domestic production, imports, food aid, and stock levels. It depends on factors like agricultural productivity, distribution, and trade. Example indicators: Domestic food production index, per capita food supply, food stock levels, and yields. *Food access* involves having the resources (economic and physical) needed to obtain nutritious food. It is influenced by income levels, food prices, distribution networks, and social support systems. Example indicators: Household Food Insecurity Access Scale (HFIAS), Household Hunger Scale (HHS), food expenditure share, and food consumption score (FCS). *Nutrition, adequacy, and utilisation* relate to the proper biological use of food, ensuring that people can absorb and benefit from nutrients. It depends on food quality, safety, preparation, dietary diversity, and access to clean water and sanitation. Example indicators: Underweight prevalence, body mass index, household dietary diversity score (HDDS), and minimum dietary diversity (MDD). *Stability* ensures that food availability, access, and utilisation are consistently maintained over time, without fluctuations due to economic, climatic, or political crises. Example indicators: Coping strategies index and food security and nutrition resilience index. *Agency* refers to the power to make decisions about food eaten and produced. It includes making choices about what to eat, what to produce, and how to process or distribute it. Example indicators: food choices, food bargaining power, advocacy and participation in food system, local food networks, social support systems, participation in food governance, food policy influence. *Sustainability* refers to the food system's ability to provide long-term food security through practices that regenerate natural, social, and economic systems to meet future food needs. Example indicators: Environmental impact, soil health & fertility, water use efficiency, biodiversity conservation, food waste reduction, sustainable farming practices.	64

[10] We provide example indicators and will include all measures of food security/insecurity

Appendix D: Study designs

Impact evaluations

We will include impact evaluation using experimental and quasi-experimental study designs to measure a change in outcomes that is attributable to an intervention. This includes studies that apply one of the following approaches:

1. Randomized evaluations with assignment at the individual, household, community or other cluster level, and quasi-randomized mechanisms using prospective methods of assignment such as alternation. This includes randomized trials where units are deliberately assigned to treatment and control groups for the purposes of research, and “natural experiments” where units are exposed to the treatment via some other random mechanism.
2. Non-randomized designs with either a known assignment variable(s) or a seemingly random assignment process:
    a. Regression discontinuity designs, where assignment is based on a threshold measured before intervention, and the study uses regression to model the assignment process.
    b. Natural experiments with clearly defined intervention and comparison groups which exploit apparently random natural variation in assignment (such as a lottery) or random errors in implementation, etc. Natural experiments that approximate randomized evaluations, regression discontinuity designs, or interrupted time series designs will be categorized as such.
3. Non-randomized studies with pre-intervention and post-intervention outcome data for both intervention and comparison groups, where data are individual level panel or pseudo-panels (repeated cross-sections), which use the following methods to control for confounding:
    a. Studies controlling for time-invariant unobservable confounding, including difference-in-differences, fixed-effects models, or models that contain a baseline measure of the dependent variable (e.g., an interaction term between time and intervention for pre-intervention and post-intervention observations).
    b. Studies assessing changes in trends in outcomes over a series of time points with a contemporaneous comparison (controlled interrupted time series, ITS), and with sufficient observations to establish a trend and control for effects on outcomes due to factors other than the intervention (such as seasonality).
4. Non-randomized studies that create a matched comparison group similar to the treated group on specific characteristics to control for observable confounding, including statistical matching, exact covariate matching, coarsened-exact matching, and propensity score matching.
5. Studies that build a counterfactual through synthetic control approaches.
6. Non-randomized studies that control for confounding using instrumental variable (IV) approaches such as two-stage least squares procedures.

We will exclude before-after studies without a comparison group or cross-sectional studies that do not attempt to control for selection bias or confounding. Studies that only examine willingness-to-pay for goods, services, process, and business models will be excluded.

Experiments conducted in tightly-controlled settings, like those in a laboratory, lab-in-the-field studies, and studies that measure immediate reactions to a short-term exposure (i.e. studies where implementation and data collection is started and completed within a single day) will be excluded.

Appendix E: List of Resilience and Environment Vulnerability Indices for the REA

This note details the environmental indices scoped to derive a shortlisting criterion for priority regions for the Rapid Evidence Assessment. The aim of the REA is to understand effects of interventions on food system resilience outcomes in countries affected or more vulnerable to climate change. With the guidance from DEval, we scoped indices related to environmental vulnerabilities and resilience that could be used to shortlist at-risk countries. This was a keyword search and snowballing from some known and recommended sources. Our criterion for shortlisting indices were the following –

- Contains quantifiable country ranking
- Looks at resilience and climate vulnerability (thus implying, we excluded rankings that looked at environmental sustainability levels, just transition indices, energy transition rankings etc.)
- Includes time period that covers the range of interventions
- Is based on sound methodology

In list A, we provide an assessment brief of the indices searched, with associated pros, cons, and assessments and inclusion status

In list B, we provide a list of projected vulnerability indices included in our analysis

List A. Overview of climate vulnerability/risk indices for REA

Indices Used in Our Review

- Global Climate Risk Index (Germanwatch – David Eckstein, Vera Künzel, Laura Schäfer) – Measures country-level impact of climate change based on extreme weather events and socio-economic data.
- ND-GAIN Country Index (University of Notre Dame Global Adaptation Initiative) – Assesses vulnerability to climate hazards and readiness for adaptation using 45 indicators, including food security.
- GDL Vulnerability Index (Radboud University, NL – Smits, J. and Huisman, J.) – Evaluates socio-economic vulnerability to climate change with projections until 2100.
- WeltRisikoIndex (Bündnis Entwicklung Hilft & Ruhr-Universität Bochum) – Combines exposure, vulnerability, and adaptive capacities using 100 indicators for comprehensive risk assessment.
- INFORM Climate Change + INFORM Risk Index (Inter-Agency Standing Committee & European Commission) – Provides climate-related risk assessment with projections up to 2050, focusing on vulnerable groups.
- Climate Vulnerability Monitor (Climate Vulnerability Forum & DARA) – Assesses climate impact across 184 countries, covering economic, health, social, and environmental vulnerabilities.

Indices Excluded from Our Review

- Climate-Conflict-Vulnerability Index (University of the Bundeswehr Munich & Potsdam Institute for Climate Impact Research) – Limited to 2024 data, making it

unsuitable for long-term trend analysis.

- FM Resilience Index (FM – Factory Mutual) – Lacks clear climate data sources, has gaps for African countries, and does not track interventions over time.
- Children's Climate Risk Index (UNICEF) – Focuses only on children and only provides data for the year 2021
- Drought Risk + Baseline Water Stress + Riverine Flood Risk Indices (World Resources Institute – WRI) – Only covers water-related risks, making it too narrow for our needs.
- Climate Change Performance Index (Multiple authors – CCPI Initiative) – Focuses on climate mitigation policies rather than vulnerability or adaptation.
- Environmental Performance Index (Yale University & Columbia University) – Primarily assesses climate change mitigation and environmental health, not resilience or vulnerability.

List B - Projected vulnerability included indices

- GDL Vulnerability Index (Radboud University, NL – Smits, J. and Huisman, J.) – Has projections up to 2100 in 5-year intervals, with key years selected for analysis (2035, 2050, 2075). Uses two relevant pathways: SSP2 ('middle of the road' scenario, assuming uneven economic growth) and SSP5 ('taking the highway' scenario, focused on rapid economic development at the cost of environmental degradation).
- INFORM Climate Change Index (Inter-Agency Standing Committee & European Commission) – Uses 2022 as the baseline with projections for 2050 and 2080. Reports indicate that climate change will increase humanitarian crises, particularly in Africa and low-income countries, with drought as a primary driver. Includes all countries rated as high and very high risk, and rankings for 2050 and 2080 allow for prospective use as a continuous variable in moderator analysis.
- Climate Vulnerability Monitor (Climate Vulnerability Forum & DARA) – Uses 2010 as a baseline with projections for 2030. Only countries classified as Acute and Severe vulnerability were included in the analysis.

Appendix F: Provisional Quantitative data extraction for the REA

Variable label	Explanation
GENERAL INFORMATION	
Coder name	Record your name
Notes	Record any notes important for the team INDICATE IF IT IS LINKED STUDY HERE AND THE EPPI OF THE MAIN STUDY (for example "Linked to study 1111111").
PUBLICATION INFORMATION	
StudyID	This is the study ID - it should match the study ID from the Outcome Mapping Sheet (e.g., 946578). If EPPI is being used, this will be the EPPI ID
EstimateID	The estimate ID will provide a specific number for each effect size extracted and should include the original study number, underscore, then the unique ID number (e.g., 946578_1, 946578_2 and so on)
Study status	Select one of the following: 1) Completed; 2) Protocol; 3) Ongoing
Author name	Author last name For 1 author: leading author last name (e.g. Gomez) For 2 authors: both author last names with ampersand in between (e.g. Smith and Bahn) For 3 or more authors: leading author last name followed by et al. (e.g. Gupta et al.)
Year of publication	Year published (publication date, not preprint or first online publication dates)
Publication type	Select one of the following: i) Journal article; ii) Book or chapter; iii) Report or working paper; iv) Conference proceedings; v) Published protocol (select if a published protocol, registration, or pre-analysis plan; vi) Ongoing study (select if not a registered study or published protocol but, for example, a description of the study on an organisational or authors' personal webpage)
INTERVENTION INFORMATION	
Intervention sub-group	Choose one or more intervention sub-group code(s) for each corresponding effect size: Choose one or more intervention sub-group code(s) for each corresponding effect size: If select Multiple intervention, add a comment in the cell with a very brief summary of the interventions: for example: "Protected areas and cash transfers". There should be at least one of the three interventions of interest (protected areas, land rights or decentralisation of land) Consumer behaviour Classes Peer support / counsellors Community meetings Professional services (dieticians / nurses) Healthy food social marketing campaigns Food production system Farmer field schools Agricultural extension programmes Other educational programmes Information and guidance Food supply and environment Storage and distribution education and capacity strengthening Process and packaging education and capacity strengthening
Intervention name and abbreviation	Provide name and abbreviation of the intervention and its different components. Include details of sections of the manuscript and page numbers where authors describe name of the intervention. Please only report the intervention related to the estimate if a paper reports on more than one intervention or treatment arm. Elements here should coincide with the previous and next columns meaning that the name of the intervention taken from the study should match with the

Variable label	Explanation
	intervention subgroup. and intervention description If you feel that the description does not coincide with the previous and next columns, complete all columns as much as you can and leave a comment indicating if you think information across the 3 intervention columns here do not match. Intervention name and abbreviation (if any or put N/A if no name) appears here. Information should reflect the evaluated intervention. For example: "SHoMaP (Smallholder Horticulture Marketing Programme). Name of the intervention: ___
Intervention description	Provide detailed description of the intervention and its different components. Include details of sections of the manuscript and page numbers where authors describe details of the intervention. Please only report the intervention related to the estimate if a paper reports on more than one intervention or treatment arm. Elements here should coincide with the 2 previous columns meaning that the description of the intervention taken from the study should match with the intervention subgroup and intervention name. If you feel that the description does not coincide with the two previous columns, complete all columns as much as you can and leave a comment indicating if you think information across the 3 columns here do not match. What is the intervention? ____ How did it work? ____ Where and when did it happen? ___ Any specification? ___ Also, reminder: any time you use verbatim, or you use data remember to put the page number, so it is easy to check and verify.
Behavioural function	Select the behavioural function of the intervention : Capability Physical Capability: The physical ability to perform the behaviour (e.g., strength, skill). Psychological Capability: The mental capacity to engage in the necessary thought processes (e.g., knowledge, cognitive skills). Opportunity Physical Opportunity: Environmental factors that make the behaviour possible (e.g., time, resources). Social Opportunity: Social norms and cultural factors that influence behaviour. Motivation Reflective Motivation: Deliberative processes such as intentions and evaluations. Automatic Motivation: Impulses, habits, and emotional responses.
Country	Country of intervention
Non-staggered intervention	Have the treated observations been exposed to the intervention for the same amount of time? 1=Yes; 0=No
Year of the intervention	The earliest date (year) observations are exposed to the intervention.
Length of follow up	How many months have elapsed between the start of the intervention (earliest date observations are exposed to the intervention) and the date of the final outcome measurement. If less than one month, use decimals (e.g. one week would be .25, etc.).
Exposure to intervention	For how long are the observations exposed to the intervention (in months)? If less than one month, use decimals (e.g. one week would be .25, etc.). Note: If the intervention is active throughout the evaluation period, this value will be the same as the length of follow up. Answer here cannot be greater than in the length of the follow up. Minimum is 0.25 (cannot be 0).

Variable label	Explanation
METHOD INFORMATION	
Evaluation Design	Select one of the options below: 1. Experimental (defined as prospective randomized assignment, where randomisation is implemented by researchers (or by decision makers in the context of an evaluation study) 2. Quasi-experimental (including natural experiments and non-randomized studies)
Evaluation Method	● If Experimental, then select: i) Randomised controlled trial ● If Quasi-experiment or natural experiment, then select one of the following: i) Natural experiment in which exposure to treatment is random; ii) Regression Discontinuity Design (RDD); iii) Difference-in-Differences (DID) / Fixed effects estimation; iv) Instrumental variable (IV) estimation; v) Endogenous treatment-effects models (including endogenous switching regression, and other methods synonymous to the Heckman two step model); vi) Statistical matching (includes PSM or statistical weighting) vii) Interrupted time series (ITS); viii) Synthetic controls
Method description	Provide a brief description of the method applied and note if any methods have been combined.
Study population	Provide any details in the paper that describe how the study population was selected, covering: a) How is the population selected? what is the sampling strategy to recruit participants from that population into the study? b) What are the characteristics of study participants? Targeted population appears first in the cell. Explanations can follow afterwards Need to add all specified information in the study on the targeted population: subsistence farmers, commercial farmers, ... (look in data section).
Additional methods	Describe any additional methods used in analysis. If none, select not applicable.
ESTIMATE INFORMATION	
Analysis type for this effect size	Free text, what type of analysis was used (OLS regression, Probit regression, 2SLS, ANCOVA, etc.)
Treatment effect estimated	1=Intention to Treat (ITT), 2=Average Treatment Effect on the Treated (ATET), 3=Average Treatment Effect (ATE) 4 = Local Average Treatment Effect (LATE), 5=Other
Treatment effect estimated other	Provide details if other treatment effect estimated Also include the relevant matching algorithm here (ex: kernel, nearest neighbour, etc...)
Unit of analysis	What is the unit of analysis? UOA for this effect size: 1= Individual, 2= Household, 3= Group (e.g., community organisation), 4= Village, 5 = Other, 6 = Not clear If OTHER, ALWAYS PLEASE SPECIFY with a comment in this cell. For example: 5 = Other, comment in this cell: "crop level" or 5 = Other, comment in this cell: "district level". In some cases, authors may use a different word for the choices 3= Group or 4= Village, but still use these 2 options. For example, if authors conduct analysis at the village leader, select 4. If authors conduct the analysis at the cooperative level, choose 3.
Covariate adjustment	Did the regression specification control for variables other than the treatment variable? 1= Yes; 0 = No. This includes matching variables.
Covariate adjustment description	List the control variables included in the specific specification related to the estimate (including any noted fixed effects).
Source	Note the page number, table number, column, and row you used to extract the estimate data [Open Answer]
OUTCOME DATASET	

Variable label	Explanation
Outcome sub-group	Choose an outcome sub-group code for each corresponding estimate: 1. Food security - Aggregated Aggregated measures of all or multiple pillars of food security 1.1 Food availability Refers to the consistent supply of sufficient quantities of food through domestic production, imports, food aid, and stock levels. It depends on factors like agricultural productivity, distribution, and trade. 1.2 Food access Involves having the resources (economic and physical) needed to obtain nutritious food. It is influenced by income levels, food prices, distribution networks, and social support systems. 1.3 Nutrition and utilisation Relates to the proper biological use of food, ensuring that people can absorb and benefit from nutrients. It depends on food quality, safety, preparation, dietary diversity, and access to clean water and sanitation. 1.4 Adequacy and sustainability Ensures that food availability, access, and utilisation are consistently maintained over time, without fluctuations due to economic, climatic, or political crises.
Outcome name	Record the outcome for the corresponding effect size. Use this open answer field to enter, in the author's own words, the name of the outcome. Need to be crop specific if specified. Crop
Outcome description	Record the outcome for the corresponding effect size. Use this open answer field to enter, in the author's own words, a description of the outcome. Be selective and concise with the excerpts being transcribed here as to ensure accurate and precise descriptions of the outcome. Include information about the unit of the outcome and how it has been measured. Include page numbers with every excerpt extracted. all units (ex: kg/hectare). level (per household, per capita,…) all crops or combination or single crop. Time period of measure (last 12 months, last season, last 7 days, last 24 hours) If measure standardized by standard deviation (nothing to specify if not) ALSO SPECIFY THE currency AND SPECIFY IF OUTCOME IS IN LOG. Don't need to specify type (binary, continuous, etc. as in the following column, also to check) Examples: "Maize yields kg/hectare in last harvest" "HDDS (out of 12 food groups over 7 days)" "Number of consumer durables (out of 20)" Need to be crop specific if specified. Crop
Outcome measurement	How was the data collected? 1=Self-reported, 2=Administrative data, 3=Satellite data
Outcome type	Record the type of outcome variable: 1=Continuous; 2=Discrete (including proportions); 3=Nominal (binary); 4=Ordinal (binary); 5=Nominal (non-binary); 6=Ordinal (non-binary); 7=Interval.
Levels or changes	0 = Unit is the level of outcome variable, 1 = Change in outcome variable
Reverse sign	Record no=0 if an increase is good, record yes=1 if a decrease is good and the sign needs to be reversed (i.e., decrease is good)
Outcome dataset	Record if data for this outcome comes from an identified dataset
TREATMENT VARIABLE INFORMATION	

Variable label	Explanation
Treatment	Record the treatment variable as written in the model (e.g., the variable name the author uses, such as "Marketing contract" or "Production contract"). This column enables to distinguish what treatment is evaluated here for this specific estimate. This is very important as many studies have multiple treatments. FOR EXAMPLE: 74713715 (Benali 2017). Authors evaluated the impact of CF offered by two export supply chain (ESC) actors HVESC and RESC. The first few estimates are from the combined effect of both actors ("ESC" in the article) and other are from HVESC specifically and others are from RESC. Here this information should appear in this column so ESC, HVESC or RESC.
Treatment type	Describe the types of treatment variable used: i) binary; ii) continuous; iii) categorical; iv) other
Comparison	1=No intervention (service delivery as usual), 2=Other intervention, 3=Pipeline (waitlist) control (still service delivery as usual) 4. Other
Describe comparison group	Describe the comparison group
Stated objective of the treatment is to increase resilience of beneficiaries (minimise vulnerabilities to environmental and other shocks)?	0: No; 1:Yes Treatment needs to mention in theory of change/conceptual framework that it aims to increase adaptability to shocks, or to reduce risks/exposure to shocks. OR treatment was designed with the aim to increase adaptability to shocks, or to reduce risks/exposure to shocks.
Resilience information	Describe how this treatment aims to reduce vulnerability to environmental and other risks and crises. If treatment does not state that it aims to reduce vulnerability to shocks and risks, select not applicable
Aspect(s) of resilience targeted?	1=Ability to cope with crises independently, 2=Ability to prepare for recurring stresses, 3=Ability to mitigate negative effects 4=Ability to gradually overcome crises through structural changes Multiple answers allowed. Independent of answer of AO.
Subgroup	Is this analysis of a subgroup or estimating heterogeneous effects? 0=no, 1=yes
Subgroup information	Describe the subgroup or variable interacted with the treatment variable (e.g., boys, girls), etc. If no subgroup or heterogeneity analysis, select not applicable
ESTIMATE DATA	
Mean treatment (Pre)	Outcome mean for the treatment group (pre-intervention)
SD treatment (Pre)	Outcome standard deviation for treatment group (pre-intervention)
Mean Control (Pre)	Outcome mean for the comparison group (pre-intervention)
SD Control (Pre)	Outcome standard deviation for control group (pre-intervention)
Mean treatment (Post)	Outcome mean for the treatment group (post-intervention)
SD treatment (Post)	Outcome standard deviation for treatment group (post-intervention)
Mean Control (Post)	Outcome mean for the comparison group (post-intervention)
SD Control (Post)	Outcome standard deviation for control group (post-intervention)
SD pooled (Pre)	Outcome standard deviation for pooled group (treatment and control) (pre-intervention)
SD pooled (Post)	Outcome standard deviation for pooled group (treatment and control) (post-intervention)
SD pooled (PP)	Outcome standard deviation for pooled group (treatment and control) (includes pre and post intervention data)
Mean difference	Overall mean difference (treatment - control)

Variable label	Explanation
SE difference	Standard error of the overall mean difference In the results table under the coefficients and in parentheses, authors do not always report SE but sometimes provides the t-stat or the p-values. Make sure you extract the correct information in the relevant column. SE in SE reg, T-stat in Tstat reg, etc.
Tstat difference	t-statistic of mean difference In the results table under the coefficients and in parentheses, authors do not always report SE but sometimes provides the t-stat or the p-values. Make sure you extract the correct information in the relevant column. SE in SE reg, T-stat in Tstat reg, etc.
Odds ratio	Odds ratio reported in the study
SE odds ratio	Odds ratio standard error reported in the study
Risk ratio	Risk ratio reported in study
SE Risk Ratio	Risk ratio standard error
Coeff reg	Report the regression coefficient of the treatment effect
SE reg	Report the associated standard error of the regression coefficient. In the results table under the coefficients and in parentheses, authors do not always report SE but sometimes provides the t-stat or the p-values. Make sure you extract the correct information in the relevant column. SE in SE reg, T-stat in Tstat reg, etc.
Tstat reg	Report the associated t statistic of the effect size (coefficient/SE) In the results table under the coefficients and in parentheses, authors do not always report SE but sometimes provides the t-stat or the p-values. Make sure you extract the correct information in the relevant column. SE in SE reg, T-stat in Tstat reg, etc. You can mentally calculate the t-statistic = coefficient estimate / standard error. DO NOT REPORT THE CALCULATE THE T-STAT IF IT NOT PROVIDED IN THE TEXT. If MENTALLY calculated t-stat or t-stat in the text is more than 10 or less than -10, simply check again the coef and se or t-stat. If still more than 10 or less than -10, put a comment indicating that you have checked this, and this is what is actually reported in the paper.
CI_LB reg	Report the associated Lower bound of the 95% Confidence interval of the effect size. If CI is reported for a different confidence level, indicate that in the notes section.
CI_UP reg	Report the associated Upper bound of the 95% Confidence interval of the effect size. If CI is reported for a different confidence level, indicate that in the notes section.
P value exact	Exact p-value if given, if not, record as written in the manuscript (e.g., p < .001, or p > .05) In the results table under the coefficients and in parentheses, authors do not always report SE but sometimes provides the t-stat or the p-values. Make sure you extract the correct information in the relevant column. SE in SE reg, T-stat in Tstat reg, etc.
Interaction term 1 coeff	Required if requested to extract information from an interaction term (in addition to a single term) For estimates based on interaction term (Y=B1treat+B2treat*female), It is very important to extract both B1 (and associated SE, T-stat or p-value) in column Coeff reg and B2 (and associated SE, T-stat or p-value) in THIS column.

Variable label	Explanation
Interaction term 1 SE	Required if requested to extract information from an interaction term (in addition to a single term)
Interaction term 1 Tstat	Required if requested to extract information from an interaction term (in addition to a single term)
Interaction term 1 CI_LB	Required if requested to extract information from an interaction term (in addition to a single term)
Interaction term 1 CI_UP	Required if requested to extract information from an interaction term (in addition to a single term)
Interaction term 1 P value exact	Required if requested to extract information from an interaction term (in addition to a single term)
Clusters treatment	Number of clusters - treatment group Check thoroughly if authors cluster the standard errors for this estimate. Most often it is specified in the model or under the table (control + F and search for "cluster").
Clusters control	Number of clusters - control group Check thoroughly if authors cluster the standard errors for this estimate. Most often it is specified in the model or under the table (control + F and search for "cluster").
Clusters total	Number of clusters - total sample Check thoroughly if authors cluster the standard errors for this estimate. Most often it is specified in the model or under the table (control + F and search for "cluster").
N treatment	Sample size - treatment group DO NOT LEAVE EMPTY. IF THE ANSWER IS NOT CLEAR HERE, INDICATE THIS. Information on sample size is very important. Either 1) information on N treatment and N control or 2) information on N total is available.
N control	Sample size - control group DO NOT LEAVE EMPTY. IF THE ANSWER IS NOT CLEAR HERE, INDICATE THIS. Information on sample size is very important. Either 1) information on N treatment and N control or 2) information on N total is available.
N total	Sample size - total sample DO NOT LEAVE EMPTY. IF THE ANSWER IS NOT CLEAR HERE, INDICATE THIS. Information on sample size is very important. Either 1) information on N treatment and N control or 2) information on N total is available.
Periods	Record how many time points (e.g. measurement points) there are in the analysis (e.g., cross sectional data is 1, panel data with 3 measurements is 3). DO NOT LEAVE EMPTY. IF THE ANSWER IS NOT CLEAR HERE, INDICATE THIS.
Does the sample size need to be corrected?	Often in panel data, models will report number of observations rather than number of participants. In this column you will indicate 1="Yes" if the sample size needs to be divided by the number of periods, and 0="No" if either it is cross-sectional data, or if the authors have already divided the number of observations by the number of panel assessments and thus no correction is necessary. DO NOT LEAVE EMPTY. IF THE ANSWER IS NOT CLEAR HERE, INDICATE THIS.
Source	Note the page number, table number, column, and row you used to extract the data
UNIT OF ANALYIS ERROR	

Variable label	Explanation
M: number of observations per cluster (unit of treatment allocation)	Example 1: Explanation column: Intervention (FFS) at the village level (p8 and p11) and analysis at the Household. There are approximately 2.5 villages per district and the sample of 1986 households 108 district. m=1986/ (108*2.5) c=0.05 Example 2: Explanation column: Intervention (land titles) at the household level (p759) and analysis at the Plots. p759: 325 farm households. In total, 1,678 plots were included in the survey. So, there are 3.6 plots per household on average. m=1678/325=5.16 c=0.05 Example 3: Explanation column: Intervention (soil and water conservation) at the village level (p27) and analysis at the Household. There were 1218 hh in 139 villages. m=1218/138=8.76 c=0.05
c: intra-cluster correlation coefficient. Assumed at 0.05 for the moment.	
Explanation	
OTHER INFORMATION	
Other linked to previous columns	Provide any other relevant information from the study

Appendix G: Provisional quantitative data extraction for the REA

Continuous outcomes

For studies reporting regression results for continuous outcomes, we will standardize the effect sizes following the approach suggested by Keef and Roberts (2004). This includes dividing the regression coefficient (β) by the pooled standard deviation (SD) of the outcome.

$$SMD = \frac{\beta}{SD_{pooled}} \quad \text{(i)}$$

When using parsimonious regression specifications, this approach is analogous to Cohen's d (d), which is the difference in means between the treatment and control (or comparison) group divided by the pooled SD of the outcome (i.e. the standardized mean difference). Because Cohen's d can be biased in cases where sample sizes are small, in all cases we will simply adjust d using Hedges' method. This transformation adjusts Cohen's d to Hedges' g using the following formula (Ellis 2010):

$$g \cong d(1 - \frac{3}{4(n_T+n_C)-9}) \quad \text{(ii)}$$

Where n denotes the sample size of the treatment (nT) and control (nC) groups. If the intervention is expected to change the SD of the outcome variable, we will use the SD of the control group to compute d instead. If the study does not report the pooled SD but information about sample size is available for both the treatment and control groups, we will use regression coefficients and standard errors (SEs) or t statistic (t) to calculate the following:

$$d = t\sqrt{\frac{1}{n_T} + \frac{1}{n_C}} \quad \text{(iii)}$$

Alternatively, when only information on the total sample size (N) is available, we will use the following formula suggested by (Polanin and Snilstveit 2016):

$$d = \frac{2t}{\sqrt{N}} \quad \text{(iv)}$$

$$Var_d = \frac{4}{N} + \frac{d^2}{2N} \quad \text{(v)}$$

Here we will calculate the t-statistic (t) by dividing the coefficient by the SE. If the authors only report confidence intervals (CI) and no SE, we will calculate the SE from the confidence intervals:

$$SD = \sqrt{N}\ \frac{(upper\ CI - lower\ CI)}{I} \quad \text{(vi)}$$

where I is 3.29 for estimates using 90% confidence intervals, 3.92 for 95% confidence intervals, and 5.15 for 99% confidence intervals.

In cases in which significance levels are reported rather than t or a beta coefficient (b) with the associated SE, then we will impute t using a t-distribution table. If the precise probability value is not reported, then we will assume the following:

Prob > 0.1: t = 0.5
0.1 ≥ Prob > 0.05: t = 1.8
0.05 ≥ Prob > 0.01: t = 2.4
0.01 ≥ Prob: > 0.001: t = 2.8
Prob: ≥ 0.001: t = 3.291

If an exact p-value is reported, we will use the following Excel function to determine the t-value.

=T.INV.2T(exact p value, (n-1))

In some cases, the studies we include in the review may not report a regression coefficient, but the group means ($\bar{X}$) and pooled SD for treatment and control group at follow up only (p + 1). Here we will calculate d using formulae provided in (Borenstein et al. 2009):

$$d = \frac{\bar{X}_{T_{p+1}} - \bar{X}_{C_{p+1}}}{SD_{p+1}} \quad \text{(vii)}$$

If the study does not report the pooled SD, it is possible to calculate it using the following formula:

$$SD_{p+1} = \sqrt{\frac{\left(n_{T_{p+1}} - 1\right) SD^2_{T_{p+1}} + \left(n_{C_{p+1}} - 1\right) SD^2_{C_{p+1}}}{n_{T_{p+1}} n_{C_{p+1}} - 2}} \quad \text{(viii)}$$

For studies reporting the difference in treatment and control group means and the pooled SDs at baseline (p) and follow up (p + 1):

$$d = \frac{\Delta\bar{X}_{T_{p+1}} - \Delta\bar{X}_{T_p}}{SD_p} \quad \text{(ix)}$$

Finally, for studies reporting mean differences between treatment and control group, standard error (SE) and sample size (n):

$$d = \frac{\Delta\bar{X}_{T_{p+1}}}{SE\sqrt{n}} \quad \text{(x)}$$

Outcomes measured as proportion of individuals

If outcomes are reported in proportions of individuals, we will calculate the Cox-transformed log odds ratio effect size (Sánchez-Meca, Marín-Martínez, and Chacón-Moscoso 2003):

$$d = LogOddsRatio \ \frac{\sqrt{3}}{\pi} \quad \text{(xi)}$$

Outcomes measured as proportion of events or days

If outcomes are reported based on proportions of events or days, we will use the standardized proportion difference effect size:

$$d = \frac{w_T - w_C}{SD(w)} \quad \text{(xii)}$$

Where w_T is the proportion in the treatment group and w_C the proportion in the comparison group, and the denominator is given by:

$$SD(w) = \sqrt{w(1-w)} \quad \text{(xiii)}$$

Here w is the weighted average of w_T and w_C:

$$w = \frac{n_T w_T + n_C w_C}{n_T + n_C}$$

Appendix H: Criteria determining selection of effect estimates for data extraction

We will extract effects reported across different interventions, outcomes, and subgroups within a study. We will address dependent effect sizes using data processing and selection techniques. We will utilize several criteria to select one effect estimate per outcome per study:

- Where studies report effects from multiple model specifications, we will use the author's preferred model specification. Only if the preferred specification is unclear, we will use the most precise estimate of the treatment effect (measured by the one with the largest t-value). This reflects regression adjustments in designs, such as RCTs, IV, RDDs, are usually made on grounds of model efficiency but explorative specifications (e.g. including interaction terms, higher order terms, etc.) may not be the most efficient estimates (in fact they could be highly inefficient) where the added terms are not significant.
- Where studies report effects from multiple estimators, we will use the author's preferred specification. Only if the preferred specification is unclear, we will use the specification that appears most robust to falsification tests (e.g. according to sensitivity analysis for propensity score matching or placebo tests for difference-in-difference estimators).
- Where different studies report on the same programme but use different samples (e.g., from different regions), we will include both estimates, treating them as independent samples, provided effect sizes are measured relative to separate control or comparison groups.
- Where studies report evidence according to subgroups of participants, we will record and report data on relevant subgroups separately.
- For studies with outcome measures at different time points, we will synthesize short- and long-term outcomes separately, following De la Rue et al. (2013).
- When studies include multiple outcome measures to assess related outcome constructs, we will follow our pre-specified preferred outcome order (described below) without reference to the results.
- When studies report multiple outcome subgroups for the same outcome construct, but do not present an effect for the full sample, we may calculate a “synthetic effect size” using the sample-weighted average, and applying appropriate formulae to recalculate variances (Borenstein et al. 2009).
- If studies include multiple treatment arms with only one control group and the treatments represent separate treatment constructs, we will calculate the effect size for treatment A versus control and treatment B versus control and include them in separate meta-analyses according to the intervention type. Where multiple treatment arms represent the same treatment construct, we may calculate a “synthetic effect size”.

This also includes criteria prioritising specific outcome measures within included studies:

- Our analysis will prioritize synthesising outcomes using composite or aggregate indicators. If a study does not report a composite measure, we will use the outcome that most closely relates to the intervention type and perform outcome mapping to identify the outcome in each study that appears most frequently across studies.

- Where an intervention targets or concerns one specific commodity, our analysis will use commodity specific outcomes for price, production, and intermediate outcomes. If the intervention targets and reports outcomes for more than one commodity, we will use the most frequent type of commodity specific outcome reported across studies. If a study reports outcomes for both arable and permanent crops, we will select one prioritized arable crop and one prioritized permanent crop to perform sensitivity analysis on the type of crop prioritized for this sample of studies. We will also distinguish between staple and cash crops, again taking the most frequent staple or cash crop reported across studies as the prioritized outcome.
- Specific preferences for measures of outcome constructs are also outlined in the table below. We will consider, where possible, creating combined and separate meta-analysis for different measures of the same outcome construct or control for groups of outcome measures in a meta-regression.

The number of possible ways any outcome construct can be measured is often large. The list of priority outcomes in the table below are unlikely to be entirely comprehensive given it only accounts for some common measures which are presented simultaneously in studies (which creates the need to choose a preferred outcome for the synthesis). We will consult subject experts, without reference to the results of a study, to establish an order of preference should studies present multiple measurements of an outcome construct that is not already captured by the priority criteria established in this protocol.

Appendix I: Risk of bias assessment tool for REA

Questions	Explanations/Answers
EstimateID	The estimate ID will provide a specific number for each effect size extracted and should include the original study number, underscore, then the unique ID number (e.g., 946578_1, 946578_2 and so on)
Intervention description	Use a few words to describe the intervention. Should be same as in the QEX (column K).
Intervention sub-group	Should be same as in the QEX (column J).
	Production system: i) Education / information - other capacity strengthening programmes ii) Education / information - Agricultural extension programmes iii) Livestock access iv) Land markets & management v) Education / information - Farmer field schools vi) Other ag inputs vii) Ag credit / savings Behaviour change communication: i) Classes ii) Peer support/counsellors iii) Community meetings Availability and affordability: i) Direct provision of foods
Outcome sub-group	Should be same as in the QEX (column AD).
	Resources i) Access to economic and livelihood resources ii) Ownership of land and assets iii) Control over resources iv) Time use Agency i) Decision-making ii) Women's rights iii) Collective action and leadership Achievements i) Gender transformative outcomes ii) Improved systems and policymaking iii) Self-esteem iv) other empowerment outcomes and indices
Outcome description	Use a few words to describe the outcome. Should be same as in the QEX (column AE and AF).
Evaluation Method	Should be same as in the QEX (column R).
	1: Randomised controlled trial 2: Natural experiment 3: RDD 4: DiD & FE 5: IV 6: Endogenous treatment-effect models 7: Statistical matching 8: ITS (Interrupted-time series)
Evaluation Method description	Provide a short description of the evaluation method referencing the study (with the page number) (column S). For example: "In this study, we address the problem of selection on unobservable by

Questions	Explanations/Answers
	combining PSM with the use of the double-difference (DD) estimator" pXXX.
1. Unconfoundedness and absence of selection bias	Q1. Was the allocation or identification mechanism able to control for selection bias? AND Was the evaluation method executed adequately to ensure comparability of groups throughout the study and prevent confounding? Yes Probably yes Probably No No Insufficient information
	Yes or **Probably Yes** if the study satisfies ALL of the following requirements (depending on the evaluation method) for this estimate (**No** or **Probably No** otherwise): If **Randomised controlled trial or a Natural experiment**: a) Centralized and independent treatment randomization at the start of the intervention is described (lottery, coin toss, random number generator). OR if randomization was done in sequence, authors provide detail on the exact settings and participants attending the lottery. OR if randomization was done in a special way, it is justified given the study setting (stratification, pairwise matching, unique random draw, multiple random draws etc.). b) A balance table is reported suggesting that allocation was random between all groups including subgroup receiving different treatment within control or treatment groups (if the comparison is relevant for this assessment). If **RDD**: a) Treatment assignment is made based on a pre-determined and independent discontinuity on a variable (assignment variable) AND the unit of analysis cannot manipulate the assignment variable. b) The mean of the covariates of the individuals immediately at both sides of the cut-off point are NOT statistically different OR authors control for the differences in the estimation model. c) Placebo tests are conducted to verify robustness. If **DiD & FE (also if combined with statistical matching)**: a) Authors use pre-treatment data to support the parallel trend assumption in the absence of the treatment OR in the absence of several rounds of pre-treatment data, authors control for differences in trends in the treatment and control groups. b) Authors control for relevant time-varying and constant differences between treatment and control groups observations OR placebo tests are conducted to verify robustness. c) If the intervention delivery is staggered, authors apply adjustments or use statistical matching. If **IV or Endogenous treatment-effect models**: a) Instrument(s) is(are) strongly correlated with the endogenous variable (indicate in the justification column, the relevance test results) OR authors use weak instrument and apply adjustments. b) Authors provide a convincing discussion that the instrument(s) is(are) exogenously generated (not correlated with the error term), for example, due to a "natural" experiment or random allocation. If **Statistical matching**: a) Authors use all relevant baseline and/or exogenous covariates (variables should not be affected by the treatment). b) Authors show based on diagnostics that the covariates are balanced after-matching across treatment and control groups' observations (with the exception of Kernel matching). c) Rosenbaum's test (or synonymous sensitivity analysis) is displayed and suggests that the estimate is not sensitive to the existence of hidden bias (bounds critical gamma cutoff value is >= 2). If **ITS**: a) Authors discuss and address non-stationarity (including seasonality).

Questions	Explanations/Answers
	b) Authors control for other time-varying confounders such as other events OR authors use a valid control group or control outcome (unaffected by the intervention). **Insufficient information**: insufficient information.
1. Justification	Q1. Answer justification (use references with page numbers).
2. Absence of non-random attrition AND significant missing data	Q2. Was the analysis conducted in the absence of non-random attrition and significant missing data? Yes Probably yes Probably No No Insufficient information
	Yes or **Probably Yes** if the study satisfies ALL of the following requirements for this estimate (**No** or **Probably No** otherwise): a) Attrition rate is less than 5% OR less than or equal to assumed in power calculations. b) Attrition is random (balance between attritors and non-attritors). OR Attrition is not random but authors apply convincing statistical techniques to identify and address the attrition bias (for example, only using observations in the analysis present in all rounds of the data). c) Analysis is conducted using most of the collected data (missing data is less than 10%) (for example, the data section reports that data was collected on 600 households and the number of observations used in the analysis is close to 600). **Insufficient information**: insufficient information.
2. Justification	Q2. Answer justification (use references with page numbers).
3. Absence of spillovers/crossovers and contamination	Q3. Was the study adequately protected against spillovers, crossovers, and contamination? Yes Probably yes Probably No No Insufficient information
	Yes or **Probably Yes** if the study satisfies ALL (a and b) of the following requirements for this estimate (**No** or **Probably No** otherwise): a) Treatment and control observations are sufficiently far away (geographically and/or socially) from one another and general equilibrium effects are unlikely so that the intervention is unlikely to spill-over to the control group observations. b) Treatment and control groups are isolated from other interventions which might affect the outcomes. Problems with crossovers and drop-outs are dealt with using intention to-treat analysis (ITT) or Local Average Treatment Effect (LATE) analysis. **Insufficient information**: insufficient information.
3. Justification	Q3. Answer justification (use references with page numbers).
4. Absence of outcome measurement	Q4. Was the outcome measured in the same way between study arms and outcome measurement was not affected by knowledge of the intervention?

Questions	Explanations/Answers
bias	Yes Probably yes Probably No No Insufficient information
	Yes or **Probably Yes** if the study satisfies the following requirement for this estimate (**No** or **Probably No** otherwise): a) Outcomes were not self-reported by participants (for example outcomes come from administrative records) OR outcomes are self-reported **but respondents are unlikely to be influenced by knowledge of administration of the intervention OR outcome assessors were blinded**. **IF RELEVANT:** **b) For self-reported outcomes: respondents in the intervention group are not more likely to have accurate answers due to recall bias;** **If relevant, discuss here how recall data bias may affect the outcome measurement of the intervention group. If it affects both treatment and control groups in a similar way, do not consider this as a risk of bias.** **Insufficient information**: insufficient information.
4. Justification	Q4. Answer justification (use references with page numbers).
5. Absence of reporting bias	Q5. Was the study free from selective analysis reporting? Yes Probably yes Probably No No Insufficient information
	Yes or **Probably Yes** if the study satisfies the following requirement for this estimate (**No** or **Probably No** otherwise): a) There is no evidence that outcomes were selectively reported (e.g. all relevant outcomes in the methods section are reported in the results section) OR There is only one possible way in which the outcome domain can be analysed OR researchers have provided the reasons for any inconsistencies (not related to the nature of the results). **To answer yes here, the authors need to provide details of a pre-analysis plan and the included outcomes should be consistent with the ones discussed in the study.** **If the pre-analysis is available and it does not contain the extracted outcome you are considering (specific row here), unless author(s) provide an explanation in the included study, it should be considered as potential selective reporting (and therefore coded as Probably no or No).** **Insufficient information**: insufficient information (if no pre-analysis plan).
5. Justification	Q5. Answer justification (use references with page numbers).
6. Unit of analysis	Q6. Unit of analysis: Is unit of analysis in cluster allocation addressed in standard error calculation?
	Yes or **Probably Yes** if the study satisfies the following requirement for this estimate (**No** or **Probably No** otherwise): **Yes** if Unit of analysis (UoA) = Unit of randomization (UoR) OR if UoA ≠ UoR and standard errors are clustered at the UoR level OR data is collapsed to the UoR level **Insufficient information**: if not enough information is provided on the way the standard errors were calculated or what the unit of analysis is.

Questions	Explanations/Answers
	"Not applicable" if it is not a cluster RCT.
6. Justification	Q6. Answer justification (use references with page numbers).
7. Summary and implications	Q7. What are the key risks of bias identified, and what are their potential implications for interpreting the effects?
	Add a brief summary that focuses on the likely implications for interpreting the effects: are the effects likely to be suppressed due to the noted sources of bias? Exaggerated? Are there substantial quality issues or lack of clarity that should be considered? What should the reader keep in mind, to contextualize the findings?
Overall score	• “High risk of bias”: if any of the bias domains were assessed as “No” or “Probably No”. • “Some concerns”: if one or several domains were assessed as “Insufficient Information” and none were “No” or “Probably No”. • “Low risk of bias”: if all of the bias domains were assessed as “Yes” or “Probably Yes”.
Notes	Notes

Appendix J: Qualitative critical appraisal tool

Study type	Methodological appraisal criteria	Response		
		Yes	No	Comment
Screening questions: assessing 'fatal flaws' (Dixon-Woods 2005) *Configurative 'fatal flaws' based on Pawson (2003) TAPUS framework*	Configurative assessment: ✓ Study reports primary data and applied methods ✓ Study states clear research questions and objectives ✓ Study states clear research design, which is appropriate to address the stated research question and objectives (*Purposivity*) ✓ The findings of the study are based on collected data, which justify the knowledge claims (*Accuracy*)			
	Screening question based on abstract and/or superficial reading of full text: Further appraisal is not feasible or appropriate when the answer is 'No' to any of the above screening questions!			
Study type	**Methodological appraisal criteria**	**Response**		
		Yes	No	Comment / Confidence judgment
1. Qualitative and descriptive quantitative, and process evaluations	**I. RESEARCH IS DEFENSIBLE IN DESIGN (**providing a research strategy that addresses the question) Appraisal indicators: ✓ *Is the research design clearly specified and appropriate for aims and objectives of the research?* Consider whether			
	i. there is a discussion of the rationale for the study design			

	ii. the research question is clear, and suited to the inquiry						
	iii. there are convincing arguments for different features of the study design						
	iv. limitations of the research design and implications for the research evidence are discussed						
	Defensible	**Arguable**	**Critical**	**Not defensible**	*Worth to continue:*		
	II. RESEARCH FEATURES AN APPROPRIATE SAMPLE (following an adequate strategy for selection of participants) Appraisal indicators: Consider whether						
	i. there is a description of study location and how/why it was chosen						
	ii. the researcher has explained how the participants were selected						
	iii. the selected participants were appropriate to collect rich and relevant data						
	iv. reasons are given why potential participants chose not take part in study						
	Appropriate sample	**Functional sample**	**Critical sample**	**Flawed sample**	*Worth to continue:*		
	III. RESEARCH IS RIGOROUS IN CONDUCT (Providing a systematic and transparent account of the research process) Appraisal indicators: Consider whether						
	i. researchers provide a clear account/description of the process by which data was collected (e.g. for interview method, is there an indication of how interviews were conducted? /Procedures for collection or recording of data?)						
	ii. researchers demonstrate that data collection targeted depth, detail and richness of information (e.g. interview/observation schedule)						

	iii. there is evidence of how descriptive analytical categories, classes, labels, etc. have been generated and used						
	iv. presentation of data distinguishes clearly between the data, the analytical frame used, and the interpretation						
	v. methods were modified during the study; and if so, has the researcher explained how and why?						
	Rigorous conduct	**Considerate conduct**	**Critical conduct**	**Flawed conduct**	*Worth to continue:*		
	IV. RESEARCH FINDINGS ARE CREDIBLE IN CLAIM/BASED ON DATA (Providing well-founded and plausible arguments based on the evidence generated) Appraisal indicators: Consider whether						
	i. there is a clear description of the form of the original data						
	ii. sufficient amount of data is presented to support interpretations and findings/conclusions						
	iii. the researchers explain how the data presented were selected from the original sample to feed into the analysis process (i.e. commentary and cited data relate; there is an analytical context to cited data, not simply repeated description; is there an account of frequency of presented data?)						
	iv. there is a clear and transparent link between data, interpretation, and findings/conclusion						
	v. there is evidence (of attempts) to give attention to negative cases/outliers etc.						
	Credible claims	**Arguable claims**	**Doubtful claims**	**Not credible**	*If findings not credible, can data still be used?*		
	V. REASEARCH ATTENDS TO CONTEXTS (Describing the contexts and particulars of the study) Appraisal indicators:						

	Consider whether						
	i. there is an adequate description of the contexts of data sources and how they are retained and portrayed?						
	ii. participants' perspectives/observations are placed in personal contexts						
	iii. appropriate consideration is given to how findings relate to the contexts (how findings are influenced by or influence the context)						
	iv. the study makes any claims (implicit or explicit) that infer generalization (if yes, comment on appropriateness)						
	Context central	**Context considered**	**Context mentioned**	**No context attention**			
	VI. RESEARCH IS REFLECTIVE (Assessing what factors might have shaped the form and output of research) Appraisal indicators: Consider whether						
	i. appropriate consideration is given to how findings relate to researchers' influence/own role during analysis and selection of data for presentation						
	ii. researchers have attempted to validate the credibility of findings (e.g. triangulation, respondent validation, more than one analyst)						
	iii. researchers explain their reaction to critical events that occurred during the study						
	iv. researchers discuss ideological perspectives/values/philosophies and their impact on the methodological or other substantive content of the research (implicit/explicit)						
	Reflection	**Consideration**	**Acknowledgement**	**Unreflective research**	*NB: Can override previous exclusion!*		
OVERALL CRITICAL APPRAISAL DECISION **Decision rule:**							

- a single critical appraisal judgement[11] in any of the 6 appraisal domains leads to a critical overall judgement. - 2 or more high critical appraisal judgements in any of the 6 appraisal domains lead to an overall high risk of bias / low quality rating. - 2 or more moderate critical appraisal judgements in any of the 6 appraisal domains lead to an overall moderate risk of bias / moderate quality rating. - which means that for a study to be rated of low risk of bias / high quality at least 5 appraisal domains need be rated as of low critical appraisal.			
HIGH QUALITY EMPIRICAL RESEARCH (Study generates new evidence relevant to the review question and complies with all methodological criteria to ensure reliability and empirical grounding of the evidence).	**MODERATE QUALITY EMPIRICAL RESEARCH** (Study generates new evidence relevant to the review question and complies with reasonable methodological criteria to ensure reliability and empirical grounding of the evidence).	**LOW QUALITY EMPIRICAL RESEARCH** (Study generates new evidence relevant to the review question and complies with minimum methodological criteria to ensure reliability and empirical grounding of the evidence).	**CRITICAL QUALITY EMPIRICAL RESEARCH** (The evidence generated by the study does not comply with minimum methodological criteria to ensure reliability and empirical grounding of the evidence).
Sources used in this section (in alphabetical order); Campbell et al (2003); CASP (2006); CRD (2009); Dixon-Woods et al (2004); Dixon-Woods et al (2006); Greenhalgh & Brown (2014); Harden et al (2004); Harden et al (2009); Harden & Gough (2012); Mays & Pope (1995); Pluye et al (2011); Spencer et al 2006; Thomas et al (2003); SCIE (2010).			

[11] For the qualitative studies, we use a slightly different language to scale the critical appraisal assessments as compared to the quantitative studies. The far-right rating column always reflects a 'critical' appraisal judgement (i.e. 'unreflective research' above) with judgements moving further to the left on a scale from high to low critical appraisal.

Study type	Methodological appraisal criteria	Response		
		Yes	No	Comment /confidence judgment
2. Mixed-methods[2] *Sequential explanatory design* *The quantitative component is followed by the qualitative. The purpose is to explain quantitative results using qualitative findings. E.g., the quantitative results guide the selection of qualitative data sources and data collection, and the qualitative findings contribute to the interpretation of quantitative results.* *Sequential exploratory design* *the qualitative component is followed by the quantitative. The purpose is to explore, develop and test an instrument (or taxonomy), or a conceptual framework (or theoretical model). E.g., the qualitative findings inform the quantitative data collection, and the quantitative results allow a generalization of the qualitative findings.* *Triangulation designs* *the qualitative and quantitative components are concomitant. The purpose is to examine the same phenomenon by interpreting qualitative and quantitative results (bringing data analysis together at the interpretation stage), or by integrating qualitative and quantitative datasets*	**I. RESEARCH INTEGRATION/SYNTHESIS OF METHODS** (Assessing the value-added of the mixed-methods approach) Applied mixed-methods design: ○ Sequential explanatory design ○ Sequential explorative design ○ Triangulation design ○ Embedded design Appraisal indicators: Consider whether			
	i. the rationale for integrating qualitative and quantitative methods to answer the research question is explained *[DEFENSIBLE]*			
	ii. the mixed-methods research design is relevant to address the qualitative and quantitative research questions, or the qualitative and quantitative aspects of the mixed methods research question *[DEFENSIBLE]*			
	iii. there is evidence that data gathered by both research methods was brought together to inform new findings to answer the mixed-methods research question (e.g. form a complete picture, synthesize findings, configuration) *[CREDIBLE]*			

(e.g., data on same cases), or by transforming data (e.g., quantization of qualitative data). Embedded/convergent design *The qualitative and quantitative components are concomitant. The purpose is to support a qualitative study with a quantitative sub-study (measures), or to better understand a specific issue of a quantitative study using a qualitative sub-study, e.g., the efficacy or the implementation of an intervention based on the views of participants.*	*iv. the approach to data integration is transparent and rigorous in considering all findings from both the qualitative and quantitative module (danger of cherry-picking)* *[RIGOROUS]*			
	v. appropriate consideration is given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results)? *[REFLEXIVE]*			

For mixed-methods research studies, each component undergoes its individual critical appraisal first. Since qualitative studies are either included or excluded, no combined risk of bias assessment is facilitated, and the assigned risk of bias from the quantitative component similarly holds for the mixed-methods research.

The above appraisal indicators only refer to the applied mixed-methods design. If this design is not found to comply with each of the four mixed-methods appraisal criteria below, then the quantitative/qualitative components will individually be included in the review:

Mixed-methods critical appraisal:	Qualitative critical appraisal:	Quantitative critical appraisal:
1. Research is defensible in design 2. Research is rigorous in conduct 3. Research is credible in claim 4. Research is reflective	Include / Exclude	1. Low risk of bias 2. Risk of bias 3. High risk of bias 4. Critical risk of bias

Combined appraisal:
Include / Exclude mixed-methods findings judged with _____ risk of bias

Section based on Pluye and collagues (2011). Further sources consulted (in alphabetical order): Creswell & Clark (2007); Crowe (2013); Long (2005); O'Cathain et al. (2008); O'Cathain (2010); Pluye & Hong (2014); Sirriyeh et al. (2011).

References

Abbentheren, Barbara, and Lioba Weigartner. 2019. “Multi-Country Resilience Study : Listening to Local People’s Voices.” Exploring Capacities and Choices to Manage Risks, Shocks and Stresses at Programme and Project Level India – Mali – Malawi. Bonn and Eschborn, Germany: GIZ. https://www.giz.de/en/downloads/giz2019-en-multi-country-resilience-study.pdf.

Aipira, Cecilia, Allanah Kidd, and Kate Morioka. 2017. “Climate Change Adaptation in Pacific Countries: Fostering Resilience Through Gender Equality.” In *Climate Change Adaptation in Pacific Countries*, edited by Walter Leal Filho, 225–39. Climate Change Management. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-50094-2_13.

AkandeY, O., and Akinyele. 2018. “Food Insecurity in Africa.” In . https://www.semanticscholar.org/paper/Food-Insecurity-in-Africa-AkandeY.-Akinyele/936f5cddc7bb4ba52c826d610c5256e0a5d07ea6?utm_source=consensus.

Alex, M. 2020. “Role of Nutrition in Maintaining Health.” *International Journal of Physical Education, Sports and Health*. https://www.semanticscholar.org/paper/Role-of-nutrition-in-maintaining-health-Alex/a3b4aa759b67d786698459cbf260e2758315da82?utm_source=consensus.

Arora, Anchal, and Devesh Birwal. 2017. “Natural Calamities, Crop Losses and Coping Strategies: An Economic Analysis from Odisha.” https://doi.org/10.22004/AG.ECON.302274.

Assan, Never. 2023. “Socio-Cultural, Economic, and Environmental Implications for Innovation in Sustainable Food in Africa.” *Frontiers in Sustainable Food Systems* 7 (July). https://doi.org/10.3389/fsufs.2023.1192422.

Asuamah Yeboah, Sunyani. 2024. “Assessing Climate Change Impacts on Food Security in Africa: Regional Variations and Socio-Economic Perspectives.” *MPRA* 120918. https://mpra.ub.uni-muenchen.de/120918/1/MPRA_paper_120918.pdf.

Barends, Eric, Denise M Rousseau, and Rob B Briner. 2017. “CEBMa Guideline for Rapid Evidence Assessments in Management and Organizations, Version 1.0.” *Centre for Evidence Based Management, Amsterdam*.

Barrett, Christopher B. 2021. “Overcoming Global Food Security Challenges through Science and Solidarity.” *American Journal of Agricultural Economics* 103 (2): 422–47. https://doi.org/10.1111/ajae.12160.

Basak, Kishore Kumer, Etienne Lwamba, Ingunn Storhaug, Pierre Marion, Ashiqun Nabi, Sanghwa Lee, and Shannon Shisler. 2024. “The Effects of Food Systems Interventions on Women’s Empowerment: A Rapid Evidence Assessment.” 2024th ed. International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/WP0062.

Béné, Christophe. 2020. “Resilience of Local Food Systems and Links to Food Security – A Review of Some Important Concepts in the Context of COVID-19 and Other Shocks.” *Food Security* 12:805–22. https://doi.org/10.1007/s12571-020-01076-1.

Béné, Christophe, Derek Headey, Lawrence Haddad, and Klaus von Grebmer. 2016. “Is Resilience a Useful Concept in the Context of Food Security and Nutrition Programmes? Some Conceptual and Practical Considerations.” *Food Security* 8 (1): 123–38. https://doi.org/10.1007/s12571-015-0526-x.

Berretta, Miriam, Meital Kupfer, Shannon Shisler, and Charlotte Lane. 2023. “Rapid Evidence Assessment on Women’s Empowerment Interventions within the Food System: A Meta-Analysis.” *Agriculture & Food Security* 12 (1): 13. https://doi.org/10.1186/s40066-023-00405-9.

Berretta, Miriam, Sanghwa Lee, Meital Kupfer, Carolyn Huang, Will Ridlehoover, Daniel Frey, Faez Ahmed, et al. 2023. “Strengthening Resilience against Shocks, Stressors and Recurring Crises in Low- and Middle-Income Countries: An Evidence Gap Map.” 2023rd ed. International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/EGM023.

BMZ. 2021a. “Resilience Analyses : Product Sheet.” Germany. https://www.bmz.de/resource/blob/100468/produktblatt-resilienzanalyse-eng-barrierefrei-291121.pdf.

———. 2021b. “Strengthening Resilience. Creating New Prospects.” Germany. https://www.bmz.de/resource/blob/100470/factsheet-strengthening-resilience-creating-new-prospects-.pdf.

BMZ Directorate for food ; rural development ; natural resources. 2019. “A World without Hunger Is Possible : German Development Action against Hunger.” Germany. https://www.bmz.de/resource/blob/23634/ab2272eb08a77798ab8e712bd10f250b/flyer-without-hunger-data.pdf.

BMZ Division 123. 2021. “Transformation of Agricultural and Food Systems : Core Area Strategy.” BMZ strategies 5. Core Area Strategy. Bonn, Germany: BMZ. https://www.bmz.de/resource/blob/100758/bmz-core-area-strategy-a-world-without-hunger.pdf.

Borenstein, Michael, Larry V. Hedges, Julian P. T. Higgins, and Hannah R. Rothstein. 2009. *Introduction to Meta-Analysis*. 1st ed. Wiley. https://doi.org/10.1002/9780470743386.

Braimoh, Ademola. 2020. “Building Resilient Food Systems in Africa.” *One Earth* 3 (3): 282–84. https://doi.org/10.1016/j.oneear.2020.08.014.

Brauw, Alan de, Marrit Van den berg, Inge D. Brouwer, Harriette Snoek, Raffaele Vignola, Mequanint B. Melesse, Gaia Lochetti, et al. 2019. “Food System Innovations for Healthier Diets in Low and Middle-Income Countries.” IFPRI Discussion Paper 01816. https://books.google.co.uk/books?hl=en&lr=&id=CvqNDwAAQBAJ&oi=fnd&pg=PR2&ots=ru9sKc5Jy7&sig=rVXfxOzIeRyGlDvG09xLK60KHdc&redir_esc=y#v=onepage&q&f=false.

Bryan, Elizabeth, and Julia A. Behrman. 2013. “Community–Based Adaptation to Climate Change: A Theoretical Framework, Overview of Key Issues and Discussion of Gender Differentiated Priorities and Participation.” https://cgspace.cgiar.org/items/d0ee5afc-8b4f-42c5-b1d5-540ead89d2a8.

Bündnis Entwicklung Hilft and Ruhr-Universität Bochum. 2024. “WeltRisikoBericht.” *WeltRisikoBericht* (blog). 2024. https://weltrisikobericht.de/worldriskreport/.

Carleton, Tamma A., and Solomon M. Hsiang. 2016. “Social and Economic Impacts of Climate.” *Science (New York, N.Y.)* 353 (6304): aad9837. https://doi.org/10.1126/science.aad9837.

CASP. 2011. “CASP Checklists - Critical Appraisal Skills Programme.” CASP - Critical Appraisal Skills Programme. 2011. https://casp-uk.net/casp-tools-checklists/.

CCPI. 2025. “Climate Change Performance Index (CCPI).” 2025. https://ccpi.org/.

CGIAR. 2019. “Scaling-up Strategies for Climate Risk Management in South Asian Agriculture.” CGIAR. January 1, 2019. https://ccafs.cgiar.org/research/projects/scaling-strategies-climate-risk-management-south-asian-agriculture.

Chodur, Gwen M., Xilei Zhao, Erin Biehl, Judith Mitrani-Reiser, and Roni Neff. 2018. “Assessing Food System Vulnerabilities: A Fault Tree Modeling Approach.” *BMC Public Health* 18 (1): 817. https://doi.org/10.1186/s12889-018-5563-x.

Clapp, Jennifer, William G. Moseley, Barbara Burlingame, and Paola Termine. 2022. “Viewpoint: The Case for a Six-Dimensional Food Security Framework.” *Food Policy* 106 (January):102164. https://doi.org/10.1016/j.foodpol.2021.102164.

“Cochrane Handbook for Systematic Reviews of Interventions - Version 6.3.” 2022. https://training.cochrane.org/handbook.

Collins, Steven H., M. Bruce Wiggin, and Gregory S. Sawicki. 2015. “Reducing the Energy Cost of Human Walking Using an Unpowered Exoskeleton.” *Nature* 522 (7555): 212–15. https://doi.org/10.1038/nature14288.

Constas, Mark, Marco D’Errico, John Hoddinott, and Rebecca Pietrelli. 2021. *Resilient Food Systems – A Proposed Analytical Strategy for Empirical Applications*. FAO. https://doi.org/10.4060/cb7508en.

Constas, Mark, T.R Frankenberger, and John Hoddinott. 2014. “Resilience Measurement Principles - Toward an Agenda for Measurement Design.” FSIN Technical Series Paper No.1. Resilience Measurement Technical Working Group: World Food Programme (WFP) and FAO. https://www.fsinplatform.org/sites/default/files/paragraphs/documents/FSIN_TechnicalSeries_1.pdf.

Crowe, Michael. 2013. “Crowe Critical Appraisal Tool (CCAT) User Guide.” *Conchra House* 10. https://scholar.google.com/scholar?cluster=3770507727949165738&hl=en&oi=scholarr.

Curran, Marina Martin, and Harriet MacLehose. 2006. “Community Animal Health Services for Improving Household Wealth and Health Status of Low Income Farmers - Martin Curran, M - 2006 | Cochrane Library.” https://doi.org/10.1002/14651858.CD003049.pub2.

CVF (Climate vulnerability forum) and DARA. 2022. “Climate Vulnerability Monitor.” Climate Analytics. 2022. https://climateanalytics.org/projects/cvm3.

De La Rue, Lisa, Joshua R. Polanin, Dorothy L. Espelage, and Terri D. Pigott. 2013. “PROTOCOL: School-based Interventions to Reduce Dating and Sexual Violence: A Systematic Review.” *Campbell Systematic Reviews* 9 (1): 1–43. https://doi.org/10.1002/CL2.106.

De Steenhuijsen Piters, Bart, Emma Termeer, Deborah Bakker, Hubert Fonteijn, and Herman Brouwer. 2022. “Perspective Chapter: Food System Resilience – Towards a Joint Understanding and Implications for Policy.” Edited by Ana I. Ribeiro-Barros, Daniel S. Tevera, Luís F. Goulao, and Lucas D. Tivana 1 (July). https://doi.org/10.5772/intechopen.99899.

Devereux, Stephen, Christophe Béné, and John Hoddinott. 2020. “Conceptualising COVID-19’s Impacts on Household Food Security.” *Food Security* 12 (4): 769–72. https://doi.org/10.1007/s12571-020-01085-0.

Dewidar, Omar, Jessica John, Aqeel Baqar, Mohamad Tarek Madani, Ammar Saad, Alison Riddle, Erika Ota, et al. 2023. “Effectiveness of Nutrition Counseling for Pregnant Women in Low- and Middle-income Countries to Improve Maternal and Infant Behavioral, Nutritional, and Health Outcomes: A Systematic Review.” *Campbell Systematic Reviews* 19 (4): e1361. https://doi.org/10.1002/cl2.1361.

Dixon-Woods, Mary, Debbie Cavers, Shona Agarwal, Ellen Annandale, Antony Arthur, Janet Harvey, Ron Hsu, et al. 2006. “Conducting a Critical Interpretive Synthesis of the Literature on Access to Healthcare by Vulnerable Groups.” *BMC Medical Research Methodology* 6 (1): 35. https://doi.org/10.1186/1471-2288-6-35.

Doherty, Bob, Jonathan Ensor, Tony Heron, and Patricia Prado. 2023. “Food Systems Resilience: Towards an Interdisciplinary Research Agenda.” *Emerald Open Research* 1 (10). https://doi.org/10.1108/EOR-10-2023-0001.

Eckstein, David, Vera Künzel, and Laura Schäfer. 2025. “Climate Risk Index | Germanwatch e.V.” 2025. https://www.germanwatch.org/en/cri.

Egger, Matthias, George Davey Smith, Martin Schneider, and Christoph Minder. 1997. “Bias in Meta-Analysis Detected by a Simple, Graphical Test.” *BMJ* 315 (7109): 629–34. https://doi.org/10.1136/bmj.315.7109.629.

Ellis, Paul D. 2010. “Effect Sizes and the Interpretation of Research Results in International Business.” *Journal of International Business Studies* 41 (9): 1581–88. https://doi.org/10.1057/jibs.2010.39.

Endris Mekonnen, Ebrahim, and Andualem Kassegn Amede. 2022. “Food Insecurity and Unemployment Crisis under COVID-19: Evidence from Sub-Saharan Africa.” *Cogent Social Sciences* 8 (1): 2045721. https://doi.org/10.1080/23311886.2022.2045721.

Ensor, Jon. 2023. “Food System Resilience: Concepts, Issues, and Challenges.” *Annual Review of Environment and Resources*, March. https://doi.org/10.1146/annurev-environ-112320-050744.

Factory Mutual. 2024. “2024 FM Resilience Index.” FM. 2024. https://www.fm.com/resources/resilience-index.

FAO. 1996a. “Report of the World Food Summit.” Rome: Food and Agriculture Organisation of the United Nations. https://www.fao.org/4/w3548e/w3548e00.htm.

———. 1996b. “World Food Summit - Final Report - Part 1.” In . Rome, Italy. https://www.fao.org/4/w3548e/w3548e00.htm.

———, ed. 2013. *Food Systems for Better Nutrition*. Rome: FAO. https://www.fao.org/4/i3300e/i3300e.pdf.

———. 2022. *Behaviour Change Communication Strategy for Food Security and Agriculture Productivity Project: “You Are What You Eat!”* FAO. https://doi.org/10.4060/cc1050en.

———. 2024. “Hunger and Food Insecurity | FAO | Food and Agriculture Organization of the United Nations.” HungerAndFoodInsecurity. 2024. https://www.fao.org/hunger/en.

———. 2025. “Regional Priorities | Regional Office for Africa | FAO.” FAORAF. 2025. https://www.fao.org/africa/regional-priorities-for-fao-in-africa/en.

FAO, AUC, United Nations Economic Commission for Africa (ECA), and WFP. 2023. *Africa - Regional Overview of Food Security and Nutrition 2023*. FAO; AUC; United Nations Economic Commission for Africa (ECA); WFP; https://doi.org/10.4060/cc8743en.

FAO, IFAD, UNICEF, WFP, and WHO. 2023. *The State of Food Security and Nutrition in the World 2023*. FAO; IFAD; UNICEF; WFP; WHO; https://doi.org/10.4060/cc3017en.

———. 2024. *The State of Food Security and Nutrition in the World 2024*. FAO; IFAD; UNICEF; WFP; WHO; https://doi.org/10.4060/cd1254en.

Fenton Villar, Paul. 2022. “Structured Literature Reviews.” World Bank Group. https://ieg.worldbankgroup.org/sites/default/files/Data/Evaluation/files/SLR_2022.pdf.

Fisher, Zachary, and Elizabeth Tipton. 2015. “Robumeta: An R-Package for Robust Variance Estimation in Meta-Analysis.” arXiv. https://doi.org/10.48550/arXiv.1503.02220.

Ganann, Rebecca, Donna Ciliska, and Helen Thomas. 2010. “Expediting Systematic Reviews: Methods and Implications of Rapid Reviews.” *Implementation Science* 5 (1): 56. https://doi.org/10.1186/1748-5908-5-56.

García-Díez, Juan, Carla Gonçalves, Luca Grispoldi, Beniamino Cenci-Goga, and Cristina Saraiva. 2021. “Determining Food Stability to Achieve Food Security.” *Sustainability* 13 (13): 7222. https://doi.org/10.3390/su13137222.

Gebre, Girma Gezimu, and Dil Bahadur Rahut. 2021. “Prevalence of Household Food Insecurity in East Africa: Linking Food Access with Climate Vulnerability.” *Climate Risk Management* 33:100333. https://doi.org/10.1016/j.crm.2021.100333.

Gebremichael, Bereket, Biruk Beletew, Melaku Bimerew, Demewoz Haile, Sibhatu Biadgilign, and Kaleab Baye. 2022. “Magnitude of Urban Household Food Insecurity in

East Africa: A Systematic Review and Meta-Analysis." *Public Health Nutrition* 25 (4): 994–1004. https://doi.org/10.1017/S1368980021003529.

Gitz, Vincent, Alexandre Meybeck, Leslie Lipper, C. De Young, and Susan Braatz. 2016. "Climate Change and Food Security: Risks and Responses." *Food and Agriculture Organization of the United Nations (FAO) Report* 110 (2): 3–36.

Global Centre on Adaptation. 2022. "Climate Risk in Africa." GCA. https://gca.org/wp-content/uploads/2023/01/GCA_State-and-Trends-in-Adaptation-2022_Climate-Risks-in-Africa.pdf.

Gustilo, Anna. 2020. "WFP Launches HungerMap Live | World Food Programme." 2020. https://www.wfp.org/stories/wfp-launches-hungermap-live.

Hartling, Lisa, Ben Vandermeer, and Ricardo M Fernandes. 2015. "Systematic Reviews, Overviews of Reviews and Comparative Effectiveness Reviews: A Discussion of Approaches to Knowledge Synthesis." *Evidence-Based Child Health: A Cochrane Review Journal* 9 (2): 486–94. https://doi.org/10.1002/ebch.1968.

Hassan, Munum, Kinza Saif, Muhammad Saad Ijaz, Zouina Sarfraz, Azza Sarfraz, Karla Robles-Velasco, and Ivan Cherrez-Ojeda. 2023. "Mean Temperature and Drought Projections in Central Africa: A Population-Based Study of Food Insecurity, Childhood Malnutrition and Mortality, and Infectious Disease." *International Journal of Environmental Research and Public Health* 20 (3): 2697. https://doi.org/10.3390/ijerph20032697.

Hedges, Larry V. 2009. "Effect Sizes in Nested Designs." *The Handbook of Research Synthesis and Meta-Analysis* 2:399–416.

Hedges, Larry V., Elizabeth Tipton, and Matthew C. Johnson. 2010. "Robust Variance Estimation in Meta-Regression with Dependent Effect Size Estimates." *Research Synthesis Methods* 1 (1): 39–65. https://doi.org/10.1002/jrsm.5.

Hendrickson, Mary K. 2015. "Resilience in a Concentrated and Consolidated Food System." *Journal of Environmental Studies and Sciences* 5 (3): 418–31. https://doi.org/10.1007/s13412-015-0292-2.

Hertel, Thomas W, Elena Irwin, Stephen Polasky, and Navin Ramankutty. 2023. "Focus on Global–Local–Global Analysis of Sustainability." *Environmental Research Letters* 18 (10): 100201. https://doi.org/10.1088/1748-9326/acf8da.

Higgins, Julian P T, James Thomas, Jacqueline Chandler, Miranda Cumpston, Tianjing Li, Matthew Page, and Vivian Welch. 2020. *Cochrane Handbook for Systematic Reviews of Interventions*. Version 6.1 (updated September 2020). Cochrane. https://training.cochrane.org/handbook.

HLPE. 2017. "Nutrition and Food Systems. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security." Rome. https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1155796/.

———. 2020. “Food Security and Nutrition: Building a Global Narrative towards 2030.” Rome: HLPE.

Iizumi, Toshichika, Hideo Shiogama, Yukiko Imada, Naota Hanasaki, Hiroki Takikawa, and Motoki Nishimori. 2018. “Crop Production Losses Associated with Anthropogenic Climate Change for 1981–2010 Compared with Preindustrial Levels.” *International Journal of Climatology* 38 (14): 5405–17. https://doi.org/10.1002/joc.5818.

“INFORM Climate Change.” n.d. Accessed February 17, 2025. https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Climate-Change.

Ingram, John, William Bellotti, Mike Brklacich, Thom Achterbosch, Bálint Balázs, Martin Banse, Simon Fielke, et al. 2023. “Further Concepts and Approaches for Enhancing Food System Resilience.” *Nature Food* 4 (6): 440–41. https://doi.org/10.1038/s43016-023-00762-5.

Ingram, John, Polly Ericksen, and Diana Liverman. 2012. *Food Security and Global Environmental Change*. 1st ed. London: Routledge. https://doi.org/10.4324/9781849776615.

Inter-Agency Standing Committee Reference Group on Risk. 2025. “INFORM - Global, Open-Source Risk Assessment for Humanitarian Crises and Disasters.” 2025. https://drmkc.jrc.ec.europa.eu/inform-index.

Intergovernmental Panel On Climate Change (Ipcc). 2023. *Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. 1st ed. Cambridge University Press. https://doi.org/10.1017/9781009325844.

IPCC. 2022. *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-Industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. 1st ed. Cambridge University Press. https://doi.org/10.1017/9781009157940.

Jideani, Afam I. O. 2020. “Research, Development and Capacity Building for Food and Nutrition Security in Sub-Saharan Africa.” *International Journal of Food Studies* 9 (2): 264–81. https://doi.org/10.7455/ijfs/9.2.2020.a1.

John Hopkins center for a Livable Future. 2024. “Food System Resilience.” Centre for a Livable Future. 2024. https://clf.jhsph.edu/projects/food-system-resilience.

Jolly, Kate, Lucy Ingram, Khalid S. Khan, Jonathan J. Deeks, Nick Freemantle, and Christine MacArthur. 2012. “Systematic Review of Peer Support for Breastfeeding Continuation: Metaregression Analysis of the Effect of Setting, Intensity, and Timing.” *BMJ* 344 (January):d8287. https://doi.org/10.1136/bmj.d8287.

Kahiluoto, Helena. 2020. “Food Systems for Resilient Futures.” *Food Security* 12:853–57. https://doi.org/10.1007/s12571-020-01070-7.

Keef, Stephen P., and Leigh A. Roberts. 2004. “The Meta-analysis of Partial Effect Sizes.” *British Journal of Mathematical and Statistical Psychology* 57 (1): 97–129.

https://doi.org/10.1348/000711004849303.

Khangura, Sara, Kristin Konnyu, Rob Cushman, Jeremy Grimshaw, and David Moher. 2012. “Evidence Summaries: The Evolution of a Rapid Review Approach.” *Systematic Reviews* 1 (1): 10. https://doi.org/10.1186/2046-4053-1-10.

Krause, Corinna, Kathrin Sommerhalder, Sigrid Beer-Borst, and Thomas Abel. 2016. “Just a Subtle Difference? Findings from a Systematic Review on Definitions of Nutrition Literacy and Food Literacy.” *Health Promotion International*, November, daw084. https://doi.org/10.1093/heapro/daw084.

Lal, Rattan. 2013. “Food Security in a Changing Climate.” *Ecohydrology & Hydrobiology* 13 (1): 8–21. https://doi.org/10.1016/j.ecohyd.2013.03.006.

Lane, Charlotte, Ingunn Storhaug, Veronika Tree, Diana Cordova-Arauz, Carolyn Huang, Daniel Frey, Faez Ahmed, et al. 2023. “Addressing the Systemic Causes of Malnutrition: The Nutrition-Sensitive Agriculture Evidence Gap Map.” 2023rd ed. International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/EGM024.

Langer, Thorsten, William Martinez, David M Browning, Pamela Varrin, Barbara Sarnoff Lee, and Sigall K Bell. 2016. “Patients and Families as Teachers: A Mixed Methods Assessment of a Collaborative Learning Model for Medical Error Disclosure and Prevention.” *BMJ Quality & Safety* 25 (8): 615–25. https://doi.org/10.1136/bmjqs-2015-004292.

Litvin, Kate, Gargi W Grandner, Erica Phillips, Lisa Sherburne, Hope C Craig, Kieu Anh Phan, Avni N Patel, and Katherine L Dickin. 2024. “How Do Social and Behavioral Change Interventions Respond to Social Norms to Improve Women’s Diets in Low- and Middle-Income Countries? A Scoping Review.” *Current Developments in Nutrition* 8 (6): 103772. https://doi.org/10.1016/j.cdnut.2024.103772.

Long, MH. 2005. “Methodological Issues in Learner Needs Analysis.” *Second Language Needs Analysis/CUP*.

Mahadevan, Renuka, and Sandy Suardi. 2013. “Is There a Role for Caste and Religion in Food Security Policy? A Look at Rural India.” *Economic Modelling* 31 (March):58–69. https://doi.org/10.1016/j.econmod.2012.11.060.

Mane, E., A.M Giaquinto, C Cafiero, S Viviani, and G. Anríquez. 2024. *Why Are Women More Food Insecure than Men? Exploring Socioeconomic Drivers and the Role of COVID-19 in Widening the Global Gender Gap – Background Paper for The Status of Women in Agrifood Systems*. Rome: FAO. https://doi.org/10.4060/cc9160en.

Mbow, Cheikh, Cynthia E. Rosenzweig, Luis G. Barioni, Tim G. Benton, Mario Herrero, Murukesan Krishnapillai, Alexander C. Ruane, Emma Liwenga, Prajal Pradhan, and Marta G. Rivera-Ferre. 2020. “Food Security.” Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. IPCC. https://ntrs.nasa.gov/citations/20200001724.

McKune, Sarah L., Erica C. Borresen, Alyson G. Young, Thérèse D Auria Ryley, Sandra L. Russo, Astou Diao Camara, Meghan Coleman, and Elizabeth P. Ryan. 2015. “Climate Change through a Gendered Lens: Examining Livestock Holder Food Security.” *Global Food Security* 6 (October):1–8. https://doi.org/10.1016/j.gfs.2015.05.001.

Mekonnen, Solomon Abate, Dassalegn Daraje Jalata, and Helen Onyeaka. 2024. “Building Resilience in Sub-Saharan Africa’s Food Systems: Diversification, Traceability, Capacity Building and Technology for Overcoming Challenges.” *Food and Energy Security* 13 (4): e563. https://doi.org/10.1002/fes3.563.

Menon, Kavitha, Shuby Puthussery, Anal Ravalia, Pooja Panchal, Ritu Rana, Sabuj Kanti Mistry, Pei-Ching Tseng, Janine Bhandol, and Dileep Mavalanka. 2018. “Effectiveness of Nutrition Interventions in Low and Middle Income Countries : A Systematic Review.” Indian Institute of Public Health Gandhinagar; Public Health Foundation of India; University of Bedfordshire, UK and BRAC, Bangladesh.

Meyer, Markus A. 2020. “The Role of Resilience in Food System Studies in Low- and Middle-Income Countries.” *Global Food Security* 24 (March):100356. https://doi.org/10.1016/j.gfs.2020.100356.

Miles, Matthew, and Michael Huberman. 1994. *Qualitative Data Analysis*. Sage Publications. https://vivauniversity.wordpress.com/wp-content/uploads/2013/11/milesandhuberman1994.pdf.

Mockshell, Jonathan, and Thea Nielsen Ritter. 2024. “Applying the Six-Dimensional Food Security Framework to Examine a Fresh Fruit and Vegetable Program Implemented by Self-Help Groups during the COVID-19 Lockdown in India.” *World Development* 175 (March):106486. https://doi.org/10.1016/j.worlddev.2023.106486.

Moore, Nick, Charlotte Lane, Ingunn Storhaug, Amber Franich, Heike Rolker, Josh Furgeson, Thalia Sparling, and Birte Snilstveit. 2021. “The Effects of Food Systems Interventions on Food Security and Nutrition Outcomes in Low- and Middle-Income Countries.” 3ie Evidence gap map report 16. 2021st ed. New Delhi, India: International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/EGM016.

Mullan, Rebecca J., David N. Flynn, Bo Carlberg, Imad M. Tleyjeh, Celia C. Kamath, Matthew L. LaBella, Patricia J. Erwin, Gordon H. Guyatt, and Victor M. Montori. 2009. “Systematic Reviewers Commonly Contact Study Authors but Do so with Limited Rigor.” *Journal of Clinical Epidemiology* 62 (2): 138–42. https://doi.org/10.1016/j.jclinepi.2008.08.002.

Murphy, Kyle, Jess Rudder, M Cappucci, M Cherian, J Deutschmann, C Elemera, L Fundukova, et al. 2024. “Evidence Review for Food Security, Nutrition, and Climate-Resilience Interventions.” IFAD, GIZ. https://innovationcommission.uchicago.edu/wp-content/uploads/2024/09/Final-Report.pdf.

Nabukonde, Ameria. 2021. “Food Security for All: Causes and Implications of Food Insecurity in Africa.” *Alternate Horizons*. https://doi.org/10.35293/ah.v4i.3585.

Nelson, Gerald, Jessica Bogard, Keith Lividini, Joanne Arsenault, Malcolm Riley, Timothy B. Sulser, Daniel Mason - D’Croz, et al. 2016. “Climate Challenges,

Vulnerabilities, and Food Security." *Proceedings of the National Academy of Sciences* 113 (2): 298–303. https://doi.org/10.1073/pnas.1506494113.

Nelson, Gerald, Jessica Bogard, Keith Lividini, Joanne Arsenault, Malcolm Riley, Timothy B. Sulser, Daniel Mason-D'Croz, Brendan Power, David Gustafson, and Mario Herrero. 2018. "Income Growth and Climate Change Effects on Global Nutrition Security to Mid-Century." *Nature Sustainability* 1 (12): 773–81. https://doi.org/10.1038/s41893-018-0192-z.

Nguyen, Hahn. 2018. "Sustainable Food Systems: Concept and Framework." FAO. https://openknowledge.fao.org/handle/20.500.14283/CA2079EN.

NJ Office of the Food Security Advocate. 2024. "Food Security in New Jersey-A Brief Primer on the Six Dimensions of Food Security.Pdf." New Jersey: Office of the Food Security Advocate. https://www.nj.gov/foodsecurity/documents/Food%20Security%20in%20New%20Jersey-A%20Brief%20Primer%20on%20the%20Six%20Dimensions%20of%20Food%20Security.pdf.

Nugent, Rachel, Thirumurthy, Harsha, Chakrabarti, Averi, Ellermeier, Nathan, and Tripathi, Arpita. 2021. "Diet-Focused Behavioral Interventions to Reduce the Risk of Non-Communicable Diseases in Low- and Middle-Income Countries: A Scoping Review of the Existing Evidence." https://foodsystemeconomics.org/wp-content/uploads/Nugent-et-al.-2023.pdf.

O'Cathain, Alicia. 2010. "Mixed Methods Involving Qualitative Research." *The SAGE Handbook of Qualitative Methods in Health Research*, 575–88. https://doi.org/10.4135/9781446268247.n30.

O'cathain, Alicia, Elizabeth Murphy, and Jon Nicholl. 2008. "The Quality of Mixed Methods Studies in Health Services Research." *Journal of Health Services Research & Policy* 13 (2): 92–98. https://doi.org/10.1258/jhsrp.2007.007074.

OECD. 2014. *Guidelines for Resilience Systems Analysis: How to Analyse Risk and Build a Roadmap to Resilience*. OECD Publishing. https://www.oecd.org/en/publications/guidelines-for-resilience-systems-analysis-how-to-analyse-risk-and-build-a-roadmap-to-resilience_3b1d3efe-en.html.

———. 2020. "Strengthening Agricultural Resilience in the Face of Multiple Risks." OECD. https://doi.org/10.1787/2250453e-en.

———. 2023. "Towards Resilient Food Systems: Implications of Supply Chain Disruptions and Policy Responses." OECD Food, Agriculture and Fisheries Papers 205. Vol. 205. OECD Food, Agriculture and Fisheries Papers. https://doi.org/10.1787/f7998e46-en.

Ogwuche, Jonathan Ali, Owoicho Christopher, and Dahiru K Muhammed. 2018. "Environmental Issues and Food Insecurity in Africa." *International Journal of Environmental Sciences*.

Olayide, Olawale Emmanuel, and Tunrayo Alabi. 2018. “Between Rainfall and Food Poverty: Assessing Vulnerability to Climate Change in an Agricultural Economy.” *Journal of Cleaner Production* 198 (October):1–10. https://doi.org/10.1016/j.jclepro.2018.06.221.

Oliver, Sandy, Kelly Dickson, K Bangpan, and Mark Newman. 2017. “Getting Started with a Review: An Introduction to Systematic Reviews.” In , 71–92. Sage Publications.

Oluoko-Odingo, Alice A. 2022. “Africa and International Food Security Treaties: Is Climate Change to Blame?” *The African Review* 49 (3): 356–76. https://doi.org/10.1163/1821889x-bja10021.

Ongoro, Eunice B., and William Ogara. 2012. “Impact of Climate Change and Gender Roles in Community Adaptation: A Case Study of Pastoralists in Samburu East District, Kenya.” http://erepository.uonbi.ac.ke/handle/11295/24185.

Onwujekwe, Emmanuel Chijioke, and Constance Chinyere Ezemba. 2021. “Food Security and Safety: Africans Perspectives A Review.” *Archives of Current Research International*, December, 14–20. https://doi.org/10.9734/acri/2021/v21i830260.

Ota, Erika, Hiroyuki Hori, Rintaro Mori, Ruoyan Tobe-Gai, and Diane Farrar. 2015. “Antenatal Dietary Education and Supplementation to Increase Energy and Protein Intake.” *The Cochrane Database of Systematic Reviews*, no. 6 (June), CD000032. https://doi.org/10.1002/14651858.CD000032.pub3.

Oya, Carlos, Florian Schaefer, Dafni Skalidou, Catherine McCosker, and Laurenz Langer. 2017. “Effects of Certification Schemes for Agricultural Production on Socio-Economic Outcomes in Low- and Middle-Income Countries: A Systematic Review.” 2017th ed. International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/SR0034.

Pérez-Escamilla, Rafael. 2017. “Food Security and the 2015–2030 Sustainable Development Goals: From Human to Planetary Health.” *Current Developments in Nutrition* 1 (7): e000513. https://doi.org/10.3945/cdn.117.000513.

Peters, Jaime L., Alex J. Sutton, David R. Jones, Keith R. Abrams, and Lesley Rushton. 2008. “Contour-Enhanced Meta-Analysis Funnel Plots Help Distinguish Publication Bias from Other Causes of Asymmetry.” *Journal of Clinical Epidemiology* 61 (10): 991–96. https://doi.org/10.1016/j.jclinepi.2007.11.010.

Pilipenko, M. V. 2023. “Dietary Nutrition: Past, Present and Future.” *Spravočnik Vrača Obŝej Praktiki (Journal of Family Medicine)*, no. 1 (January), 29–32. https://doi.org/10.33920/med-10-2301-03.

Pingali, Prabhu, Luca Alinovi, and Jacky Sutton. 2005. “Food Security in Complex Emergencies: Enhancing Food System Resilience.” *Disasters* 29 (s1): S5–24. https://doi.org/10.1111/j.0361-3666.2005.00282.x.

Pluye, Pierre, and Quan Nha Hong. 2014. “Combining the Power of Stories and the Power of Numbers: Mixed Methods Research and Mixed Studies Reviews.” *Annual Review of Public Health* 35 (1): 29–45. https://doi.org/10.1146/annurev-publhealth-032013-182440.

Pluye, Pierre, Romina Pace, Gillian Bartlett, Ann C. Macaulay, Jon Salsberg, Justin Jagosh, and Robbyn Seller. 2011. “Mixed Methods Appraisal Tool—2011 Version.” https://doi.org/10.1037/t21090-000.

Polanin, Joshua R., and Birte Snilstveit. 2016. “Converting between Effect Sizes.” *Campbell Systematic Reviews* 12 (1): 1–13. https://doi.org/10.4073/cmpn.2016.3.

Poljanšek, K., S. Marzi, L. Galimberti, D. Dalla Valle, J. S. Pal, A. H. Essenfelder, J. Mysiak, and C. Corbane. 2022. “INFORM Climate Change Risk Index.” https://www.cde.ual.es/wp-content/uploads/2022/11/inform-climate-change-risk-index-KJNA31138ENN-1.pdf.

R CORE TEAM. 2022. “A Language and Environment for Statistical Computing (Version 4.2.0) [Computer Software].”

Radboud University, Jeroen Smits, and Janine Huisman. 2024. “The GDL Vulnerability Index (GVI).” *Social Indicators Research* 174 (2): 721–41. https://doi.org/10.1007/s11205-024-03399-4.

Sam, Anu Susan, Azhar Abbas, Subash Surendran Padmaja, Harald Kaechele, Ranjit Kumar, and Klaus Müller. 2019. “Linking Food Security with Household’s Adaptive Capacity and Drought Risk: Implications for Sustainable Rural Development.” *Social Indicators Research* 142 (1): 363–85. https://doi.org/10.1007/s11205-018-1925-0.

Sánchez-Meca, Julio, Fulgencio Marín-Martínez, and Salvador Chacón-Moscoso. 2003. “Effect-Size Indices for Dichotomized Outcomes in Meta-Analysis.” *Psychological Methods* 8 (4): 448–67. https://doi.org/10.1037/1082-989X.8.4.448.

Sasson, Albert. 2012. “Food Security for Africa: An Urgent Global Challenge.” *Agriculture & Food Security* 1 (1): 2. https://doi.org/10.1186/2048-7010-1-2.

Schleussner, Carl-Friedrich, Delphine Deryng, Sarah D’haen, William Hare, Tabea Lissner, Mouhamed Ly, Alexander Nauels, et al. 2018. “1.5°C Hotspots: Climate Hazards, Vulnerabilities, and Impacts.” *Annual Review of Environment and Resources* 43 (1): 135–63. https://doi.org/10.1146/annurev-environ-102017-025835.

Schmitz, Christoph, Hans Van Meijl, Page Kyle, Gerald C. Nelson, Shinichiro Fujimori, Angelo Gurgel, Petr Havlik, et al. 2014. “Land-Use Change Trajectories up to 2050: Insights from a Global Agro-Economic Model Comparison.” *Agricultural Economics* 45 (1): 69–84. https://doi.org/10.1111/agec.12090.

Schünemann, Holger J, and Lorenzo Moja. 2015. “Reviews: Rapid! Rapid! Rapid! …and Systematic.” *Systematic Reviews* 4 (1): 4, 2046-4053-4–4. https://doi.org/10.1186/2046-4053-4-4.

Sidahmed, Ahmed E. 2018. “Recent Trends in Drylands and Future Scope for Advancement.” In *Climate Variability Impacts on Land Use and Livelihoods in Drylands*, edited by Mahesh K. Gaur and Victor R. Squires, 21–57. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-56681-8_2.

Sirriyeh, Reema, Rebecca Lawton, Peter Gardner, and Gerry Armitage. 2012. “Reviewing Studies with Diverse Designs: The Development and Evaluation of a New Tool.” *Journal of Evaluation in Clinical Practice* 18 (4): 746–52. https://doi.org/10.1111/j.1365-2753.2011.01662.x.

Snilstveit, Birte, Raag Bhatia, Kristen Rankin, and Beryl Leach. 2017. “3ie Evidence Gap Maps: A Starting Point for Strategic Evidence Production and Use.” 2017th ed. International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/WP0028.

Snilstveit, Birte, Martina Vojtkova, Ami Bhavsar, Jennifer Stevenson, and Marie Gaarder. 2016. “Evidence & Gap Maps: A Tool for Promoting Evidence Informed Policy and Strategic Research Agendas.” *Journal of Clinical Epidemiology* 79 (November):120–29. https://doi.org/10.1016/j.jclinepi.2016.05.015.

Springmann, Marco, Daniel Mason-D’Croz, Sherman Robinson, Tara Garnett, H. Charles J. Godfray, Douglas Gollin, Mike Rayner, Paola Ballon, and Peter Scarborough. 2016. “Global and Regional Health Effects of Future Food Production under Climate Change: A Modelling Study.” *The Lancet* 387 (10031): 1937–46. https://doi.org/10.1016/S0140-6736(15)01156-3.

Stehfest, Elke, Willem-Jan van Zeist, Hugo Valin, Petr Havlik, Alexander Popp, Page Kyle, Andrzej Tabeau, Daniel Mason-D’Croz, Tomoko Hasegawa, and Benjamin L. Bodirsky. 2019. “Key Determinants of Global Land-Use Projections.” *Nature Communications* 10 (1): 2166. https://doi.org/10.1038/s41467-019-09945-w.

Sterne, Jonathan A C, Jelena Savović, Matthew J Page, Roy G Elbers, Natalie S Blencowe, Isabelle Boutron, Christopher J Cates, et al. 2019. “RoB 2: A Revised Tool for Assessing Risk of Bias in Randomised Trials.” *BMJ*, August, l4898. https://doi.org/10.1136/bmj.l4898.

Stewart, Ruth, Laurenz Langer, Natalie Rebelo Da Silva, Evans Muchiri, Hazel Zaranyika, Yvonne Erasmus, Nicola Randall, et al. 2015. “The Effects of Training, Innovation and New Technology on African Smallholder Farmers’ Economic Outcomes and Food Security: A Systematic Review.” *Campbell Systematic Reviews* 11 (1): 1–224. https://doi.org/10.4073/csr.2015.16.

Stone, Jamie, and Shahin Rahimifard. 2018. “Resilience in Agri-Food Supply Chains: A Critical Analysis of the Literature and Synthesis of a Novel Framework.” *Supply Chain Management* 23:207–38. https://doi.org/10.1108/SCM-06-2017-0201.

Storhaug, Ingunn, Mark Engelbert, Diana Belén Córdova-Aráuz, Charlotte Lane, Independent consultant, Heike B Rolker, Bristol Veterinary School, University of Bristol Rothamsted Research, et al. 2024. “The Evidence on Food Systems and Nutrition: Insights from a Living Evidence and Gap Map.” 2024th ed. International Initiative for Impact Evaluation (3ie). https://doi.org/10.23846/EGM035.

Tendall, D. M., J. Joerin, B. Kopainsky, P. Edwards, A. Shreck, Q. B. Le, P. Kruetli, M. Grant, and J. Six. 2015. “Food System Resilience: Defining the Concept.” *Global Food Security* 6 (October):17–23. https://doi.org/10.1016/j.gfs.2015.08.001.

Termine, Paola. 2024. “Ensuring Food Security: Why Agency and Sustainability Matter.”

HLPE - High Level Panel of Experts (blog). 2024. https://www.fao.org/cfs/cfs-hlpe/insights/news-insights/news-detail/ensuring-food-security--why-agency-and-sustainability-matter/en.

Thomas, James, Alison O'Mara-Eves, and Ginny Brunton. 2014. "Using Qualitative Comparative Analysis (QCA) in Systematic Reviews of Complex Interventions: A Worked Example." *Systematic Reviews* 3 (1): 67. https://doi.org/10.1186/2046-4053-3-67.

Tricco, Andrea C., Jesmin Antony, Wasifa Zarin, Lisa Strifler, Marco Ghassemi, John Ivory, Laure Perrier, Brian Hutton, David Moher, and Sharon E. Straus. 2015. "A Scoping Review of Rapid Review Methods." *BMC Medicine* 13 (1): 224. https://doi.org/10.1186/s12916-015-0465-6.

Ujjwal, KC, Harry Campbell-Ross, Cecile Godde, Rachel Friedman, Lilly Lim-Camacho, and Steven Crimp. 2024. "A Systematic Review of the Evolution of Food System Resilience Assessment." *Global Food Security* 40 (March):100744. https://doi.org/10.1016/j.gfs.2024.100744.

UNDESA. 2023. "Anual Highlights Report: Towards Sustainable Development for All." United Nations Department of Economic and Social Affairs. https://www.un.org/sites/un2.un.org/files/desa-highlight-report-2022-2023.pdf.

UNICEF. 2021. "The Children's Climate Risk Index (CCRI) Interactive Atlas | NDC Partnership." 2021. https://ndcpartnership.org/knowledge-portal/climate-toolbox/childrens-climate-risk-index-ccri-interactive-atlas.

United Nations. 2024. *The State of Food Security and Nutrition in the World 2024*. FAO; IFAD; UNICEF; WFP; WHO; https://doi.org/10.4060/cd1254en.

University of Notre Dame Global Adaptation Initative. n.d. "ND-GAIN Index." Accessed February 3, 2025. https://gain-new.crc.nd.edu/.

University of the Bundeswehr Munich and Potsdam. n.d. "Climate—Conflict—Vulnerability Index (CCVI)." CCVI — Climate Conflict Vulnerability Index. Accessed February 3, 2025. https://climate-conflict.org/www.

Valentine, Jeffrey C., Ariel M. Aloe, and Timothy S. Lau. 2015. "Life After NHST: How to Describe Your Data Without ' *p* -Ing' Everywhere." *Basic and Applied Social Psychology* 37 (5): 260–73. https://doi.org/10.1080/01973533.2015.1060240.

Viechtbauer, Wolfgang. 2010. "Conducting Meta-Analyses in *R* with the **Metafor** Package." *Journal of Statistical Software* 36 (3). https://doi.org/10.18637/jss.v036.i03.

Viechtbauer, Wolfgang, and Mike W.-L. Cheung. 2010. "Outlier and Influence Diagnostics for Meta-Analysis." *Research Synthesis Methods* 1 (2): 112–25. https://doi.org/10.1002/jrsm.11.

Visser, Janna, and James Wangu. 2021. "Women's Dual Centrality in Food Security Solutions: The Need for a Stronger Gender Lens in Food Systems' Transformation." *Current Research in Environmental Sustainability* 3:100094. https://doi.org/10.1016/j.crsust.2021.100094.

Visser, Marianne E., Anel Schoonees, Chibundu N. Ezekiel, Nicola P. Randall, and Celeste E. Naude. 2020. “Agricultural and Nutritional Education Interventions for Reducing Aflatoxin Exposure to Improve Infant and Child Growth in Low- and Middle-income Countries - Visser, ME - 2020 | Cochrane Library.” https://doi.org/10.1002/14651858.CD013376.pub2.

Waddington, Hugh, Howard White, Birte Snilstveit, Jorge Garcia Hombrados, Martina Vojtkova, Philip Davies, Ami Bhavsar, et al. 2012. “How to Do a Good Systematic Review of Effects in International Development: A Tool Kit.” Journal of Development Effectiveness 4 (3): 359–87. https://doi.org/10.1080/19439342.2012.711765.

Waddington Hugh, Snilstveit Birte, Hombrados Jorge, Vojtkova Martina, Phillips Daniel, Davies Philip, and White Howard. 2014. “Farmer Field Schools for Improving Farming Practices and Farmer Outcomes: A Systematic Review.” https://onlinelibrary.wiley.com/doi/full/10.4073/CSR.2014.6.

Watson, Daniella, Patience Mushamiri, Paula Beeri, Toussaint Rouamba, Sarah Jenner, Simone Proebstl, Sarah H. Kehoe, et al. 2023. “Behaviour Change Interventions Improve Maternal and Child Nutrition in Sub-Saharan Africa: A Systematic Review.” *PLOS Global Public Health* 3 (3): e0000401. https://doi.org/10.1371/journal.pgph.0000401.

WFP. 2022. “WFP’s Contribution to Resilient Food Systems in Vulnerable and Shock-Prone Settings : A Practical Framework and Orientation Note for WFP Programme Teams.” Roma: WFP. https://shorturl.at/D9LO4.

———. 2024. “WFP 2025 Global Outlook.” WFP. https://www.wfp.org/publications/wfp-2025-global-outlook.

———. 2025. “HungerMap LIVE.” 2025. https://hungermap.wfp.org/.

WHO. 2024a. “Fact Sheets - Malnutrition.” 2024. https://www.who.int/news-room/fact-sheets/detail/malnutrition.

———. 2024b. “Hunger Numbers Stubbornly High for Three Consecutive Years as Global Crises Deepen: UN Report.” 2024. https://www.who.int/news/item/24-07-2024-hunger-numbers-stubbornly-high-for-three-consecutive-years-as-global-crises-deepen--un-report.

Wilson, David B., David Weisburd, and David McClure. 2011. “Use of DNA Testing in Police Investigative Work for Increasing Offender Identification, Arrest, Conviction and Case Clearance.” *Campbell Systematic Reviews* 7 (1): 1–53. https://doi.org/10.4073/csr.2011.7.

World Bank. 2022. “World Bank Approves $2.3 Billion Program to Address Escalating Food Insecurity in Eastern and Southern Africa.” World Bank. 2022. https://tinyurl.com/4hf2xht3.

———. 2025. “Enhancing Food and Nutrition Security in the Sahel and Horn of Africa.” 2025. https://www.worldbank.org/en/results/2024/01/04/enhancing-food-and-nutrition-security-in-the-sahel-and-horn-of-afe-africa.

World Resources Institute. 2025. “Aqueduct | World Resources Institute.” January 28, 2025. https://www.wri.org/aqueduct.

Wudil, Abdulazeez Hudu, Muhammad Usman, Joanna Rosak-Szyrocka, Ladislav Pilař, and Mortala Boye. 2022. “Reversing Years for Global Food Security: A Review of the Food Security Situation in Sub-Saharan Africa (SSA).” *International Journal of Environmental Research and Public Health* 19 (22): 14836. https://doi.org/10.3390/ijerph192214836.

Yale University and Columbia University. 2024. “Environmental Performance Index |.” 2024. https://epi.yale.edu/.

Included studies in the Rapid Evidence Assessment (REA) scope

Abate, Gashaw Tadesse, Alan de Brauw, Nicholas Minot, Rob Vos, James Warner, Solomon B. Wassie, and Shijie Yang. 2021. “Evaluating the Impact of Multi-Intervention Development Projects: The Case of Ethiopia’s Community-Based Integrated Natural Resources Management Project.” International Food Policy Research Institute (IFPRI). Vol. 02069. https://doi.org/10.2499/p15738coll2.134856.

Alemu, Mohammed Hussen, Afton Halloran, Søren Bøye Olsen, Jacob Paarechuga Anankware, Philip Nyeko, Monica Ayieko, Evans Nyakeri, et al. 2023. “Promoting Insect Farming and Household Consumption Through Agricultural Training and Nutrition Education in Africa: A Study Protocol for a Multisite Cluster-Randomized Controlled Trial.” https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0288870.

Banerjee, Abhijit, Dean Karlan, Robert Osei, Bram Thuysbaert, and Christopher Udry. 2017. “Graduation From Ultra Poverty In Ghana.” 3ie Grantee Final Report. Vol. Not applicable. http://www.3ieimpact.org/sites/default/files/2018-08/3ie%20Grantee%20Final%20Report%20OW2.206.pdf.

Barnabas, Bulus, Sylvester Amoako Agyemang, Edvin Zhllima, and Miroslava Bavorova. 2023. “Impact of Homegrown School Feeding Program on Smallholders’ Farmer Household Food Security in Northeastern Nigeria.” Other 12 (12): 2408–408. https://doi.org/10.3390/foods12122408.

Beyuo, Alexis, and Nana Akua Anyidoho. 2022. “An Impact Assessment of Farmer Participation on Food Security in Northwestern Ghana.” The European Journal of Development Research 34:1831-1856-831–1856. https://doi.org/10.1057/s41287-021-00444-7.

Biggeri, Mario, Alessandro Carraro, Federico Ciani, and Donato Romano. 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. https://doi.org/10.1016/j.worlddev.2021.105810.

Biggeria, Mario, Francesco Burchi, Federico Ciani, and Raoul Herrmann. 2018. “Linking Small-Scale Farmers To The Durum Wheat Value Chain In Ethiopia: Assessing The Effects On Production And Wellbeing.” Food Policy 79:77–91. https://doi.org/10.1016/j.foodpol.2018.06.001.

Blacker, Lauren, Marianne V Santoso, Elias Mtinda, Rachel N Bezner Kerr, Sera L Young, Laura Harnett, Neema Kassim, and Clara JO -Not applicable Mollay. 2018. “Evaluating the Impact of a Participatory Nutrition-Sensitive Agriculture Intervention on Women’s Empowerment and Child’s Diet in Singida, Tanzania.” https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01557963/full.

Bonan, Jacopo, and Laura Pagani. 2018. “Junior Farmer Field Schools, Agricultural Knowledge And Spillover Effects: Quasi-Experimental Evidence From Northern Uganda.” Journal of Development Studies 54:2007–22. https://doi.org/10.1080/00220388.2017.1355457.

Boucher, Stephen R., Michael R. Carter, Jon Einar Flatnes, Travis J. Lybbert, Jonathan G. Malacarne, Paswel Marenya, and Laura A. Paul. 2022. “Bundling Stress Tolerant Seeds and Insurance for More Resilient and Productive Small-Scale Agriculture.” NBER Working Paper Series. Vol. 29234. https://doi.org/10.3386/w29234.

Brander, Michael, Thomas Bernauer, and Matthias Huss. 2020. “Improved On-Farm Storage Reduces Seasonal Food Insecurity Of Smallholder Farmer Households – Evidence From A Randomized Control Trial In Tanzania.” Food Policy. https://doi.org/10.1016/j.foodpol.2020.101891.

Carneiro, Pedro, Lucy Kraftman, Imran Rasul, and Molly Scott. 2021. “Do Cash Transfers Promoting Early Childhood Development Have Unintended Consequences on Fertility?” Innovations for Poverty Action (IPA). https://www.povertyactionlab.org/sites/default/files/research-paper/working_paper_914_Do-Cash-Transfers-Have-Unintended-Effects-On-Fertility_Nigeria_Aug2021.pdf.

Datta, Saugato, Joshua Martin, Catherine MacLeod, Laura B Rawlings, and Andrea Vermehren. 2021. “Do Behavioral Interventions Enhance the Effects of Cash on Early Childhood Development and Its Determinants? Evidence from a Cluster-Randomized Trial in Madagascar.” The World Bank Group. Vol. 9747. https://doi.org/10.1596/1813-9450-9747.

Deschamps-Laporte, Jean-Philippe. 2013. “The Impact Of Extension Services On Farming Households In Western Kenya - A Propensity Score Approach.” Örebro University School of Business Working Papers. Vol. 5/2013. https://www.oru.se/institutioner/handelshogskolan/forskning/working-papers/working-papers-2013/.

Diaw, Adama, and Aliou Diagne. 2017. “Impact Evaluation Of The Matam Development Project (Prodam) II Extension In Senegal On Household Income, Food Security And Employment.” Registry for International Development for Impact Evaluations (RIDIE). https://ridie.3ieimpact.org/index.php?r=site/downloadStudy&id=558.

Dzanku, F. M., and R. D. JO Osei. 2018. “Impact of Pre– and Post-Harvest Training Reminders on Crop Losses and Food Poverty in Mali.” https://doi.org/10.22004/ag.econ.275924.

Fongar, Andrea, Vincent Linderhof, Beatrice Ekesa, Youri Dijkxhoorn, and Martha Dorcas Nalweyiso. 2023. “Impact of Healthy Food and Diet Information on Household Food Security: A Randomized Control Trial in Kampala, Uganda.” Other 6. https://doi.org/10.3389/fsufs.2022.1063331.

Francesconi, Gian Nicola, and Ruerd Ruben. 2012. “The Hidden Impact Of Cooperative Membership On Quality Management: A Case Study From The Dairy Belt Of Addis Ababa.” Journal of Entrepreneurial and Organizational Diversity 1 (1): 85–103. https://doi.org/10.5947/jeod.2012.005.

Freeman, Matthew C, Anna S Ellis, Emily Awino Ogutu, Bethany A Caruso, Molly Linabarger, Katie Micek, Richard Muga, Amy Webb Girard, Breanna K Wodnik, and Kimberly Jacob Arriola. 2020. “Impact of a Demand-Side Integrated WASH and Nutrition Community-Based Care Group Intervention on Behavioural Change: A Randomised Controlled Trial in Western Kenya.” BMJ Global Health 5 (11). https://doi.org/10.1136/bmjgh-2020-002806.

Fuller, R. 2012. “Effectiveness Review: Food Security And Livelihoods Support Among Fishers And Fish Processors, Democratic Republic Of Congo.” Oxfam GB. https://reliefweb.int/report/democratic-republic-congo/food-security-and-livelihoods-support-among-fishers-and-fish.

Fuller, Robert. 2012. “Effectiveness Review: Livestock Commercialisation For Pastoralist Communities In North Dakoro, Niger.” Oxfam GB. https://oxfamilibrary.openrepository.com/handle/10546/262466.

Galasso, Emanuela, Ann M. Weber, Christine P. Stewart, Lisy Ratsifandrihamanana, and Lia C. H. Fernald. 2019. “Effects Of Nutritional Supplementation And Home Visiting On Growth And Development In Young Children In Madagascar: A Cluster-Randomised Controlled Trial.” The Lancet Global Health 7 (9): E1257–68. https://doi.org/10.1016/S2214-109X(19)30317-1.

Gilligan, Daniel O., Alejandra Arrieta, Stephen Devereux, John Hoddinott, Dereje Kebede, Natasha Ledlie, Keetie Roelen, and Alemayehu Seyoum Taffesse. 2020. “Impact Evaluation of Improved Nutrition through Integrated Basic Social Services and Social Cash Transfer Pilot Program (IN-SCT) in Oromia and SNNP Regions, Ethiopia:Endline Impact Evaluation Report.” UNICEF Publish Report. https://www.ifpri.org/publication/impact-evaluation-improved-nutrition-through-integrated-basic-social-services-and-social.

Grijalva-Eternod, Carlos S., Mohamed Jelle, Hani Mohamed, Katie Waller, Bishar Osman Hussein, Emmanuel Barasa, Andrea Solomon, et al. 2023. “Evaluation of Conditional Cash Transfers and mHealth Audio Messaging in Reduction of Risk Factors for Childhood Malnutrition in Internally Displaced Persons Camps in Somalia: A 2 × 2 Factorial Cluster-Randomised Controlled Trial.” PLoS Medicine 20 (2). https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1004180.

Hidrobo, Melissa, Lieven Huybregts, Naureen Karachiwalla, and Shalini Roy. 2020. “Multi-Component Cash Transfer Programs: Evidence from Mali’s Social Safety Net Program.” International Food Policy Research Institute (IFPRI).

https://doi.org/10.2499/p15738coll2.133601.

Iddrisu, Mubarak, Robert Aidoo, and Camillus Abawiera Wongnaa. 2020. “Participation in UTZ-RA Voluntary Cocoa Certification Scheme and Its Impact on Smallholder Welfare: Evidence from Ghana.” World Development Perspectives. https://doi.org/10.1016/j.wdp.2020.100244.

IFAD JO. 2018. “Impact Assessment: Agricultural Sector Development Programme–Livestock (ASDP-L) and Agriculture Service Support Programme (ASSP).” https://ideas.repec.org/p/ags/unadia/288463.html.

Issahaku, Gazali and Abdulai Awudu. 2020. “Can Farm Households Improve Food and Nutrition Security through Adoption of Climate-Smart Practices? Empirical Evidence from Northern Ghana.” Wiley Online Library 42 (3): 559–79. https://doi.org/10.1093/aepp/ppz002.

Justine Briaux, Yves Martin-Prevel, Sophie Carles, Sonia Fortin, Yves Kameli, Laura Adubra, Renk Andre’a, et al. 2020. “Evaluation of an Unconditional Cash Transfer Program Targeting Children’s First-1,000-Days Linear Growth in Rural Togo: A Cluster-Randomized Controlled Trial.” PLoS Medicine 17 (11): e1003388-1003388. https://doi.org/10.1371/journal.pmed.1003388.

Kalid, Mohamed, Renée Flacking, Munshi Sulaiman, and Fatumo Osman. 2022. “Effects of Nutrition Counselling and Unconditional Cash Transfer on Child Growth and Family Food Security in Internally Displaced Person Camps in Somalia - A Quasi-Experimental Study.” International Journal of Environmental Research and Public Health 19 (20): 13441–3441. https://doi.org/10.3390/ijerph192013441.

Kangmennaang, Joseph, Rachel Bezner Kerr, Esther Lupafya, Laifolo Dakishoni, Mangani Katundu, and Isaac Luginaah. 2017. “Impact Of A Participatory Agroecological Development Project On Household Wealth And Food Security In Malawi.” Food Security 9 (3): 561–76. https://doi.org/10.1007/s12571-017-0669-z.

Kithi, Laurine, Amin Mugera, and Bujdoso Geza. 2023. “Impacts of Farmer Field Schools on Food Security and Environmental Conservation in Western Kenya.” African Journal of Agricultural Research 19 (3): 235–46. https://doi.org/10.5897/AJAR2020.15388.

Larsen, Anna Folke, and Helene Bie Lilleør. 2014. “Beyond The Field: The Impact Of Farmer Field Schools On Food Security And Poverty Alleviation.” World Development 64:843–59. https://doi.org/10.1016/j.worlddev.2014.07.003.

Leroy, Jef L, Deanna Olney, and Marie Ruel. 2016. “Tubaramure, A Food-Assisted Integrated Health And Nutrition Program In Burundi, Increases Maternal And Child Hemoglobin Concentrations And Reduces Anemia: A Theory-Based Cluster-Randomized Controlled Intervention Trial.” Journal of Nutrition 146 (8): 601–8. https://doi.org/10.3945/jn.115.227462.

Luoto, Jill E., Frances E. Aboud, Lia C. H. Fernald, and Daisy R. Singla. 2021. “An Implementation Evaluation of A Group-Based Parenting Intervention to Promote Early Childhood Development in Rural Kenya.” BMC Public Health. https://doi.org/10.3389/fpubh.2021.653106.

Machila, Munyaradzi, Michael C. Lyne, and P. Nuthall. 2015. “Assessment of an Outsourced Agricultural Extension Service in the Mutasa District of Zimbabwe.” Other 7 (5): 142–49. https://doi.org/10.5897/jaerd2015.0677.

MacPherson, Claire, and Olivier Sterck. 2021. “Empowering Refugees through Cash and Agriculture: A Regression Discontinuity Design.” Journal of Development Economics 149. https://doi.org/10.1016/j.jdeveco.2020.102614.

Mensah-Homiah, Joseph, Owuraku Sakyi-Dawson, AM Bonsu, and Grace S. Marquis. 2012. “Microenterprise development coupled with nutrition education can help increase caregivers' incomes and household accessibility to animal source foods.” African Journal of Food, Agriculture, Nutrition and Development 12 (1). https://doi.org/10.18697/ajfand.49.ENAM4.

Merchant, Emily V., Martins Odendo, Norah Maiyo, Ramu Govindasamy, Xenia K. Morin, James E. Simon, and Daniel J. Hoffman. 2023. “An Evaluation of Nutrition, Culinary, and Production Interventions Using African Indigenous Vegetables on Nutrition Security Among Smallholder Farmers in Western Kenya.” Frontiers in Nutrition 10. https://doi.org/10.3389/fnut.2023.1154423.

Mpiira, Robert, and Patrick Okello. 2020. “A Multisectoral Approach To Eradication Of Malnutrition In Vulnerable Groups: A Cluster-Randomised Trial.” Lancet Global Health 7:8. https://doi.org/10.31080/ASNH.2020.04.a-multisectoral-approach-to-eradication-of-malnutrition-in-vulnerable-groups-a-cluster-randomized-trial.

Nkonya, Ephraim, Dauda Bawa, Edward Kato, David Maurice, Nasiru Murtala, Hadiza Nuhu, Patrick Kwaghe, Yakubu Bila, and Rabiu Sani. 2019. “Humanitarian Assistance and Resilience-Building: Impact of Fadama III-AF II on Food Security and Livelihood Restoration in Northeastern Nigeria.” International Food Policy Research Institute. https://doi.org/10.2499/p15738coll2.133172.

Ntakyo, Proscovia Renzaho, and Marrit van den Berg. 2019. “Effect Of Market Production On Rural Household Food Consumption: Evidence From Uganda.” Food Security 11:1051-1070-051–1070. https://doi.org/10.1007/s12571-019-00959-2.

Okyere, Charles Yaw, and Lukas Kornher. 2023. “Carbon Farming Training and Welfare: Evidence From Northern Ghana.” Land Use Policy 134. https://doi.org/10.1016/j.landusepol.2023.106932.

Osei, Robert Darko, Fred M. Dzanku, Isaac Osei-Akoto, Felix Asante, Louis S. Hodey, Pokuaa N. Adu, Kwabena Adu-Ababio, and Massa Coulibaly. 2018. “Impact of Voice Reminders to Reinforce Harvest Aggregation Services Training for Farmers in Mali.” 3ie Series Report. Vol. 90. http://3ieimpact.org/evidence-hub/publications/impact-evaluations/impact-voice-reminders-reinforce-harvest-aggregation.

Pan, Yao, Munshi Sulaiman, and Stephen C. Smith. 2015. “Agricultural Extension And Technology Adoption For Food Security: Evidence From Uganda.” Institute for Study of Labor (IZA) Discussion Paper. Vol. 9206. https://www.iza.org/publications/dp/9206/agricultural-extension-and-technology-adoption-for-food-security-evidence-from-uganda.

Porter, Catherine, and Radhika Goyal. 2016. “Social Protection For All Ages? Impacts Of Ethiopia’s Productive Safety Net Program On Child Nutrition.” Social Science & Medicine 159:92–99. https://doi.org/10.1016/j.socscimed.2016.05.001.

Premand, Patrick, and Oumar Barry. 2020. “Behavioral Change Promotion, Cash Transfers and Early Childhood Development: Experimental Evidence from a Government Program in a Low-Income Setting.” Other. Vol. 9368. https://documents1.worldbank.org/curated/en/756191598464680389/pdf/Behavioral-Change-Promotion-Cash-Transfers-and-Early-Childhood-Development-Experimental-Evidence-from-a-Government-Program-in-a-Low-Income-Setting.pdf.

Pretari, Alexia. 2019. “Resilience In North East Ghana: Impact Evaluation Of The Climate Resilient Agricultural And Food Systems (Crafs) Project.” Oxfam Effectiveness Review Series. https://doi.org/10.21201/2019.5235.

Rusike, J., N.M. Mahungu, S.S. Lukombo, T. Kendenga, S.M. Bidiaka, A. Alene, A. Lema, and V.M. Manyong. 2014. “Does A Cassava Research-For-Development Program Have Impact At The Farm Level? Evidence From The Democratic Republic Of Congo.” Food Policy 46:193–204. https://doi.org/10.1016/j.foodpol.2014.03.012.

Rutherford, Diana Duff, Holly M. Burke, Kelly K. Cheung, and Samuel H. Field. 2016. “Impact Of An Agricultural Value Chain Project On Smallholder Farmers, Households, And Children In Liberia.” World Development 83:70–83. https://doi.org/10.1016/j.worlddev.2016.03.004.

Sakketa, Tekalign Gutu, Raoul Herrmann, Chewe Nkonde, Mwelwa Lukonde, and Michael Brüntrup. 2022. “The Effects of a Private-Sector Driven Smallholder Support Programme on Productivity, Market Participation and Food and Nutrition Security: Evidence of a Nucleus-Outgrower Scheme From Zambia.” Other. Vol. 19/2022. https://doi.org/10.23661/idp19.2022.

Santoso, Marianne V, Rachel N Bezner Kerr, Neema Kassim, Haikael Martin, Elias Mtinda, Peter Njau, Kelvin Mtei, John Hoddinott, and Sera L Young. 2021. “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): 2010–21. https://doi.org/10.1093/jn/nxab052.

Shapiro, Jeremy. 2019. “The Impact of Recipient Choice on Aid Effectiveness.” World Development 116:137–49. https://doi.org/10.1016/j.worlddev.2018.10.010.

Sibhatu, Kibrom T., Aslihan Arslan, and Emanuele Zucchini. 2022. “The Effect of Agricultural Programs on Dietary Diversity and Food Security: Insights From the Smallholder Productivity Promotion Program in Zambia.” Food Policy 113. https://doi.org/10.1016/j.foodpol.2022.102268.

Siewe, Francois, Henry Egwuma, Ben Ahmed, Adunni Sanni, Sunday T. Abu, Oluwaseun A. Ojeleye, Cordelia O. Nwahia, Raoul Fani Djomo Choumbou, and Abubakar A. Abdulahi. 2023. “A Best-Bet System of Rice Intensification and Poverty Alleviation in Zamfara State, Nigeria: A Mixed Method Analysis.” Agricultural Systems.

https://doi.org/10.1016/j.agsy.2023.103805.

Sissoko, Penda, Sékou Sala Guindo, Sadio Togola, Bakary Désiré Dembélé, Lars Kåre Grimsby, and Jens B. Aune. 2023. “Effect of Adoption of Climate-Smart-Agriculture Technologieson Cereal Production, Food Security and Food Diversity in Central Mali.” Agriculture 13 (1196). https://doi.org/10.3390/agriculture13061196.

Steinke, Jonathan, Lemlem Teklegiorgis Habtemariam, Christoph Kubitza, Markolf Maczek, Boran Altincicek, and Stefan Sieber. 2023. “Stronger Food and Nutrition Security Impacts From More Intense Project Participation: Evidence From a Multi-Country Intervention Program.” The Journal of Development Studies 59 (6): 873–93. https://doi.org/10.1080/00220388.2023.2182684.

Tambo, Justice A., Fredrick Mbugua, Solomon Agyemang Duah, Birgitta Oppong-Mensah, Christopher Yao Ocloo, and Frances Williams. 2023. “Pest Risk Information, Agricultural Outcomes and Food Security: Evidence From Ghana.” Food Security 15:1667-1683-667–1683. https://doi.org/10.1007/s12571-023-01398-w.

Tesfamariam, Bahta Yonas, Enoch Owusu-Sekyere, Donkor Emmanuel, and Tlalang Boipelo Elizabeth. 2018. “The Impact of the Homestead Food Garden Programme on Food Security in South Africa.” Food Security, 95–110.

Walton, Colleen. 2012. “Sustainable Livelihoods and Food and Nutrition Security of Kenyan Smallholder Farm Women.” Other. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjR8PTly8eEAxXc9gIHHXnRCgMQFnoECBEQAQ&url=https%3A%2F%2Fislandscholar.ca%2Fislandora%2Fobject%2Fir%253A6088%2Fdatastream%2FPDF%2Fdownload%2Fir_6088.pdf&usg=AOvVaw2gcCdHNRGjujZ-fntMekQ_&opi=89978449.

Wang, Dongqing, Leonard K. Katalambula, Andrea R. Modest, Abbas Ismail, Augustine Malero, Dayana Bray, Haley Cinq-Mars, et al. 2023. “Meals, Education, and Gardens for In-School Adolescents (MEGA): A Cluster Randomized Trial of Adolescent Nutrition Intervention Packages in Tanzania.” Current Developments in Nutrition 7 (11). https://doi.org/10.1016/j.cdnut.2023.101254.

Wanjala, Bernadette M., and Roldan Muradian. 2013. “Can Big Push Interventions Take Small-Scale Farmers Out Of Poverty? Insights From The Sauri Millennium Village In Kenya.” World Development 45:147–60. https://doi.org/10.1016/j.worlddev.2012.12.014.

Wanyama, J.M., E.M. Nyambati, L.O. Mose, C. Mutoko, W.M. Wanyonyi, E. Wanjekeche, and S.C. Rono. 2010. “Assessing Impact Of Soil Management Technologies On Smallholder Farmers’ Livelihoods In North Western Kenya.” African Journal of Agricultural Research 5 (21): 2899–2908. https://doi.org/10.5897/AJAR.9000066.

Weinhardt, Lance S, Loren W. Galvao, Alice F. Yan, Patricia Stevens, Thokozani Ng’ombe Mwenyekonde, Emmanuel Ngui, Lindsay Emer, Katarina M. Grande, Lucy Mkandawire-Valhmu, and Susan C. Watkins. 2017. “Mixed-Method Quasi-Experimental Study of Outcomes of a Large-Scale Multilevel Economic and Food Security Intervention on HIV Vulnerability in Rural Malawi.” AIDS and Behaviour 21 (3): 712–23. https://doi.org/10.1007/s10461-016-1455-1.