Synthesis of Evidence on the Impacts of Nutrition-sensitive Interventions on Maternal and Children's Nutrition Outcomes

Research Protocol

Thomas de Hoop, Adria Molotsky, Amos Laar, Averi Chakrabarti, Garima Siwach, Rebecca Walcott, Varsha Ranjit, Torben Behmer

NOVEMBER 2023

Synthesis of Evidence on the Nutritional Impacts of Nutrition-Sensitive Interventions

Research Protocol

Thomas de Hoop, Adria Molotsky, Amos Laar, Averi Chakrabarti, Garima Siwach, Rebecca Walcott, Varsha Ranjit, Torben Behmer

NOVEMBER 2023

AIR® Headquarters
1400 Crystal Drive, 10th Floor
Arlington, VA 22202-3289
+1.202.403.5000 | **AIR.ORG**

09/2023

Contents

Exhibits

Introduction

Despite modest progress, maternal and child undernutrition remains a major global health concern. Nutrition data from 50 low- and middle-income countries (LMICs) show improvements in linear growth for children younger than age 5. Reductions in wasting were smaller (Victora et al., 2021), with data from the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Bank (2021) showing that 45 million children under age 5 currently suffer from wasting (WHO, 2021). Overweight and obesity have also increased significantly in LMICs (Popkin, Corvalan, & Grummer-Strawn, 2019), highlighting how some of the poorest LMICs face a simultaneous manifestation of both undernutrition and obesity or a double burden of malnutrition.

Existing literature increasingly suggests that nutrition-specific interventions that address the proximal determinants of nutritional health (e.g., inadequate dietary intake and disease) are necessary but not sufficient to achieve reductions in stunting and wasting (Bhutta et al., 2013; Ruel et al., 2013; Bhutta et al., 2020; Keats et al., 2021; Leroy et al., 2021). According to the Lancet Series on Maternal and Child Nutrition, promising nutrition-specific interventions that reduce stunting and wasting by addressing its immediate causes include management of acute malnutrition, optimal caloric intake, protein, calcium, and multiple micronutrient supplementation, preventive strategies for malaria in pregnancy, strategies to promote breastfeeding and complementary feeding, and food supplementation in food secure and insecure populations (Bhutta et al., 2013). Achieving accelerations in reductions in stunting and wasting will, however, require additional investments in large-scale nutrition-sensitive programs that address key underlying determinants of nutrition and enhance the coverage and effectiveness of nutrition-specific interventions (Ruel et al., 2013; Bhutta et al., 2020; Keats et al., 2021; Leroy et al., 2021).

Examples of promising nutrition-sensitive interventions include social protection and safety net programs, such as cash transfers and women's self-help groups , water, sanitation, and hygiene (WASH) services, nutrition-sensitive agriculture programs, and early childhood development interventions (Alderman, 2020; Bhutta et al., 2020; Keats et al., 2021). Various studies highlight how such interventions can create synergies with nutrition-specific programs to generate larger impacts on nutrition outcomes, such as stunting and wasting (e.g., Ruel et al., 2013; Leroy et al., 2022; Margolies et al., 2022; Storhaug et al., 2022; Bhutta et al., 2020; Keats et al., 2021). However, up until now, no study has combined existing estimates of the impact of nutrition-sensitive interventions from systematic reviews with representative estimates of the costs of nutrition-sensitive interventions. As a result, significant evidence-gaps remain on what investments are required to generate the largest impacts of nutrition-sensitive interventions on nutrition outcomes to contribute to the Sustainable Development Goals (SDGs).

For nutrition-specific interventions, Shekar et al. (2017) present an overview of the investments required to reach global targets for stunting, anemia, breastfeeding, and wasting. Their analyses demonstrate how investments in effective nutrition-specific interventions can generate returns of investment between $4 (for investments to reduce wasting) and $35 (for investments to encourage exclusive breastfeeding). In response to these large returns on investment, they identify ways to raise

the needed financial resources. Shekar et al. (2023) also highlight how innovative financing is critical to generate larger funding streams for addressing nutrition challenges.

Yet, researchers have not conducted similar analyses to synthesize evidence on the impact and cost-effectiveness of nutrition-sensitive interventions in achieving reductions in stunting and wasting and improvements in other nutrition outcomes or dietary diversity. One reason is that more evidence is available on the impact of nutrition-specific interventions on nutrition outcomes. However, rigorous evidence on the impact of nutrition-sensitive interventions on stunting, wasting, other nutrition outcomes and dietary diversity has increased considerably since 2017 (Bhutta et al., 2020; Keats et al., 2021).

In addition, there is an urgent need to accelerate progress in nutrition outcomes considering that progress in nutrition outcomes should ultimately achieve SDG 2.2 to end all forms of malnutrition, including achieving targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons (WHO, 2023). Achieving this goal requires rigorous evidence on the impact of nutrition-sensitive interventions on stunting, wasting, other nutrition outcomes, and dietary diversity as well as the costs and cost-effectiveness of these interventions.

Research Questions

To respond to the evidence-gap discussed above, the American Institutes for Research (AIR) will produce analyses to synthesize evidence on the impact of nutrition-sensitive interventions on nutrition outcomes such as stunting and wasting, as well as dietary diversity, and the cost-effectiveness of nutrition-sensitive interventions. This report presents the protocol for this synthesis. The review will maintain a particular focus on stunting, wasting, and dietary diversity but will include other nutrition outcomes as well. In addition, we will primarily focus on nutrition-sensitive social protection (including women's economic empowerment programs) and nutrition-sensitive agriculture interventions but will include analyses on the impact and cost-effectiveness of other nutrition-sensitive interventions. The cost-effectiveness analysis (CEA) will combine information about impacts and costs to generate evidence on the resources required for scaling up and replicating these interventions to ultimately attain SDG 2.2. In doing so, this review will address the following research questions:

1. What are the effects of nutrition-sensitive interventions on maternal and child nutrition outcomes?
    a. What types of nutrition-sensitive interventions contribute to improvements in nutrition outcomes and dietary diversity for children, adolescent girls, mothers, and women of reproductive age? What is the magnitude of the effect(s)?
    b. Through what mechanisms do nutrition-sensitive interventions generate nutrition outcomes and dietary diversity?
    c. What are the evidence gaps in the relationship between nutrition-sensitive interventions and nutrition outcomes?

2. What is the cost-effectiveness of nutrition-sensitive interventions in achieving improvements in nutrition outcomes and dietary diversity for children, adolescent girls, mothers, and women of reproductive age?

AIR will focus on a wide variety of nutrition-sensitive interventions to examine these questions. We will, for example, include analyses on the impact and cost-effectiveness of social protection interventions (e.g., cash transfers, self-help groups, savings groups and public works programming), nutrition-sensitive agriculture, early childhood development programs WASH and water security services, and programs that facilitate access to health and family planning services. Among these interventions, we will provide more in-depth analyses on social protection and agriculture interventions. To obtain a better understanding about which nutrition-sensitive interventions work, for whom, and under what circumstances, we will also examine barriers and facilitators toward the effectiveness of nutrition-sensitive interventions by incorporating qualitative studies.

Methods

This protocol describes the methods for a mixed-methods review that will include (a) a systematic review of impact evaluations focused on nutrition-sensitive interventions; (b) an evidence synthesis of qualitative studies that are explicitly linked to these impact evaluations; (c) a meta-analysis of the impacts of nutrition-sensitive social protection and agricultural interventions on stunting, wasting, and dietary diversity by intervention type (for interventions for which sufficient evidence is available); and (d) a costing and cost-effectiveness analysis identifying the resources necessary to implement effective nutrition-sensitive interventions and achieve progress in nutrition outcomes and dietary diversity as well as an assessment of the most cost-effective approaches to achieve reductions in stunting and wasting and improvements in dietary diversity.

AIR will examine the impact and cost-effectiveness of a wide variety of nutrition-sensitive interventions, but the synthesis will place a larger emphasis on nutrition-sensitive social protection and agriculture interventions. This is because of the wide scope of the exercise and the ambitious timeline. For example, we will only conduct meta-analyses for intervention types with six or more impact estimates. In addition, we will only conduct meta-analyses for stunting, wasting, and dietary diversity and limit our analyses of intermediate outcomes (e.g., food security, breastfeeding practices) to narrative syntheses. We will extract data on the effects of specific nutrition-sensitive interventions from impact evaluations and systematic reviews that were conducted since 2013.[1,2] We will also limit the inclusion of qualitative

[1] The review by Ruel et al. (2013) on nutrition-sensitive interventions was published in The Lancet in 2013 and captures information on many relevant evaluations prior to 2013. Therefore, for the sake of efficiency (and because of relevance for the current time period), we will focus on impact evaluations published after this date which the review does not include.

[2] We will, however, only extract effect sizes for impact evaluations that were not included in existing meta-analyses examining the impact of nutrition-sensitive interventions on stunting and wasting. One systematic review on the impact of nutrition-sensitive agriculture interventions published in 2021 includes a search for impact

studies to 'sibling studies' (i.e., performance and process evaluations linked to the experimental or quasi-experimental studies identified for inclusion in the synthesis) to provide context and lessons learned around implementation. For cost-effectiveness analysis, we will primarily rely on sibling studies, but may include information from other sources (i.e., program documents) as well.

The remainder of this protocol is structured as follows: we begin with a typology and conceptual framework justifying the sectors of focus and potential linkages to nutrition outcomes, which will guide the methodology including the database search, evaluation mapping, and evidence synthesis. Next, we provide the details of the research protocol including methods for screening, coding, analyzing, synthesizing, and triangulating evidence from systematic reviews, randomized controlled trials and quasi-experimental studies, and the associated qualitative evidence and information about costs and cost-effectiveness. Finally, we describe the process for searching for and collating cost data and the cost-effectiveness analyses.

Conceptual Framework

Over the years, the concept and definitional perspectives of nutrition-sensitive interventions have evolved. Reflecting the current understanding of the complex relationships between food, health, and overall well-being, nutrition-sensitive interventions aim to address the distal, and underlying causes of malnutrition (e.g., Ruel et al., 2013; Leroy et al., 2022; Keats et al., 2021).

One of the cardinal developments in the 1990s was the development of the UNICEF Conceptual Framework for malnutrition (UNICEF, 2021). This framework ignited a shift toward nutrition-sensitive approaches that recognize the broader determinants of malnutrition – taking into account distal factors or basic causes of malnutrition (including economic, education, ideological and political superstructure), enabling environments or underlying causes (including healthcare, health services, unhealthy environments, and household food insecurity), proximal components or immediate causes (including inadequate dietary intake, disease) and manifestations or outcomes (health or lack thereof – malnutrition or death). The framework called for, and valorized efforts to integrate nutrition into various sectors, such as agriculture, education, and social protection.

evaluations up until 2018 (Sparling et al., 2021). In addition, a systematic review on the impact of social assistance programs on women's and children's nutritional status published in 2022 included a search for impact evaluations up until 2020 (Olney et al., 2022). These findings suggest that a substantial number of impact evaluations will already be included in existing meta-analyses. In those cases, we will extract effect sizes from those existing meta-analyses. We recognize, however, that not all impact evaluations are included in existing systematic reviews. We plan to extract effect sizes for impact evaluations of nutrition-sensitive interventions for which no meta-analyses are available and for impact evaluations that were published after searches for systematic reviews took place. In addition, we plan to review and cross-check some of the effect size calculations to ensure that the information is reliable.

Defining nutrition sensitive interventions

As outlined above, the concept and definitional perspectives on nutrition-sensitive interventions have evolved from a narrow focus on nutrient deficiencies to a more holistic approach that recognizes the interconnectedness of nutrition with agriculture, health, education, and social factors. The overarching goal of those interventions is to combat malnutrition in all its forms and within planetary boundaries.

Broadly and plainly, nutrition-sensitive interventions are actions (programs, policies, or strategies) implemented across various sectors that aim to improve overall nutrition and address the underlying determinants of malnutrition. Such interventions go beyond direct or nutrition-specific interventions such as providing supplements or treating acute malnutrition. Instead, they create an enabling environment that supports optimal nutrition outcomes. Examples of nutrition-sensitive interventions include cash transfers, early childhood development programs, women's self-help group and savings group programs, and WASH services.

Ruel and Alderman (2013) define nutrition-sensitive interventions as "actions, policies or programs that address the underlying determinants of malnutrition by incorporating specific nutrition goals and actions." In 2020, UNICEF similarly defined nutrition-sensitive interventions as "those that address the underlying determinants of malnutrition—food security, adequate care and feeding practices, and a safe and hygienic environment—while also contributing to immediate nutrition outcomes." Other definitional perspectives emphasize **integration** (integrating nutrition considerations into programs and policies in sectors such as agriculture, health, education, and social protection); **multi-sectorality** (involving collaboration across various government departments, non-governmental organizations and other non-state actors); and **long-term impact and sustainability** (creating sustainable improvements in nutrition by addressing the root causes of malnutrition, such as poverty, lack of access to nutritious foods, and inadequate care practices, or sustainably addressing the nutritional needs of humans and the planet). It is worth noting that, irrespective of the definitional perspective, nutrition-sensitive interventions are designed to address the broader context in which malnutrition is produced and affected by physical, clinical, or social factors.

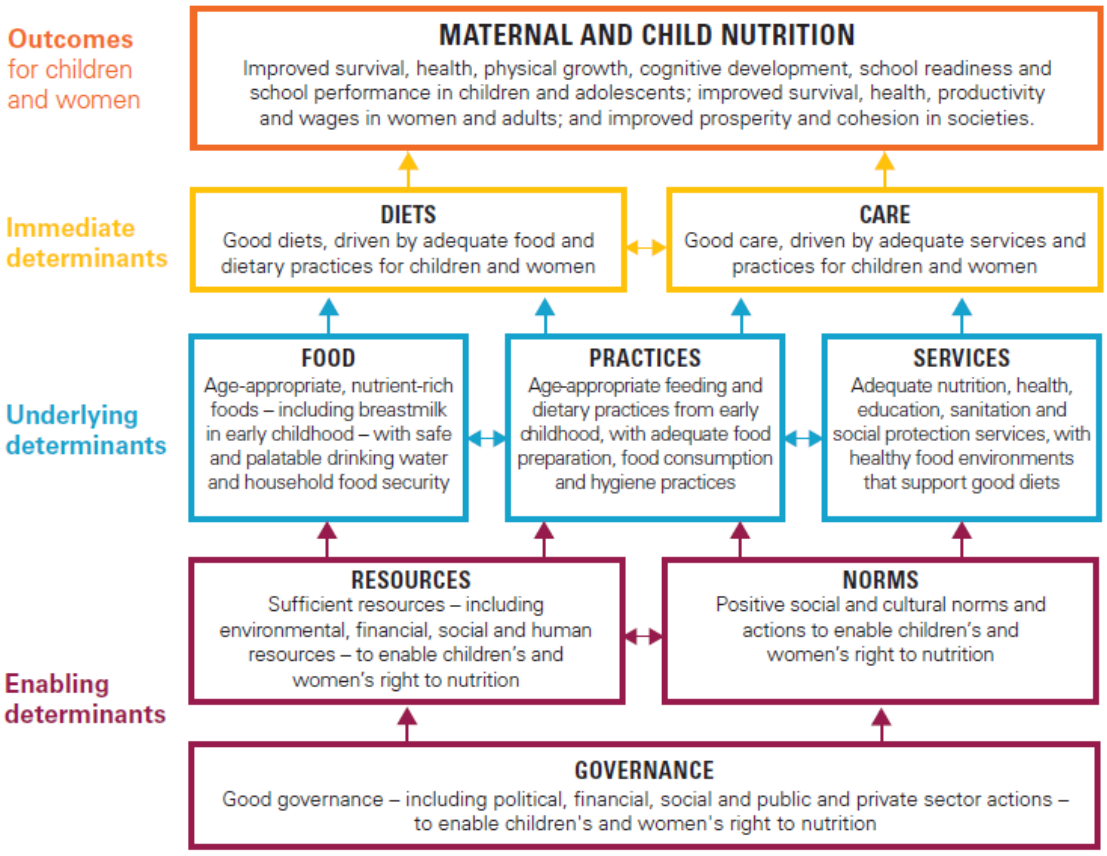
Frameworks for Nutrition-Sensitive Interventions

Several frameworks exist that provide guidance for state actors, non-state actors, and practitioners to design and implement effective nutrition-sensitive interventions. The selection of frameworks requires consideration of contextual factors and other needs, including compounding crises such as climate change and global pandemics. Outlined earlier, the 1990 UNICEF Conceptual Framework identifies three important determinants to address in order to improve nutrition – basic, underlying, and immediate determinants. The underlying causes determine whether the diet is adequate, and the person is healthy (immediate causes of malnutrition). The underlying causes themselves are affected by basic causes determined by the social, economic, and political context. Given that nutrition is a complex issue with multiple factors interacting in a non-linear fashion, all such factors are relevant. The World Bank (2013), advises that, for interventions to be nutrition-sensitive, the underlying and basic causes have to be taken into consideration. In 2020, UNICEF updated its 1990 framework (see ***Exhibit 1***), acknowledging

the increasing triple burden of malnutrition – undernutrition, micronutrient deficiencies, and overweight (UNICEF, 2021).

Arguably, the most popular and influential framework thus far is the one articulated in the 2013 Lancet Series on Maternal and Child Undernutrition (see Black et al 2013; Ruel and Alderman 2013). Adapted from Scaling Up Nutrition (SUN, 2011) and Shekar et al (2013), Ruel and Alderman's (2013) examination of interventions and their potential to improve nutrition is guided by this framework (see ***Exhibit 2***). The framework outlines the dietary, behavioral, and health determinants of optimum nutrition, growth, and development, and how they are affected by underlying food security, caregiving resources, and environmental conditions, which are in turn shaped by economic and social conditions, national and global contexts, capacity, resources, and governance. The Lancet Series focuses on how these determinants can be changed to enhance growth and development, including the nutrition-specific interventions that address the immediate causes of suboptimum growth and development and the potential effects of nutrition-sensitive interventions that address the underlying determinants of malnutrition and incorporate specific nutrition goals and actions.

Exhibit 1*:* UNICEF Conceptual Framework on the Determinants of Maternal and Child Nutrition

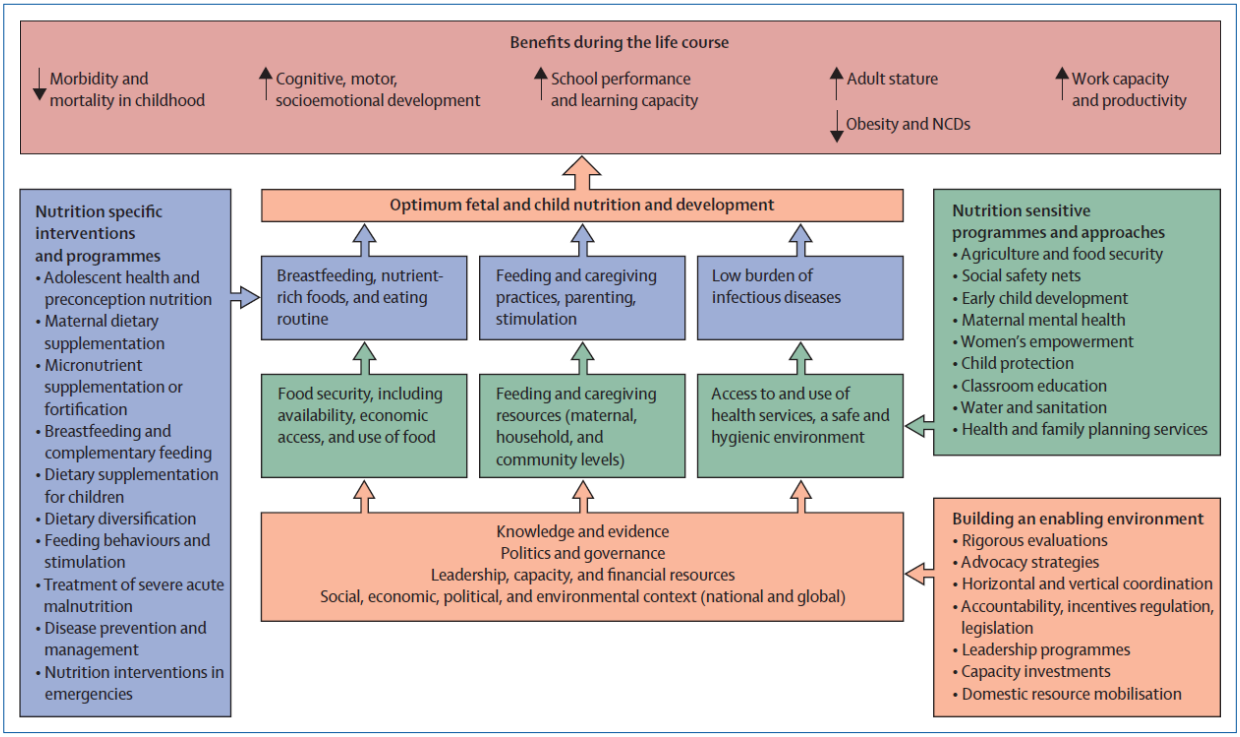


To illustrate, the authors of the framework show pathways through which agriculture can affect nutrition outcomes using data from the World Bank (2007) and Gillespie et al. (2012). For instance, as a

source of food – agriculture increases household availability and access to food from own production; as a source of income, agriculture increases income from wages earned by agricultural workers or through the marketing of agriculture commodities produced. Agriculture can also affect women's social status and empowerment - women's participation in agriculture can, for example, affect their access to, or control over, resources and assets, and increase their decision-making power regarding intra-household allocation of food, health, and care.

Similarly, social protection programs such as cash transfers, asset transfers and self-help and savings groups, could enable households to improve asset ownership and household food consumption, which could in turn increase food security and dietary diversity followed by potential improvements in nutrition outcomes. When women receive cash or assets, this may increase their agency, which could in turn result in larger improvements in maternal and child nutrition outcomes after improvements in food security and dietary diversity (de Groot et al., 2017). Similarly, women may increase their decision-making power after increasing their savings and access to credit, which could in turn provide them with opportunities to improve their own and their children's nutrition outcomes (Brody et al., 2017; Gram et al., 2019).

Exhibit 2*: Framework for actions to achieve optimum child nutrition and development*



Source: Ruel and Alderman, 2013.

Discourses on food systems, and food systems transformation have also covered nutrition-sensitive food systems (e.g., Fanzo et al., 2018; Fanzo et al., 2021) that promote climate-friendly agricultural practices. Such food systems go beyond feeding people to nourishing them. Thus, food systems-facing nutrition-sensitive interventions consider the entire food system, from production to consumption, as a key

determinant of nutrition, and while considering the implications of climate change. It focuses on promoting sustainable, equitable, and nutritious food systems that provide access to diverse and healthy foods for all.

In this synthesis, we will look at the interventions and outcomes from ***Exhibit 3Exhibit 4*** and adapt the frameworks (see ***Exhibit 5***) discussed above elaborating on the set of actions or interventions which qualify as nutrition-sensitive. Because of the broad nature of nutrition-sensitive interventions, we will not provide equal emphasis to each of the nutrition-sensitive interventions. Instead, we aim to contribute to the literature by conducting meta-analyses of social protection and agriculture programs[3] and narrative syntheses of other nutrition-sensitive interventions. For interventions for which meta-analyses are available, we will primarily rely on those existing meta-analyses and where possible update them with newly available studies that were produced after the search for the meta-analysis took place. For the outcomes, we will conduct meta-analyses for stunting, wasting, and dietary diversity, while conducting more narrative analyses for some of the other more prominent outcomes, such as anemia, overweight, low birth weight, , breastfeeding, obesity, and micronutrient deficiencies, , as well as an intermediate outcome like food security. We selected these outcomes in close consultation with the World Bank and a Technical Advisory Group and based on the SDGs.

Exhibit 3: Overview with examples of nutrition-sensitive interventions

	Nutrition-sensitive interventions**
Social protection programs (including women's economic empowerment programs)	
1.	Safety Nets and Cash Transfers
2.	Savings groups
3.	Self-help Groups
4.	Income Generation (e.g., public works programs)
5.	Maternity and paternity leave
6.	School meals and other nutrition programs in school settings
7.	Food transfers
Health	
8.	Malaria intermittent preventive treatment in pregnancy

[3] We will conduct meta-analyses of social protection programs with six or more studies describing impacts on stunting, wasting or dietary diversity to the extent the timeline allows for it. For these meta-analyses we will prioritize intervention types with a larger number of studies. For example, it is likely that we will include a larger number of studies examining the impact of cash transfers than studies examining the impact of self-help groups or savings groups. In that case, we will prioritize a meta-analysis of cash transfer programs and conduct meta-analyses of self-help and savings group programs if the timeline allows for it. We may also conduct additional meta-analyses after submitting a draft report for inclusion in the final report.

9.	Family Planning
10.	Kangaroo mother care
11.	Delayed Cord Clamping
Agriculture and Water	
12.	Livelihood and agricultural support programs
13.	Biofortification
14.	Agricultural diversification
15.	Food System
16.	WASH services and water security
Other nutrition-sensitive interventions	
17.	Early childhood development (e.g., pre-school interventions)
18.	Iron and folic acid supplements for adolescents
19.	Deworming for adolescents

**Nutrition-sensitive interventions listed above are based on discussions with the World Bank and the Technical Advisory Group and not exhaustive.

Exhibit 4: Overview of desired nutrition outcomes.

Nutrition Outcomes and Intermediate outcomes**	
Outcomes directly linked to the Global Nutrition Targets	
1.	Stunting (number of children under-5 who are stunted)
2.	Wasting (childhood wasting)
3.	Anemia (anemia in women of reproductive age)
4.	Low birth weight (% of newborns with low birth weight
5.	Childhood overweight (childhood overweight)
6.	Breastfeeding (rate of exclusive breastfeeding in the first 6 months)
7.	Obesity
8.	Nutrient Intake
9.	Micronutrient deficiencies
Intermediate outcomes	
10.	Dietary diversity
11.	Food security

**Nutrition outcomes listed above are based on the SDGs and not exhaustive.

In addition to these interventions and outcomes, our conceptual framework (***Exhibit* 6**) includes moderators that will likely affect the impact of nutrition-sensitive interventions. We include moderators at the individual-level (gender, age) as well as at the community level (shocks). Gender and age are important moderators because the impact of nutrition-sensitive interventions can differ depending on gender norms and the time period during which individuals are affected by malnutrition. For community-level shocks, we include weather-related shocks related to climate change (e.g., droughts

and floods) and pandemics because the impact of nutrition-sensitive interventions will likely differ when such shocks happen, and because of the importance of examining how climate change and COVID-19 may have affected the effectiveness of nutrition-sensitive interventions.

It is important to note that only nutrition-specific interventions or only nutrition-sensitive interventions alone will likely not achieve the maternal and child nutrition outcomes, but instead an integrated approach which includes both nutrition-specific and nutrition-sensitive interventions is needed. Poor nutrition outcomes are a multisectoral challenge and require a multisectoral-based solution, inclusion of different types of interventions (nutrition-specific and nutrition-sensitive), programs under each type of intervention, and intervention domains (promotion, prevention, management, implementation, and monitoring) to improve nutrition outcomes. **Error! Reference source not found.*5*** presents a simplified conceptual model illustrating how improvements in nutrition-specific interventions (such as micronutrient supplementation or disease prevention) alone are unlikely to be sufficient to improve nutritional outcomes and how improvements in nutrition outcomes likely require synergies between different nutrition-sensitive interventions. The figure illustrates how positive and significant effects on nutrition outcomes require improvements in both nutrition-specific and nutrition-sensitive interventions, suggesting that nutrition-specific and nutrition-sensitive interventions may need to be combined to achieve larger improvements in nutrition outcomes.

***Exhibit* 5*: Intervention pathways – nutrition-specific and nutrition-sensitive* interventions.**

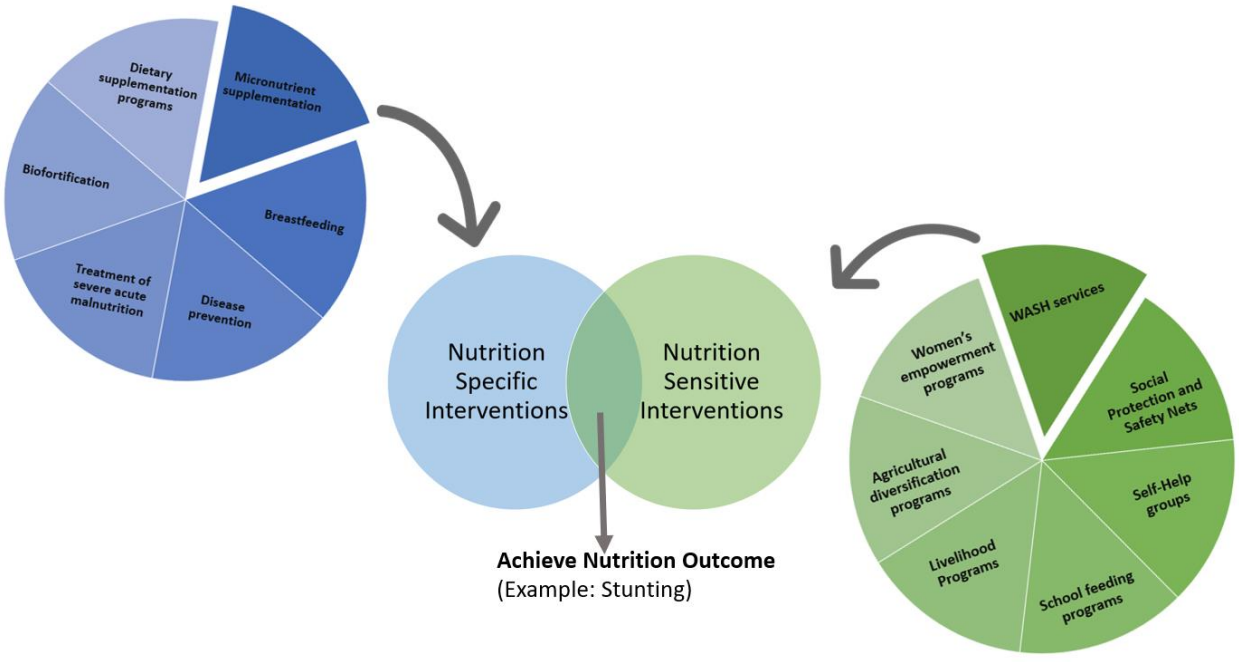
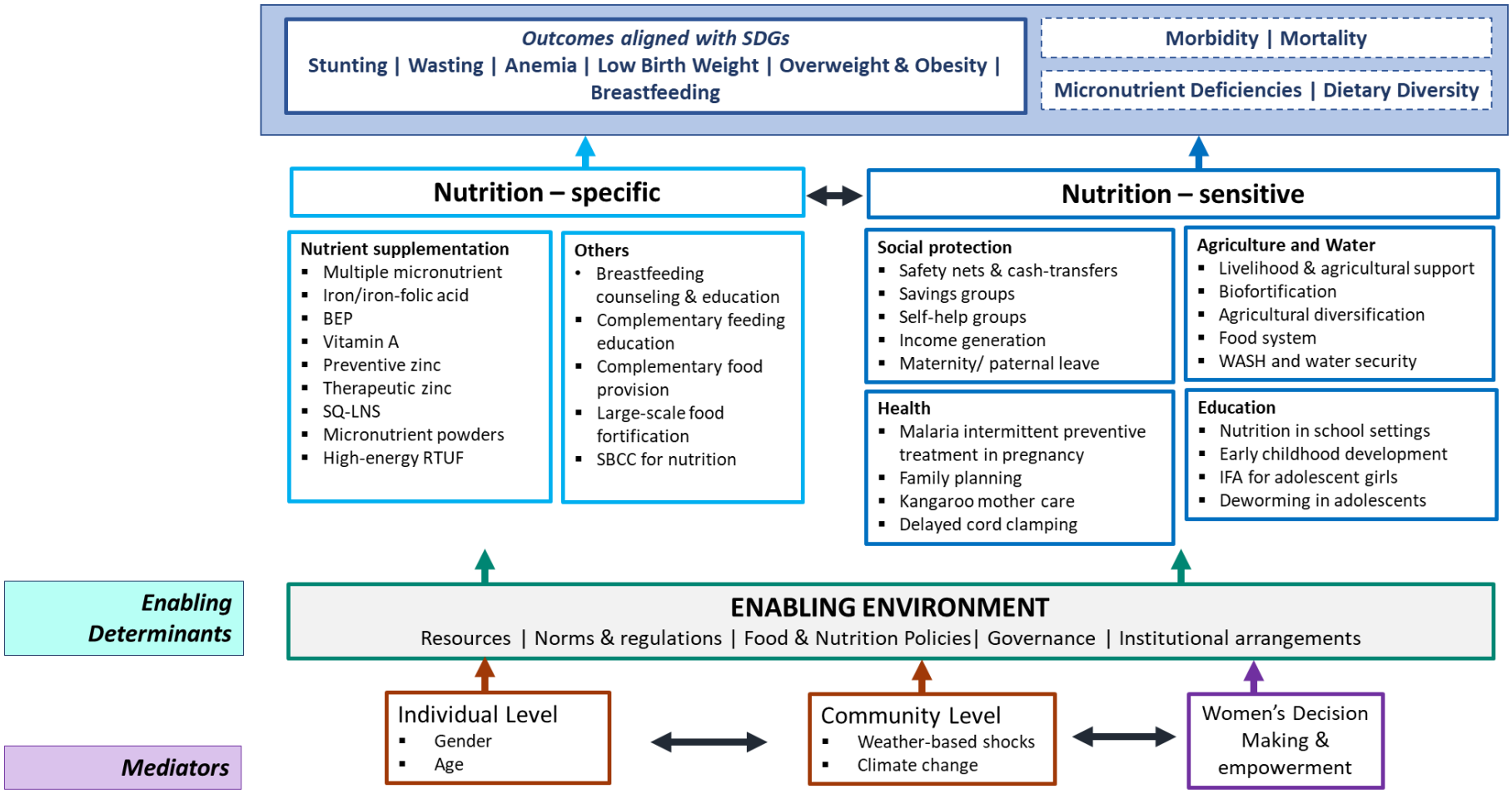


Exhibit 6: Adapted conceptual framework



Midrange Theories to Describe Impact Pathways of Nutrition-Sensitive Interventions

To better understand the pathways through which nutrition-sensitive interventions influence nutrition outcomes and dietary diversity, we developed multiple midrange program theories for the nutrition-sensitive interventions we will emphasize in the synthesis. These midrange program theories "identify and test the principles that cause action, and the underlying assumptions required for these principles to work as expected" (Vigneri, 2021, pp. 1). For the development of midrange program theories, we placed particular focus on social protection interventions, livelihood and agriculture interventions, and women (economic) empowerment interventions because we plan more in-depth analyses on these intervention types.

The midrange program theories provide explanatory analyses of how and why an intervention is expected to work (or not work). The program mid-range theories help explain the mechanisms through which nutrition-sensitive interventions can lead to improved nutrition outcomes, as well as under which conditions. We recognize that the pathways described as part of the midrange program theories include various intermediary steps (including feedback and mutually reinforcing loops). However, we do not present an exhaustive overview of these intermediary steps, to keep the midrange program theories tractable.

Midrange program theory 1: Social protection interventions impact nutrition outcomes positively
Mid-range theories of social protection interventions support the hypothesis that social protection instruments (particularly those that include food transfers, cash transfers, asset transfers, livelihood-related insurance, labor regulations, and public works programs) can increase and/or stabilize household income, improve maternal and childcare practices, improve people's diets, and thus lead to improved nutritional outcomes in women and children. Such transfers could increase household budgets devoted to food and can change diet composition and quality. In addition, price subsidies on fortified foods may enable households to invest in more nutritious diets. School meals conditional on school attendance also could positively affect children's food security.

Midrange program theory 2: Women economic empowerment interventions impact nutrition and health outcomes positively
Empowering women through self-help, savings groups or other social protection programs aiming to improve women's economic empowerment can positively influence dietary diversity and nutrition through various pathways. When these interventions empower women, they could enable women to play a pivotal role in decision-making related to food choices, family health, and resource allocation. Women's agency and decision-making power could then allow women to prioritize the health of their families, including their children. Economic empowerment of women through income-generating activities can also enhance their ability to access nutritious foods, healthcare services, and education for themselves and their children. Overall, the empowerment of women, whether through education, economic opportunities, or enhanced decision-making power, has the potential to create a ripple effect with the potential to improve the nutritional well-being of the entire household.

PT3: Livelihood and agricultural interventions impact nutrition and health outcomes positively
Livelihood interventions (such as agricultural diversification programs; small-scale farming support; livestock and poultry farming initiatives; microfinance and income-generating activities; nutrition-

sensitive value chain development; integrated farming systems; and farmer field schools) could directly and indirectly impact nutritional outcomes. For instance, small-scale farming support, and agricultural diversification interventions (the practice of growing a variety of crops including fruits, vegetables, legumes and raising different types of livestock), may have positive impacts on nutrition outcomes by influencing the availability, accessibility, and diversity of food sources. Through training, resources, and access to markets, such support for small-scale farmers could increase household income, improve access to diverse foods, enhance food security, and positively affect nutrition outcomes.

Exhibit 7 maps the pathways via which nutrition-sensitive interventions (social protection, women economic empowerment, livelihood and agricultural interventions) can impact nutrition outcomes.

Exhibit 7. ***Select nutrition sensitive Intervention and pathways to nutrition impact***

Nutrition sensitive Intervention	Pathways	Impact of intervention	Mid-range theories
Social protection and safety nets	Cash transfers (of adequate size), food transfers, food vouchers, or subsidies **increase purchasing power for food and other essentials** (especially for low-income households). Regular cash transfers offer investment opportunities, which can lead to longer-term positive impacts. Cash transfers can facilitate household investment in businesses and agriculture. Income from these ventures can lead to long-term improvements in food security and nutrition outcomes. Cash transfers or food assistance programs can increase dietary diversity and **enhance household food security by ensuring a reliable source of and access to diverse food.** Also, asset transfers can enable households to start small businesses which can in turn enable these households to increase their income. Social protection programs that target pregnant women, mothers, and young children, and provide specific support for MCH can address underlying determinants of malnutrition by providing safety nets during times of economic or environmental shocks. In this way these programs can **prevent households from resorting to coping mechanisms that negatively impact nutrition**. **Social protection programs such as school meals** provide nutritious meals that meet recommended dietary guidelines and standards. School meal programs help address food insecurity by ensuring that children have access to regular, reliable meals during school hours.	**Reduced poverty and increased income can translate to improved access to nutritious foods,** leading to better overall nutrition. One possible unintended negative consequence of cash transfers is misapplication of the cash e.g., to health-harming products (such as unhealthy foods). **Cash transfers can help households achieve dietary diversity and food security** – via a consistent access to a diverse range of nutrient-rich foods, which can in turn result in **better nutrition outcomes** Nutrition education empowers individuals and families to make informed food choices, leading to **improved dietary practices.** **Improved MCH outcomes** contribute to better nutrition during critical periods of growth and development. Emergency assistance reduces vulnerability to shocks; and ensures that families can **meet their basic needs, including nutrition** and **recovery from shocks and emergencies.**	**Income Theory:** This theory suggests that an increase in household income, facilitated by social protection programs such as cash transfers or conditional cash transfers, leads to improved access to nutritious food and better dietary choices. As a result, nutrition outcomes are enhanced. This income theory assumes that cash transfers do not result in unintended price increases of nutritious foods. **Livelihoods Diversification Theory:** This theory posits that social protection programs can help households diversify their sources of income, reducing their reliance on a single, often unstable, income source. A diversified livelihood can improve access to food and nutrition, leading to better outcomes. **Time Allocation Theory:** Social protection programs, such as conditional cash transfers or maternity leave benefits, can free up time for caregivers to focus on child feeding and other nutrition-related activities. This can lead to improved feeding practices and nutrition outcomes. For school meal programs, several theories help explain how such programs impact child nutrition and health outcomes. The theories consider the complex interplay of various factors influencing children's dietary intake, health status, and overall well-being.

	School meal interventions that include a variety of food items from different food groups, promote a more diverse diet. School meal programs can incorporate nutrition education components, to teach children about the importance of healthy eating habits and making informed food choices. School meal programs can be designed to include nutrient-dense foods that address common micronutrient deficiencies among children. School meal programs, when implemented equitably – inclusive of students from different socioeconomic backgrounds, can help reduce disparities in nutritional status	Children receive essential nutrients crucial for growth, development, and overall well-being, which can improve their nutritional status. Improved food security can lead to improved overall dietary intake and nutritional well-being. Improved nutrition knowledge and awareness could empower students to make healthier food choices. Improved intake of essential vitamins and minerals helps prevent deficiencies and associated health issues.	**Social Cognitive Theory:** Through observational learning, the exposure to healthy food choices and positive eating habits of others can influence children to make healthier choices, with ripple effects at home. School meal programs can serve as a model for healthy eating behaviors. When children witness their peers and teachers consuming nutritious meals, it can positively impact their own food choices. **Ecological Systems Theory:** School meal programs can impact nutritional outcomes via multiple pathways and at several levels: **Microsystem (Individual Level):** The immediate environment, including the school and home, influences a child's nutrition. School meal programs contribute to the microsystem by providing a structured opportunity for healthy eating. **Mesosystem (Interactions):** Interactions between the school and family environments influence child nutrition. **Exosystem (Community):** School meal programs that engage with the broader community can contribute to a supportive food environment. **Macrosystem (Cultural and Societal Values):** Cultural norms and societal values influence dietary choices. School meal programs that align with cultural preferences enhance their effectiveness.

Women empowerment interventions	Empowering women with control over household resources (e.g. savings and credit), enables them to make decisions regarding food purchasing and allocation, including for their children. It can impact nutrition outcomes by addressing gender disparities, increasing women's agency, and improving their access to resources Aspects of women **empowerment interventions focus on training, and access to information, including nutrition knowledge**. Women empowerment interventions that address gender norms, and those that that facilitate women's participation in agriculture can impact nutrition outcomes by addressing gender disparities, increasing women's agency, and improving their access to resources. Also, non-agricultural livelihood activities provide income and access to markets Through **enhanced decision-making power, e**mpowered women have a greater say in household decisions, including those related to food choices, dietary preferences, and resource allocation. Empowerment interventions that include nutrition education and behavior change communication (BCC) utilizing various channels (e.g., media, community events) to deliver nutrition messages and promote healthier behaviors Some women empowerment interventions **facilitate and assure financial inclusion and promote savings**. Increased **financial security can be a route to food security** and improved overall nutrition.	**Greater control over resources** ensures that adequate and nutritious food is available for the entire family, leading to **improved overall nutrition** **Improved information** empowers women to make informed decisions about food choices, feeding practices, and **overall family nutrition**. Increased availability of diverse and nutritious foods for their families and communities Improved breastfeeding and complementary feeding practices contribute to better infant and young child nutrition, promoting healthy growth and development. Reduced gender-based violence and stress and its negative outcomes. Improved mental health can lead to better appetite, digestion, and overall nutritional status. Women's participation in decision-making ensures that nutrition is prioritized and that resources are allocated for nutritious foods. Can lead to better food allocation and feeding practices, benefiting the nutritional status of women and children Increased exposure to nutrition education and BCC leads to improved awareness, attitudes, and	Mid-range theories that elucidate how women's empowerment interventions can influence nutrition outcomes include: **Intra-household Resource Allocation Theory:** This theory focuses on how resources, including food, are allocated within households. Women's empowerment interventions, by increasing women's decision-making power and control over resources, can lead to improved allocation of food and resources for the entire family, particularly for children. **Women's Agency and Decision-Making Theory:** This theory emphasizes the importance of women's agency and their ability to make decisions regarding their own health and nutrition. Women's empowerment interventions can enhance women's autonomy, decision-making authority, and self-efficacy, leading to better nutrition practices and outcomes. **Income and Economic Empowerment Theory:** Economic empowerment interventions, such as providing women with income-generating opportunities or access to microfinance, can increase household income. This can lead to improved food security, better access to nutritious food, and ultimately, enhanced nutrition outcomes.

		practices related to nutrition.	
Livelihood and agriculture interventions (including agriculture diversification):	**Income generation and purchasing power.** Livelihood interventions (agriculture-related or otherwise), such as skill-building programs or income-generating activities, increase households' income and economic stability. As with women's empowerment programs, livelihood interventions that facilitate access to credit can promote financial security. Financial security is a route to food security and improved overall nutrition. Livelihood interventions can also promote **diversification of income sources** (e.g., agriculture, small businesses) and provide families with more stable and reliable sources of income. Access to agricultural resources and inputs like seeds, fertilizers, and training, could enhance agricultural productivity and food security. Livelihood interventions that promote nutrition-sensitive agricultural practices, such as biofortification or production of nutrient-dense foods like fruits, vegetables, legumes, and animal-source foods or crop diversification, focus on producing nutrient-dense foods. Successful agriculture interventions can increase farmers' incomes through higher yields and better market access, reducing poverty and improving households' purchasing power. Livelihood interventions **that build resilience, and reduce vulnerability to external shocks (**e.g., climate-related events, economic crises) can lead to increased food security after large shocks.	Higher income levels enable families to afford a greater variety of nutritious foods, reducing food insecurity and improving overall dietary quality. Diversified income sources reduce vulnerability to economic shocks, ensuring consistent access to food and better nutrition. Increased agricultural productivity leads to higher availability of diverse and nutritious foods for consumption. Increased availability, access to, and consumption of nutrient-rich crops contributes directly to improved dietary quality and nutritional outcomes. Higher incomes enable families to afford a more varied and nutritious diet, positively impacting nutrition outcomes. Reduced vulnerability ensures consistent access to adequate and nutritious food, preventing malnutrition. Greater food production and availability ensure a stable supply of nutritious foods, reducing the risk of food scarcity and malnutrition. Increased availability of diverse crops contributes	**Income and Expenditure Theory:** Livelihood interventions that increase household income provide families with more resources to allocate towards nutritious food. This theory suggests that improved income leads to better purchasing power for nutritious food items, ultimately enhancing nutrition outcomes. **Food Security and Vulnerability Theory:** Livelihood interventions (both agricultural and non-agricultural) can help improve household food security by providing stable income-generating opportunities. This, in turn, could reduce vulnerability to food insecurity and malnutrition, leading to improved nutrition outcomes. **Time Allocation and Labor Theory:** Livelihood interventions that increase productivity and efficiency in income-generating activities can lead to more time available for household members to engage in activities related to food preparation and nutrition, potentially resulting in improved nutrition outcomes. **Resilience and Coping Mechanisms Theory:** Livelihood interventions that enhance household resilience to shocks and stresses, such as droughts or economic downturns, can prevent disruptions in food supply and access. This, in turn, may contribute to better nutrition outcomes.

	Agricultural interventions, such as improved farming practices, access to quality seeds, and irrigation, could lead to increased agricultural productivity and a higher availability of diverse food crops. Agricultural diversification involves cultivating a range of crops with different nutrient profiles, including staples, vegetables, fruits, and legumes. Diverse agricultural production provides a buffer against crop failures or market fluctuations, reducing the risk of food insecurity within households.	to a wider range of essential nutrients in the diet, leading to improved overall nutrition. Reduced food insecurity ensures consistent access to a variety of nutrient-rich foods.	**Micronutrient Biofortification Theory:** Agricultural interventions that focus on biofortification aim to increase the micronutrient content of staple crops. This theory posits that the consumption of biofortified crops can directly contribute to improved micronutrient intake and nutrition outcomes. **Food Security and Livelihood Diversification Theory**: Agricultural interventions can enhance household food security by providing a stable supply of food through increased agricultural productivity. Additionally, interventions that promote livelihood diversification can reduce dependency on a single income source, leading to improved food security and nutrition. **Market Access and Value Chain Theory:** Agricultural interventions that improve access to markets and strengthen value chains for agricultural products can lead to increased income for households. This enhanced income can be used to purchase a greater variety of nutritious foods, positively impacting nutrition outcomes. **Resilience and Coping Mechanisms Theory:** Agricultural interventions that build resilience in communities, such as through the introduction of drought-resistant crops or diversified farming systems, can help households better cope with external shocks. This can prevent disruptions in food supply and access, ultimately

			contributing to improved nutrition outcomes. **Dietary Diversity and Quality Theory:** Agricultural diversification leads to a wider variety of crops and animal products being available for consumption. This theory posits that a diverse diet, which includes a wide range of food groups, is crucial for meeting essential nutrient requirements and achieving better nutrition outcomes.

Methodology

In this section, we present the specific methods for our synthesis including inclusion and exclusion criteria for the systematic review, the synthesis of quantitative and qualitative studies, and the cost-effectiveness analysis.

Inclusion criteria for evidence synthesis

To conduct the evidence synthesis, we will employ transparent inclusion and exclusion criteria to ensure findings are representative of the existing evidence base on the impact of nutrition-sensitive interventions on nutrition outcomes. The use of non-systematic literature review methods, in the absence of clear inclusion and exclusion criteria, can result in biased claims about the state of the current evidence (Waddington et al., 2012).

Inclusion and exclusion criteria to guide the systematic database search and screening:

Inclusion criteria

We developed an initial search strategy using Boolean search strings based on our inclusion criteria, focusing on key populations, interventions, comparisons, and outcomes (PICO). We ran two separate search strings: (a) an 'ICO' string without population characteristics to identify relevant systematic reviews and evidence syntheses because systematic reviews and syntheses often do not mention the population of focus (i.e., countries or regions) in their title or abstract, and (b) a full 'PICO' search to identify impact evaluations (randomized controlled trials and quasi-experimental studies). To illustrate, for impact evaluations, we searched for studies that mention at least one population keyword *and* at

least one of the intervention keywords *and* at least one of the comparison terms *and* at least one of the outcome terms (the terms within each category will be separated with 'or').[4]

Population. Here we included the names of all countries categorized by the World Bank as low- and middle-income countries as of September 2023, as well as the demonyms for these countries (for example, Mozambique as well as Mozambican) since papers might refer to their study populations using either term. In addition, we included a number of descriptive keywords that abstracts and titles might use to refer to these countries such as low-income country, middle-income economy, developing country, low GDP and third world. For such terms, we used left truncation to pick up different variations: 'low-income countr*' would enable us to pick up papers mentioning 'low-income country' as well as 'low-income countries.'

Intervention. We used a wide range of keywords for different types of interventions, starting with general terms (such as 'nutrition sensitive') and then including terms for agriculture interventions (such as 'animal husbandry' and 'agricultural input subsidy'), child-focused interventions ('early childhood development', 'school feeding'), women's empowerment strategies ('village savings and loan associations'), social protection ('cash transfers' and 'public works'), parental leave ('maternity leave' and 'paternity leave'), and health interventions ('family planning'), among other domains.

Comparison. This part of the search string comprises keywords on the different types of methods that this evidence synthesis will cover. For the review-focused search string, we included terms such as systematic reviews, literature reviews and meta-analyses. For the search string used for other studies, we created a composite list of quantitative study designs, including randomized controlled trials, propensity score matching, difference-in-differences analysis, cost-benefit analysis, and economic evaluations.

Outcomes. Finally for this part of the string, we added keywords for a wide array of nutrition outcomes: child outcomes like height-for-age, stunting, wasting, mid-upper-arm circumference, low birth weight; specific micronutrients and micronutrient status like iron, folate, iodine, and anemia; overnutrition such as obesity; early initiation of and exclusive breastfeeding; and diet-specific outcomes such as meal frequency and dietary diversity. While the main focus of the evidence synthesis is on literature studying nutrition outcomes, we also decided to include food security terms in our search strategy to provide an understanding of the pathways that might generate intervention impacts. We will only include studies

[4] Another option would have been to use an ICO search without population terms for reviews as well as other types of studies. This approach would, however, have identified many more studies – including studies from high-income countries – making the screening process lengthy and difficult to complete. This is a legitimate concern since the volume of research from high-income countries is much larger than the volume of evidence from LMICs. Country-specific research increases with country wealth, as is demonstrated by Das et al. (2013) based on a database of 76,046 empirical economics papers: "over the 20-year span of the data, there were 4 empirical economics papers on Burundi, 9 on Cambodia and 27 on Mali. This compares to the 37,000 or so empirical economics papers published on the U.S. over the same time period." Also, only 2 percent of research in health economics journals covers LMICs (Hirvonen, 2020).

that estimate impacts on food security **and** nutrition outcomes, however. Studies focused solely on food security are outside the purview of this synthesis.

Exhibit 5 provides an overview of our inclusion criteria. Annex A presents our final search string.

Exhibit 5: Overview of Inclusion Criteria

Domain	Inclusion Criteria
Publication dates	2013 – 2023
Publication accessibility	Published in English. The team will also consider papers in Spanish or French if shared with the synthesis team and flagged as a key paper by the technical advisory group, but we will not search for French and Spanish papers. Publicly available or shared with the synthesis team
Evaluation focus	Assesses the impacts, costs and/or cost-effectiveness of a nutrition-sensitive intervention or a process evaluation that is directly linked to the randomized controlled trial or quasi-experimental study of a nutrition-sensitive intervention
Population of interest	Focuses on population(s) in low- and middle-income countries
Intervention focus	Studies nutrition-sensitive interventions, including those that fall within the purview of agriculture, social protection (including women's economic empowerment), and health
Methods	Impact evaluations (randomized controlled trials or quasi-experimental studies with a comparison group); evidence syntheses (e.g., systematic reviews, scoping reviews, meta-analyses); costing studies (e.g., cost-benefit analyses, cost-effectiveness studies, costing studies); qualitative sibling studies that are directly linked to the randomized controlled trial or quasi-experimental study (e.g., process evaluations or implementation science linked to the intervention)
Outcomes	Outcome related to individual-level nutritional status and dietary diversity (we will include the latter element to provide an overview of an important mechanism)

Exclusion criteria

Apart from excluding all studies that do not meet the inclusion criteria in ***Exhibit 5*** above (e.g., studies in high-income countries), below we describe our additional exclusion criteria:

- Studies focusing solely on nutrition-specific interventions, such as soda taxes, infant and young child feeding programs, breastfeeding counseling and education, large-scale food fortification,

social and behavioral change communication campaigns for nutrition, and provision of vitamin A/zinc/iron/folic acid (with the exception of those that target schools and adolescent girls).[5]

- Qualitative studies identified through the search string that are not a companion paper to one of the quantitative studies included in the evidence synthesis.
- Study protocols since we will include only studies that present results.
- Studies reporting associational research without a causal interpretation (e.g., regressions using cross-sectional data), including papers that use data (typically baseline data) from an impact evaluation to present correlational data.

We will also place a larger emphasis on social protection and agriculture programs. We will present more details on this methodological choice in our section describing the meta-analysis and quantitative narrative synthesis.

Screening

We will execute the search strings in three databases: Web of Science, PubMed and the 3ie Development Evidence Portal since these are expected to cover a wide range of disciplines and journals – e.g., PubMed tends to contain biomedical and public health research and 3ie contains the largest database of impact evaluations in LMICs.[6] Next, we will export the results of all our searches and upload them into EPPI Reviewer, an online software tool for synthesis studies. In EPPI Reviewer, we will identify and consolidate all duplicated results, as we might identify the same papers across different databases and/or different versions of some papers (the working paper and the published paper). Then, the research team will screen the title and abstract of each paper to determine whether the study meets the inclusion criteria; AIR will exclude the study if it does not meet the inclusion criteria.

During the screening of titles and abstracts, we will address a single question, which is to determine whether a study meets the inclusion criteria. Reviewers will have access to detailed inclusion criteria to make this determination. Studies that are marked yes will qualify for full text review. Reviewers will include a study for full text review when in doubt.

At the start of this screening process, at least two reviewers will be assigned to a set of papers to review individually and check the extent to which screening decisions align for matched reviewers. Reviewers will meet to discuss papers on which they disagree and once there is consistency on perceptions around the inclusion criteria (i.e., we have achieved an interrater reliability of >0.80), the team will proceed to complete the abstract screening process individually.

To conduct the abstract screening in a speedy and efficient manner, we will leverage the machine learning approaches available within EPPI Reviewer. We will turn on a classification model-based

[5] We will include studies that examine a package of nutrition-specific and nutrition-sensitive interventions if the evaluated intervention includes at least one nutrition-sensitive component.

[6] Because the 3ie database is focused on impact evaluations and systematic reviews for LMICs, there was no need to specify the Population or Comparison components of the search string; we executed a single Intervention-Outcome search.

machine learning capability, while the team manually screens the initial set of paper abstracts and based on its learnings from this observation, the software will estimate the likelihood of inclusion based on the text from the title and abstract.[7] EPPI Reviewer then divides unscreened studies into probability deciles based on their probability of inclusion and we will begin screening the rest of the studies by these likelihoods. By screening the highest probability papers first, the expectation is that we will first find many studies that meet the inclusion criteria in the initial stages of screening after using the machine learning capability, but that subsequently the screening process will plateau and we will find far fewer studies to include.[8] The team will screen the abstracts of papers until they encounter a critical mass of papers that do not meet the inclusion criteria (e.g., 150), at which point in time, we will halt the screening process.

Once the team has shortlisted papers based on the screening of abstracts, AIR will implement another manual screening process for the studies that were potentially eligible based on the review of titles and abstracts–a review of the full text of papers. Here the team will use a more detailed screening tool than the one that was used to screen abstracts– a full text screening tool (see ***Exhibit 6*** below).

Exhibit 6: Full text screening tool

	Category
1	Eligible based on date: • Exclude, study published before 2013. • Include, review published between 2013-2018 • Include, review published between 2019-2023 • Include, impact evaluation published between 2013-2018 • Include, impact evaluation published between 2019-2023
2	Eligible based on Country/Region of Focus: Exclude, study not in LMICs
3	Eligible based on Intervention type: Exclude, not a nutrition-sensitive program
4	Eligible based on methods: Exclude, not an RCT, quasi-experimental design or systematic review
5	Eligible based on outcome: Exclude, not a nutrition or dietary diversity outcome
6	Exclude, study not in English
7	Include, process evaluation
8	Include, cost information

[7] EPPI Reviewer uses machine learning algorithms to look for patterns in the titles, abstracts and references of papers, examining trigrams, sentiments, context and other natural language processing features with a standard logistic regression (tf-idf) to detect the relative novelty of phrases or keywords in the document and the frequency with which these appear.

[8] De Hoop et al. (2023) present an example of how to leverage EPPI reviewer for this purpose.

Development of Search strategy

The initial search string was informed by the team's subject matter expertise and a broad literature search. To refine the preliminary string and test its efficacy, we aggregated 14 key papers – review papers and a number of high-profile impact evaluations – expected to exemplify the type of research in this domain (such as those that study the impacts of microfinance on children's nutrition and the effects of cash transfers on child height), which we refer to going forward as "anchor papers" (see list in Annex B). We used these anchor papers to build out the search string based on terms appearing frequently in the titles, abstracts and keywords of these papers. We included punctuation to ensure the search string was targeted – for example, we included quotations around "nutrition sensitive" to identify papers that had the entire phrase, rather than just "nutrition" or just "sensitive." Additionally, we made sure to include different variants of phrases since different authors/journals/countries might use different versions – for example, "nutrition sensitive" as well as "nutrition-sensitive."

We iterated this string through various rounds of testing on Web of Science, PubMed and the 3ie Development Evidence Portal. We adjusted the search strings slightly to meet the needs of different databases, for example by incorporating the publication year in the search query.. During this process, we manually reviewed the abstracts of the initial papers identified during each search and when these appeared to be irrelevant, we identified the keywords that were picking these up and could therefore be omitted to make the search string more targeted and precise. For example, we dropped 'primary school' and 'welfare' from the list of intervention keywords since these terms were too broad and therefore picked up papers that did not focus on nutrition-sensitive interventions.

Following some initial searches, we leveraged the R package litsearchr (Grames et al., 2019) to build out the search strings. We analyzed the bibliographic information (title and abstract) for the papers identified during our preliminary searches. This package employs text-mining algorithms to assess the information we input to provide a list of terms/phrases mentioned frequently by the identified papers. The research team then manually perused this list to identify terms missing from the initial search strings that AIR considered relevant.

When testing each iteration of the search string, we examined whether these searches were picking up the 14 anchor papers. Our initial test searches failed to pick up quite a few of the anchor papers, especially the reviews. We verified that all 14 anchor papers were indexed in the three databases and then compared the abstracts of the missing papers with our search terms to determine why the searches did not identify the studies. We found that the review anchor papers tended to not specify the countries or regions of focus (such as LMICs) in the abstract and thus were not fulfilling the Population component of our search string. Accordingly, we decided to use two separate search strings: one for reviews and one for studies using other methodologies. The review search string (Search String A) excludes the Population terms, includes all the Intervention terms, includes only the review-specific terms (such as systematic review and evidence synthesis) for the Comparison component, and includes all the Outcome terms. The other studies search string (Search String B) includes all the Population, Intervention and Outcome search strings, and the non-review-focused Comparison terms. Because he

3ie database focuses on impact evaluations and reviews in LMICs, we executed a single search string of all Intervention and Outcome terms in that database. Using these search strategies, we were able to pick up 13 of the 14 anchor papers (***Exhibit 10***).[9]

Exhibit 7: Number of hits and number of anchor papers

	Web of Science	3ie	PubMed	# anchor papers identified
Search String A (reviews)	3,374	3,773	1,134	8
Search String B (other types of studies)	4,694	6,616	742	8

Note: These numbers are based on searches conducted on September 21, 2023, prior to our finalization of the single 3ie search string. The Web of Science search is on paper abstracts, the 3ie search excludes population terms and is conducted on paper abstracts, and the PubMed search is conducted on titles and abstracts. There is some overlap in the anchor papers identified via Search Strings A and B: across the searches we identified 13 of the 14 anchor papers.

The iterative search string development process led to the search strings presented in Annex A.

Impact Evaluation Synthesis

In this section, we describe the steps we will take to conduct our synthesis of all impact evaluation studies published post 2013 identified through our search. We will conduct a narrative synthesis of these studies but will also conduct meta-analysis by intervention type for those interventions for which enough evidence is available on the impact of nutrition-sensitive interventions on stunting, wasting, and dietary diversity. For the latter, we plan to update existing meta-analyses with new impact evaluations where feasible. This section describes our approach to conducting those analyses.

Data Extraction

Once impact evaluations are identified, we will work on extracting the data for analysis. Team members with expertise in impact evaluations will independently extract information from each experimental or quasi-experimental study included in the review. We will code the studies based on the conceptual framework. Specifically, we will code for the year the study took place, the methodology, the intervention type, specific implementation characteristics, the region and country context, the outcomes included in the study, whether the study examines heterogeneous impacts by gender, age, and climate or pandemic shocks, whether the study reports any information about costs, and whether the study reports a process evaluation or other qualitative sibling study that we can include in our qualitative analysis. ***Exhibit 11*** summarizes a draft of the data extraction/coding tool we will use. We plan to further develop the data extraction tool based on the evidence we encounter.

[9] The one anchor paper that our search strings could not find was an impact evaluation with no country specification in the title or abstract.

We will only code for implementation characteristics for intervention types for which we anticipate sufficient quantitative evidence is available. In this way, we can use the implementation characteristics to examine potential heterogeneities in the effect sizes using meta-regressions. For intervention-types for which we anticipate only limited quantitative evidence, we will exclusively rely on the qualitative sibling studies to understand how implementation may affect the effectiveness of the program.

Exhibit 11: Preliminary Coding Framework

Study	Year	Methodology	Intervention type	Implementation Characteristics	Region	Country	Outcomes	Heterogeneity by gender	Heterogeneity by age	Heterogeneity by shock	Cost information	Qualitative sibling study
Study name	2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023	Randomized Controlled Trial Difference-in-Difference Analysis Instrumental variable analysis Propensity score matching Regression discontinuity design	Cash transfers Public works Microfinance (including self-help and savings groups) Early childhood development Nutrition-sensitive agriculture Other women's groups Etc.	**Cash transfers** Transfer size Frequency of cash transfer Gender of cash transfer recipient **Microfinance** Savings group, self-help group, or individual microfinance **Early childhood development** Preschool Psychosocial stimulation interventions Other early childhood education program Etc. **Nutrition-sensitive agriculture** Agricultural extension Farmer field school Farmer producer organization etc.	East Asia and Pacific Europe and Central Asia Latin America and the Caribbean Middle East and North Africa North America South Asia sub-Saharan Africa	Country Name	Stunting Wasting Obesity Food Security Dietary Diversity Anemia Etc.	Yes No	Yes No	Yes No	Yes No	Yes No

Risk of Bias Assessment

We will determine the rigor of the quantitative studies using an adaptation of a set of criteria to assess selection-bias and confounding (Hombrados & Waddington, 2012). Selection bias and confounding are based on the quality of the identification strategy to determine causal effects and assessment of equivalence across the beneficiaries and nonbeneficiaries.

The use of the risk of bias assessment will enable AIR to examine whether studies have a low, medium, or high risk of selection-bias. Because of the ambitious timeline, we decided to not include assessments of performance bias, outcome and analysis reporting bias and other biases in our risk of bias assessment, however.

We will use an adaptation of the tool developed by Hombrados & Waddington (2012) because this tool is better suited for determining the methodological rigor of quasi-experimental studies than risk of bias assessment tools that are generally used in public health research, such as the Cochrane guides for randomized controlled trials (Cochrane ROB-2) or the ROBINS-1 tool for assessing risk of bias in non-randomized studies of interventions (ROBINS-1) (Higgins et al., 2019; Sterne et al., 2016). We previously used adaptations of the tool in a number of recent systematic reviews published by the Campbell Collaboration and the Global SDG synthesis coalition (Brody et al., 2017; Chinen et al., 2017; Stone et al., 2020; Nakamura et al., forthcoming; de Hoop et al., 2023). Annex C presents the risk of bias assessment tool.

We anticipate conducting risk of bias assessments for all of the included impact evaluations of social protection and agriculture interventions. We will consider conducting risk of bias assessments for other nutrition-sensitive interventions as well, but the feasibility of doing so will depend on the volume of included impact evaluations.

Effect Size Calculations

To calculate effect sizes of the included quantitative studies, we will use two different methods. For impact evaluations that were not previously included in meta-analyses, we will use the extracted information from each experimental or quasi-experimental study to estimate the standardized effect sizes (for continuous variables) or odds ratios (for stunting or wasting) across studies. In addition, we will calculate standard errors and 95 percent confidence intervals, where possible. For impact evaluations that were previously included in meta-analyses, we will extract information about the effect size and the standard error from the meta-analysis.[10] We will impute confidence intervals if they are available from the text or forest plot or estimate them by obtaining additional information from the impact evaluation. For the latter we will use the same methods as described below.

[10] We will use the average of the effect sizes and the confidence intervals if a study is included in more than one meta-analysis. We will also cross-check the effect sizes reported in the meta-analyses with a sub-sample of impact evaluations to ensure that the meta-analyses are based on reliable information.

Next, we present the process to calculate effect sizes for newly included impact evaluations, which is heavily based on Brody et al. (2015) and de Hoop et al. (2023).

We will report two types of effect sizes. We will calculate the Hedges' *g* sample-size-corrected standardized mean differences (SMDs) for continuous outcome variables, which measure the effect size in units of standard deviation of the outcome variable. We will calculate odds ratios for binary outcome variables.

First, we will calculate SMD in Cohen's *d* effect sizes by dividing the mean difference with the pooled standard deviation by applying the formula in Equation 1:

(1) $SMD = \frac{Yt - Yc}{Sp}$

Here SMD refers to the standardized mean differences, Y_t refers to the outcome for the treatment group, Y_c refers to the outcome for the comparison group, and S_p refers to the pooled standard deviation.

The pooled standard deviation S_p can be calculated by relying on the formulas in Equations 2 and 3:

(2) $S_p = \frac{\sqrt{\left((SDy^2) * (nt + nc - 2)\right) - \left(\frac{\beta^2 * (nt * nc)}{nt + nc}\right)}}{nt + nc}$

(3) $S_p = \frac{\sqrt{(nt - 1) * st^2 + (nc - 1) * sc^2}}{nt + nc - 2}$

We will use Equation 2 for regression studies with a continuous dependent variable. In this equation, SD_y refers to the standard deviation for the point estimate from the regression, n_t refers to the sample size for the treatment group, n_c refers to the sample size for the control group, and β refers to the point estimate. We will use Equation 3 when there is information about the standard deviation for the treatment group and the control group separately.

We will correct the SMD for small sample size bias by relying on Equation 4, which transforms Cohen's *d* to Hedges' *g*:

(4) $SMD_{corrected} = SMD_{uncorrected} * \left(1 - \frac{3}{4 * (nt + nc - 2) - 1}\right)$

We will rely on Equation 5 to estimate the standard error of the SMD:

(5) $SE = \sqrt{\frac{nt + nc}{nc * nt} + \frac{SMD^2}{2 * (nc + nt)}}$

Where possible, we will calculate odds ratios by relying on 2X2 contingency tables (Lipsey & Wilson, 2001; see ***Exhibit 2***).

Exhibit 12. Estimation of Odds Ratios

	Frequencies	
Treatment or comparison group	**Success**	**Failure**
Treatment group	A	B

Comparison group	B	D

We will calculate the odds ratio using Equation 6, where $\overline{ES}$ refers to the effect size:

(6) $$\overline{ES} = \frac{ad}{bc}$$

In the cases in which we are not able to retrieve the missing data, we will extract or impute effect sizes and associated standard errors based on commonly reported statistics, such as the *t* or *F* statistic or *p*- or *Z*-values, using David B. Wilson's practical meta-analysis effect-size calculator. In studies that do not report sample sizes for the treatment and the control or comparison group, we will assume equal sample sizes across the groups.

We will only calculate effect sizes for intervention-types, for which we plan to conduct new or updated meta-analyses and only if we find six or more randomized controlled trials or quasi-experimental studies. These intervention-types include cash transfers and agriculture programs. We will also consider conducting effect size calculations and meta-analyses for social protection programs such as self-help groups and savings groups, depending on whether the timeline allows for it. We do not plan to conduct additional effect size calculations for other interventions because of the ambitious timeline. For these interventions (water, sanitation, and hygiene programs and early childhood development programs), we will rely on previous meta-analyses to estimate effect sizes. It is also likely that we will not find sufficient studies (more than six) to conduct reliable meta-analyses for each intervention type.

Meta-Analysis

For cash transfers and nutrition-sensitive agriculture interventions (and possibly for women's empowerment programs), we will pool the results of the quantitative studies that focus on the effects of nutrition-sensitive interventions using meta-analysis for each combination of stunting, wasting and intervention type that includes six or more studies. We will conduct separate meta-analyses for stunting and wasting and separate meta-analyses by intervention type. We will examine the heterogeneity of the effect sizes for stunting and wasting across studies and use meta-regression to model the variation in effect size. We will also examine heterogeneity by using I-squared and Q as well as tau-squared and the visualization of the forest plots (Borenstein et al., 2009). We will use Stata to conduct the meta-analysis.

We will perform an extensive sensitivity analysis for six effect size moderators:

- Risk of selection-bias
- Study design (randomized controlled trials versus quasi-experimental studies)
- Gender
- Age
- Climate and COVID-19 shocks
- Region

We will start our analysis with separate meta-analyses of randomized controlled trials and quasi-experimental evaluations for determining the effects of interventions. Then we will use an iterative approach to determine the potential bias from pooling randomized controlled trials and quasi-experimental evaluations. We will use random-effects meta-analysis because the average effect of the

interventions is likely to differ across contexts due to differences in program design or contextual characteristics. We will conduct meta-regressions to examine heterogeneous effects by the six effect size moderators. We also plan meta-regressions when there are substantial differences within intervention types and sufficient studies are available. For example, the impact of cash transfers may differ depending on the frequency of cash transfers and the transfer size.

We will include one effect size per study in a single meta-analysis. Where studies report more than one effect size on the basis of different statistical methods, we will select the effect size with the lowest risk of bias. Where studies present several impact estimates for different variables that measure the same construct, we will use a sample-size weighted average to measure a "synthetic effect size." In cases where more than one study uses the same data set to measure an outcome variable, we will extract the effect size from the study with the lowest risk of bias. Or if the risk of bias is the same, we will extract the effect size by estimating an average effect size through inverse-weighted random effect meta-analysis. In cases where one study measures the same outcome variable at different periods in time, we will extract the effect size by relying on the outcome measure that was measured at a time that was closest to the time period of the measurement in other studies included in the same meta-analysis. In cases where studies include more than one treatment arm, we will include the effect size from the treatment arm that is most similar to the other programs that are included in the meta-analysis.

Narrative Synthesis

We will report the results of impact evaluations using a narrative synthesis approach in cases where a combination of outcome measures and group type only results in five or fewer studies (Campbell et al., 2019) or when we rely on previous meta-analyses to calculate the effect size (as for water sanitation and hygiene and access to healthcare interventions). This will involve providing a rationale for grouping studies for the synthesis (based on intervention type and outcome measure as discussed above), describing the synthesis methods, an investigation of the heterogeneity in the reporting of the effects, and an analysis of the methods used to determine the certainty of evidence. For the synthesis methods we will link the results to the theory of change of the program and examine the number of studies that find positive impacts along the causal chain of the theory of change, for example by comparing impacts on food security, dietary diversity, and nutrition outcomes. This analysis approach will also enable us to assess where the theory of change breaks down. For this analysis of pathways, we will focus specifically on mechanisms linked to food security and dietary diversity.

Publication bias

We will use two methods to determine the potential for publication bias of social protection and agriculture interventions (and possibly women's empowerment programs). First, we will assess the potential for publication bias using funnel plots. Second, we will conduct Egger's test to determine the potential for publication bias in studies that focus on nutrition-sensitive interventions.[11]

[11] It may, however, not be feasible to finalize tests for publication bias in the first draft of the report.

Qualitative Synthesis

After the abstract and title screening process and full text reviews of qualitative sibling studies, qualitative evidence synthesis will take place in two stages, (a) quality appraisal of the studies, and (b) thematic synthesis of the studies.

(a) Critical appraisal of qualitative research studies

We will assess the quality of the included qualitative studies using the nine-item Critical Appraisal Skills Programme Qualitative Research Checklist (Critical Appraisal Skills Programme [CASP], 2013), making judgments on the adequacy of stated aims, the data collection methods, the analysis, the ethical considerations, and the conclusions drawn. For each item, the qualitative researcher will determine whether the study had adequately met the item and gave "yes," no," or "can't tell" responses. To determine the overall methodological rating for each study, we will rate each item in the criteria for every study on a scale of High (mentioned and well explained), Medium (mentioned but missing at least one element), Low (alluded to but not described in full or explicitly), N/A, or Not mentioned. We will decide the cut-off score for inclusion of studies after the review of all studies is complete by calculating the average assessment score to determine how well the study rated on the most critical items (i.e., design and methods) in the scoring tool*. See **Exhibit 8** for the Quality Appraisal Criteria*.

Exhibit 83. Quality Appraisal Criteria

Criteria	Coding
Screening Question: Is there a clear statement of study aims of the research?	Yes / Can't tell / No
Screening Question: Is a qualitative methodology appropriate?	Yes / Can't tell / No
Is it worth continuing?	Yes / Can't tell / No
Was the research design appropriate to address the aims of the research?	Yes / Can't tell / No
Was the recruitment strategy appropriate to address the aims of the research?	Yes / Can't tell / No
Were the data collected in a way that addressed the research question?	Yes / Can't tell / No
Has the relationship between researcher and participants been adequately considered?	Yes / Can't tell / No
Have ethical issues been taken into consideration?	Yes / Can't tell / No
Was the data analysis sufficiently rigorous?	Yes / Can't tell / No
Is there a clear statement of findings?	Yes / Can't tell / No
Is the research valuable?	Yes / Can't tell / No

(b) Thematic synthesis of the studies of qualitative research studies

After full-text review, we will conduct a thematic synthesis of the qualitative study findings. AIR will code each study's main findings to encapsulate the content of each and categorize into higher order themes (such as 'intervention delivery mechanisms'). We will then extract implications for better

understanding why or how nutrition-sensitive interventions achieve nutrition outcomes in various contexts. The purpose of this activity is to analyze and consolidate evidence from the included studies, documenting enablers and barriers related to intervention content, context, and implementation processes linked to the theory of change. The qualitative reviewer will analyze qualitative data in two steps: i.) data extraction, and ii.) coding and interpretation/analysis of data.

Data extraction. The first step in the qualitative evidence synthesis is to extract data from the studies that passed the critical appraisal process. We will import all studies that meet the criteria for inclusion and pass the quality appraisal into NVivo®, a qualitative data analysis software program. To extract data from the studies, we will focus on the sections on findings, author's conclusions, and author's recommendations (second-order data). Although we will focus on these sections of the studies, importing the full-text studies will enable reviewers to understand the context of the full study as we code the data and allow for identification of the characteristics that may have influenced the design and implementation of a nutrition-sensitive intervention.

The qualitative researcher will extract data from relevant studies. Ideally, at least two research team members will independently extract data on the same two studies and compare and address any inconsistencies in the types of data extracted for each category. Once consensus is achieved, the two researchers will extract remaining data on a subset of studies. However, because of the ambitious timeline, only one researcher will extract data from relevant studies, followed by quality spot checks of the extracted data by another research team member.

Coding and Thematic analysis. We will conduct a thematic analysis of the extracted data in NVivo to synthesize evidence from the selected studies. The coding framework will build on a combination of deductive (top-down) and inductive (bottom-up) approaches. Using a deductive approach, we will develop themes informed by the conceptual frameworks (such as the *UNICEF Conceptual Framework on the Determinants of Maternal and Child Nutrition 2020)*, our adapted conceptual framework, research questions, and common areas of inquiry in qualitative studies of nutrition-sensitive interventions. We will code study findings into topic nodes, using the conceptual framework as a guide. For example, a component within the framework will be assigned a node in NVivo which will enable coders to pull relevant data from studies into the node that corresponds to a component in the framework. ***Exhibit 9*** presents an indicative list of deductive codes.

Through a deductive approach, coders will apply predetermined codes to the data derived from studies. On the other hand, an inductive approach will allow researchers to search for thematic patterns, emergent themes, and notable outliers in the data to identify the barriers and facilitators to successful implementation. To finalize the coding framework and ensure interrater reliability, coders will select, read, and code a small, representative sample of papers. This will also enable coders to formulate initial themes to respond to the research questions. Ultimately, a coding framework will serve as the tool for organizing and subsequently analyzing and interpreting information.

A thematic synthesis will allow us to broadly link themes to delivery; enablers and barriers to intervention effects (such as context, intervention content), contextual factors affecting the implementation; barriers to and facilitators of delivery. A thematic analysis will also allow us to produce

descriptive theme from 'thin' data and to develop descriptive themes with more-in-depth analytic themes from 'thicker data'.

Exhibit 9. Draft Deductive Synthesis Framework

Thematic Category	Codes	Sub-codes
Design	• Problem analysis • Theory of change • Relevance to population • Intervention type	Key outcomes of interest • Stunting • Wasting • Obesity • Overweight • Food Security • Agricultural production • Dietary diversity
Implementation of interventions related to: Maternal and child health services, social protection programs, Self-help groups, School feeding programs, Livelihoods programs, etc.	• Effectiveness • Implementation process • Mechanism of delivery • Barriers • Enablers • Sustainability	• Consideration and inclusion of local or disadvantaged groups • Consideration of local context • Consideration of cultural norms • Inclusion of cultural adaptations • Consideration of social and religious norms • Inclusion of gender considerations and gender norms in design • Fidelity of implementation
Moderators	• Individual level characteristics • Community-level factors	• Gender • Age • Weather • Climate change

Triangulation

Following the thematic synthesis and analysis, we will integrate qualitative themes within the quantitative synthesis for triangulation. Specifically, we will conduct an analysis along the causal chain of the theory of change using findings of the qualitative analysis to complement and explain the quantitative findings. The integrated findings will be used to examine whether and where any causal chain links break down in our theory of change. In other words, findings from the qualitative synthesis will describe, explore, and aid the interpretation of both the nature and extent of the impact of nutrition-sensitive interventions, as well as the implementation features that are associated with impacts on stunting and wasting.

Costing Analysis

We will employ two approaches to collate cost data. First, we will extract secondary data on cost and cost-effectiveness estimates as reported in existing studies, following our search strategy and coding framework presented earlier. Second, we will employ a top-down approach to collect and analyze cost

data in line with the program experience approach developed by Horton et al. (2010), which was applied in the investment framework for nutrition-specific interventions (Shekar et al., 2017). This method uses existing program budgets and expenditure documents to construct reliable cost estimates for nutrition-sensitive program activities and is in line with recently published guidelines for the economic evaluation of multisectoral nutrition strategies (Levin et al., 2023). Under both approaches, we will assess costs in their programmatic context, identifying key intervention activities, implementation stages (e.g., pre-implementation vs implementation), the scope of the intervention (e.g., whether the intervention is delivered independently or as part of a comprehensive service package), the scale of the intervention, and the intervention timeline (in line with frameworks developed by Cost Analysis Standards Project [CASP], 2021 and Siwach et al., 2019).

We will conduct systematic searches of the literature for published studies containing programmatic cost data for key nutrition-sensitive interventions and will consult publicly available program documents and databases (e.g., WB status implementation reports) to supplement our understanding of total costs and unit costs. Following the methods used in An Investment Framework for Nutrition, we will extrapolate missing cost data using data from similar interventions in other countries in the same region (Shekar et al., 2017). For example, we will impute cost data on cash transfer programs in Uganda using cost data from Kenya when cost data are available for comparable cash transfer programs in Kenya but missing in Uganda. AIR has previously applied this approach in other contexts. For example, using data from BRAC's microfinance SHG programming costs in Bangladesh, Tanzania, and Uganda, we created a prediction model based on implementation characteristics like scale, loan size, group size, and country-specific characteristics, to predict costs of implementing such programs in Nigeria. We will apply similar approaches to extrapolate intervention costs of nutrition-sensitive programming.

We will collate cost data into a cost database, including important implementation characteristics as well as intervention type, scale, and timeframe. For each specific intervention with associated costs identified, we will record a brief intervention description, the country or countries of implementation, the scale and scope of the intervention, and the timeframe for implementation. Recording these intervention characteristics is important to ensure reasonable aggregation across interventions of the same type. For example, the unit costs of cash transfer programs can vary considerably depending on the transfer amount, frequency, duration, and delivery modality; taking a simple mean to estimate an average cost per participant misses the context and heterogeneity that is important for financing decisions. In addition to implementation characteristics, we will also assess intended primary outcomes of the interventions. While we will focus on stunting, wasting, and dietary diversity in the meta-analysis, we will record several attributable outcomes (not just nutrition and dietary diversity outcomes) to maintain a holistic view of the interventions' impact and return on investment. ***We will*** categorize all intervention cost data in the cost database by currency and costing year, and will use published exchange rates to convert all costs to a common currency, adjusted for inflation. We will apply a consistent currency conversion method for all interventions, converting to USD using the market exchange rates, and adjusting for inflation using the Consumer Price Index (CPI) method. This adjustment will facilitate accurate comparisons of unit costs for interventions that occurred in different countries and/or different years. To analyze the costs for multi-year interventions, we will account for

the time preference of money (i.e., a dollar today is worth more than a dollar tomorrow) by employing a standard annual discount rate of 3% (Shekar et al., 2017; Wilkinson et al., 2014). For example, a four-year intervention that costs $100 each year has a lower overall cost than a four-year intervention that costs $400 up front due to the time preference adjustment. We will consider alternate scenarios with higher discount rates, estimating costs discounted at 10% and 15% (in addition to the base assumption of 3%) given that developing countries tend to apply generally higher social discount rates (Dhaliwal et al., 2013).

Exhibit presents illustrative implementation characteristics we will use to predict intervention costs.

We will categorize all intervention cost data in the cost database by currency and costing year, and will use published exchange rates to convert all costs to a common currency, adjusted for inflation. We will apply a consistent currency conversion method for all interventions, converting to USD using the market exchange rates, and adjusting for inflation using the Consumer Price Index (CPI) method. This adjustment will facilitate accurate comparisons of unit costs for interventions that occurred in different countries and/or different years. To analyze the costs for multi-year interventions, we will account for the time preference of money (i.e., a dollar today is worth more than a dollar tomorrow) by employing a standard annual discount rate of 3% (Shekar et al., 2017; Wilkinson et al., 2014). For example, a four-year intervention that costs $100 each year has a lower overall cost than a four-year intervention that costs $400 up front due to the time preference adjustment. We will consider alternate scenarios with higher discount rates, estimating costs discounted at 10% and 15% (in addition to the base assumption of 3%) given that developing countries tend to apply generally higher social discount rates (Dhaliwal et al., 2013).

Exhibit 15: Illustrative Implementation Characteristics

Cash Transfer Programs	Nutrition-sensitive Agriculture Programs	Early Childhood Development Programs	Nutrition-sensitive WASH Programs	Nutrition-sensitive Women's Groups
Transfer size	Number of trainings	Number of community health workers	Number of improved facilities	Organizing purpose for women's group
Frequency of transfer	Crop focus	Number of trainings	Number of community educators	Target population for members
Duration of program	Duration of program	Duration of program	Duration of program	Duration of program
Number of program participants	Number of program participants	Number of program participants	Number of program participants	Number of program participants

Gender of cash transfer recipient	Group-level or individual level targeting	Group-level or individual-level targeting	Group-level or individual-level targeting	Frequency of meetings

For each nutrition-sensitive intervention, we will describe the costs per participant from the program perspective as well as the participant perspective (if data are available). The program perspective encompasses all costs borne by the program provider to implement the intervention, while the participant perspective includes costs borne by those participating in the intervention. Examples of program perspective costs include personnel costs for program staff and equipment costs. Examples of participant costs include travel costs to a program site and the productivity loss of a day's wage to attend the program. Program costs inform potential providers about the cost to implement a given intervention, but the full societal costs of an intervention must also include participant costs.

Because the precision of cost estimates may vary with program context and collection method, we will conduct an uncertainty analysis around the estimated costs to understand the cost components with the highest variation and the upper and lower bounds of the total costs to deliver selected nutrition-sensitive interventions. This will include comparisons of the costs of nutrition-sensitive interventions by country, implementation characteristics, etc.

Cost-Consequence and Cost-Effectiveness Analysis

After analyzing cost data, AIR will compare costs to the intervention effects identified in the systematic review and meta-analyses.[12] Because these nutrition-sensitive interventions are likely to produce an array of positive benefits, we propose to first conduct a cost–consequence analysis. A cost–consequence analysis lists the outcomes of an intervention in an "impact inventory," including nutrition and other outcomes relevant to the theory of change pathways to nutrition outcomes (e.g., food security, dietary diversity) (Neumann et al., 2016). AIR will present the impact inventories for the interventions under consideration alongside their associated costs, and decision makers can then view unit costs for specific nutrition outcomes in context with a qualitative overview of the basket of benefits attributable to a nutrition-sensitive intervention. Viewing costs and outcomes holistically in a cost-consequence analysis mitigates some of the difficulties inherent in apportioning costs to specific nutrition outcomes for broader, nutrition-sensitive interventions. As in the cost analysis, we aim to include uncertainty intervals around point estimates of impacts to avoid biasing the results in favor of interventions with large but imprecise outcomes (Evans & Popova, 2016). We will also discount intervention effects at the same rate as intervention costs (3%) to account for time preference of outcomes and provide accurate comparisons of benefits across differing time horizons (e.g., an intervention that saves 10 lives in one year is more effective than an intervention that saves 10 lives in two years). Presenting the nutrition-sensitive interventions in a cost-consequence analysis will illustrate a comprehensive return on investment for each intervention. Finally, we will identify the subset of nutrition outcomes that can be

[12] For this analysis we will compare costs and effects by region where feasible.

readily converted to disability-adjusted life years (DALYs) or Lives Saved using the Global Burden of Disease dataset or other published estimators. Converting these outcomes to standardized units enables aggregation and cost-effectiveness comparisons across nutrition-specific interventions producing these outcomes. If data are available, we will aggregate outcomes in standardized units (DALYs, lives saved) for each intervention to illustrate a nutrition-focused return on investment.

We will use findings from the systematic review, meta-analyses, and cost–consequence analysis to inform a CEA. A CEA focuses on one common outcome (i.e., stunting, wasting, dietary diversity) and associated intervention costs to produce a cost per unit of effect (i.e., the cost-effectiveness ratio) for each program, such as the cost per stunting incidence averted (Shekar et al., 2017). It is important to note that the cost-effectiveness ratio is a measure of program efficiency in achieving a single desired outcome, and it is thus a much narrower depiction of return on investment than the cost-consequence analysis. Further, it is likely that nutrition-sensitive interventions producing a range of outcomes may not produce discrete nutrition outcomes as cost-efficiently as nutrition-specific interventions. Following best practices, we will estimate the cost per additional unit of effect for each program in increasing order of effectiveness (Drummond, 2015; Neumann et al., 2016; NASEM, 2016; Siwach et al., 2019). This cost per additional unit of effect is referred to as the incremental cost-effectiveness ratio (ICER) and informs decision makers of the cost per additional outcome produced from the next most effective intervention. For interventions producing health outcomes, meaningful comparisons of the cost-effectiveness ratios are facilitated by estimating the ICER and comparing it to a willingness to pay threshold (NASEM, 2016). That is, when a decision maker is faced with a choice between two interventions, and one intervention is both more effective and more expensive than the alternative, the decision maker must decide how much they are willing to pay for the added effectiveness of the more expensive intervention. We will also incorporate published estimates of cost-effectiveness for nutrition-sensitive interventions to supplement our analysis. Finally, we will include estimates of uncertainty around both costs and outcomes, plotting upper and lower limits of cost-effectiveness ratios on the cost-effectiveness plane (Drummond, 2015).

Limitations

The proposed synthesis has a number of inherent limitations because of the ambitious timeline.

First, given the ambitious timeline for this work, the AIR team is unable to conduct a full systematic review of all impact evaluations conducted on nutrition-sensitive interventions on nutrition outcomes. Similarly, we must limit our meta-analyses to the set of intervention-outcome pairings for which there are at least six studies and for specific intervention types and to cash transfer and agriculture programs (and possibly women's empowerment programs, such as self-help groups and savings groups). While the proposed approach will enable AIR to synthesize the literature and estimate effect sizes for relevant studies, by necessity we are unable to conduct a full synthesis or meta-analysis across all eligible studies (i.e., those studies synthesized and analyzed in existing reviews) and must rely on the original synthesis and analysis methods of the authors of the existing reviews. Where possible, and within the bounds of this existing study, we will assess the quality and rigor of the existing review articles to and acknowledge

potential biases resulting from the methods used by other authors, to enable our present study and review to be as unbiased and transparent as possible.[13]

Second, we will gather our cost data from literature searches and public databases, and it is unlikely that detailed programmatic cost data will be readily available for every nutrition-specific intervention, country, and implementing partner. Thus, inclusion in our cost database will be biased toward interventions with implementers who prioritize making such cost data public, and it is likely that we will have disproportionately low representation of government-implemented programs. We will mitigate this fragmentation and selection bias of cost data by conducting targeted data searches for underrepresented implementers and by extrapolating regional adjustments for underrepresented locales (Shekar et al., 2017).

Third, cost-effectiveness analysis may underestimate the efficiency of interventions producing multiple outcomes. That is, evaluations of nutrition-sensitive interventions (especially broad, multi-sectoral interventions) may affect a wide range of outcomes. For this reason, evaluations that only focus on nutrition outcomes may make nutrition-sensitive interventions appear less cost-effective than narrower nutrition-specific interventions. While quantifying the broad range of outcomes produced by nutrition-sensitive interventions is outside the scope of this study, we do attempt to narratively acknowledge the added value of these interventions and tailor our analysis to decision makers focused on maximizing investments for nutrition.

Fourth, the ambitious timeline requires that we limit the qualitative synthesis to sibling studies. While we will only include a limited number of qualitative studies, a focus on sibling studies will ensure that we can explicitly link the lessons about mechanisms and implementation from the qualitative studies to the quantitative evidence because the qualitative and quantitative studies will focus on the same interventions.

Detailed Workplan

This section lays out our workplan for this synthesis. We developed a Gantt chart (***Exhibit 16.***) highlighting all the major steps and due dates for our work on this project. During month one, we developed this research protocol, identifying the nutrition-sensitive interventions for inclusion in our review, laid out a conceptual framework to justify the sectors of focus and linkages with nutrition outcomes, presented inclusion criteria and methods for the evidence synthesis, and highlighted how the synthesis can contribute to the existing literature. In addition, we tested the search strings to ensure that we would include a comprehensive overview of the literature while keeping the review manageable within the timeframe. Additionally, the protocol provides information on data sources, data access, methodology, and output for all three research activities: the systematic review, meta-analysis, and

[13] As discussed in our section on the risk of bias assessment, we will conduct risk of bias assessments for all impact evaluations of social protection and agriculture programs, but the feasibility of doing so for other interventions will depend on the volume of evidence.

cost-effectiveness assessments. During the first month, we will also hold discussions with the World Bank and members of the TAG to discuss the research design and solicit recommendations. We will subsequently submit the meeting minutes to the World Bank. Simultaneously, we will commence the three research activities, each focused on one of the three objectives of this project. Having separate staff assigned to the systematic review, meta-analysis, and costing and cost-effectiveness analysis (albeit with some overlap) will enable us to conduct them in parallel.

In Months 2-4, we will continue working on the three work streams. For the review, we will complete the inception phase tasks for this component (study identification, coding, and risk of bias assessments, data extraction), and will begin the synthesis of the studies as well as setting up the meta-analyses. We will also identify and confirm cost studies and qualitative sibling studies for inclusion in our study, and create our database of costs for the cost analyses. In Month 4, we will convene another TAG meeting to present preliminary results and discuss interpretation of results/next steps, and submit the minutes from this meeting to the World Bank.

The following month, we will finalize all analyses for the three research streams and draft the final report. We will submit the draft for review to the World Bank and put together the products for final presentation (e.g., slides). Once we receive feedback on the draft report, we will revise and finalize the report and the presentation material and consider developing products for peer-reviewed publications.

In the final month, we will organize a workshop for key stakeholders and the broader nutrition community (including policy makers, practitioners, and academics) to present findings from our investigation. We will also invite TAG members to attend. Subsequently, we will put together a final report incorporating feedback from the dissemination workshop and submit to the World Bank after which we will start producing papers for peer-review.

Exhibit 16. Gantt Chart

Activity	2023-2024							
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Contract signing	●							
Kick-off meeting WB and AIR	●							
Develop and iterate search string	●	●						
Finalize search string and inclusion criteria		●						
Draft research protocol		●						
First TAG meeting – research design		●						
Run search and begin abstract review			●	●				
Identify and begin collecting cost data			●	●				
Finalize abstract review				●				
Begin full text reviews & study coding				●				
Identify and confirm cost studies				●	●			

Activity	2023-2024							
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Identify and confirm sibling studies				●	●			
Complete full text reviews & coding					●			
Complete risk of bias assessments					●			
Complete quantitative data extraction					●			
Create cost database					●			
Second TAG meeting – progress update					●			
Conduct narrative quantitative and qualitative syntheses						●		
Begin meta-analysis					●			
Conduct cost uncertainty analysis					●	●		
Complete meta-analysis						●		
Conduct cost-consequence and CEA						●		
Draft final report						●		
Submit draft report and presentation slides						●		
Revise final report based on feedback							●	
Consider studies for peer-reviewed publications							●	
Organize dissemination workshop							●	
Submit final, revised report							●	
Make final revisions, research outputs, as needed							●	●
Continue working on peer-reviewed publications							●	●
End of contract								●

Note: Bold denotes a deliverable submitted to the World Bank.

References

Bhutta, Z.A., Das, J.K., Rizvi, A., Gaffey, M.F., Walker, N., Horton, S., Webb, P., Lartey, A., & Black, R.E. (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *The Lancet, 382*(9890): 452-477.

Black, R.E., Bhutta, Z.A., Bryce, J., Morris, S.S. and Victora, C.G., 2013. The Lancet's Series on Maternal and Child Undernutrition. *The Lancet*, *2013*, pp.1-12.

Borenstein, M., Hedges, L.V., Higgins, J.P.T., and Rothstein, H. (2009). *Introduction to Meta-Analysis.* Chichester: Wiley.

Brody, C., de Hoop, T., Vojtkova, M., Warnock, R., Dunbar, M., Murthy, P., & Dworkin, S.L. (2015). Economic self-help group programs for improving women's empowerment? A systematic review. *Campbell Systematic Reviews, 11*(1), 1-182.

Brody, C., de Hoop, T., Vojtkova, M., Warnock, R., Dunbar, M., Murthy, P., & Dworkin, S.L. (2017). Can self-help group programs improve women's empowerment? A systematic review. *Journal of Development Economics*. 9(1), 15-40.

Campbell, M., McKenzie, J.E., Sowden, A., Katikireddi, S.V., Brennan, S.E., Thomson, H. (2020). Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guidelines. *Lancet, 368*(l6890). doi: 10.1136/bmj.l6890

Chinen, M., de Hoop, T., Balarin, M., & Alcazar, L. (2016). PROTOCOL: Vocational and business training to increase women's participation in higher skilled occupations in low-and middle-income countries: a protocol for a systematic review. *Campbell Systematic Reviews*, 12(1), 1-46.

Cost Analysis Standards Project [CASP]. (2021). Standards for the Economic Evaluation of Educational and Social Programs. Arlington, VA: American Institutes for Research.

Critical Appraisal Skills Programme (CASP) (2013). Collabouration for Qualitative Methodologies. Available from http://www.casp-uk.net/wp-content/uploads/2011/11/CASP-Qualitative-Research-Checklist-31.05.13.pdf.

Das, J., Do, Q-T., Shaines, K., & Srikant, S. (2013). U.S. and them: The geography of academic research. *Journal of Development Economics* 105, 112-130.

De Groot, R., Palermo, T., Handa, S., Ragno, L. P. & Peterman, A. (2017) Cash Transfers and Child Nutrition: Pathways and Impacts. *Development Policy Review* 35(5), 621-643.

De Hoop, Thomas, Andi Coombes, Melissa Rodgers, Averi Chakrabarti, Ozen Guven, Marlous de Milliano, Philomena Panagoulias, et al. (2023). "Synthesis of Evidence on the Partnership Pillar of the Sustainable Development Goals." New York: The Global SDG Synthesis Coalition. https://www.sdgsynthesiscoalition.org/pillar/partnership-pillar

Dhaliwal, I., Duflo, E., Glennerster, R., & Tulloch, C. (2013). Comparative cost-effectiveness analysis to inform policy in developing countries: a general framework with applications for education. *Education policy in developing countries, 17*, 285-338.

Drummond, M.F., Sculpher, M.J., Claxton, K., Stoddart, G.L., & Torrance, G.W. (2015). *Methods for the Economic Evaluation of Health Care Programmes.* (4th ed.). Oxford University Press. https://books.google.co.uk/books?id=lvWACgAAQBAJ

Evans, D.K. & Popova, A. (2016). What really works to improve learning in developing countries? An analysis of divergent findings in systematic reviews. *World Bank Research Observer, 31*(2): 242-270. http://hdl.handle.net/10986/29308

Fanzo, J., Davis, C., McLaren, R., & Choufani, J. (2018). The effect of climate change across food systems: Implications for nutrition outcomes. *Global food security*, *18*, 12-19.

Fanzo, J., Haddad, L., Schneider, K. R., Béné, C., Covic, N. M., Guarin, A., ... & Moncayo, J. R. (2021). Rigorous monitoring is necessary to guide food system transformation in the countdown to the 2030 global goals. *Food Policy*, *104*, 102163.

Geyik, Ö., Hadjikakou, M. and Bryan, B.A., 2023. Climate-friendly and nutrition-sensitive interventions can close the global dietary nutrient gap while reducing GHG emissions. *Nature Food*, *4*(1), pp.61-73.

Gillespie S, Harris J, Kadiyala S. The agriculture-nutrition disconnect in India: what do we know? IFPRI Discussion Paper 01187. Washington, DC: International Food Policy Research Institute, 2012.

Gornitz, R., V., Bowman, M. & Blake, R. 2010: Climate observations and projections. *Ann. New York Acad. Sci.*, 1196, 41-62, doi:10.1111/j.1749-6632.2009.05314.x

Gram, L., Fitchett, A., Ashraf, A., Nayreen & Osrin, D. (2019) Promoting women's and children's health through community groups in low-income and middle-income countries: a mixed-methods systematic review of mechanisms, enablers and barriers. *BMJ Global Health.* 4(6), 1-17.

Grames, E. M., Stillman, A. N., Tingley, M. W., & Elphick, C. S. (2019). An automated approach to identifying search terms for systematic reviews using keyword co-occurrence networks. *Methods in Ecology and Evolution*, *10*(10), 1645-1654.

Higgins JP, Thomas J, Chandler J. Cochrane Handbook for systematic reviews of interventions. John Wiley & Sons, 2019.

Hirvonen, K. (2020). This is US: Geography of Evidence in Top Health Economics Journals. *Health Economics, 29*(10), 1316-1323.

Hombrados, J., & Waddington, H. (2012). Internal validity in social experiments and quasi-experiments: An assessment tool for reviewers. Mimeo. 3ie.

Horton, S., M. Shekar, C. McDonald, A. Mahal, and J. K. Brooks. (2010). *Scaling Up Nutrition: What Will it Cost*? Directions in Development Series. Washington, DC: World Bank.

Keats, E.C., Das, J.K., Salam, R.A., Lassi, Z.S., Imdad, A., Black, R.E., & Bhutta, Z.A. (2021). Effective interventions to address maternal and child malnutrition: An update of the evidence. *The Lancet Child & Adolescent Health, 5*(5): 367-384.

Leroy, J.L., Koch, B., Roy, S., Gilligan, D., & Ruel, M. (2021). Social assistance programs and birth outcomes: A systematic review and assessment of nutrition and health pathways. *The Journal of Nutrition*. https://pubmed.ncbi.nlm.nih.gov/34590144/

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

Levin, C., L. Tokos Harp, J. Crocker, J. Wun, C. Kemp, E. Choo, A. Margolies, A. Gelli. (2023). Strengthening Economic Evaluation for Multisectoral Strategies for Nutrition: *SEEMS Nutrition Common Approach Guidance Document*. University of Washington Department of Global Health.

Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. Thousand Oaks, CA, United States: SAGE.

Margolies, A. , Kemp, C. G. , Choo, E. M. , Levin, C. , Olney, D. , Kumar, N. , Go, A. , Alderman, H., & Gelli, A. (2022). Nutrition-sensitive agriculture programs increase dietary diversity in children under 5 years: A review and meta-analysis. *Journal of Global Health*, 12, 08001.

Nakamura, P., Molotsky, A., Castro Zarzur, R., Ranjit, V., Haddad, Y., & de Hoop, T. (Forthcoming). Language of instruction in schools in low-and middle-income countries: A systematic review. *Campbell Systematic Reviews.*

National Academies of Sciences, Engineering, and Medicine [NASEM]. (2016). *A Framework for Education Health Professionals to Address the Social Determinants of Health*. Washington, DC: The National Academies Press. https://doi.org/10.17226/21923

Neumann, P.J., Ganiats, T.G., Russell, L.B., Gillian, D.S., & Siegel, J.E. (2016). *Cost-Effectiveness in Health and Medicine*, 2nd edn (New York, 2016; online edn, Oxford Academic, 17 Nov. 2016), https://doi.org/10.1093/acprof:oso/9780190492939.001.0001

Pingali, P. and Sunder, N., 2017. Transitioning toward nutrition-sensitive food systems in developing countries. *Annual Review of Resource Economics*, *9*, pp.439-459.

Popkin BM, Corvalan C, Grummer-Strawn LM. (2020). Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet, 395*(10217):65-74. doi: 10.1016/S0140-6736(19)32497-3.

Ruel MT, Alderman H, Maternal and Child Nutrition Study Group (2013).. Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet, 382*(9891):536–51.

Scaling Up Nutrition. (2011). Progress report from countries and their partners in the Movement to Scale Up Nutrition. New York: UN.

Sharma, S., 2021. A conceptual model and framework of nutrition-sensitive and specific interventions across Life stages in India. *Journal of Family Medicine and Primary Care*, *10*(11), p.3976

Shekar M, Kakietek J, D'Alimonte MR, Rogers HE, Eberwein JD, Akuoku JK, Pereira A, Soe-Lin S, Hecht R. (2017). Reaching the global target to reduce stunting: an investment framework. *Health Policy Plan, 32*(5):657-668. doi: 10.1093/heapol/czw184.

Shekar M, Ruel-Bergeron J, Herforth A. Module A. (2013). Introduction. In: Improving nutrition through multisectoral approaches. Washington, DC: International Bank for Reconstruction and Development.

Shekar, M., O'Hearn, M., Knudsen, E., Shibuya, K., Bishop, S., van Berchem, H., Egerton-Warburton, C., Shibata Okamura, K., & Mozaffarian, D. (2023). Innovative financing for nutrition. *Nature Food, 4*: 464-471.

Siwach, G., de Hoop, T., Ferrari, G., & Belyakova, Y. (2019). Guidelines on Estimating the Costs and Cost-Effectiveness of Women's Groups in International Development. Washington, DC: American Institutes for Research.

Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. BMJ 2016;355:i4919.

Stone, R., De Hoop, T., Coombes, A., & Nakamura, P. (2020). What works to improve early grade reading in Latin America and the Caribbean? A systematic review and meta-analysis. *Campbell Systematic Reviews*, 16(1), 1-112.

Storhaug, I.G., Lane, C., Morre, N., Engelbert, M., Sparling, T.M., Franich, A., Rolker, H., & Snilstveit, B. (2022). Making the most of existing research: an evidence gap map of the efforts of food systems interventions in low-income and middle-income countries. *BMJ Open, 12*(e055062). doi: 10.1136/bmjopen-2021-055062

UNICEF. (2021). UNICEF Conceptual Framework on Maternal and Child Nutrition. New York: UNICEF.

Victoria, C.G., Christina, P., Vidaletti, L.P., Gatica-Dominguez, G., Menon, P., & Black, R.E. (2021). Revisiting maternal and child undernutrition in low-income and middle-income countries: variable progress towards an unfinished agenda. *Lancet, 397*(10282): 1388-1399.

Vigneri, M. (2021). The science in the middle: Middle level theory in international development evaluation. Retrieved from https://researchonline.lshtm.ac.uk/id/eprint/4669422/1/CEDIL-Methods-Working-Paper-3-MLT-Vigneri-doi.pub_.pdf

Waddington, H., White, H., Snilstveit, B., Garcia Hombrados, J., Vojtkova, M., Davies, P., Bhavsar, A., Eyers, J., Perez Koehlmoos, T., Petticrew, M., Valentine, J.C. & Tugwell, P. (2012). How to do a good systematic review of effects in international development: a tool kit. *Journal of Development Effectiveness.* 4(3), 359-387.

Wilkinson, T., Chalkidou, K., Walker, D., Lopert, R., Teerawattananon, Y., Chantarastapornchit, V., ... & Briggs, A. (2014). Bill and Melinda Gates Foundation Methods for Economic Evaluation Project (MEEP): Final Report. *London: National Institute for Health and Clinical Excellence*.

World Bank. (2007). From agriculture to nutrition. Pathways, synergies and outcomes. Washington, DC: The International Bank for Reconstruction and Development.

World Health Organization (WHO). (2021). Levels and trends in child malnutrition: UNICEF/WHO/The World Bank Group joint child malnutrition estimates: key findings of the 2021 edition. WHO. https://www.who.int/publications/i/item/9789240025257

World Health Organization (WHO). (2023). SDG Target 2.2 | *Malnutrition: End all forms of malnutrition, including achieving targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.* WHO. https://www.who.int/data/gho/data/themes /topics/indicator-groups/indicator-group-details/GHO/sdg-target-2.2-child-malnutrition

Annex A. Search Terms

Population

"low income countr*" OR "low-income countr*" OR "low-income econom*" OR "low income econom*"OR "lower-middle-income countr*" OR "lower middle income countr*" OR "lower-middle-income econom*" OR "lower middle income econom*" OR "middle income countr*" OR "middle-income countr*" OR "middle-income econom*" OR "middle income econom*" OR "developing countr*" OR "less developed countr*" OR "less-developed countr*" OR "underdeveloped countr*" OR "under developed countr*" OR "under-developed countr*" OR "underserved countr*" OR "under served countr*" OR "under-served countr*" OR "LMIC*" OR "low GDP" OR "low-GDP" OR "low GNP" OR "low-GNP" OR "fragile state" OR "third world" OR "transitional countr" OR "high burden countr*" OR "high-burden countr*" OR "Asia*" OR "South Asia*" OR "Africa*" OR "Latin America*" OR "South America*" OR "Central America*" OR LAC OR "Middle East*" OR MENA OR "sub-Saharan Africa*" OR "sub Saharan Africa*" OR Caribbean OR "West Indies" OR Afghanistan* OR Afghan* OR Albania* OR Algeria* OR Angola* OR Argentin* OR Armenia* Or Azerbaijan* OR Azeri* OR Bangladesh* OR Belarus* OR Belize* OR Benin* OR Bhutan* OR Bolivia* OR Bosnia* OR "Bosnia and Herzegovina" OR Botswana OR Motswana OR Brazil* OR Bulgaria* OR "Burkina Faso" OR Burkinabè OR Burkinabe OR Burundi* OR "Cabo Verde*" OR "Cape Verde*" OR Cameroon* OR Cambodia* OR "Central African Republic" OR "Central African" OR Chad* OR China OR Chinese OR Colombia* OR Comoros OR Comorian OR "Cote d'Ivoire" OR "Ivory Coast" OR Ivorian OR Congo* OR "Costa Rica*" OR Cuba* OR "Democratic Republic of Congo" OR "Republic of Congo" OR "Democratic People's Republic of Korea" OR "North Korea*" OR Korea* OR Djibouti* OR Dominica* OR "Dominican Republic" OR Ecuador* OR Egypt* OR "Arab Republic of Egypt" OR "El Salvador" OR Salvador* OR Eritrea* OR Eswatini OR Swazi OR "Liswati" OR Ethiopia* OR "Equatorial Guinea*" OR Equatoguinean OR Fiji* OR Gabon* OR Gambia* OR Gaza* OR Palestin* OR Georgia* OR Ghana* OR Grenada OR Granad* OR Guatemala* OR Guinea* OR "Guinea-Bissau" OR Haiti* OR Hondura* OR India* OR Indonesia* OR Iran* OR "Islamic Republic of Iran" OR Iraq* OR Jamaica* OR Jordan* OR Kazakhstan* Or Kazakh* OR Kenya* OR Kiribati OR "I-Kiribati" OR Kosovo OR Kosova* OR Kyrgyz* OR Lao* OR Lao PDR OR "Lao People's Democratic Republic" OR Lebanon OR Leban* OR Lesotho OR Mosotho OR Basotho OR Liberia* OR Libya* OR Madagascar OR Malagasy OR Malawi* OR Malaysia* OR Malay OR Maldives OR Maldivian OR Mali* OR "Marshall Islands" OR Marshallese OR Mauritius OR Mauritian OR Mauritania* OR Mexic* OR Micronesia* OR "Federated States of Micronesia" OR Moldova* OR Mongolia* OR Montenegr* OR Morocc* OR Mozambique OR Mozambican OR Burma OR Burmese OR Myanmar OR Myanma* OR Namibia* OR Nepal* OR Nicaragua* OR Niger* OR Nigeria* OR "North Macedonia" OR Macedonian OR Palau* OR Pakistan* OR Paraguay* OR Peru* OR Philippines OR Philipines OR Phillipines OR Phillippines OR Filipino OR "Papua New Guinea*" OR "Republic of Congo" OR "Republic of Korea" OR "South Korea*" OR Rwanda OR Rwand* OR "Russian Federation" OR Russia* OR Samoa* OR "Sao Tome and Principe" OR "São Tomé*" OR "Sao Tome*" OR Santomean OR "SãoToméan" OR Senegal* or Serbia* OR "Sierra Leone*" OR "Sri Lanka*" OR "Solomon Island*" OR Somalia* OR "South Africa*" OR "South Sudan*" OR Sudan* OR "St. Lucia" OR "Saint Lucia*" OR "St. Vincent" OR "Saint Vincent and the Grenadines" OR "St. Vincent and the Grenadines" OR "Vincentian and Grenadinian" OR Vincy OR "Vincentian" OR "Grenadinian" OR

Swaziland OR Emaswati OR Liswati OR Suriname* OR Syria* OR “Syrian Arab Republic” OR Tajikistan* Or Tajik OR Tanzania* OR Thailand OR Thai OR “Timor-Leste” OR “Timor Leste” OR “East Timor*” OR Timorese OR Maubere OR Tokelau* OR Togo* OR Tonga* OR Tunisia* OR Turkey OR Turkish OR Turkiye OR “Türkiye” OR Turk OR Turkmenistan* Or Turkmen* OR Tuvalu* OR Uganda* OR Ukraine OR Ukrainian OR Uzbekistan OR Uzbek OR Vanuatu* OR “Ni-vanuatu” OR Vietnam* OR “Viet Nam” OR “West Bank” OR Gaza* OR Yemen* OR “Republic of Yemen*” OR Zambia* OR Zimbabwe* OR Zimbo

Intervention

“nutrition sensitive” OR “nutrition-sensitive” OR “nutrition sensitivity” OR “behavior change communication” OR “behaviour change communication” OR “BCC” OR “home garden” OR “homestead production” OR “kitchen garden” OR “livestock” OR “animal husbandry” OR “biofortifi*” OR “bio-fortifi*” OR “aquaculture” OR “cash crop*” OR “farm input subsid*” OR “agricultural input subsid*” OR “agriculture input subsidy” OR “agriculture training” OR “agricultural training” OR “agriculture extension” OR “agricultural extension” OR “irrigation” OR “value chain*” OR “dairy farming” OR “nutrition-sensitive agricultural intervention” OR “nutrition sensitive agriculture intervention” OR “livelihoods training” OR “farmers group” OR “food system” OR “preschool” OR “early childhood nutrition” OR “early learn*” OR “kindergart*” OR “early childhood develop*” OR ECD OR “school feeding” OR “school lunch” OR “school nutrition” OR “school meals” OR “savings group*” OR “self-help group” OR “savings group” or “health layering” OR “nutrition layering” OR “food security layering” OR “VSLA” OR “Village Savings and Loan Association” “Saving* and Internal Lending Communit*” OR “SILC” OR ROSCA OR “rotating savings and credit assoc*” “Microfinance” OR “Microloan” OR “microcredit” OR “PLA group” OR “community mobilization” OR “community mobilisation” OR “participatory learning and action group” OR “mentor*” OR “leadership development” OR “entrepreneur*” OR “access to education” OR “social protection” OR “cash transfer*” OR “cash grant” OR “public works” OR “cash for work” OR “MGNREGS” OR “MGNREGA” OR “cash plus” OR “graduation program” OR “asset transfer” OR “cash aid” OR “cash assistance” OR “social safety net” OR “income support” OR “public support” OR “family planning” OR “preconception care” OR “natal care” OR “contracepti*” OR “WASH” OR “water, sanitation, and hygiene” OR “water, sanitation and hygiene” OR “sexual and reproductive health” OR “menstrual health management” OR “menstrual hygiene” OR “marketing restriction*” OR “public food procurement” OR “women’s group” OR “nurturing care” OR “transfer program” OR “cash assistance” OR “front of pack label*” OR “food label” OR “maternity leave” OR “paternity leave” OR “parental leave” OR biofortif* OR "bio-fortification" OR "bio-fortified" OR "bio-fortify"

Comparison

Reviews:

"systematic review*" OR "rapid review*" OR "evidence synthesis" OR “evidence gap map*” OR “review*” OR “meta-analysis” OR “meta analysis” OR “literature review”

Others:

evaluation OR "impact evaluation" OR "impact analysis" OR “random* control* trial” OR experiment* OR “quasi-experiment*” OR "regression discontinuity" OR “difference-in-difference*” OR “difference in difference*” OR "propensity score" OR “quasi random” OR “quasi-random” OR “costing analys*” OR

“cost-effectiveness analys*” OR “instrumental variable*” OR “synthetic control” OR “quasi-random” OR “natural experiment” OR “case control” OR “case-control” OR “cost analys*” OR “benefit-cost analys*” OR “benefit cost analys*” OR “cost-benefit analys*” OR “cost benefit analys*” OR “cost-utility analys*” OR “cost utility analys*” OR “return on investment” OR “economic evaluation” OR “value for money” OR “vfm” OR “impact” OR “block design” OR "inverse probability weighting" OR "exact matching"

Outcome

“height” OR “height-for-age” OR “HAZ” or “weight” OR “overweight” OR “underweight” OR “weight-for-age” OR “weight-for-height” OR “WAZ” OR “WHZ” OR “stunting” OR “stunted” OR “wasting” OR “wasted” OR “MUAC” OR “mid-upper-arm circumference” OR “mid upper arm circumference” OR “mid-upper-arm-circumference” OR “anemia” OR “anaemia” OR “anemic” OR “anaemic” OR “Hb” OR “haemoglobin” OR “hemoglobin” OR “calori*” OR “obese” OR “obesity” OR “body mass index” OR “BMI” OR “preterm birth*” OR “small-for-gestational age” OR “small for gestational age” OR “low birth weight” OR “micronutrient status” OR “macronutrient status” OR “HbA1c” OR “vitamin” OR “vitamin A” OR “iron” OR “iodine” OR “folate” OR “food security” OR “diet diversity” OR “dietary diversity” OR “nutrient gap” OR “meal frequency” OR “food availability” OR “food accessibility” OR “ food affordability” OR “nutrition status” OR “nutritional status” OR “breastfeeding” OR “physical growth” OR “children’s nutrition” OR “child nutrition” OR “women’s nutrition” OR “nutrition outcome” OR “nutrition-related outcome*” OR “birth weight”

Annex B. Anchor Articles Reference List

Baird, S., McIntosh, C., & Ozler, B. (2019). When the money runs out: Do cash transfers have sustained effects on human capital accumulation. *Journal of Development Economics https://www.sciencedirect.com/science/article/abs/pii/S0304387818312732*

Chakrabarti, A., Handa, S., Natali, L., Seidenfeld, D., & Tembo, G. (2020). More evidence on the relationship between cash transfers and child height. *Journal of Development Effectiveness.* *https://www.tandfonline.com/doi/full/10.1080/19439342.2020.1731568*

Filmer, D., Friedman, J., Kandpal, E., & Onishi, J. (2023). Cash transfers, food prices, and nutrition impacts on ineligible children. *Review of Economics and Statistics.* *https://direct.mit.edu/rest/article-abstract/105/2/327/100989/Cash-Transfers-Food-Prices-and-Nutrition-Impacts*

Gichuru, W., Ojha, S., Smith, S., Robert Smyth, A., Szatkowski, L. (2019). Is microfinance associated with changes in women's well-being and children's nutrition? A systematic review and meta-analysis. *BMJ Open.* *https://pubmed.ncbi.nlm.nih.gov/30696674/*

Haghparast-Bidgoli, H., Harris-Fry, H., Kumar, A., Pradhan, R., Mishra, N.K., Padhan, S., Ojha, A.K., Narayan Mishra, S., Fivian, E., James, P., Ferguson, S., Krishnan, S., O'Hearn, M., Palmer, T., Koniz-Booher, P., Danton, H., Minovi, S., Mohanty, S., Rath, S., Rath, S., Nair, N., Tripathy, P., Prost, A., Allen, E., Skordis, J., & Kadiyala, S. (2022). Economic evaluation of nutrition-sensitive agricultural interventions to increase maternal and child dietary diversity and nutritional status in rural Odisha, India. *The Journal of Nutrition.* https://www.sciencedirect.com/science/article/pii/S0022316623086029?via%3Dihub

Kumar, N., Scott, S., Menon, P., Kannan, S., Cunningham, K., Tyagi, P., Wable, G., Raghunathan, K., Quisumbing, A. (2018). Pathways from women's group-based programs to nutrition change in South Asia: A conceptual framework and literature review. *Global Food Security* https://www.sciencedirect.com/science/article/pii/S2211912417300834

Leroy, J.L., Koch, B., Roy, S., Gilligan, D., & Ruel, M. (2021). Social assistance programs and birth outcomes: A systematic review and assessment of nutrition and health pathways. *The Journal of Nutrition*. https://pubmed.ncbi.nlm.nih.gov/34590144/

Manley, J., Balarajan, Y., Malm, S., Harman, L., Owens, J., Murthy, S., Stewart, D., Winder-Rossi, N.E., & Khurshid, K. (2020). Cash transfers and child nutritional outcomes: A systematic review and meta-analysis.

Margolies, A., Kemp, C.G., Choo, E.M., Levin, C., Olney, D., Kumar, N., Go, A., Alderman, H., & Gelli, A. (2022). Nutrition-sensitive agriculture programs increase dietary diversity in children under 5 years: A review and meta-analysis. *Journal of Global Health.* https://pubmed.ncbi.nlm.nih.gov/35198152/

Olney, D.K., Gelli, A., Kumar, N., Alderman, H., Go, A., & Raza, A. (2022). Social assistance programme impacts on women's and children's diets and nutritional status. *Maternal & Child Nutrition.* *https://onlinelibrary.wiley.com/doi/full/10.1111/mcn.13378*

Raghunathan, K., Kumar, N., Gupta, S., Chauhan, T., Kathuria, A.K., & Menon, P. (2023). Learning together: Experimental evidence on the impact of group-based nutrition interventions in rural Bihar. *World Development*. https://www.sciencedirect.com/science/article/pii/S0305750X23000852

Ruel, M.T., Alderman, H., & the Maternal and Child Nutrition Study Group. (2013). Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in in improving maternal and child nutrition? *The Lancet. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(13)60843-0/fulltext*

Ruel, M.T., Quisumbing, A., & Balagamwala, M. (2018). Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security* https://www.sciencedirect.com/science/article/pii/S221191241730127X

Storhaug, I.G., Lane, C., Moore, N., Engelbert, M., Sparling, T.M., Franich, A., Rolker, H., & Snilstveit, B. (2022). Making the most of existing research: An evidence gap map of the effects of food systems interventions in low-income and middle-income countries. *BMJ Open*. https://pubmed.ncbi.nlm.nih.gov/35732381/

Annex C. Risk of Bias Assessment

Exhibit C-1. Risk of Bias Tool for Experimental and Quasi-Experimental Studies

Ask these questions for all quantitative studies
Are the mean values or the distributions of the covariates at baseline statistically different for the control or comparison group ($p<0.05$)?
Are these differences controlled for using covariate analysis in the impact evaluation?
Is difference-in-difference estimation used?
If the study is quasi-experimental and uses difference-in-difference estimation, is it showing that the parallel trends assumption is valid?
If the study does not use difference-in-difference, does the study control for baseline values of the outcome of interest (ANCOVA)?
Attrition
Is the attrition rate from the study below 10%?
Is the attrition rate statistically significantly different between the treatment and comparison group?
Sample Size
Does the study account for lack of independence between observations within assignment clusters if the outcome variables are clustered?
Is the sample size likely to be sufficient to find significant effects of the intervention?
Ask questions below only for studies that apply randomization
Does the study apply randomized assignment?
Ask questions below only for studies that apply regression discontinuity designs
Is the allocation of the programme based on a pre-determined continuity on a continuous variable and blinded to the beneficiaries or, if not blinded, individuals cannot reasonably affect the assignment variable in response to knowledge of the participation rule?
Ask questions below only for studies that apply matching
Are the characteristics of the treatment and comparison group similar? (based on statistical significance tests) after matching?
Ask questions below only for studies that apply instrumental variable estimation
Does the study describe clearly the instrumental variable(s)/identifier used and why it is exogenous?
Are the instruments jointly significant at the level of $F \geq 10$? If an F test is not reported, does the author report and assess whether the R-squared of the instrumenting equation is large enough for appropriate identification (R-sq > 0.5)?