# Impact pathways of shocks, conflicts and crises on dietary patterns and malnutrition in low- and middle-income countries

Final synthesis report

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Nutrition Research Facility
Knowledge and Research for Nutrition

## About the Nutrition Research Facility

The Knowledge and Research for Nutrition project of the European Commission (2020-2026) aims to provide improved knowledge and evidence for policy and programme design, management and monitoring & evaluation in order to reach better nutrition outcomes.

The project is implemented by Agrinatura - the European Alliance on Agricultural Knowledge for Development – which has established a Nutrition Research Facility, pooling expertise from European academia and having the ability to mobilise internationally renowned scientific networks and research organisations from partner countries.

The Nutrition Research Facility provides expert advice to the European Commission and to the European Union (EU) Member States and Partner Countries.

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# List of Acronyms

| Acronym | Description |
|---|---|
| **CSB** | Corn–soya blend |
| **COVID-19** | Coronavirus Disease 2019 |
| **EU** | European Union |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **HEB** | High-energy biscuits |
| **iCCM** | Integrated Community Case Management |
| **IYCF** | Infant and Young Child Feeding |
| **LNS** | Lipid-based nutrient supplement |
| **LMIC** | Low- and middle-income countries |
| **MAM** | Moderate acute malnutrition |
| **NRF** | Nutrition Research Facility |
| **OECD** | Organisation for Economic Co-operation and Development |
| **RUSF** | Ready-to-use supplementary food |
| **RUTF** | Ready-to-use therapeutic food |
| **SAM** | Severe Acute Malnutrition |
| **SCC** | Shocks, Conflicts and Crises |
| **WASH** | Water, Sanitation and Hygiene |
| **WHO** | World Health Organization |

# Content

# Executive summary

Fragile and crisis-affected contexts are increasingly influencing the global food and nutrition landscape in Low- and Middle-Income Countries (LMIC). These environments are characterised by structural vulnerabilities, including undernutrition, poverty, food insecurity and constrained health and social protection systems, which interact with shocks, conflicts and crises (SCC) to increase dietary and nutrition risks. Armed conflict, economic instability, pandemics and climate-related events impact food production, trade, markets and service delivery systems. These disruptions also have impacts on livelihoods, increasing food price volatility, reducing purchasing power and limiting access to diverse and nutrient-dense foods, thereby affecting dietary quantity and quality. As a result, long-term dietary constraints are associated with increased risks of wasting, stunting and micronutrient deficiencies, particularly among women of reproductive age and young children.

Given this multidimensional and protracted nature of many crises, the United Nations and the Organisation for Economic Co-operation and Development conceptualised the Humanitarian–Development–Peace nexus (HDP) to improve coherence between emergency response, longer-term development and peacebuilding efforts. Despite increasing awareness of these dynamics, for nutrition programming, evidence remains limited on how interventions operate within disrupted food systems, especially beyond the acute phase.

This research study stems from an evidence need prioritisation exercise conducted by the Nutrition Research Facility (NRF) through an online consultation with decision-makers in Asia. The exercise identified a top-priority question for nutrition programming, posed by decision makers: “How does changing food supply and food prices impact on dietary patterns and therefore on all forms of malnutrition in children under-five and women of reproductive age?”. During the consultation, stakeholders outlined the critical need to focus on SCC and recovery, particularly in countries facing recurrent crises, including Uzbekistan, the Philippines, Yemen and Bangladesh. The study systematically reviewed the evidence on nutrition-specific and nutrition-sensitive interventions implemented in fragile and crisis-affected settings to identify and map their impact pathways on diets and malnutrition in LMIC. An expert consultation was subsequently held to contextualise and interpret the review findings. Eight impact pathways were identified through the systematic literature review and validated by experts:

- Direct food consumption and child feeding
- Household income and purchasing power
- Women’s involvement in agricultural livelihoods
- Consumer awareness and behaviour
- Supporting systems (health and care systems)
- Supporting systems (food prices and trade)
- Agriculture as a source of income
- Agriculture as a source of food

Interventions targeting food consumption, child feeding and health and childcare systems were most consistently associated with improvements in nutrition outcomes, including reductions in acute malnutrition and mortality. In acute crisis settings, these pathways function as protective mechanisms, preventing rapid deterioration in nutritional status. However, their sustained impact depends on continuity of service delivery during recovery and stabilisation phases.

Economic access interventions, including cash transfers, income-generating activities and market support, were frequently associated with improvements in dietary quantity and diversity. The translation into anthropometric improvements was however less consistently observed, suggesting that dietary gains may not fully translate into improvements in the nutritional status where caregiving conditions, health services or environmental determinants are limited.

Agricultural production and women's involvement in agricultural livelihoods-related interventions showed positive associations with dietary outcomes in several settings, despite some heterogeneity across settings. Similarly, policy interventions related to food prices and trade showed heterogeneous effects. Some studies reported increased household spending on nutritious foods or improved affordability, yet others found no dietary improvements. In certain contexts, trade reforms were associated with reduced dietary quality. The observed heterogeneity across these impact pathways likely reflects their context-dependent nature, whose effectiveness may be conditioned by institutional arrangements, gender norms, workload distribution, access to land and credit, and/or market functioning. The variability may also reflect limitations in the evidence base, and these findings should therefore be interpreted with caution. These are topics that warrant further empirical investigation, to distinguish between conditional effectiveness and evidence gaps.

## Operationalising the HDP nexus and addressing cross-cutting enablers

The experts emphasised the need to more clearly operationalise the HDP nexus. The study findings suggest a potential sequencing logic aligned with the HDP principles that may support more coherent programming across crisis phases in SCC settings:

- Humanitarian phase: Interventions targeting food consumption, child feeding and essential health services play a protective role in preventing rapid deterioration in nutritional status.
- Recovery phase: Income support, market access and continuity of service delivery are central to stabilising diets and reducing the risk of relapse into acute malnutrition.
- Longer-term stabilisation: Livelihood systems, food production, market governance and institutional capacity influence whether short-term dietary improvements are translated into sustained improvements in nutritional status.

Nutrition interventions do not operate in isolation and the continuity of support across phases is key to ensure that nutrition gains achieved during emergencies persist. As also observed in this study, when interventions contribute to strengthening systems (e.g. supply chains, information systems and local service capacity), improvements are more likely to be maintained. Therefore, nutrition programming can provide a practical entry point for operationalising the HDP nexus.

An additional topic raised was that the effectiveness of the different impact pathways depends on systemic enablers that are frequently weakened in fragile contexts. These include governance and coordination, financing and institutional capacity, information systems, inclusion of nutritionally vulnerable groups, political economy dynamics and social networks and community trust. The systemic enablers influence whether improvements achieved during the acute phase are maintained during recovery and sustained over time. Operationalising the HDP nexus therefore requires explicit attention to these cross-cutting enablers.

## From evidence to implementation: programming implications

This study integrates literature and expert-based evidence to provide a more structured understanding of how nutrition interventions operate within food systems in fragile and crisis-affected settings. The findings indicate that stand-alone interventions are unlikely to generate sustainable improvements in nutrition outcomes in fragile settings. Multi-component approaches combining direct nutrition support with income, market and service delivery mechanisms appear more promising, particularly when embedded within strengthened governance, financing and institutional frameworks.

The observed variability across pathways underscores the need for context-sensitive programming and improved monitoring of intermediate food system outcomes, including food affordability, market access and caregiving capacity, to better understand why dietary improvements translate into nutrition gains.

By situating nutrition programming within the broader logic of the HDP nexus, the study reinforced the importance of continuity across crises phases and of strengthening institutional capacity. Nutrition interventions can mitigate the immediate impacts of shocks, but their long-term effectiveness depends on

the economic and governance conditions that determine resilience. In this sense, strengthening nutrition programming in fragile contexts should involve not only expanding intervention coverage, but also embed interventions within coherent and sustained systemic strategies that address structural vulnerability over time.

Taken together, the findings underscore that nutrition outcomes are shaped by interacting economic, behavioural and systemic mechanisms rather than isolated actions. Building on the identified entry points, four priority directions for policy and programming emerge:

- **Improve coverage and uptake of interventions in fragile settings** by addressing access barriers, strengthening delivery systems and tailoring approaches to contexts affected by conflict, displacement and climate shocks.
- **Design multi-component interventions grounded in local drivers** that respond to context-specific determinants of malnutrition, integrate supply- and demand-side strategies, and leverage community systems.
- **Align nutrition investments with the Humanitarian–Development–Peace (HDP) nexus** to ensure continuity across emergency response, recovery and long-term systems strengthening, while promoting resilience and social cohesion.
- **Strengthen learning and evidence generation** through adaptive programming, rigorous evaluation and improved data systems to inform scalable and context-responsive solutions.

## Keywords

Fragile and crisis-affected contexts; food security; food systems; Humanitarian–Development–Peace nexus; impact pathways; low-and-middle-income countries; malnutrition; nutrition programming; resilience

# Background

## Shocks, conflicts and crises as drivers of malnutrition

Fragile and conflict-affected settings are increasingly influencing the global food and nutrition landscape in Low- and Middle-Income Countries (LMIC). These contexts are characterised by pre-existing vulnerabilities, including undernutrition, high food insecurity, poverty, and weak essential health and care services [1]. Acute or protracted crises such as armed conflict, economic downturns, pandemics and climate-related events can aggravate the pre-existing vulnerabilities, increasing the risk of inadequate diets and malnutrition, particularly among women of reproductive age and young children [1]. These crises have often compounded effects. For example, resource scarcity following a natural disaster may trigger conflict, conflict may drive economic instability, and prolonged conflict and shock can lead to crises like famine and economic recession. In this sense, regions already in crises are more vulnerable to subsequent shocks, reinforcing cycles of vulnerability, food insecurity and malnutrition that are difficult to reverse [2].

The scale and frequency of shocks, conflicts and crises (SCC) have increased in recent decades, with profound implications for food systems [3]. Crises damage economic and social assets, limit access to land and water, disrupt agricultural production, destroy rural infrastructure and weaken markets, all of which simultaneously affect household incomes, purchasing power and access to essential services. As a result, SCC often lead to reduced food availability, price volatility and declining diet quality [4–6]. Historical events like the 2007-2008 food crisis in India [7], as well as more recent shocks including the Coronavirus disease 2019 (COVID-19) pandemic[8] and the ongoing Russia-Ukraine conflict [9], highlight the cascading effects of such situations on food systems, potentially exacerbating the risk of malnutrition. Disruptions to Ukraine's cereal exports following the Russia–Ukraine conflict triggered global food price increases, disproportionately affecting countries in Africa and Asia that are highly dependent on wheat imports from the region [10].

The Nutrition Research Facility (NRF) has synthesised evidence on the impact of the COVID-19 pandemic on diet quality, food security and nutrition in LMIC, documenting the systemic effects of income loss, food insecurity and service disruptions in crisis settings. According to this work [11], the major effects of the COVID-19 pandemic and containment measures included: i) increases in moderate and severe food insecurity, particularly during lockdown periods; ii) loss of household income, as a result of unemployment and loss of income generating activities, was identified as a key driver of deteriorating food security and reduced diet quality; iii) shifts towards less diverse and less nutritious diets, driven primarily by reduced purchasing power. The impacts of the COVID-19 on food systems and diets varied between and within countries and manifested with various intensity degrees, duration and in different forms, according to timing, duration and stringency of national COVID-19 restriction measures and policies, context-specific food value chain responses and differentiated impacts of restriction measures on different groups, disproportionately affecting women, socio-economically vulnerable populations, informal workers and young adults reliant on daily wages. Where existing and well-functioning social protection and public food distribution systems were in place or expanded, they helped mitigate adverse effects on food insecurity and diet quality. However, safety nets alone were insufficient, highlighting the need for broader food systems investments.

## Links between food system shocks, food prices and malnutrition

Food system shocks associated with SCC affect nutrition outcomes through multiple, interlinked pathways operating at biological, behavioural and systemic levels. Evidence from economic crises experienced in the past 2–3 decades in several LMIC worldwide [12] has suggested that increases in food prices [11] lead to decreases in dietary intake (both quantity and quality, including the micronutrient content). These can then result in increased childhood undernutrition (wasting and stunting) and micronutrient deficiencies (namely vitamin A and zinc) and maternal undernutrition (low BMI and micronutrient deficiencies), which, in turn,

may result in poor birth outcomes such as foetal growth restriction and preterm birth, closely associated with increased infant and child mortality [12].

At the systemic level, food price increases and declining affordability influence dietary behaviours (*e.g.* food acquisition patterns and habits, and food shopping practices). Evidence from Asia [13] indicated that healthy and diverse diets have become progressively less affordable since the late 1990s, with food cost, income constraints and lack of purchasing power being identified as major barriers to achieving food security. Recent shocks, including the Russia–Ukraine conflict, have further amplified these dynamics, leading to record-high staple foods and input prices, disrupting supply-chain and reducing food productivity in regions inside the war zone and beyond, leading to millions more malnourished people in LMIC. Empirical evidence from Lebanon shows high levels of food insecurity, reduced dietary diversity and changes in household food purchasing in response to price increases [14].

More broadly, increases in food price and trade disruptions affecting food, fertiliser, and fuel present a significant risk of aggravating the global prevalence of malnutrition, particularly among women and children, through three main ways [15]: 1) rising prices and decreased food accessibility directly affect dietary quality, especially in low-income countries where populations spend a larger proportion of their household income on food; 2) elevated prices and trade interruptions may hinder access to vital humanitarian services, exacerbating malnutrition rates; 3) countries may divert funds from nutrition improvement initiatives to other priorities when facing SCC.

## Nutrition interventions in fragile contexts: current evidence and limitations

Despite a growing body of literature focusing on the links between extreme climate events [16] and between food availability and prices [17] and child malnutrition, more specific analyses of how shocks, conflicts and crises affect malnutrition, especially conflict-induced wasting, remains limited. Moreover, existing evidence on the impacts of conflict on food security and public health has also not been consistently translated into actionable nutrition interventions, and the literature is especially sparse on interventions implemented during recovery phases. As a result, there is a critical knowledge gap in understanding how nutrition interventions can mitigate disruptions in food supply and food environments caused by shocks, conflicts and crises, and how they can move beyond short-term assistance to support recovery and longer-term food system dynamics.

In response to the awareness that many crises are protracted and multidimensional, the United Nations and the Organisation for Economic Co-operation and Development (OECD) advanced the HDP nexus as a framework to strengthen coordination between humanitarian response, long-term development and peacebuilding efforts [18]. The HDP approach emphasises coherence and sequencing across crisis phases, with the aim of addressing immediate needs while simultaneously reducing structural vulnerabilities [18]. The European Union has progressively adopted this “Triple Nexus” orientation within its external action, recognising the need to bridge emergency response and longer-term system strengthening [19]. In fragile and crisis-affected settings, this perspective is particularly relevant for nutrition programming, as short-term emergency interventions may not generate sustained improvements unless embedded within broader food systems and service delivery strategies.

## Rationale and objectives of the study

The present research study stems from an evidence need prioritisation exercise conducted by the Nutrition Research Facility (NRF) through an online consultation with decision-makers in Asia. The exercise identified a top-priority question for nutrition programming, posed by decision makers: “How does changing food supply and food prices impact dietary patterns and therefore all forms of malnutrition in children under-five and women of reproductive age?”. During the consultation, stakeholders outlined the critical need to focus on SCC and recovery, particularly in countries facing recurrent crises, including Uzbekistan, the Philippines, Yemen and Bangladesh. This study systematically reviewed the evidence on nutrition-specific and nutrition-

sensitive interventions implemented in fragile and crisis-affected settings to identify and map their impact pathways on diets and malnutrition in LMIC. Second, an expert consultation was held to contextualise and interpret the review findings.

# Methodology overview

This study was organised into two complementary methodological components. First, a systematic review of literature reviews synthesised existing evidence on the effectiveness of nutrition interventions in fragile and crisis-affected settings in terms of improving diet and nutrition outcomes, through the mapping of different impact pathways, linking interventions to outcomes. Second, an expert consultation was conducted to contextualise and interpret these pathways, assessing their relevance, specificity and applicability across different crisis contexts.

A set of working definitions and an overview of the methodological approach used in each step is provided in Appendix 1, to support interpretation.

# Results

## Systematic review

The systematic review synthesised evidence from 16 published reviews covering a wide range of nutrition-specific and nutrition-sensitive interventions implemented in fragile and crisis-affected settings across 51 countries in Africa, Asia and other regions. The reviews focused on interventions spanning food supply chains, food environments, consumer behaviour, diets, and supporting systems, and reported outcomes across dietary quantity, quality and diversity, child feeding practices, and multiple nutrition and health indicators, including micronutrient status, anthropometry, acute malnutrition and mortality. Interventions were implemented in diverse crisis contexts, including armed conflict, natural disasters, economic crises and protracted food insecurity. Detailed information of included studies, namely the list of interventions and outcomes reported, as well as quality appraisal results, are provided in Appendix 2.

### Effects of nutrition interventions in dietary and nutrition outcomes

Across the 16 included reviews, a total of 158 nutrition interventions were identified and analysed based on their effects on dietary and nutrition outcomes. These were subsequently grouped into impact pathways, differentiated by their entry point in the food system and the mechanisms through which these effects were generated:

- **Pathway I – Food consumption and child feeding:** Interventions acting directly at the consumption stage through food intake and child feeding.
- **Pathway II – Food environment and economic access**
  **IIa – Household income and purchasing power:** Interventions increasing income, food affordability and expenditure on nutrient-rich foods.
  **IIb – Women's participation in agricultural livelihoods:** Interventions affecting food environments through women's empowerment and involvement in agricultural livelihoods.
- **Pathway III – Consumer awareness and behaviour:** Interventions targeting maternal knowledge, caregiving capacity, and health-seeking practices for infant and young child feeding (IYCF).
- **Pathway IV – Supporting systems**
  **IVa – Health and childcare systems:** Interventions strengthening IYCF and maternal capacity through health, care and community services.
  **IVb – Agri-food policy systems:** Interventions affecting food purchasing, expenditure and consumption through price, trade and policy mechanisms.
- **Pathway V – Food production and supply chains**
  **Va – Agriculture as a source of food:** Interventions increasing food availability and dietary intake through production and diversification.
  **Vb – Agriculture as a source of income:** Interventions improving diets and nutrition through income generation and market participation.

The pathways are briefly described in the following subsections and additional details are available in Appendix 3.

**The evidence suggests that nutrition interventions implemented in fragile settings are associated with improvements in diets, and the impacts on the nutritional status are more pathway-dependent (Figure 1):**

- **Interventions targeting consumption and feeding, caregiving and behaviour showed the most consistent effects on dietary and nutrition outcomes** (Pathways I, III, IVa)**.** These pathways operate primarily through direct food consumption and feeding and through enhanced maternal caregiving capacity, health-seeking behaviour and IYCF practices.
- **Interventions targeting food accessibility, income and food production,** including cash-based support and agricultural livelihoods (Pathways IIa, Va and Vb), **consistently improved dietary quantity, quality and diversity**, but showed **more limited and context-dependent effects on nutrition outcomes**. These pathways mainly operate through food supply chains and food environments, by increasing availability, affordability and purchasing power.
- **Interventions targeting food environment, including women's empowerment and participation in agricultural livelihoods, and agri-food policy interventions** (Pathways IIb and IVb), showed **mixed effects on dietary outcomes and very limited evidence of nutrition impacts**. These pathways act through changes in food prices, expenditure patterns and time allocation, sometimes generating trade-offs that constrain caregiving and health-seeking.

Across intervention groups, studies directly measuring intermediate changes in food system components were scarce, and many pathways relied on theory rather than empirically verified mechanisms.

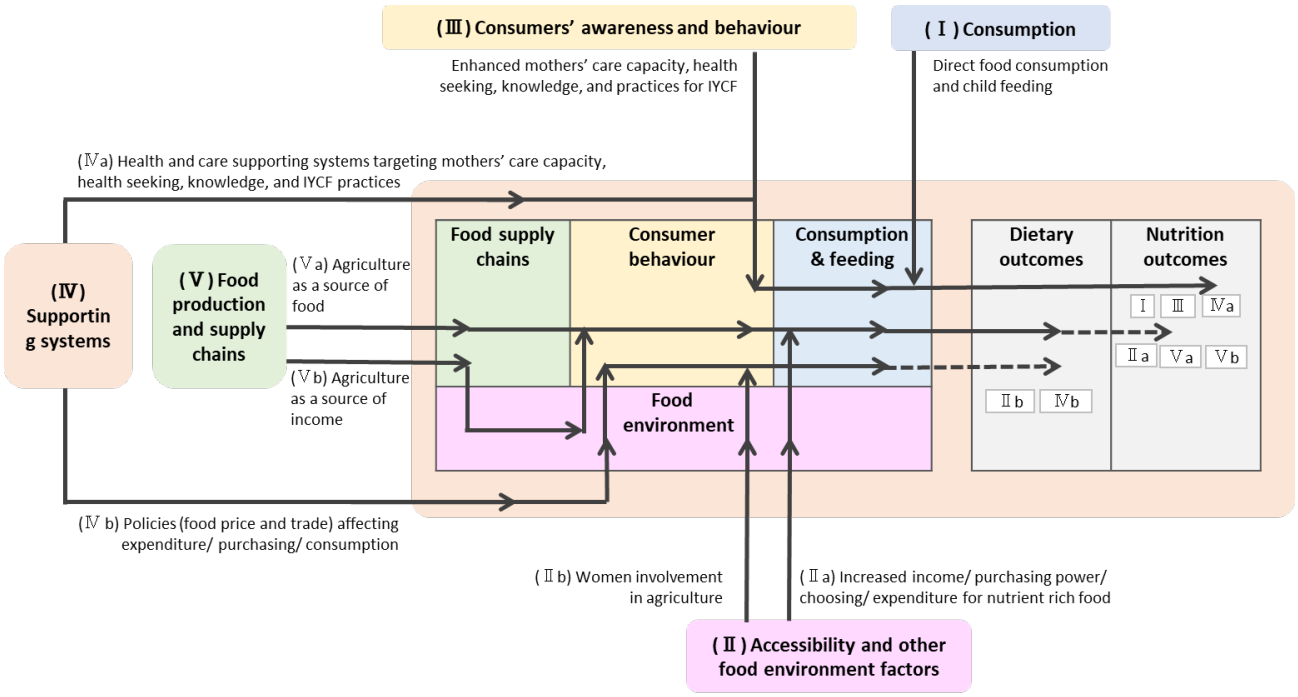


***Figure 1. Impact pathways of nutrition interventions in dietary and nutrition outcomes, in fragile settings.***
*Solid arrows represent empirically observed pathways and dashed arrows represent weak of mixed impact on dietary and nutrition outcomes. IYCF: Infant and young child feeding.*

*Interventions targeting food consumption and child feeding (pathway I)*

Interventions targeting dietary intake and child feeding were implemented as standalone (*e.g.,* supplementary feeding, micronutrient supplementation, provision of food rations) or in combination with other components, such as health/care support systems and consumer awareness (e.g., supplementary feeding integrated into health programmes). **Overall, the pathways** focused **on improving dietary intake and child feeding as the primary mechanisms of impact. There was limited evidence suggesting additional benefits through increased food access, affordability or productivity in specific contexts.**

These nutrition-specific interventions showed consistent improvements in nutrition outcomes across crisis settings, including conflict [20–22], natural disasters [23] and other crisis-affected settings [24–28]. Reported effects include lower incidence of low birth weight, improved child growth indicators (e.g., height and head circumference), reductions in anaemia, wasting, underweight and stunting, and better recovery from acute malnutrition. Although most studies reporting on interventions targeting food consumption and child feeding demonstrated improved nutrition outcomes, only a few documented intermediate effects on food supply chains or the food environment, suggesting that the main mechanism of action is through direct increases in food and nutrient intake and improved feeding practices, rather than through upstream food-system changes. When supplementary feeding was combined with health or behaviour change components, interventions further strengthened dietary and nutrition outcomes by improving caregiver knowledge and feeding practices.

*Interventions targeting the food environment and economic access (pathways IIa and IIb)*

Interventions targeting the food environment and household economic access focused on improving access to food through cash-based transfers, food transfers, food vouchers and income-support mechanisms, including agricultural employment. These interventions were often delivered as standalone measures or as integrated interventions, combining economic support with complementary actions, such as nutrition education, caregiving support or women's employment in agriculture. Two distinct but interconnected pathways were identified.

**Pathway IIa represents interventions that increase household income and purchasing power,** such as conditional and unconditional cash transfers, food vouchers, food transfers and income-support mechanisms. Most measured effects of these interventions were related to food accessibility and affordability, while impacts on consumer behaviour and other food environment dimensions were often theorised rather than directly measured. Across the included reviews, these interventions were **consistently associated with improvements in dietary outcomes** (increased dietary quantity, quality and diversity, and more frequent child meals) [28–30]. These effects were essentially driven by improved food accessibility and affordability, higher food and non-food expenditures, and changes in consumer behaviour, including greater household control over food purchases [29]. **Evidence of direct nutrition impacts** was less consistent, but most often reported when **economic support was combined with complementary nutrition or health interventions**, and included reductions in moderate and severe acute malnutrition, improvements in child anthropometry and lower mortality [28,30].

**Pathway IIb represents interventions affecting food environment through changes in women's empowerment and participation in agricultural livelihoods,** including women's employment in agricultural production, processing or marketing, and broader engagement in agrifood activities [31–33]. These interventions **improved food availability, household income and dietary quality, but their effects on nutrition outcomes were more variable and highly context dependent.** Evidence from reviews in Bangladesh and India indicates that women's engagement in agricultural activities can contribute to improved dietary outcomes through increased food availability or income, particularly during harvest periods [32,33]. However, the nutrition impacts of these interventions are highly context dependent, with several studies highlighting trade-offs between women's productive roles and caregiving capacity. Settings characterised by increased agricultural workloads without adequate caregiving, health or social protection

support were associated with reduced childcare and health-seeking and, in some contexts, mixed or adverse maternal and child nutrition outcomes [31–33]. In sum, **interventions involving women's agricultural livelihoods can improve diets, but their nutrition impacts seem to be more dependent on factors such as workload, seasonality and the presence of supportive systems that protect caregiving and health**.

#### *Interventions targeting consumers' awareness and behaviour (pathway III)*

Interventions targeting consumer awareness and behaviour focused on improving nutrition knowledge, feeding practices and food-related decision-making. These interventions included nutrition education, behaviour change communication, counselling on infant and young child feeding (IYCF), and community-based awareness campaigns, delivered either as standalone interventions or in combination with caregiving or health system support.

Across the included reviews, interventions targeting consumer awareness and behaviour, particularly IYCF promotion, breastfeeding counselling and nutrition education, were **consistently associated with improvements in child feeding practices and selected dietary outcomes,** including increased exclusive breastfeeding rates and duration, improved complementary feeding and, in some cases, greater dietary diversity [34–37]. These effects were reported across conflict, natural disaster and other crisis-affected settings.

**Evidence of nutrition impacts,** such as reductions in acute malnutrition, anaemia or improvements in child anthropometry, **was more limited and most frequently observed when awareness-raising interventions were combined with caregiving or health system support,** including postnatal care, mobile clinics, trained community health workers or integrated IYCF services [37–42]. Several studies documented intermediate mechanisms, such as increased caregiver knowledge, improved feeding practices and reduced diarrhoeal disease following WASH interventions, which possibly mediated observed nutrition gains [38,41–43].

Consumer awareness and behaviour change interventions alone were the most frequently reported and play an important role in improving feeding practices. However, their effects on dietary and particularly on nutrition outcomes are stronger and more consistent when embedded within broader caregiving, health or service delivery systems.

### Interventions targeting supporting systems (pathways IVa and IVb)

Interventions targeting supporting systems influenced dietary and nutrition outcomes either by strengthening maternal care and feeding capacity or by modifying food affordability and accessibility through agri-food policies. Two distinct pathways were identified. **Health and care-based interventions (Pathway IVa) had positive impacts on dietary and nutrition outcomes by improving maternal knowledge, IYCF practices, and access to counselling and community health services**; in contrast, **policy-based interventions (Pathway IVb) influenced food affordability and accessibility through changes in food prices, rural wages, and market conditions,** but their effects on diet and nutrition outcomes were mixed and often not directly measured.

**Pathway IVa includes interventions integrated with health and childcare systems**, such as postnatal counselling, breastfeeding promotion, WASH services and community-based health and nutrition programmes. These were associated with improved dietary practices, notably through direct counselling and caregiver support, that strengthened knowledge and behaviour regarding food preparation and feeding [27,40–42]. A further mechanism involved community health volunteers working on improving nutrition awareness and reducing acute malnutrition through home-based support [41,42].

**Pathway IVb covers interventions implemented through broader agri-food policy mechanisms, such as price regulation and trade liberalisation (S-policy).** These interventions affected food purchasing, expenditure, and consumption patterns by modifying food prices and rural wages [32,33]. The evidence on diet and nutrition outcomes was mixed: some studies reported increased household spending on nutritious food, and others improved affordability and accessibility, without corresponding impacts on diet or nutrition

outcomes. In addition, certain trade reforms were associated with reduced dietary quality following price increases [32]. Overall, the evidence on the impact of these policy interventions on diet and nutrition remain limited and heterogeneous.

#### *Interventions targeting food production and supply chains (pathways Va and Vb)*

Interventions in food production and supply chains contributed to dietary and nutrition outcomes in two distinct but complementary ways:

**Pathway Va (agriculture as a source of food) is focused on increasing the availability and consumption of nutritious foods at household level.** In this pathway, food production and diversification directly improved diets by increasing access to nutrient-rich foods. The most prominent effects were observed through a direct link between production and improved child feeding practices and dietary quality. Additional mechanisms operated through farm expansion or market access, indirectly supporting consumption and feeding improvements. **Dietary outcomes were consistently improved across these pathways,** but measurable nutrition impacts were less frequent [31–33].

**Pathway Vb (agriculture as a source of income) aims for income generation and market participation**, improving household purchasing power and influencing food choices. In this pathway, income from agricultural activities, often alongside women's empowerment, supported improved quantity and quality of food purchases. These changes translated into dietary improvements and, in some cases, into nutrition gains, including reductions in anaemia and night blindness [31–33]. **Nutrition impacts were strongest when production or income-based interventions were combined with childcare or health-support systems** [32,33].

## Experts' consultation

The eight-expert panel comprised senior nutrition, food systems and policy experts with substantial professional experience in fragile and crisis-affected contexts across multiple regions, including sub-Saharan Africa, Europe and Southeast Asia. Participants brought complementary perspectives spanning research, policy and operational practice, allowing the consultation to capture both evidence-informed and practice-based insights. Despite the limited number of experts in comparison to the expected sample size, their collective experience provided a robust basis to assess how the pathways identified in the literature align with real-world implementation realities and to highlight contextual factors that shape nutrition outcomes in SCC settings.

The following subsections present the main findings of this consultation. More detailed results and considerations are available in the final report of the expert consultation (link – to be included in the final version of the report).

### Relevance, specificity and applicability

Table 1 summarises the expert ratings across four criteria, based on quantitative Likert-scale responses collected during the expert consultation. "Relevance" reflects how important each pathway was perceived to be for influencing diets and nutrition in crisis settings; "specificity" reflects whether a pathway's effects were perceived as particularly shaped by SCC dynamics, or as impacts that are also commonly observed in non-crisis or stable contexts; "persistence of impact" reflects whether effects were expected to be short-term or sustained beyond the acute phase, and "geographical relevance" reflects experts' assessment of whether a pathway is broadly applicable across different regions, rather than being specific to a single geographical context. The colour coding reflects the consistency and direction of expert ratings, with green indicating consistently high ratings; yellow indicating generally positive ratings with variability, suggesting context-dependent performance; and orange indicating lower or more uncertain ratings.

***Table 1.*** *Summary of expert ratings on the relevance, specificity and expected persistence of nutrition impact pathways in shocks, conflicts and crises (SCC) settings.*

| Impact pathways | Criteria | | | |
|---|---|---|---|---|
| | Relevance | Specificity | Persistence of Impact | Geographical applicability |
| Food consumption and child feeding (I) | | | | |
| Household income and purchasing power (IIa) | | | | |
| Women's participation in agricultural livelihoods (IIb) | | | | |
| Consumers awareness and behaviour (III) | | | | |
| Supporting systems: health and childcare (IVa) | | | | |
| Supporting systems: Food prices and trade (IVb) | | | | |
| Agriculture as a source of food (Va) | | | | |
| Agriculture as a source of income (Vb) | | | | |

**Legend:** Green shade indicates high relevance and specificity ratings; orange indicates a tendency for low ratings; yellow reflects a tendency for positive ratings, but including some mixed classifications, thus disclosing that the impact may be more contextual.

**Overall, experts' ratings revealed distinct profiles across impact pathways, reinforcing that diet and nutrition in fragile settings are influenced by multiple, interacting mechanisms rather than by isolated interventions. Most pathways were globally applicable across fragile settings.** More specific findings:

- **Food consumption and child feeding (I), supporting systems for health and childcare (IVa) and agriculture as a source of food (Va)** received the most consistently high ratings for relevance, indicating that experts viewed these pathways as central to understanding dietary and nutrition outcomes in SCC settings. Ratings for specificity to fragile contexts were generally positive, though more mixed, suggesting that although these pathways are strongly influenced by crisis dynamics, similar mechanisms may also operate in more stable contexts. Assessments of persistence of impacts were likewise mixed, indicating that effects are often perceived as important beyond the immediate response, but may depend on other factors, such as, for example, crisis type, timing and accompanying supporting systems.
- **Income-mediated pathways, namely household income and purchasing power (IIa) and agriculture as a source of income (Vb),** were more consistently associated with impacts extending beyond the acute phase. Experts perceived these pathways as important for recovery and longer-term resilience, supporting diet and nutrition beyond immediate crisis response.
- **Food prices and trade (IVb)** received generally positive but mixed ratings across relevance, specificity to fragile contexts and persistence of impact. This pattern reflects broad recognition of their importance for influencing diets and nutrition during crises, but greater uncertainty regarding how directly these effects are driven by SCC dynamics and for how long they persist.
- **Women's participation in agricultural livelihoods (IIb) and consumer awareness and behaviour (III)** showed the greatest heterogeneity in experts' ratings across criteria. Although they recognised their potential relevance, particularly over longer time horizons, the variability in ratings likely reflected concerns about trade-offs, implementation constraints and strong context sensitivity.
- **Regarding the perceived specificity of impact pathways to different types of SCC**, experts highlighted these patterns: food consumption and child feeding (I) and agriculture as a food source (Va) were consistently associated with natural shocks; household income and purchasing power (IIa) and food

prices and trade (IVb) to economic crises; and c) household income and purchasing power (IIa) alongside health and childcare to armed conflicts and displacement.

Taken together, three key messages emerged:

- **Pathways that act through economic access to food and health and childcare systems were perceived as central to nutrition outcomes in fragile contexts;**
- **More sustained impacts were more often associated with income-mediated and system-level pathways, than with direct food or behaviour-only interventions;**
- **Context matters, with several pathways operating differently depending on the type of shock, and with other potential factors such as timing and the enabling conditions in place.**

### Insights from the Asian context

Although the impact pathways identified in this study were generally considered applicable to Asian contexts, experts rated the strength of evidence supporting their effects on dietary and nutrition outcomes in SCC settings as more limited for Asia. This is possibly related to heterogeneity across countries and crisis types, which may reflect uncertainty rather than lack of relevance. Experts' ratings therefore appear to reflect lower confidence in the robustness and consistency of Asia-specific evidence, rather than disagreement on the underlying mechanisms through which these pathways operate. This interpretation is also consistent with the composition of the consultation panel, which included limited representation of experts with Asia-specific experience.

This pattern partly reflects the available evidence base. Compared with other regions, the literature from Asia in shock- and crisis-affected settings has more frequently focused on economic shocks, food prices and affordability, and resulting food insecurity, particularly in urban and market-reliant contexts, than on integrated nutrition programming across health, social protection and food systems. For example, during the 2007–2008 global food price crisis in India, rising food prices reduced access to nutritious diets and increased the risk of food insecurity among low-income households [7]. Research on food environments in Southeast Asia further expanded these findings, highlighting income constraints and limited purchasing power, triggered by rising food costs, as barriers to accessing healthy and diverse diets [13]. Similar dynamics linking price shocks to deteriorating dietary diversity and food insecurity have also been documented in crisis contexts in Lebanon, following the Ukraine–Russia war [14].

Evidence on integrated nutrition interventions during protracted crises or recovery phases in Asia remains more limited and uneven [44], which likely contributed to more mixed assessments of evidence strength across pathways. Therefore, these findings caution against broad generalisation and underscore the need for context-specific analysis, particularly in relation to market integration, urban–rural dynamics and social protection systems. They also demonstrate how income support, market dynamics and nutrition outcomes are interconnected across shock and recovery phases and reaffirm the relevance of the research question originally posed by Asian decision makers by clarifying where evidence is strongest (*e.g.,* on food prices, affordability and market-mediated food insecurity) and where key gaps remain, particularly regarding integrated nutrition interventions and recovery-phase programming in crisis settings. Overall, there remains a need for more Asia-specific programme designs and empirical studies to test and document these linkages across diverse crisis contexts.

### Cross-cutting enablers and the Humanitarian-Development-Peace nexus

When asked to provide additional insights about additional factors or conditions that influence how the eight impact pathways operate in fragile contexts, almost all experts emphasised several cross-cutting systemic enablers that determine whether interventions can achieve their intended dietary and nutrition outcomes. System-level enablers influencing impact pathways' effectiveness include:

- **Governance and coordination:** Effective integration within national and subnational governance systems is critical to coordinate action, sustain delivery and align nutrition interventions across sectors and actors.
- **Financing and institutional capacity:** Adequate and predictable financing, combined with strong governance mechanisms, is essential to sustain nutrition action in SCC settings beyond short-term emergency cycles.
- **Information systems:** Robust routine and crisis-sensitive data systems enable targeting, adaptation, scale-up and continuity of interventions throughout shocks and recovery phases.
- **Inclusion of nutritionally vulnerable groups:** Infants, young children and breastfeeding women are often insufficiently centred in food system and livelihood frameworks, despite breastfeeding being a critical source of food security and nutrition during crises. Systematic integration of these groups into intervention design, including strengthened breastfeeding support in emergencies, was highlighted as a priority.
- **Political economy dynamics:** Market power, vested interests, informal governance arrangements and the role of humanitarian actors shape food system functioning in SCC contexts and influence whether interventions effectively reach vulnerable populations.
- **Social networks and community trust:** Social and community networks were seen as key multipliers of impact, particularly for behaviour change, IYCF, women's empowerment and access-related pathways.

**Operationalising the humanitarian–development–peace nexus** was also identified as a cross-cutting requirement, by several experts, linking emergency response with long-term system strengthening, resilience and sustainability. Specific considerations include:

- Prioritise prevention alongside emergency response to reduce vulnerability before shocks;

- Ensure that investments made during crises simultaneously contribute to strengthening systems, namely health services delivery, supply chains, regulatory frameworks, and local provider capacity;

• Establish coordinated financing windows, joint preparedness plans, strong routine data systems, and adaptive programming that bridges immediate life-saving actions with long-term capacity building.

**Box 1. From emergency response to system strengthening: What the impact pathways imply for the humanitarian–development–peace nexus**

Impact pathways do not operate in isolation. Their effectiveness depends on a broader ecosystem of enabling conditions, many of which are structurally weakened in fragile contexts. As such, operationalising the humanitarian–development–peace nexus seems to be an important requirement for translating pathway-level interventions into sustained dietary and nutrition outcomes.

The findings of this study suggest a sequencing logic consistent with the humanitarian–development–peace principles. With continuity across phases, nutrition gains achieved during emergencies are more likely to persist:

- **Humanitarian phase:** interventions targeting food consumption, child feeding and health systems play a protective role in preventing rapid deterioration in nutritional status.
- **Recovery phase:** income support, market access and continuity of service delivery are central to stabilising diets and preventing relapse into acute malnutrition.
- **Longer-term stabilisation:** livelihoods, food production (including agriculture, but also fisheries and aquaculture, livestock, …), market governance and institutional capacity influence the extent to which short-term dietary gains translate into sustained improvements in nutritional status.

In this perspective, **nutrition programming provides a concrete and evidence-backed entry point for implementing the humanitarian–development–peace nexus in practice.** This implies that nutrition investments should be designed not only focused on delivering immediate dietary impact, but also on strengthening the cross-cutting enablers identified in this study — *governance and coordination mechanisms, predictable financing and institutional capacity, routine and crisis-sensitive information systems, inclusion of nutritionally vulnerable groups, attention to political economy dynamics, and reinforcement of social and community networks* — which condition the effectiveness of interventions and persistence of nutrition gains across crisis phases.

# Conclusions and recommendations

## General conclusions

This study identified eight impact pathways through which nutrition interventions in fragile contexts impact diet and nutrition. Across pathways, there was high consistency that integrated nutrition interventions are more likely to improve dietary outcomes and create conditions for nutrition impact than standalone approaches. The relevance and performance of individual pathways are suggested to be context-dependent, depending on aspects such as shock exposure, system capacity and population vulnerability.

**Integrated nutrition interventions, especially those combining food production and food access with caregiving, health or behaviour change, are associated with better diets and nutrition outcomes.** Meaningful integration of combined approaches allows addressing the multi-cause nature of malnutrition in contexts of shocks and crises, which in turn requires a sound understanding of the complex and interacting causes of undernutrition. For this reason, current views on "integration" refer to the intentional combination of nutrition-specific interventions addressing the immediate determinants of undernutrition with nutrition-sensitive actions targeting underlying and basic/systemic determinants, such as food security and livelihoods, education, WASH and social protection, within a coherent, multi-sectoral programme or delivery platform [44]. Globally, the most commonly described integration strategies in fragile contexts include

integrated Community Case Management[1] and Integrated Management of Childhood Illness [2], Child Health Days, immunisation, early child development, and cash transfers [44]. The present expert consultation further highlighted the importance of explicit links between income support and nutrition actions, community-based nutrition delivery through trusted platforms and the integration of protection and gender-sensitive measures to mitigate trade-offs[3]. These elements are often underrepresented in published literature but are critical for translating dietary improvements into nutrition impact in practice.

**Income-support interventions consistently improve dietary quantity, quality and diversity, but their translation into nutrition outcomes remains context-dependent.** Across the reviewed evidence, income pathways primarily operate through increased purchasing power and changes in food acquisition and expenditure patterns, with nutrition impacts emerging most clearly when income gains are embedded within broader systems that support savings, financial inclusion, market engagement and shock resilience. Evidence from other integrated livelihood interventions reported in the literature, including community-based savings groups (usually composed of women) combined with livelihood or skills training, showed that these multi-component approaches improve food security, reduce reliance on negative coping strategies, enhance engagement with local markets and support recovery from shocks, thereby creating more stable conditions for sustained dietary and nutrition improvements [45].

At the same time, the effectiveness of income-based interventions is mediated by market functioning and food price dynamics. Trade disruptions, price volatility and input cost shocks (well documented for example during recent crises such as the COVID-19 pandemic and the Russia-Ukraine conflict [9,10,12]), have been shown to weaken food affordability and offset potential nutrition gains from income support, particularly in import-dependent LMIC [13–17]. Despite their central role in shaping whether income gains translate into improved diets and nutrition, interventions explicitly targeting market stabilisation, price transmission or trade-related constraints remain poorly documented in fragile settings [46]. In this study, experts considered market dynamics and price volatility as relevant impact pathways, despite under addressed, by highlighting the need to better integrate income-support interventions with measures that strengthen market access, price stability and food availability to achieve more sustained nutrition impact in practice.

**Evidence on agricultural pathways and women's empowerment showed context-dependent effects on diets and nutrition**, consistent with the existing literature. Agricultural and smallholder interventions targeting crop production, livestock, and fisheries' potential to support resilience and food security have increasingly been implemented in humanitarian and conflict-affected settings in the past decade. However, evidence [45] on the impacts on food security and nutrition is limited, despite effects in leveraging incomes, purchasing power, dietary diversity and nutritional quality have been described in stable settings [45]. This study adds to the existing body of evidence by suggesting that women's empowerment may act as an indirect contributor to nutrition outcomes in such interventions, as long as important trade-offs are addressed. Despite women's central role in sustaining household food security during shocks, conflicts and crises, their

[1] Integrated Community Case Management is a strategy to train, support, and supply community health workers (CHWs) to provide diagnostic, treatment, and referral services for children aged younger than 5 years for 3 common illnesses: malaria, pneumonia, and diarrhoea. For more information: https://www.childhealthtaskforce.org/hubs/iccm.

[2] Integrated Management of Childhood Illness is a comprehensive approach to child health that combines preventive and curative interventions to reduce mortality, illness and disability, and to promote healthy growth and development among children under five. It focuses on improving the quality of care through strengthened clinical case management, resilient health systems, and enhanced family and community health practices, including nutrition, care-seeking and early childhood development. For more information: https://www.who.int/teams/maternal-newborn-child-adolescent-health-and-ageing/child-health/integrated-management-of-childhood-illness.

[3] The following were referred by experts as examples of the most effective and operationally relevant integrated practices in fragile settings: a) Income and food access combined with nutrition and care, such as public works programmes (cash or food for work) and composite cash transfer and nutrition education models; b) Health–nutrition service integration, including micronutrient supplementation delivered alongside routine maternal and child health services, immunisation, hygiene promotion and WASH interventions; c) Community-based behaviour change and service delivery, particularly nutrition education delivered through community health workers and peer support groups; d) Social protection and safeguarding-linked nutrition interventions, including safety nets connected to health services and food assistance combined with protection measures, especially for pregnant and breastfeeding women and young children; e) Gender-sensitive integrated programmes, addressing women's time burden and caregiving trade-offs through the combination of livelihood support and care-protective measures.

ability to translate this role into improved nutrition outcomes is often constrained by structural and systemic barriers such as limited access to land, credit, technologies, extension services and markets, which restrict their capacity to turn agricultural work into stable income and better diets for their families. These challenges are further reinforced by social norms and discriminatory legal frameworks that limit women's decision-making power, mobility and control over resources. At the same time, the additional responsibilities women assume in agricultural production frequently increase their time burden, leaving less time and energy for caregiving, with direct consequences for diets and nutrition [47].

As noted by Abdullahi et al. [44], agricultural and livelihood support are more likely to improve diet and nutrition when they are delivered through multicomponent programmes combining nutrition-sensitive and specific actions, rather than implemented as standalone interventions. Al Dachache et al. [45] further recommend the implementation of multi-component interventions targeting nutrition education, health, agricultural provision, and income generation, to improve child diet and nutrition. Consistent with this, experts in this study emphasised the relevance of support-system interventions that explicitly link livelihoods to caregiving, health and IYCF support, including measures that strengthen women's access to productive resources such as land, credit and microcredit, and noted that pregnant and breastfeeding women remain insufficiently targeted in food systems and agricultural programming. These findings underscore the need for gender-sensitive integration that anticipates trade-offs and safeguards caregiving time and addresses structural constraints on women's access to land, financial services and income-generating opportunities, as conditions for achieving meaningful nutrition impact.

**Beyond individual intervention pathways, experts highlighted a set of cross-cutting factors that are critical to the effectiveness of integrated nutrition interventions in fragile contexts and frequently overlooked.** These include political readiness and leadership, institutional capacities and resources, supervision and workforce stability, functioning supply chains and logistics, reliable information systems, and sustained community engagement and trust. Similar enabling and constraining factors have been identified in the literature. For example, successful integration has been shown to depend on political readiness, leadership, capacities/resources, supervision, supply chains, logistics, workforce stability, and community trust. Persistent barriers include short-term funding, staff turnover, weak logistics, fragmented information systems, and coordination problems [44].

The expert call to better operationalise the humanitarian–development–peace nexus reflects these systemic challenges, which is consistent with broader assessments of implementation challenges that influence nutrition outcomes in EU-supported countries [48]. Although the EU has established a robust framework to guide the nexus implementation[4] , recent evidence from sub-Saharan Africa suggests that translation into practice remains uneven and that the enabling conditions for integrated delivery may not yet be consistently in place in some countries and contexts. Documented constraints include differences in programming cycles and institutional mandate, short-term funding horizons, and limited human resources capacity for sustained coordination [48]. Addressing these cross-cutting constraints represents a key opportunity to strengthen the effectiveness and sustainability of integrated nutrition approaches, by improving coherence across interventions and their capacity to support sustainable improvements in diets and nutrition in fragile settings. These systemic enablers have a key influence on whether nutrition improvements achieved during the acute phase are maintained during recovery and sustained over time (Box 1).

**Across the reviewed and contextualised evidence, impacts on dietary outcomes were reported more consistently than impacts on nutrition outcomes**. This likely reflects both biological and methodological factors, but not necessarily lack of impact. Changes in dietary intake can occur rapidly, for example following interventions that improve food access or purchasing power, whereas measurable improvements in nutritional status require sustained exposure over longer timeframes and are therefore less likely to be

[4] Details available here: https://civil-protection-humanitarian-aid.ec.europa.eu/what/humanitarian-aid/resilience-and-humanitarian-development-peace-nexus_en

detected within the short implementation or evaluation periods typical of fragile settings. In addition, it may also reflect differences in study design and data collection, since dietary indicators are easier to measure and more frequently captured than nutrition outcomes, particularly in fragile settings where in-person assessments, follow-up and longitudinal measurement are often constrained [44,49]. Moreover, interventions targeting food access and consumption are more widely implemented and documented than those addressing longer-term nutritional outcomes [49], contributing to an imbalance in the available evidence. The need to act rapidly in SCC contexts, combined with short funding cycles and operational constraints, often limits the capacity to rigorously document intermediate pathways and nutrition impacts [44,49]. As a result, the observed evidence gaps may reflect limitations in measurement and documentation rather than a lack of intervention effectiveness, which reinforces the importance of strengthening learning and monitoring alongside programme delivery.

## Strengths and limitations

A strength of this study is the integration of a systematic review with an expert consultation, enabling triangulation between published evidence and more operational experience in fragile and crisis-affected contexts. This combined approach strengthened the analysis by corroborating the impact pathways identified in the literature, contextualising them within real-world delivery constraints, and identifying several priorities that are often underrepresented in formal evaluations, such as trade-offs and system-level bottlenecks. The study further benefited from a food systems lens, allowing pathways to be analysed beyond individual interventions and across supply, access, and care/enabling system dimensions. This overarching study also complements a previous NRF work on the impact of global shocks on diet and nutrition, namely the COVID-19 pandemic [11], as it extends the focus beyond a single shock to multiple forms of shocks, conflicts and crises and analyses intervention pathways across crisis phases. Both studies advance a more thorough understanding of how nutrition programming can mitigate the impacts of systemic disruptions in fragile settings.

Some limitations should nevertheless be noted. Much of the literature underpinning the systematic review infers impact pathways conceptually rather than directly measuring intermediate food system mechanisms, for example placing a stronger focus on food access than on longer-term or systemic determinants, resulting in uneven evidence robustness across pathways. The expert consultation involved a limited number of participants due to voluntary participation and time constraints and did not include non-governmental organisations' representatives. Although participating experts brought substantial operational and policy experience in fragile contexts, the small sample size affects primarily the quantitative component of the expert's consultation survey and, in particular, the observed heterogeneity in pathway ratings should be interpreted cautiously, since a larger panel might have led to more convergent classifications. Nevertheless, the qualitative insights remain informative for contextualising the pathways. Finally, both study components reflect broader data and monitoring constraints typical of fragile settings, including difficulties in accessing affected populations, disruptions to monitoring systems and limited longitudinal measurement. Overall, these limitations are mostly inherent to the evidence base rather than the study design and reinforce the need to strengthen learning, monitoring and implementation research alongside programme delivery in fragile settings.

## Recommendations

### Improve coverage and uptake of nutrition interventions in fragile contexts

- Deliver nutrition interventions through platforms that already reach families, such as routine health contacts, community programmes and social protection delivery mechanisms, to minimise missed opportunities.
- Strengthen community-based delivery and trust, particularly through community health workers and peer support groups, with adequate supervision and realistic workloads.

- Address practical access barriers that limit uptake, including distance, insecurity, costs and limited-service availability, using outreach or mobile delivery where routine services are disrupted.
- Monitor coverage and uptake alongside outcomes, by tracking who is reached, who drops out and why, to allow programmes to adapt rapidly during shocks.
- Reduce the burden on households by offering integrated services at the same point in time (e.g. screening, counselling and referral together), rather than relying on multi-step referral systems that increase drop-out.

### Design and implement effective multi-component nutrition interventions

- Base intervention design on a clear understanding of local drivers of undernutrition, including how shocks affect food access, market functioning, caregiving practices and household vulnerability.
- Make integration explicit in programme design, by clearly describing how nutrition actions are combined with health, social protection or livelihood interventions, and by defining expected pathways to dietary and nutrition outcomes.
- Link income and livelihood support to nutrition-relevant actions, including nutrition education, IYCF support, access to health services and basic financial inclusion, to increase the likelihood that income gains translate into improved diets and nutrition.
- Apply a gender-sensitive approach across interventions, recognising women's central role in food security while addressing constraints related to time, caregiving responsibilities and access to land, credit and income opportunities.

### Align nutrition investments with the Humanitarian–Development–Peace nexus

- Use nutrition programming as an entry point for operationalising the nexus at country level, linking life-saving response with longer-term system strengthening.
- Design interventions with an explicit sequencing logic across humanitarian, recovery and stabilisation phases, ensuring continuity of delivery and institutional strengthening across programming cycles.
- Promote joint planning and financing across humanitarian and development instruments to avoid repeated interruption of services in protracted crises.

### Strengthen learning, monitoring and evidence for decision-making

- Invest in implementation-focused evidence generation, particularly in Asian crisis settings, embedding process evaluation and basic costing within integrated programmes to document how integration works, the resource implications involved, and under which constraints.
- Measure intermediate food-system outcomes, including food affordability, market access, price volatility and caregiving capacity, to better understand why dietary gains do or do not translate into nutrition outcomes.
- Strengthen and harmonise information systems, and promote longer-term, flexible financing arrangements, to reduce fragmentation, staff turnover and service disruption associated with short-term emergency funding cycles.

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# Appendices

## Appendix 1. Working definitions and methodological details

### Working definitions

**Shocks, conflicts and crises:** the terms shock, conflict and crisis are used to capture different forms of disruption that affect food systems. These are often interconnected [2], with one triggering or amplifying another, affecting food supply chains, food prices, purchasing power and access to services.

Shocks refer to sudden and unexpected events like natural disasters and public health emergencies (e.g., pandemics)[50].

Conflicts refer to violent struggles or oppositions among different groups or factions, often resulting in population displacement, among other impacts (e.g., international or civil wars, political upheavals)[2].

Crises refer to broader and/or prolonged disruptions characterised by profound challenges and can be precipitated by shocks or conflicts (e.g., economic recessions, climate change)[51].

**Impact pathways:** in this study, impact pathways describe the logical sequence through which programme activities (e.g., food provision, cash transfers or nutrition education) lead to changes in different components of the food system (e.g. food availability, household income or nutrition knowledge), and how these intermediate changes translate into final dietary and nutrition outcomes (e.g. improved diet quality, stunting reduction).

**Nutrition interventions:** Nutrition interventions can be divided into nutrition-specific and nutrition-sensitive interventions[52]:

Nutrition-specific interventions are those that address the immediate causes of malnutrition, by improving dietary intake, nutrient adequacy and feeding practices. Examples include micronutrient supplementation, food fortification, feeding programmes, treatment of severe acute malnutrition, breastfeeding promotion, and support for Infant and Young Child Feeding (IYCF).

Nutrition-sensitive interventions are those that address the underlying and systemic causes of malnutrition, by influencing household food security, caregiving and feeding practices, access to essential services, and the socio-economic conditions that shape these factors. Examples include cash transfers, social safety nets, improvement of agricultural practices, income generation programmes, women's empowerment initiatives and behaviour change interventions.

### Systematic review

#### Proposed framework for analysis of impact pathways

To map impact pathways from nutrition interventions to dietary and nutrition outcomes, the study adopts the food system framework depicted in reference Food and Agriculture Organization of the United Nations (FAO) publications, The State of Food Security and Nutrition in the World 2021 [53] and 2022 [46]. This framework was used to trace how nutrition interventions enter or affect specific food system components, generate intermediate changes (e.g. in food availability, affordability or consumer behaviour), and how these changes translate into dietary and nutrition outcomes.

The analytical framework considers core food system components, including food supply chains, the food environment, consumer behaviour, and diets and nutrition and health outcomes. Data on other food system

components (e.g. other supporting food systems) were additionally extracted, where relevant. Additionally, the framework considered shocks, conflicts, and crises (SCC) as food system drivers. Table S1 summarises the analytical framework, showing how interventions were classified according to their entry point into the food system and the dietary and nutrition outcomes assessed.

***Table S1.*** *The proposed framework for analysis, including the key components and subcomponents (adapted from the HLPE/FAO 2021 and FAO 2022 food system framework).*

<table>
<tr><td>Drivers</td><td colspan="4">Shocks, conflicts, and crisis</td><td>Impact</td></tr>
<tr><td rowspan="2">Agri-food component</td><td rowspan="2">Other systems supporting food systems</td><td rowspan="2">Food supply chains</td><td rowspan="2">Consumer behaviour</td><td colspan="2">Diets</td><td rowspan="2">Nutrition and health</td></tr>
<tr><td>Consumption Feeding</td><td>Dietary outcome</td></tr>
<tr><td rowspan="2">Intervention and outcome description and classification</td><td rowspan="2">S-social<br>Social protection system<br>S-health<br>Health system<br>S-others<br>Environmental Transportation system<br>Energy systems<br>Other systems<br>S-care<br>Childcare<br>S-policy<br>Policy, governance, and political economy; food and agricultural policy support</td><td rowspan="2">F-production<br>Food and agricultural production systems<br>F-processing<br>Packaging and processing<br>F-market<br>Storage and distribution<br>Wholesale, retail, and marketing<br>International trade<br>F-waste<br>Food waste and loss management</td><td rowspan="2">C-behaviour<br>Choosing when and what food acquire, prepare, cook, store, and eat.<br>C-awareness<br>Information and awareness of nutrition and health and impacts of choices</td><td rowspan="2">D-intake<br>Intake<br>Feeding</td><td rowspan="2">D- quality<br>D- quantity<br>D-diversity<br>D-child feeding</td><td>N-status<br>N-anthropometry<br>N-acute malnutrition<br>N-mortality</td></tr>
<tr><td>Others: social, economic, environments, ecosystems</td></tr>
<tr><td></td><td colspan="3">Food environment<br>F-availability: Factors addressing availability<br>F-accessibility: Physical/social/ economic access to food<br>F-affordability: Factors addressing purchasing/ expenditure and prices for nutrient-rich food<br>F-utilisation: Utilisation and food quality and safety</td><td colspan="2"></td></tr>
</table>

### *Understanding food system components*

Food system components were defined in line with FAO frameworks [46,53] and used to structure the analysis of impact pathways.

**Food supply chains** encompass all stages from food production to distribution, including production, storage, processing, distribution, wholesale, retail, marketing, trade, and food waste and loss management.

**Consumer behaviour** focuses on how individuals choose, acquire, prepare, cook, store, and consume food. It is influenced by nutrition and health information and awareness.

**Diets** refer to the quality, quantity, diversity, safety, and adequacy of diets, which determine dietary intake.

**Nutrition and health** outcomes refer to the direct impacts of diet on nutrition status and health, critical for food security and overall well-being.

The **food environment** refers to the physical, economic, political, and socio-cultural contexts in which consumers interact with the food system to make decisions about acquiring, preparing, and consuming food[21]. It encompasses various dimensions including availability and physical access (proximity), economic access (affordability), promotion/advertising and information, as well as food quality and safety[54]. In this

study, the factors influencing food environment are categorised according to food security pillars: Food availability refers to the physical presence of food. Food accessibility focuses on the economic and physical access to food, considering factors like food prices, household income, and infrastructure. Food affordability focuses on the relationship between food prices and the individual or household purchasing power, influencing their ability to access nutritious foods. Food utilisation is the effective use of food, shaped by factors such as nutritional knowledge, dietary preferences, and food safety.

**Supporting systems** refers to a set of interconnected systems that enable food systems to function more effectively. Environmental systems provide the necessary resources for food production, such as water, soil, and biodiversity. Social protection systems support vulnerable populations by ensuring access to food and other necessities during crisis. Childcare systems support children's nutritional and health needs, ensuring proper feeding, growth, and development. Health systems contribute to public health through healthcare services and medical treatments. Transportation and energy systems are essential for efficient food supply chains.

### *Classification of interventions*

Interventions were classified according to their entry point into the food system, using the analytical framework described above (see **Table S1** for more details[1]). This classification was used to support the mapping of impact pathways across studies.

Entry points included:

**Food supply chains:** production, processing, markets and food loss and waste
**Consumer behaviour:** consumer behaviour and consumer awareness
**Diets:** Dietary intake
**Food environments:** food availability, accessibility, affordability and utilization
**Supporting system:** social protection, health, childcare, policy and other enabling systems

The interventions were also grouped according to the type of outcomes reported, distinguishing between dietary and nutrition outcomes (**Table S1**):

**Dietary outcomes**: included changes in dietary quantity, quality, diversity and child feeding practices (e.g. meal frequency, fruit and vegetable intake, dietary diversity, exclusive breastfeeding).

**Nutrition outcomes**: included changes in nutritional status, anthropometry, acute malnutrition and mortality (e.g. anaemia prevalence, stunting, wasting, child mortality).

### *Mapping the impact pathways*

For each study included in the systematic review, impact pathways were mapped by identifying the food system component through which the intervention operated (entry point). Interventions were then traced through the food system framework to identify intermediate changes (e.g., in food availability, affordability, consumer behaviour, etc). and their association with reported dietary and nutrition outcomes.

General impact pathways were synthesised by grouping similar intervention mechanisms and tracing how these mechanisms influenced food system components and translated into dietary and nutrition outcomes across the evidence base, using the food system framework. Individual studies could contribute to more than one impact pathway.

## Search strategy

The search strategy was guided by the "Population, Intervention, Comparison, and Outcome" (PICO) framework [55], which was used to structure the research question and improve search precision.

[1] Detailed coding categories are provided in Table 1 for transparency.

**Population:** the focus was on LMIC, and search terms included synonyms and a list of specific countries as defined by World Bank [56].
**Intervention:** included both nutrition-specific and nutrition-sensitive interventions, including micronutrient supplementation, food fortification, feeding programmes, treatment of severe acute malnutrition, promotion of breastfeeding, support for IYCF and agriculture, health, social protection, early child development, and education. The broad umbrella terms "nutrition-specific" and "nutrition-sensitive" interventions were also included to ensure comprehensive coverage of the search.
**Comparator:** given that this was a systematic review of systematic reviews, no additional comparator search terms were specified, as comparisons between intervention and non-intervention groups were embedded within the included studies.
**Outcomes:** the primary outcomes included dietary and nutrition outcomes, with search terms capturing covering malnutrition, undernutrition, dietary quality, nutrients, micronutrient deficiency, and anthropometric indicators (e.g., stunting, wasting, height-for-age, weight-for-age, overweight and obesity).

To reflect the broader context of the research question, additional terms related to food system components (e.g., food supply chain, food environment, and consumer behaviour) and crisis-related disruptions (e.g., natural disaster, war, pandemic, and recession) were incorporated in the search term.

## Inclusion and exclusion criteria

The specific inclusion and exclusion criteria were as follows:

Inclusion criteria

- Systematic reviews assessing the effectiveness, impact or pathway of nutrition-specific or nutrition-sensitive interventions on dietary and/or nutrition outcomes in fragile and crisis-affected settings in LMIC.
- Studies including women of reproductive age and/or children (reflecting priority populations identified by decision-makers).

Exclusion criteria

- Not systematic reviews. Examples: editorials, comment, letter/reply to the editor, grey literature, conference abstract.
- Studies focusing exclusively on upper-middle-income or high-income countries.
- Studies that do not address nutrition interventions, dietary outcomes or relevant crisis or fragility contexts.

## Database searches, study screening and selection

Literature searches were conducted in three biomedical databases (PubMed, Embase and Cochrane), from their inception to 14 Jan 2024.

The study selection was conducted by two reviewers who independently conducted a two-stage screening process: initially screening titles and abstracts, followed by a full-text review. If disagreements arose and consensus could not be reached, a third reviewer served as an arbitrator to facilitate resolution during the negotiation process.

Forward and backward citation tracking was performed to identify additional relevant reviews, and targeted manual searches were conducted to ensure comprehensive coverage of the existing evidence base.

## Data extraction

Key study characteristics were extracted from each included systematic review, including the types of interventions, effects on food system components, reported dietary and nutrition outcomes and, if reported, the authors' proposed pathways linking interventions to outcomes. Contextual information such as the

number of studies included, year of publication, characterisation of the sample/participants, countries and SCC settings.

Where relevant, original studies cited within these reviews were examined in depth to clarify mechanisms of outcome pathways not fully described in the review. Data extraction was conducted by two reviewers, with a sub-sample corresponding to 30% cross-checked for consistency and further verified by a third reviewer for accuracy. Discrepancies were resolved through discussion.

### Data synthesis and analysis

The research team anticipated encountering diverse study designs and a high degree of heterogeneity in intervention and outcome measurements, which would pose challenges for statistically pooling data across different systematic reviews.

Evidence was therefore synthesised narratively, focusing on how different intervention mechanisms influenced food system components and how these changes were associated with dietary and nutrition outcomes. This synthesis captured the direction and consistency of reported effects across studies (e.g., number of studies reporting statistical significance), rather than effect sizes.

### Risk of bias assessment

The methodological quality of included systematic reviews was assessed using the AMSTAR 2 (A MeaSurement Tool to Assess systematic Reviews 2)[57], categorising studies according to high, moderate, low, or critically low quality based on established appraisal criteria.

## Experts' consultation

### Study design

This study employed an expert consultation as a qualitative, interpretive component designed to complement the findings of the systematic review. Specifically, this consultation aimed to contextualise the evidence, assess the relevance and applicability of impact pathways across different fragility settings and regional contexts, and identify areas of convergence and uncertainty not captured in the systematic review.

The consultation was implemented through a questionnaire administered electronically. Experts remained anonymous to one another; to reduce the risk that individual or institutional positions would dominate the consultation process, addressing common challenges identified when using other approaches for reaching expert consensus [58–60].

### Panel composition and stakeholders' eligibility

The expert panel included individuals with professional experience in the design, implementation or governance of nutrition programmes in LMIC. Participants were identified through targeted strategic outreach, building on a pre-identified list of initiatives with similar objectives to the NRF and of relevant individuals and institutions (NRF Deliverable 2.2, available here).

To ensure diversity of perspectives across the research–policy–practice spectrum, the panel included experts from three main typologies: i) researchers, ii) programme officers, civil society or non-governmental organisations representatives working on programme implementation and iii) local, national and regional-level policymakers.

Participants were eligible if they: i) belonged to one of the expertise typologies outlined above; ii) had professional experience relevant to nutrition programming in LMIC; iii) were familiar with food systems

approaches and nutrition ; iv) were fluent in English; v) were able to engage with an online survey platform; and (vi) provided informed consent to participate.

### Sampling

A purposive sampling strategy was used to identify professionals with relevant expertise and experience, implemented in two tiers:

1. Direct invitation of individuals with relevant expertise, drawing on the previously identified lists of relevant experts and the professional networks of the NRF research team.
2. Snowball sampling, whereby invited experts were encouraged to disseminate the survey to additional individuals meeting the inclusion criteria, to improve the diversity and comprehensiveness of the panel [61].

Eligibility and participation criteria were clearly communicated during the invitation to ensure transparency and consistency. This multi-tiered recruitment strategy aimed to ensure a diverse sample, thereby improving the relevance and applicability of the findings [58,61].

### Sample size

There are no standardised guidelines for determining the sample size using this methodology, and the decision is often informed by the study objectives, scope, and methodology [58,60]. The consultation initially aimed to recruit approximately 50 experts through direct invitations and snowball sampling, including targeted outreach to strengthen representation from Asian settings. In practice, the final panel comprised 8 experts, with 4 reporting experience in Asian contexts.

### General approach

#### *Survey structure*

The expert consultation was implemented though an online questionnaire, designed and administered using EU Survey®, following the structure provided in Annex 1. The questionnaire was piloted internally by NRF team members prior to launch.

A secure weblink was shared with experts. An informed consent section was embedded at the start of the questionnaire, which participants were required to complete before accessing the survey. The questionnaire primarily consisted of closed-ended questions using 5-point Likert scales, with an additional “unable to score” option to allow respondents to indicate uncertainty where appropriate. Open-ended questions were included to capture qualitative insights, particularly operational or contextual details not fully covered by the quantitative questions.

In addition, a short summary of the objectives and general information, the contact of LG and GA was made available for those seeking further details about the study.

#### *Strategies to enhance result reliability and validity for use*

All questions and key definitions were formulated in plain language, to improve clarity and consistency of responses.

The consultation initially remained open for three weeks, a timeframe commonly used in expert consultation studies involving geographically dispersed stakeholders [58–60]. The data collection period was subsequently extended by an additional two weeks to allow for further responses.

A structured feedback document is planned to be shared with participants who consented to further contact, once the study was finalised. This feedback process aimed to support transparency and encourage participants to reflect on the collective responses [58–60].

## Data analysis

The data was extracted from the EU Survey® platform and processed using Excel®. Descriptive statistics were used to summarise and present participants' responses. Responses to 5-point Likert items were treated as ordinal data, with specific attention given to the "unable to score" option.

Qualitative responses were analysed thematically. Two independent researchers (GA and LG) reviewed open-ended responses and identified key themes, with differences discussed and resolved through consensus.

## Ethical considerations

Informed consent was obtained from all participants prior to their participation, ensuring they were fully informed about the study's objectives, procedures and their rights. Participation was entirely voluntary, and individuals were informed they had the option to withdraw from the study at any time without consequence.

All responses were anonymised prior to analysis, and no identifying information was linked to the data presented. Data were securely stored in password-protected files accessible only to the core research team (LG and GA) and managed in accordance with institutional data protection policies.

Given that the study did not involve the collection of personal, sensitive, or clinical data, and participants contributed in their professional capacity as experts, formal ethical approval was not required. Nevertheless, the study adhered to the reporting guideline for priority setting of health research (REPRISE) [62], thereby safeguarding the rights and integrity of all participants.

## Contingency plan

The panel was expected to involve experts from diverse backgrounds and geographical sub-regions, which despite enriching the process, could also introduce varying interpretation of the 'impact pathways framework'. To address this, clear guidance and definitions were provided within the questionnaire, and structured response formats were used to support comparability across inputs.

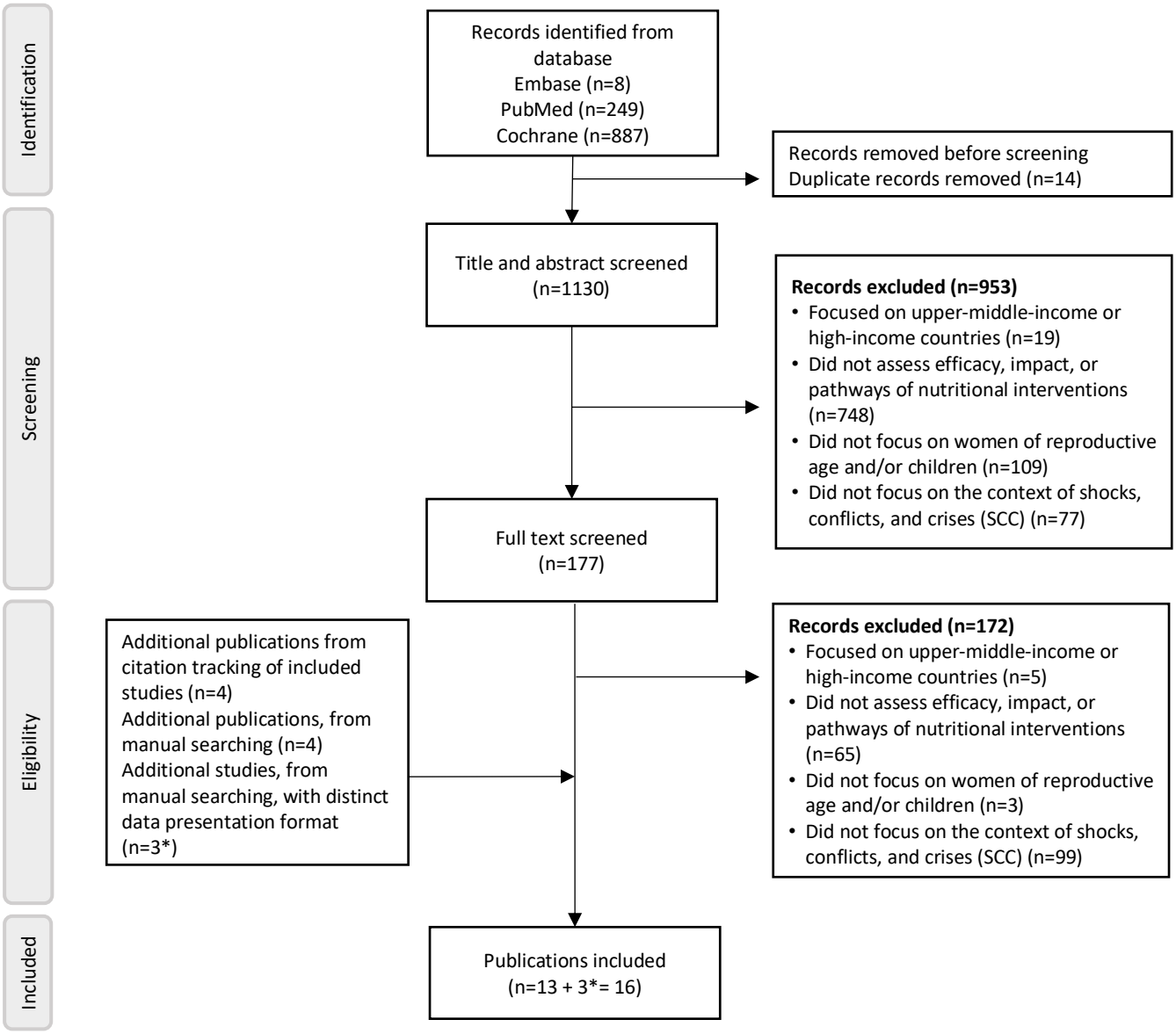
Given the busy schedules of participating experts, delays in response or incomplete participation were expected to occur. To mitigate this, clear expectations regarding timelines were communicated at the outset, with personalised reminders to the invitees to maintain engagement. An extended submission window of two weeks was provided, given a low response rate observed at the end of the 3-weeks deadline defined originally. No technical difficulties with the online platform were reported, but to account for this scenario, alternative formats such as email-based input was prepared be made available.

# Appendix 2. Overview of included reviews, interventions and outcomes (Systematic review)

## Characteristics of included publications

A total of 1144 records were identified from the databases. After removing duplicates (n=14), 1130 records remained and were screened by title and abstract. Of these, 953 records were excluded and 177 were screened in full text. Following full-text assessment, 172 records were excluded. Additional publications, from citation tracking of the included reviews (n=4) and manual searching (n=7) were added, resulting in 16 publications included in the present review (**Figure S1**).

***Figure S1.*** *Flow diagram of included studies (Systematic review).*




*Three publications were analysed separately due to their distinct data presentation formats. Hereafter, we refer to these as sub-set II publications.

Due to differences in articles structure and analysis approaches, study details from the 13 reviews (covering 87 original studies) and the three structurally distinct reviews (sub-set II publications, covering 71 interventions), were described separately. Summary characteristics and study information for the 13 reviews and for the sub-set II publications are reported in the final report of the Systematic Review (Annexes; tables S2A - S2C).

### *Target countries and fragile settings*

Included studies in the 16 reviews were conducted in 51 countries/regions, mostly in Africa (n= 23) and Asia (n= 19): Afghanistan, Algeria, Bangladesh, Bhutan, Bosnia-Herzegovina, Burundi, Cameroon, Central African Republic, Chad, China, Democratic Republic of Congo (DRC), Ecuador, El Salvador, Ethiopia, Guinea Bissau, Haiti, India, Indonesia, Iran, Iraq, Jordan, Kenya, Kosovo, Lebanon, Liberia, Macedonia, Madagascar, Malawi, Mali, Mexico, Myanmar, Nepal, Nicaragua, Niger, Pakistan, Palestine, Philippines, Sierra Leone, Somalia, South Sudan, Sri Lanka, Sudan, Syria, Tanzania, Togo, Thailand, Uganda, Ukraine, Yemen, Zambia, Zimbabwe.

The 87 original studies in the 13 reviews covered various fragile settings, including conflict (n= 38; 10 reviews), natural disaster (n= 12; 5 reviews), SCC-sensitive countries/non-specified (n= 18; 4 reviews), food crisis/seasonal hunger (n= 9; 3 reviews), economic crisis (n= 4; 2 reviews), and combination [n= 6: conflict + natural disaster (n= 3), conflict + economic crisis (n= 1), natural disaster + food crisis (n= 1), conflict +food crisis +economic crisis (n= 1); 6 reviews]). Of the sub-set II publications, one focused on climate change adaptation interventions, while the other two reviews reported on SCC-sensitive contexts, specifically in India and Bangladesh.

### *Study years and participants*

The number of participants included in the 13 reviews ranged from 140 to 1,136,311 individuals. The review studies were published between 2015 to 2024, including original studies published between year 1993 to 2022. Numbers of participants in the sub-set II publications were not indicated.

### *Intervention characteristics*

The full range of interventions studied in relation to dietary or nutrition outcomes are described in **Table S2**.

***Table S2.*** *Type of interventions classified based on the adopted food system framework*

| Components | Key stages, systems, and components | Type of interventions | Interventions in the studies |
|---|---|---|---|
| Food supply chains (F) | • Food and agricultural production systems | F-production | Technology or programme aiming at enhanced seed quality, yield, produce quality and cultural and postharvest management<br>• Homestead food production[41]<br>• Ricefield-based fish seed production[41]<br>• Vegetable production program[41]<br>• Crop production & diversification[41]<br>• Large-scale, crop-diversification project[41]<br>• Integrate fish and vegetable production into aquaculture systems[41]<br>• Backyard poultry raising[41]<br>• Irrigation and farm size[40]<br>• Cow and buffalo production & ownership[40]<br>• Dairy production and joining cooperatives[40]<br>• Production of the improved small ruminant breeds[39]<br>• Biofortification programmes[39]<br>• Climate-smart agriculture[39]<br>• Farm diversity[39]<br>• Seed and voucher fairs[39]<br>• Solar-powered drip irrigation technology[39]<br>• Livestock ownership[39] |
| | • Packaging and processing | F-processing | Processing technology or programme aimed at enhancing shelf life, quality, and distribution<br>• No interventions identified |
| | • Storage and distribution<br>• Wholesale, retail, and marketing<br>• International trade | F-market | Technology or programme that enhancing storage capacity, wider and longer distribution, improving marketing, and trading for targeted supply chains<br>• No interventions identified |
| | • Food waste and loss management | F-waste | Technology or programme aiming at reducing food waste and loss; food bank program; composition program<br>• Reducing post-harvest losses and food waste[39] |

| Components | Key stages, systems, and components | Type of interventions | Interventions in the studies |
|---|---|---|---|
| | | | • Targeting women in campaigns to reduce food loss and waste[39] |
| Consumer behaviour (C) | • Choosing when and what food acquire, prepare, cook, store, and eat. | C-behaviour | Programmes aiming at changing consumers' behaviours toward choosing/ preparing/ consuming nutrient-rich or healthy food ingredients or diets<br>• Women empowerment[40] |
| | • Information and awareness of nutrition and health and impacts of choices | C-awareness | Nutrition/health education and/or courses including infant and young child feeding provided to household women, care givers and targeted consumers<br>• Maternal and infant and young child feeding nutrition education[42–53] |
| Diets (D) | • Quantity, quality, diversity, safety, adequacy | D-intake | Food and micronutrient supplementation, fortification, food distribution/aids, child feeding/ school feeding programmes<br>• Formulated supplementary foods[46,54–63]<br>• Micronutrient supplementation[45,58,60,61,64–70]<br>• Corn Soy Blend Plus[68,71–75]<br>• Food ration[76–78]<br>• Ready-to-use supplementary/ therapeutic food[48,70–74,79–82] |
| Food environment dimensions (F) | Factors addressing food availability | F-availability | Programmes that support local production, farmers' markets, and crop diversifications<br>• No intervention identified |
| | Factors addressing food accessibility | F-accessibility | Programmes aiming at enhancing the economic and physical accesses to food, targeted/ untargeted cash transfer, food vouchers, income generation program, agricultural employment, opportunity in participating in food supply chain<br>• Unconditional/conditional cash transfer[39,59,83–96,96–99]<br>• Food voucher[91,92,94,97,100]<br>• Food transfer[91,94,96,101]<br>• Agricultural employment for household income[41] |
| | Factors addressing food affordability | F-affordability | Increasing purchasing power for healthy foods<br>• No intervention identified |
| | Factors addressing food utilisation and others | Other dimensions of food environment (F-utilisation/ F-other) | Utilisation: Programmes aimed at enhancing food safety or reducing exposure to health risks, mass media nutritional promotion, promotion campaigns for healthy diets<br>Utilisation:<br>• No intervention identified<br>Others:<br>• Mothers serving as agricultural workers, pluckers in tea plantations[41]<br>• Mothers engaged in agricultural activities[41]<br>• Farmer training and dissemination of low-cost aquaculture technologies[41] |
| Supporting systems (S) | • Social protection system | S-social | Providing social safety net for vulnerable populations<br>• Postwar social assistance programmes[102]<br>• Productive Safety Net[96] |
| | • Health system | S-health | Providing health counselling services; primary healthcare; medical treatments; health workers trainings; water, sanitation and hygiene program<br>• Improve sanitation/hygiene practices[54,63,103]<br>• Health education[68,70]<br>• Refer for treatment[48,55,70,74]<br>• Medical treatment[61,64,82]<br>• Maternal education and counselling[81]<br>• Hold training courses on acute malnutrition management for doctors, nurses, medical students, and health workers[74,81,104] |
| | • Childcare system | S-care | Community-based nutrition/ childcare centres offering nutrition and care support, promoting, and providing child health programmes focusing breastfeeding and complementary feeding practices<br>• Implement nutrition-specific supervision[62,105] |

| Components | Key stages, systems, and components | Type of interventions | Interventions in the studies |
|---|---|---|---|
| | | | • Standard growth monitoring[49,62]<br>• Nutrition education[45–47,51,62,69]<br>• Provide counselling or sessions (feeding optimisation, hygiene instruction, and a cooking demonstration)[46,48,52,70,75,95,100]<br>• Promote exclusive breastfeeding[106–111]<br>• Enhance community-based nutrition[46,50,64,112–115]<br>• Training health workers on mother counselling for childcare[116]<br>• Provide tents to offer a safe place for mothers to breastfeed[117] |
| | • Policy supporting food system | S-policy | Implementing policy that supporting sustainable agricultural practices and food security; regulations to limit the marketing of unhealthy foods to children; policy that promoting local food production<br>• Rice price regulations[40,41]<br>• Food price volatility[41]<br>• Trade liberalisation[41]<br>• Rice or wheat prices regulation[40]<br>• Coarse grain prices regulation[40] |
| | • Environmental system<br>• Transportation system<br>• Energy system<br>• Governance, political economy and others | S-others | • Postwar economic assistance programmes (especially land reform)[102] |

**Legend:** F = subcomponents under Food supply chains or food environment; C = subcomponents under Consumer behaviour; D = subcomponents under Diets; S = subcomponents under Supporting systems. See table S1 for more information.
**Note:** Reference numbers in this table refer to the original studies included in the systematic review (available here; link to be added upon publication @ NRF repository) and do not correspond to the main reference list.

## Outcomes

Details on the classification of dietary and nutrition outcomes, along with the measured outcomes in the studies, are provided in **Table S3**.

***Table S3.*** *Type of dietary and nutrition outcomes classified based on evidence measured*

| Components | Type of evidence measured | Type of outcomes classified | Outcomes measured in the studies |
|---|---|---|---|
| Dietary outcomes | • Quantity | D-quantity | Increased consumption of food; enhanced food security<br>• Increased meal frequency[42,84,90–93,93,118]<br>• Increased food and nutrient consumption[54,63,88,94,96,100,101,119]<br>• Increased food security[85,88,93,99] |
| | • Quality, safety, adequacy | D-quality | Increased intake of micronutrients, nutrient-rich food, fruits and vegetables, animal source food<br>• Increased intake of beans, fruits, green leafy vegetables, egg, animal protein and peanut/seed butters and micronutrients[42,54,63,87,89,90,93,94,96,116,119] |
| | • Diversity | D-diversity | Increased intake of more types of food groups, increased dietary diversity score<br>• Dietary diversity[42,83,84,86–89,91,93,94,96,100,101,115,118,119] |
| | • Child feeding | D-child feeding | Increased rates of exclusive breastfeeding in the first 6 months; improved complementary feeding practices<br>• Feeding duration[82]<br>• Initiation of breastfeeding within 1 hour of birth.[64,95]<br>• Breastfeeding frequency[43,63,107,116,120]<br>• Exclusive breastfeeding[95,108,110,113,114,117] |

| Components | Type of evidence measured | Type of outcomes classified | Outcomes measured in the studies |
|---|---|---|---|
| Nutrition/health outcomes | • Malnutrition status measured with biochemical indicators | N-malnutrition status | Reduced level or rates of micronutrient deficiencies - reduced iron-deficiency anaemia, vitamin A deficiency, zinc deficiency<br>• Anaemia, iron deficiency, haemoglobin levels[43,46,57,60,62,65,66,73,119,121] |
| | • Growth and development measured with anthropometry indicators | N-anthropometry | Reduced child stunting and wasting, reduced prevalence of overweight and obesity<br>• Height, weight[44,48,52,66,71,73,79,82,98,111,122]<br>• Wasting, underweight, stunting, height-for-age z-score, weight-for-age z-score, weight-for-height z-score, mid-upper arm circumference[42,44–47,48–50,52,56,57,60,65–68,75,79,80,82,92,97,102,116,119,123–125]<br>• Neonates' body weight, head circumference [77,78] |
| | • Acute malnutrition | N-acute malnutrition | Decreased cases of severe/ moderate acute malnutrition; improved recovery rates from acute malnutrition.<br>• Moderate acute malnutrition[59,74,104,113,126]<br>• Severe acute malnutrition[47,48,59,74,75,81,104,105,113,126]<br>• Global acute malnutrition[47,51,55,61,69,70,74,76,79,82,90,92,127] |
| | • Mortality | N-mortality | Reduced maternal mortality, lower child mortality rate<br>• Mortality[48,59,75,80,109,124,127] |

**Legend:** Legend: D = subcomponents under Dietary outcomes; N = subcomponents under Nutrition and health outcomes. See table S1 for more information.

**Note:** Reference numbers in this table refer to the original studies included in the systematic review (available here; link to be added upon publication @ NRF repository) and do not correspond to the main reference list.

## Quality appraisal of included reviews

According to AMSTAR 2 appraisal, one of the 16 reviews was rated as moderate quality, while the remaining were classified as low or critically low quality (**Table S4**).

***Table S4.*** *Quality appraisal of included systematic reviews (AMSTAR 2).*

| | Pega (2015) [1] | Pradhan (2016) [5] | Shah (2021) [11] | Als (2020) [17] | Munyuzangabo (2020) [19] | Bridge (2024) [23] | van Daalen (2022) [41] | Kim (2020) [55] | Ghodsi (2021) [58] | Dall'Oglio (2020) [65] | Rabbani (2020) [74] | Marshall (2021) [78] | Balhara (2017) [86] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Did the research questions and inclusion criteria for the review include the components of PICO?** | Yes | Yes | No | Yes | No | No | Yes | No | No | No | No | No | Yes |
| **2. Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?** | Yes | Yes | No | No | No | Yes | Partial Yes | No | Yes | No | Yes | No | Yes |
| **3. Did the review authors explain their selection of the study designs for inclusion in the review?** | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | No | Yes | Yes | Yes |
| **4. Did the review authors use a comprehensive literature search strategy?** | Yes | Yes | Yes | Yes | Partial Yes | Partial Yes | Partial Yes | Partial Yes | Partial Yes | Partial Yes | Partial Yes | Partial Yes | Partial Yes |
| **5. Did the review authors perform study selection in duplicate?** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **6. Did the review authors perform data extraction in duplicate?** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **7. Did the review authors provide a list of excluded studies and justify the exclusions?** | Yes | No | No | No | No | No | No | No | No | No | No | No | No |
| **8. Did the review authors describe the included studies in adequate detail?** | Partial Yes | Yes | Partial Yes | Partial Yes | Partial Yes | Yes | Partial Yes | Partial Yes | Partial Yes | No | Partial Yes | Partial Yes | Partial Yes |
| **9. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review? RCT** | Partial Yes | NA | No | NA | NA | Partial Yes | NA | No | NA | No | NA | No | Partial Yes |
| **NRSI** | Partial Yes | Partial Yes | Partial Yes | Partial Yes | No | Partial Yes | Partial Yes | Partial Yes | Yes | Partial Yes | No | No | Partial Yes |
| **10. Did the review authors report on the sources of funding for the studies included in the review?** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA | Yes | Yes | Yes |
| **11. If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results? RCT** | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **NRSI** | Yes | NA | NA | NA | NA | NA | NA | NA | Yes | NA | NA | NA | NA |
| **12. If meta-analysis was performed, did the review authors assess the potential impact of RoB unindividual studies on the results of the meta-analysis or other evidence synthesis?** | NA | NA | NA | NA | NA | NA | NA | NA | Yes | NA | NA | NA | NA |
| **13. Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?** | Yes | Yes | Yes | No | No | Yes | Yes | No | No | No | No | No | Yes |
| **14. Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?** | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes |

| | Pega (2015) [1] | Pradhan (2016) [5] | Shah (2021) [11] | Als (2020) [17] | Munyuzangabo (2020) [19] | Bridge (2024) [23] | van Daalen (2022) [41] | Kim (2020) [55] | Ghodsi (2021) [58] | Dall'Oglio (2020) [65] | Rabbani (2020) [74] | Marshall (2021) [78] | Balhara (2017) [86] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **15. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?** | NA | NA | NA | NA | NA | NA | Yes | NA | No | NA | NA | NA | NA |
| **16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Quality | Moderate | Low | Critically Low | Critically Low | Critically Low | Low | Low | Critically Low | Critically Low | Critically Low | Critically Low | Critically Low | Low |

**Legend:** NRSI: non-randomised studies on intervention

## Appendix 3. Mapping of impact pathways of nutrition interventions on dietary and nutrition outcomes, according to their entry point in the food system

This appendix includes a more detailed understanding of the proposed mechanisms underlying each of the impact pathways. Tables S5a and S5b further provide the references supporting each of the mechanisms.

### Detailed explanation of the pathways' mechanisms

#### *Interventions targeting food consumption and child feeding (Pathway I)*

Interventions targeting dietary intake and child feeding were implemented as standalone (D-intake: supplementary feeding, micronutrient supplementation, provision of food rations) or in combination with other components, such as health/care support systems and consumer awareness (Composite D-intake; e.g., supplementary feeding integrated into health programmes).

These nutrition-specific interventions showed consistent improvements in nutrition outcomes across crisis settings, including conflict [20–22], natural disasters [23] and other crisis-affected settings [24–28]. Reported effects lower incidence of low birth weight, improved child growth indicators (e.g., height and head circumference), reductions in anaemia, wasting, underweight and stunting, and better recovery from global acute malnutrition. Although most studies reporting on interventions targeting food consumption and child feeding demonstrated improved nutrition outcomes, only a few documented intermediate effects on food supply chains or the food environment, suggesting that the dominant pathway operates through direct increases in food and nutrient intake and improved feeding practices, rather than through upstream food-system changes.

The impact pathways of D-intake and Composite D-intake interventions on diet and nutrition outcomes are illustrated in Figure S2. Eight pathways (A–H) were identified, with the main pathways highlighted by bold arrows. The dominant pathway (Path A) reflects interventions that directly target food consumption and child feeding, with limited involvement of food supply chains or food environment components. When supplementary feeding was combined with health or behaviour change components (Composite D-intake), interventions further strengthened dietary and nutrition outcomes by improving caregiver knowledge and feeding practices (Paths C, D, F, G and H). **Overall, the pathways centred on improving dietary intake and child feeding as the primary mechanisms of impact, with more limited evidence suggesting additional benefits through increased food access, affordability or productivity in specific contexts (Paths B, E and F).**

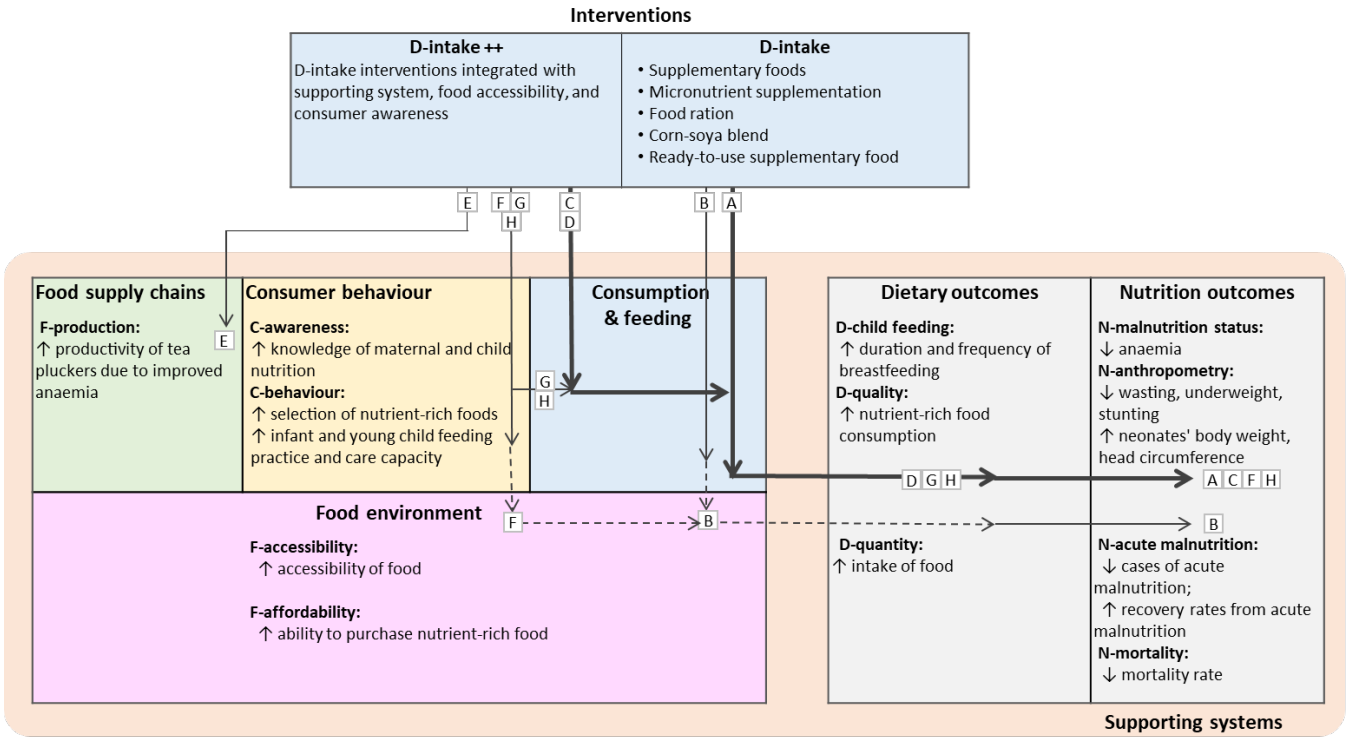



***Figure S2. Impact pathways of interventions targeting direct food consumption and child feeding (I).***
Solid arrows represent empirically observed pathways and dashed arrows represent theoretical links between food system components. Bold pathways indicate primary, consistently evidenced impact pathways across studies. Each of the "small boxes" (A to H) represent a cluster of interventions (more detail about these clusters is available upon request to the NRF team). "++": combined with other interventions; IYCF: Infant and young child feeding.

### *Interventions targeting the food environment and economic access (pathways IIa and IIb)*

Interventions targeting the food environment and household economic access focused on improving access to food through cash-based transfers, food transfers, food vouchers and income-support mechanisms, including agricultural employment. These interventions were often delivered as standalone measures (F-accessibility) or as integrated interventions (Composite F-accessibility), combining economic support with complementary actions, such as nutrition education, caregiving support or women's employment in agriculture. Two distinct but interconnected pathways were identified.

**Pathway IIa represents interventions that increase household income and purchasing power,** such as conditional and unconditional cash transfers, food vouchers, food transfers and income-support mechanisms. Across the included reviews, these interventions were **consistently associated with improvements in dietary outcomes** (increased dietary quantity, quality and diversity, and more frequent child meals) [28–30]. These effects were essentially driven by improved food accessibility and affordability, higher food and non-food expenditures, and changes in consumer behaviour, including greater household control over food purchases [29]. **Evidence of direct nutrition impacts** was less consistent, but most often reported when **economic support was combined with complementary nutrition or health interventions**, and included reductions in moderate and severe acute malnutrition, improvements in child anthropometry and lower mortality [28,30].

As illustrated in Figure S3 (Paths A to G), most measured effects related to food accessibility and affordability. Impacts of these interventions on consumer behaviour and other food environment dimensions were often theorised rather than directly measured.

**Pathway IIb represents interventions affecting food environment through changes in women's empowerment and participation in agriculture and related livelihoods,** including women's employment in agricultural production, processing or marketing, and broader engagement in agrifood activities [31–33]. These interventions **improved food availability, household income and dietary quality, but their effects on nutrition outcomes were more variable and highly context dependent.**

Evidence from reviews in Bangladesh and India indicates that women's engagement in agricultural activities can contribute to improved dietary outcomes through increased food availability or income, particularly during harvest periods [32,33]. However, the nutrition impacts of these interventions are highly context dependent, with several studies highlighting trade-offs between women's productive roles and caregiving capacity. Settings characterised by increased agricultural workloads without adequate caregiving, health or social protection support were associated with reduced childcare and health-seeking and, in some contexts, mixed or adverse maternal and child nutrition outcomes [31–33].

As illustrated in Figure S3 (Paths H and I), **food environment interventions involving women's agricultural livelihoods can improve diets, but their nutrition impacts seem to be more dependent on factors such as workload, seasonality and the presence of supportive systems that protect caregiving and health**.

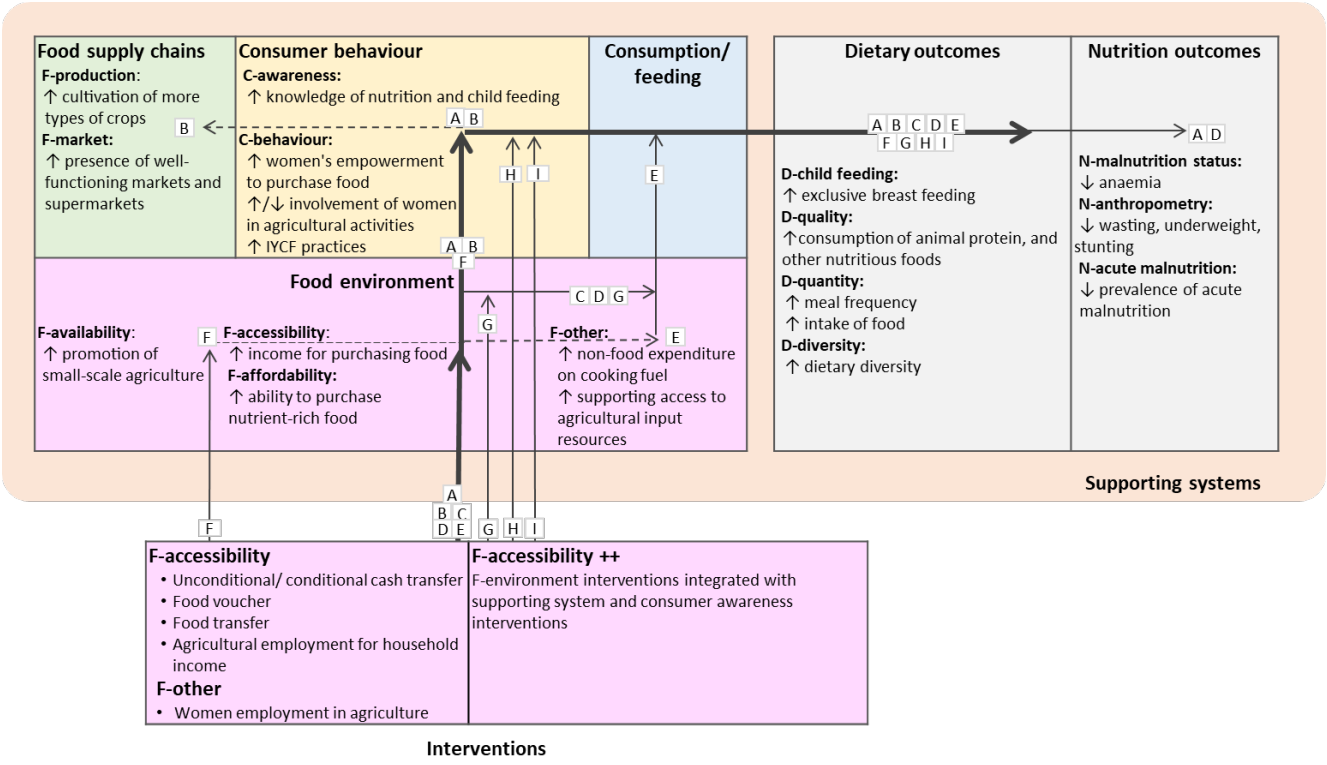



***Figure S3. Impact pathways of interventions targeting the food environment (II).***
Solid arrows represent empirically observed pathways and dashed arrows represent theoretical links between food system components. Bold pathways indicate primary, consistently evidenced impact pathways across studies. Each of the "small boxes" (A to H) represents a cluster of interventions (more detail about these clusters is available upon request to the NRF team). "++": combined with other interventions; IYCF: Infant and young child feeding.

### *Interventions targeting consumers' awareness and behaviour (Pathway III)*

Interventions targeting consumer awareness and behaviour focused on improving nutrition knowledge, feeding practices and food-related decision-making. These interventions included nutrition education, behaviour change communication, counselling on infant and young child feeding (IYCF), and community-based awareness campaigns, delivered either as

standalone interventions (C-awareness or C-behaviour) or in combination with caregiving or health system support (Composite C-awareness).

Across the included reviews, interventions targeting consumer awareness and behaviour, particularly IYCF promotion, breastfeeding counselling and nutrition education, were **consistently associated with improvements in child feeding practices and selected dietary outcomes,** including increased exclusive breastfeeding rates and duration, improved complementary feeding and, in some cases, greater dietary diversity [34–37]. These effects were reported across conflict, natural disaster and other crisis-affected settings.

**Evidence of nutrition impacts,** such as reductions in acute malnutrition, anaemia or improvements in child anthropometry, **was more limited and most frequently observed when awareness-raising interventions were combined with caregiving or health system support,** including postnatal care, mobile clinics, trained community health workers or integrated IYCF services [37–42]. Several studies documented intermediate mechanisms, such as increased caregiver knowledge, improved feeding practices and reduced diarrhoeal disease following WASH interventions, which possibly mediated observed nutrition gains [38,41–43].

As illustrated in **Figure S4**, consumer awareness and behaviour change interventions alone were the most frequently reported and play an important role in improving feeding practices (Path A). However, their effects on dietary and particularly on nutrition outcomes are stronger and more consistent when embedded within broader caregiving, health or service delivery systems (paths B and C).

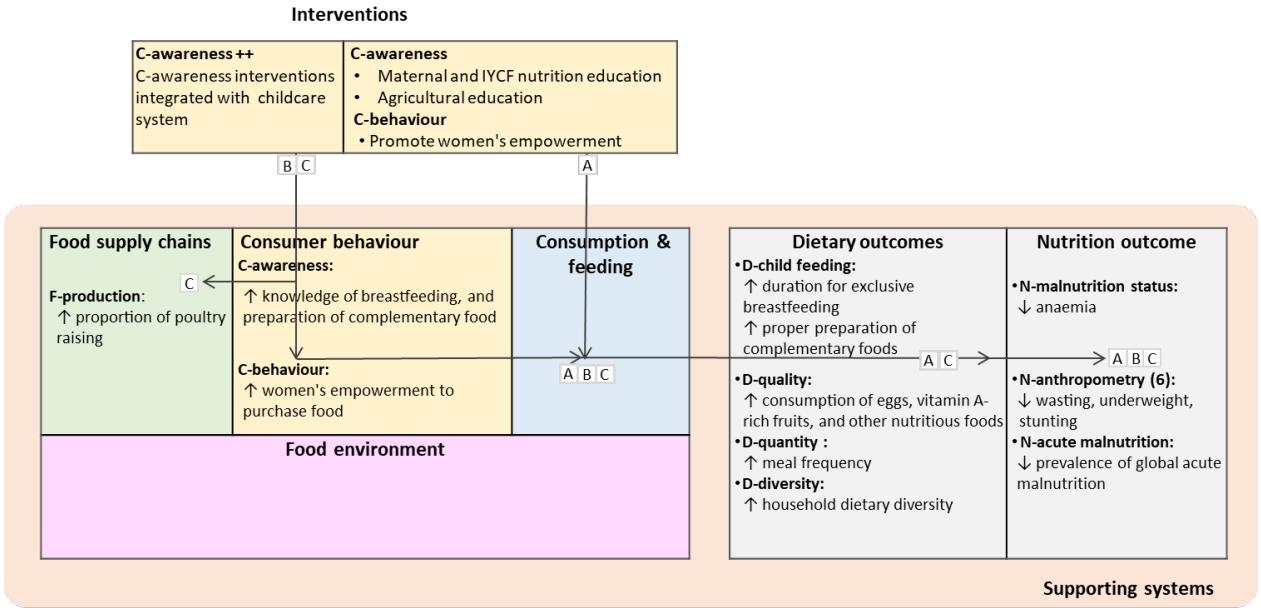



***Figure S4. Impact pathways of interventions targeting consumer awareness and behaviour change (III).***
*Solid arrows represent empirically observed pathways and dashed arrows represent theoretical links between food system components. Bold pathways indicate primary, consistently evidenced impact pathways across studies. Each of the "small boxes" (A to C) represent a cluster of interventions (more detail about these clusters is available upon request to the NRF team). "++": combined with other interventions; IYCF: Infant and young child feeding.*

### *Interventions targeting supporting systems (Pathways IVa and IVb)*

Interventions targeting supporting systems influenced dietary and nutrition outcomes either by strengthening maternal care and feeding capacity (S-health and S-care) or by modifying food affordability and accessibility through agri-food policies (S-social and S-policy). Two distinct pathways were identified (Figure S4).

**Pathway IVa includes interventions integrated with health and childcare systems (S-health and S-care)**, such as postnatal counselling, breastfeeding promotion, WASH services and community-based health and nutrition programmes. These led

to improved dietary practices through direct counselling and care (Path A), and to increased knowledge and behaviour change among caregivers regarding feeding and food preparation, which improved feeding practices primarily through direct counselling and caregiver support (Paths B and C) [27,40–42]. One further pathway (Path D) involved community health volunteers enhancing awareness and reducing acute malnutrition through home-based support [41,42].

**Pathway IVb covers interventions implemented through broader agri-food policy mechanisms, such as price regulation and trade liberalisation (S-policy).** These interventions affected food purchasing, expenditure, and consumption patterns by modifying food prices and rural wages [32,33]. Although one pathway (Path E) showed a positive effect on nutrition by increasing household spending on nutritious food, others (Paths F, G, and H) improved affordability and accessibility, but without reported impacts on diet or nutrition. Some evidence pointed to negative consequences, including reduced dietary quality linked to price increases following trade reforms [32].

**Health and care-based interventions (Pathway IVa) had positive impacts on dietary and nutrition outcomes by improving maternal knowledge, IYCF practices, and access to counselling and community health services**; in contrast, **policy-based interventions (Pathway IVb) influenced food affordability and accessibility through changes in food prices, rural wages, and market conditions,** but their effects on diet and nutrition outcomes were mixed and often not directly measured (Figure S5).

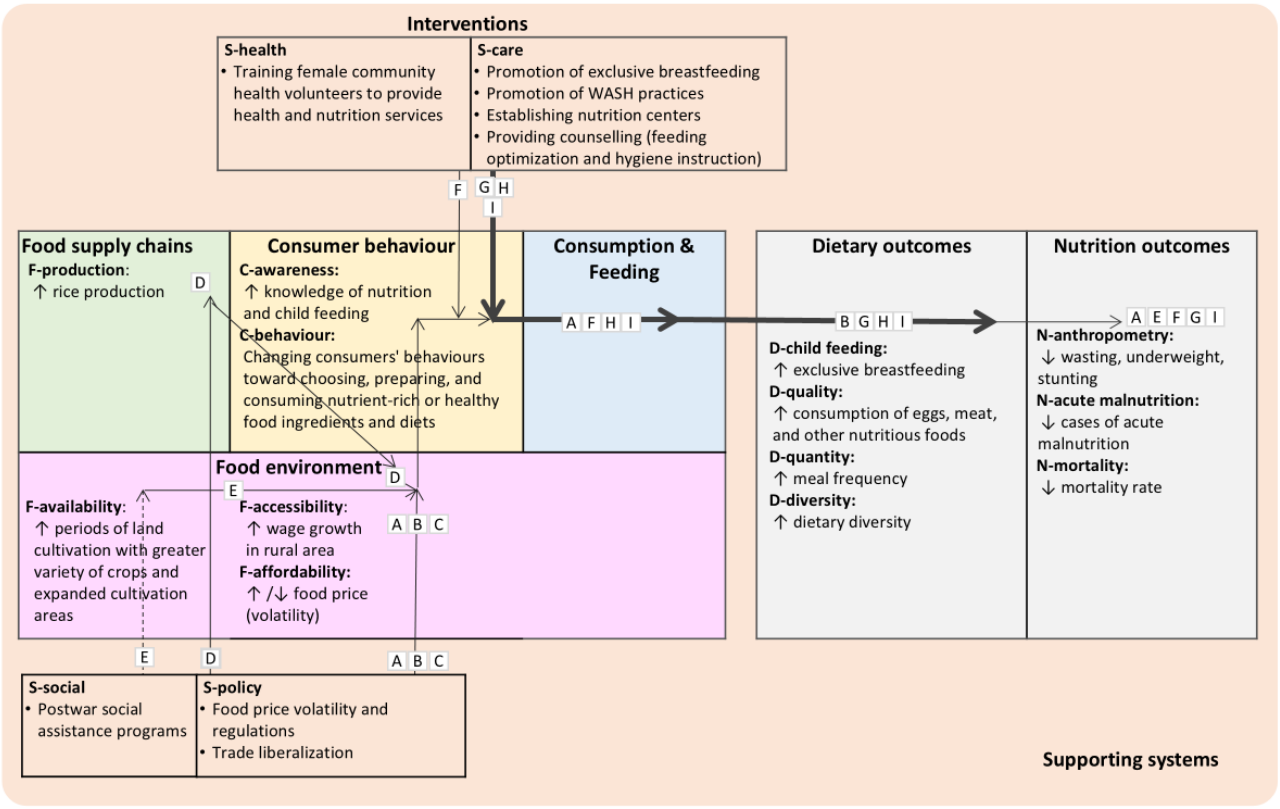



***Figure S5. Impact pathways of interventions with supporting systems.***
Solid arrows represent empirically observed pathways and dashed arrows represent theoretical links between food system components. Bold pathways indicate primary, consistently evidenced impact pathways across studies. Each of the "small boxes" (A to I) represent a cluster of interventions (more detail about these clusters is available upon request to the NRF team). "++": combined with other interventions; IYCF: Infant and young child feeding.

### *Interventions targeting food production and supply chains (pathways Va and Vb)*

Interventions in food production and supply chains contributed to dietary and nutrition outcomes in two distinct but complementary ways:

**Pathway Va (agriculture as a source of food) is focused on increasing the availability and consumption of nutritious foods at household level.** In this pathway, food production and diversification directly improved diets by increasing access to nutrient-rich foods. The most prominent effects were observed through Paths A, B and F, which link production directly to improved child feeding practices and dietary quality. Additional pathways (Paths C and D) operated through farm expansion or market access, indirectly supporting consumption and feeding improvements. Dietary outcomes were consistently improved across these pathways, but measurable nutrition impacts were less frequent and observed only in selected cases (notably Path B) [31–33].

**Pathway Vb (agriculture as a source of income) aims for income generation and market participation**, improving household purchasing power and influencing food choices. In this pathway, Paths G, H, I and K illustrate how income from agricultural activities, often alongside women's empowerment, supported improved quantity and quality of food purchases. These changes translated into dietary improvements and, in some cases, into nutrition gains, including reductions in anaemia and night blindness (Paths F, I and J) [31–33]. Path J further highlights that **nutrition impacts were strongest when production- or income-based interventions were combined with childcare or health-support systems** [32,33] (Figure S6).

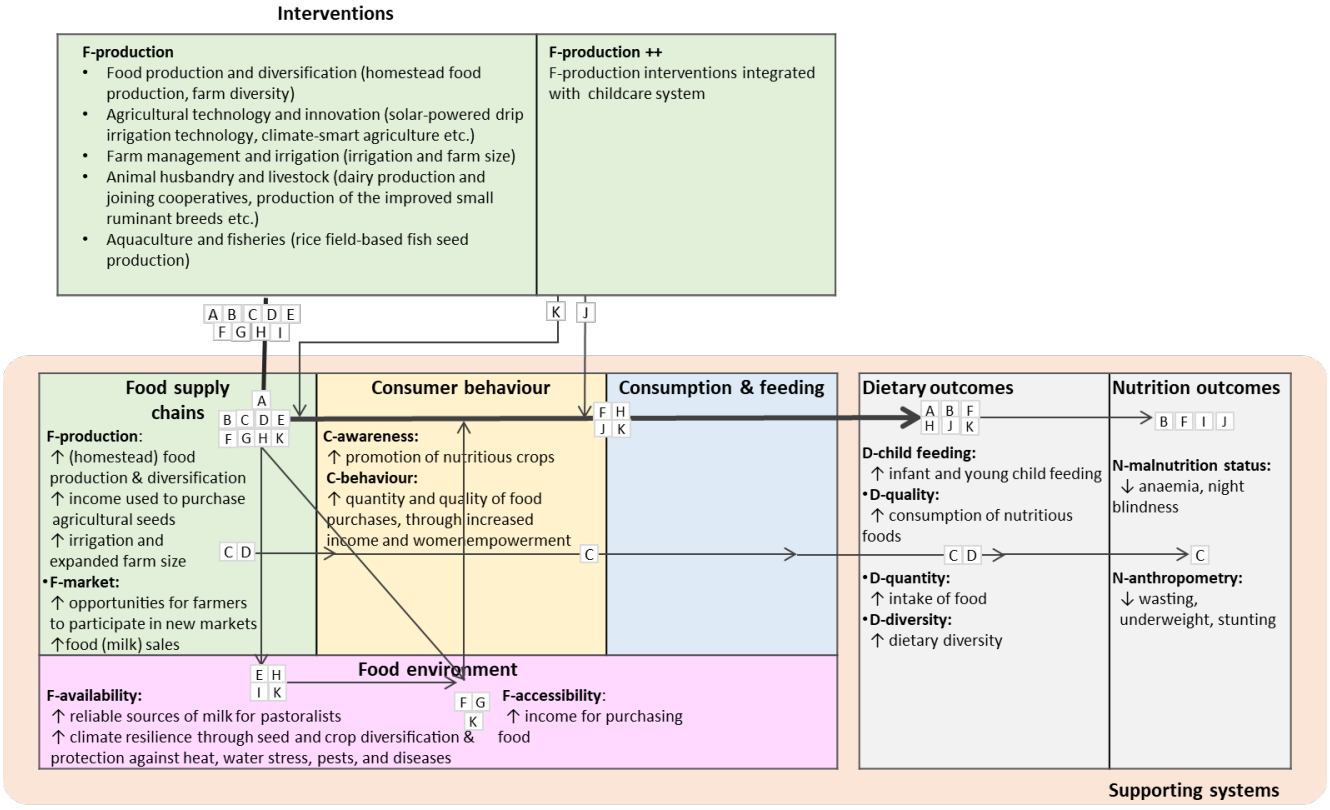



***Figure S6. Impact pathways of interventions targeting food production and supply chains.***
Solid arrows represent empirically observed pathways and dashed arrows represent theoretical links between food system components. Bold pathways indicate primary, consistently evidenced impact pathways across studies. Each of the "small boxes" (A to K) represent a cluster of interventions (more detail about these clusters is available upon request to the NRF team). "++": combined with other interventions; IYCF: Infant and young child feeding.

## Supporting tables

***Table S5a.*** *Summary of impact pathways of different types of nutrition interventions on dietary/nutrition outcomes through food systems, data retrieved from the 87 relevant studies in the 13 review articles.*

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| **D-intake (16):** There are a total of 16 studies specifically focusing on D-intake, with 15 of them showing improved nutrition outcomes. However, none of the studies measured the effects on the food system. The proposed pathways in 4 studies primarily involved increasing physical food accessibility, supporting systems, and enhancing consumer awareness and behaviour. | | | | | | | |
| Shah et al., 2021[11] | Vautier et al., 1999[12] | **D-intake:** • Supplementary feeding (food ration) | I -1 | NA | NA | **N-acute malnutrition** | Conflict |
| Munyuzangabo et al., 2020[19] | Carrara et al., 2017[20] | **D-intake:** • Supplementary feeding (food ration) | I -1 | NA | NA | **N-anthropometry** | Conflict |
| Munyuzangabo et al., 2020[19] | Shrimpton et al., 2009[21] | **D-intake:** • Supplementary feeding (food ration) | I -1 | NA | NA | **N-anthropometry** | Conflict |
| Kim et al., 2020[55] | Morikawa et al., 2013[56] | **D-intake:** • Provide supplementary feeding | I -1 | NA | NA | **N-anthropometry** | Conflict |
| Marshall et al., 2021[78] | Giles et al., 2015[80] | **D-intake:** • Supplementary feeding (food supplements) | I -1 | NA | NA | **N-anthropometry** | Economic crisis |
| Balhara et al., 2017[86] | Amthor et al., 2009[90] | **D-intake:** • Supplementary feeding (RUTF) | I -1 | NA | NA | **N-anthropometry** **N-acute malnutrition** | Food crisis |
| Pradhan et al., 2016[5] Balhara et al., 2017[86] | Rah et al., 2011[7] | **D-intake:** • Supplementary feeding (micronutrient powder) | I -1 | NA | NA | **N-anthropometry** | Natural disaster |
| Balhara et al., 2017[86] | Nackers et al., 2010[89] | **D-intake:** • Supplementary feeding (RUTF, CSB) | I -1 | NA | NA | **N-anthropometry** | Seasonal hunger |
| Bridge et al., 2024[23] | Isanaka et al., 2019[24] | **D-intake:** • Supplementary feeding (RUSF, CSB++, Misola, Locally milled flour mixture) | I -1 | NA | NA | **N-mortality** | SCC-sensitive country |
| Balhara et al., 2017[86] | Grellety et al., 2012[88] | **D-intake:** • Supplementary feeding (RUTF) | I -1 | NA | NA | **N-anthropometry** **N-mortality** | SCC-sensitive country |
| Balhara et al., 2017[86] | Huybregts et al., 2012[91] | **D-intake:** • Supplementary feeding (RUTF, CSB) | I -1 | NA | NA | **N-malnutrition status** **N-anthropometry** | Combination |
| Balhara et al., 2017[86] | Bilukha et al., 2011[92] | **D-intake:** • Supplementary feeding (micronutrient powder) | I -2 | NA | **F-accessibility** **S-health/care** | **N-malnutrition status** **N-anthropometry** | Conflict |
| Marshall et al., 2021[78] Balhara et al., 2017[86] | Lopriore et al., 2004[79] | **D-intake:** • Supplementary feeding (micronutrient-fortified supplements) | I -2 | NA | **F-accessibility** **C-behaviour** **S-health** | **N-malnutrition status** **N-anthropometry** | Conflict |
| Pradhan et al., 2016[5] Marshall et al., 2021[78] Balhara et al., 2017[86] | Dong et al., 2013[6] | **D-intake:** •Supplementary feeding (supplementary foods) | I -2 | NA | **F-accessibility** | **N-malnutrition status** **N-anthropometry** | Natural disaster |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| Balhara et al., 2017[86] | Isanaka et al., 2009[87] | **D-intake:**<br>• Supplementary feeding (RUTF) | I -2 | NA | **F-accessibility**<br>**S-health** | **N-anthropometry** | SCC-sensitive country |
| Munyuzangabo et al., 2020[19] | McGready et al., 2001[22] | **D-intake:**<br>•Supplementary feeding (thiamine hydrochloride, polished rice, fish) | - | NA | **C-awareness** | NA | Conflict |
| **Composite D-intake (D-intake ++) (20):**<br>There are a total of 20 studies involving composite D-intake, with 4 showing improved dietary outcomes and 17 showing improved nutrition outcomes. However, only 2 studies measured the effects on the food system, suggesting that increased consumer awareness mediated the intervention's effects on outcomes. An additional 4 studies proposed that enhanced consumer behaviour mediated the intervention's effects. | | | | | | | |
| Marshall et al., 2021[78] | Magoni et al., 2008[81] | **D-intake + C-awareness:**<br>• Supplementary feeding (micronutrient and food supplement)<br>• Nutrition education:<br>• Conduct health education (feeding practices, development of counselling skills, and problem-solving regarding feeding issues) | I -3 | NA | NA | **N-malnutrition status**<br>**N-anthropometry**<br>**N-acute malnutrition** | Conflict |
| Shah et al., 2021[11]<br>Marshall et al., 2021[78] | Nielsen et al., 2004[13] | **D-intake + S-health:**<br>• Supplementary feeding (micronutrient supplement and flour mixture)<br>• Medical treatment | I -3 | NA | NA | **N-acute malnutrition** | Conflict |
| Shah et al., 2021[11] | Tappis et al., 2012[14] | **D-intake + S-health:**<br>• Supplementary feeding (fortified blended foods, oil, and sugar)<br>• Refer for treatment | I -3 | NA | NA | **N-acute malnutrition** | Conflict |
| Shah et al., 2021[11] | Dureab et al., 2017[15] | **D-intake + S-health:**<br>• Supplementary feeding (therapeutic milks and RUTF)<br>• Hold training courses on SAM management<br>• Provision of maternal education and counselling<br>• Referral for treatment | I -3 | NA | NA | **N-acute malnutrition**<br>**N-mortality** | Conflict |
| Pradhan et al., 2016[5] | US Centers for Disease Control and Prevention, 2012[8] | **D-intake + S-health:**<br>• Supplementary feeding (CSB, vitamin A and oil)<br>• Health education | I -3 | NA | NA | **N-anthropometry** | Natural disaster |
| Bridge et al., 2024[23] | Stewart et al., 2020[27] | **D-intake + S-care:**<br>• Supplementary feeding (LNS)<br>• Standard Madagascan growth monitoring<br>• Nutrition education<br>• Intensive nutrition counselling<br>• Early childhood stimulation and parenting messages | I -3 | NA | NA | **N-malnutrition status** | Economic crisis |
| Bridge et al., 2024[23] | Rajabi et al., 2022[28] | **D-intake + S-care:**<br>• Supplementary feeding (CSB, and super cereal plus) | I -3 | NA | NA | **N-anthropometry**<br>**N-acute malnutrition**<br>**N-mortality** | Economic crisis |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| | | • Provide counselling (feeding optimisation, hygiene instruction, and a cooking demonstration) | | | | | |
| Marshall et al., 2021[78]<br>Balhara et al., 2017[86] | Choudhury et al., 1993[82] | **D-intake + S-care:**<br>• Supplementary feeding (vitamin A supplement)<br>• Implement nutrition education<br>• Train in the preparation of oral rehydration therapy. | I -3 | NA | NA | **N-acute malnutrition** | Natural disaster |
| Bridge et al., 2024[23] | Charle-Cuéllar et al., 2021[26] | **D-intake + S-care:**<br>• Supplementary feeding (RUTF)<br>• Provide supportive supervision for Integrated iCCM.<br>• Implement nutrition-specific supervision. | I -3 | NA | NA | **N-acute malnutrition** | SCC-sensitive country |
| Bridge et al., 2024[23] | Addo et al., 2020[33] | **D-intake + C-awareness + S-care:**<br>• Supplementary feeding (SQ-LNS)<br>• Provide counselling on IYCF.<br>• Implement community-based nutrition education for mothers and pregnant women. | I -3 | NA | NA | **N-malnutrition status**<br>**N-anthropometry** | Conflict |
| Ghodsi et al., 2021[58] | Yousafzai et al., 2014[59] | **D-intake + C-awareness + S-care:**<br>• Enhanced nutrition (nutritional education and micronutrient supplement)<br>• Responsive stimulation training for children | I -3 | NA | NA | **N-anthropometry** | SCC-sensitive country |
| Shah et al., 2021[11] | Hammoud, 2015[16] | **D-intake + S-health + S-care:**<br>• Supplementary feeding (RUSF, RUTF, micronutrients and protein-rich biscuits)<br>• Conduct pediatric consultations<br>• Deliver health education<br>• Refer for treatment | I -3 | NA | NA | **N-acute malnutrition** | Conflict |
| Bridge et al., 2024[23] | Lelijveld et al., 2021[25] | **D-intake + C-awareness + S-health + S-care**<br>• Supplementary feeding (RUTF)<br>• Hold nutrition sessions (IYCF, cooking, WASH, health care seeking, child development)<br>• Attend clinic<br>• Offer nutrition counselling | I -3 | NA | NA | **N-anthropometry**<br>**N-acute malnutrition**<br>**N-mortality** | SCC-sensitive country |
| Bridge et al., 2024[23] | Paul et al., 2012[31] | **D-intake + S-health + S-care:**<br>• Supplementary feeding (LNS)<br>• Improve infant feeding practices<br>• Improve sanitation/hygiene practices | I -4 | NA | NA | **D-child feeding**<br>**D-quality**<br>**D-quantity** | Natural disaster |
| Pega et al., 2015[1] | Langendorf et al., 2014[4] | **D-intake + F-accessibility:**<br>• Supplementary feeding (LNS, Super cereal)<br>• Cash transfer | I -6 | NA | **F-affordability**<br>**C-behaviour** | **N-acute malnutrition**<br>**N-mortality** | Seasonal hunger |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| Balhara et al., 2017[86] | | | | | | | |
| Bridge et al., 2024[23] | Desai et al., 2015[32] | **D-intake + S-health + S-care:**<br>• Supplementary feeding (LNS)<br>• Provide lessons on WASH, IYCF, or a combined approach of WASH + IYCF. | Ⅰ-7 | **C-awareness** | NA | **D-quality**<br>**D-quantity** | SCC-sensitive country |
| Bridge et al., 2024[23] | Locks et al., 2019[30] | **D-intake + S-health + S-care:**<br>• Supplementary feeding (micronutrient and food supplements)<br>• Conduct community- and facility-based counselling (handwashing, SQ-LNS, IYCF practices)<br>• Administer vaccinations | Ⅰ-7 | **C-awareness** | NA | **D-child feeding** | SCC-sensitive country |
| Pradhan et al., 2016[5]<br>Shah et al., 2021[11]<br>Marshall et al., 2021[78] | Jayatissa et al., 2012[9] | **D-intake + S-health:**<br>• Supplementary feeding (RUTF, HEBs, CSB)<br>• Refer for treatment<br>• Provide health staff with a series of training sessions | Ⅰ-8 | NA | **C-behaviour** | **N-acute malnutrition** | Combination |
| Pradhan et al., 2016[5]<br>Marshall et al., 2021[78]<br>Balhara et al., 2017[86] | Kumar et al., 2005[10] | **D-intake + C-awareness + S-care:**<br>Set up Nutrition Care Centers:<br>• Targeted feeding<br>• Nutrition and health education | Ⅰ-8 | NA | **C-behaviour** | **N-anthropometry**<br>**N-acute malnutrition** | Natural disaster |
| Bridge et al., 2024[23] | Maust et al., 2015[29] | **D-intake + S-health + S-care:**<br>• Supplementary feeding (RUTF, nutrient supplements)<br>• Provide insecticide-treated bed net and a package of oral rehydration salts<br>• Nutrition counselling | Ⅰ-8 | NA | **C-behaviour** | **D-child feeding**<br>**N-anthropometry**<br>**N-acute malnutrition** | Conflict |
| **F-accessibility (19):**<br>There are a total of 19 studies specifically focusing on F-accessibility, with 14 studies showing improved dietary outcomes and 7 studies showing improved nutrition outcomes. 12 and 6 studies show that the interventions affected dietary and nutrition outcomes through food environment dimensions (including increasing food availability, food-accessibility, and food affordability) and enhanced consumer awareness and behaviour, respectively. | | | | | | | |
| Ghodsi et al., 2021[58] | Trenouth et al., 2018[62] | **F-accessibility:**<br>•Cash-based interventions (standard cash, double cash and fresh food voucher with cash) | Ⅱ-1 | NA | **F-accessibility**<br>**C-behaviour**<br>**C-awareness** | **N-anthropometry** | SCC-sensitive country |
| Ghodsi et al., 2021[58] | Ghodsi et al., 2018[60] | **F-accessibility:**<br>•Distribute food/voucher/cash transfers to electronic cards | Ⅱ-1 | NA | **F-accessibility**<br>**C-behaviour**<br>**C-awareness** | **N-anthropometry** | SCC-sensitive country |
| van Daalen et al., 2022[41] | Falb et al., 2020[47] | **F-accessibility:**<br>• Unconditional cash transfers | Ⅱ-1 | **F-affordability**<br>**C-behaviour** | **F-affordability**<br>**S-social** | **D-quantity** | Conflict |
| van Daalen et al., 2022[41] | Bliss et al., 2018[44] | **F-accessibility:**<br>•Conditional emergency cash transfer program | Ⅱ-1 | NA | **C-awareness** | **D-quality**<br>**D-quantity**<br>**N-anthropometry**<br>**N-acute malnutrition** | Food crisis |
| van Daalen et al., 2022[41] | Kurdi, 2021[54] | **F-accessibility:** | Ⅱ-1 | **C-behaviour**<br>**C-awareness** | **C-awareness** | **D-diversity**<br>**D-quality** | Conflict |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| | | • Provides monthly cash transfers to households | | | | | |
| van Daalen et al., 2022[41] | Schwab, 2020[52] | **F-accessibility:**<br>• Food or cash transfer | Ⅱ-1 | **C-behaviour** | **C-behaviour** | **D-diversity**<br>**D-quantity** | Combination |
| van Daalen et al., 2022[41] | Hidrobo et al., 2014[49] | **F-accessibility:**<br>• Cash transfers, food vouchers, or food transfers | Ⅱ-2 | NA | **F-market**<br>**C-behaviour**<br>**C-awareness** | **D-diversity**<br>**D-quality**<br>**D-quantity** | Conflict |
| Pega et al., 2015[1] | Aker et al., 2011[2] | **F-accessibility:**<br>• Unconditional Cash Transfer | Ⅱ-2 | **F-production**<br>**F-affordability** | **F-production** | **D-diversity** | Combination |
| van Daalen et al., 2022[41] | Sibson et al., 2018[53] | **F-accessibility:**<br>• Unconditional cash transfers | Ⅱ-3 | **F-accessibility** | NA | **D-diversity**<br>**D-quantity** | Food crisis |
| van Daalen et al., 2022[41] | Hou, 2010[50] | **F-accessibility:**<br>• Conditional cash transfer program | Ⅱ-3 | **F-affordability** | **F-availability** | **D-diversity** | Natural disaster |
| Marshall et al., 2021[78] | Moench-Pfanner et al., 2005[83] | **F-accessibility:**<br>Food for Work:<br>• Provide rice, sometimes combined with oil and/or pinto beans<br>• Increased employment | Ⅱ-4 | **F-affordability** | NA | **N-malnutrition status** | Economic crisis |
| Ghodsi et al., 2021[58] | Fenn et al., 2017[61] | **F-accessibility:**<br>•Cash-based interventions (standard cash, double cash and fresh food voucher with cash) | Ⅱ-4 | NA | **F-accessibility** | **D-diversity**<br>**D-quality**<br>**D-quantity**<br>**N-malnutrition status**<br>**N-anthropometry** | SCC-sensitive country |
| van Daalen et al., 2022[41] | Doocy et al., 2020[45] | **F-accessibility:**<br>•Food provision, food vouchers, and cash transfers | Ⅱ-4 | NA | **F-accessibility** | **D-diversity**<br>**D-quantity**<br>**N-anthropometry** | Food crisis |
| van Daalen et al., 2022[41] | Doocy et al., 2020[46] | **F-accessibility:**<br>•Cash and voucher assistance | Ⅱ-4 | NA | NA | **D-diversity**<br>**D-quantity**<br>**N-anthropometry**<br>**N-acute malnutrition** | Food crisis |
| van Daalen et al., 2022[41] | Aker, 2017[42] | **F-accessibility:**<br>• Cash and voucher transfer | Ⅱ-5 | **F-affordability**<br>**F-accessibility** | **F-other** | **D-diversity**<br>**D-quantity** | Conflict |
| van Daalen et al., 2022[41]<br>Marshall et al., 2021[78] | Grijalva-Eternod et al., 2018[48] | **F-accessibility:**<br>• Transfer monthly unconditional cash.<br>• Distribute once-only a non-food items kit.<br>• Provide piped water free of charge. | Ⅱ-5 | NA | **F-other** | **D-diversity**<br>**D-quality**<br>**D-quantity** | Combination |
| van Daalen et al., 2022[41] | MacPherson et al., 2021[51] | **F-accessibility:**<br>• Income-generating activities<br>• Cash transfers | Ⅱ-6 | **F-availability** | **F-accessibility** | **D-diversity**<br>**D-quality**<br>**D-quantity** | Conflict |
| van Daalen et al., 2022[41] | Bliss et al., 2016[43] | **F-accessibility**:<br>• Cash transfer programmes | - | NA | **F-affordability** | NA | Food crisis |
| Pega et al., 2015[1] | Macours et al., 2012[3] | **F-accessibility:**<br>• Conditional cash transfer | - | **F-affordability** | NA | NA | SCC-sensitive country |
| **Composite F-accessibility (F-accessibility ++) (3):**<br>There are a total of 3 studies involving composite F-accessibility, all of which show improved dietary outcomes, mediated through increased food availability, food accessibility, and enhanced consumer awareness and behaviour. | | | | | | | |
| Rabbani et al., 2020[74] | Dozio et al., 2016[75] | **F-accessibility + S-care:**<br>• Distribution of food vouchers<br>• Cooking demonstration<br>• Sensitisation on child care practices<br>• Psychological support | Ⅱ-7 | NA | **F-accessibility** | **D-diversity**<br>**D-quantity** | Conflict |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| Bridge et al., 2024[23]<br>Marshall et al., 2021[78] | Kurdi et al., 2020[34] | **F-accessibility + C-awareness + S-care:**<br>• Provide monthly cash transfers<br>• Conduct nutrition and health education sessions (training on EBF, complementary feeding, preparing nutritious meals, handwashing practices, treatment of drinking water, and how to treat diarrhea) | Ⅱ-8 | **C-awareness** | NA | **D-child feeding** | Conflict |
| Balhara et al., 2017[86] | Baye et al., 2014[93] | **F-accessibility + S-social:**<br>• Food or cash transfers | Ⅱ-9 | **F-other** | **F-availability**<br>**C-behaviour** | **D-diversity**<br>**D-quality**<br>**D-quantity** | Food crisis |
| **C-awareness (2):**<br>Only 2 studies specifically focus on C-awareness, with 1 study showing improved dietary outcomes and 2 studies showing improved nutrition outcomes, both mediated through increased consumer awareness. | | | | | | | |
| Marshall et al., 2021[78] | Yang et al., 2015[84] | **C-awareness:**<br>• Nutrition education<br>• Concepts in food and nutrition<br>• When and how to add the complementary food<br>• Homemade complementary food<br>• Benefits of breast-feeding preventing common | Ⅲ-1 | **C-awareness** | NA | **D-child feeding**<br>**N-malnutrition status** | Natural disaster |
| Ghodsi et al., 2021[58] | Saleem et al., 2014[63] | **C-awareness:**<br>• Maternal educational messages regarding appropriate complementary feeding | Ⅲ-1 | NA | **C-awareness** | **N-anthropometry** | SCC-sensitive country |
| **Composite C-awareness (C-awareness ++) (6):**<br>There are a total of 6 studies involving composite C-awareness, with 1 demonstrating improved dietary outcomes, showing positive effects on nutrition outcomes, and 2 showing that enhanced consumer awareness and behaviour were the food system components through which the intervention affected the dietary and nutrition outcomes. | | | | | | | |
| Bridge et al., 2024[23]<br>Kim et al., 2020[55] | Mayhew et al., 2014[35] | **C-awareness + S-care:**<br>• Monitor the weights of children<br>• Promote feeding practices | Ⅲ-2 | NA | NA | **N-anthropometry** | Conflict |
| Bridge et al., 2024[23] | Bisimwa et al., 2009[37] | **C-awareness + S-care:**<br>• Launch a public awareness campaign.<br>• Recruit and train community volunteers.<br>• Arrange monthly community weighing sessions. | Ⅲ-2 | NA | NA | **N-anthropometry** | Conflict |
| Dall'Oglio et al., 2020[65] | Mwendwa et al., 2016[66] | **C-awareness + S-care:**<br>• Support and promote appropriate feeding practices<br>• Maternal and IYCF nutrition education | Ⅲ-2 | NA | NA | **N-acute malnutrition**<br>**N-anthropometry** | Conflict |
| Bridge et al., 2024[23] | Ayalew et al., 2021[38] | **C-awareness + S-care:**<br>• Conduct training sessions (cooking demonstrations focused on complementary feeding practices)<br>• Provide individual counselling and support for feeding practices and to demonstrate cooking procedures | Ⅲ-2 | NA | **C-behaviour** | **N-anthropometry** | SCC-sensitive country |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| Bridge et al., 2024[23] | Kim et al., 2019[36] | **C-awareness + S-care:**<br>• Promote nutrition-sensitive agricultural activities.<br>• Conduct interpersonal communication activities focused on IYCF.<br>• Implement a mass media campaign on IYCF practices | Ⅲ-3 | **F-production**<br>**C-awareness** | NA | **D-diversity**<br>**D-quality**<br>**D-quantity**<br>**N-anthropometry** | SCC-sensitive country |
| Kim et al., 2020[55] | Kim et al., 2008[57] | **C-awareness + S-care:**<br>•Provide an electronic picture book to communicate public health messages (micronutrients, WASH, diet, breastfeeding and peripartum care) | - | **C-awareness** | NA | NA | Conflict |
| **S-health/care (19):**<br>There are a total of 19 studies specifically focusing on S-health or care, with 10 demonstrating improvements in dietary outcomes, 8 showing positive effects on nutrition outcomes, and 3 showing that enhanced consumer awareness and behaviour as the intervention impact pathway through food system. | | | | | | | |
| Rabbani et al., 2020[74] | Sallam et al., 2018[104] | **S-health:**<br>• Trained female community health volunteers provide health and nutrition services | Ⅳ-6 | **C-behaviour**<br>**C-awareness** | **C-behaviour** | **N-acute malnutrition** | Conflict |
| Als et al., 2020[17] | Roberts et al., 2001[18] | **S-health:**<br>• Use the improved container for water collection | - | **S-other** | NA | NA | Conflict |
| Balhara et al., 2017[86] | Aakre et al., 2017[94] | **S-care:**<br>•Infant and children feeding practices | Ⅳ-7 | NA | NA | **N-anthropometry** | Conflict |
| Balhara et al., 2017[86] | Hejna et al., 2019[99] | **S-care:**<br>• Diagnosis and treatment of SAM and MAM.<br>• Promotion of WASH practices<br>• Establish nutrition centers | Ⅳ-7 | NA | NA | **N-acute malnutrition** | Conflict |
| Balhara et al., 2017[86] | Jakobsen et al., 2003[96] | **S-care:**<br>•Breast feeding practice | Ⅳ-7 | NA | NA | **N-mortality** | Conflict |
| Balhara et al., 2017[86] | Lung'aho et al., 2009[97] | **S-care:**<br>•Capacity-building for IYCF, mother-to-mother groups, and breastfeeding and young child feeding practices. | Ⅳ-7 | NA | NA | **D-child feeding**<br>**N-acute malnutrition** | Conflict |
| Balhara et al., 2017[86] | International Medical Corps USAID, 2016[95] | **S-care:**<br>•Breast feeding, feeding their children with iron rich and iron fortified food and other interventions | Ⅳ-7 | NA | NA | **N-anthropometry** | SCC-sensitive country |
| Marshall et al., 2021[78] | Rossi et al., 2008[85] | **S-care:**<br>• Establish therapeutic feeding centers<br>•Establish supplementary feeding centers | Ⅳ-7 | NA | **S-health** | **N-acute malnutrition**<br>**N-mortality** | Combination |
| Bridge et al., 2024[23]<br>Marshall et al., 2021[78] | Balaluka et al., 2012[39] | **S-care:**<br>• Promote exclusive breastfeeding | Ⅳ-8 | NA | NA | **D-child feeding** | Conflict |
| Dall'Oglio et al., 2020[65] | UNICEF, 2016[71] | **S-care:**<br>IYCF program:<br>• Education sessions<br>• Counselling and support for lactating mothers at home | Ⅳ-8 | NA | NA | **D-child feeding** | Conflict |

| Review | Original study | Types of intervention | No. of pathway | Effects of interventions on the food system | Proposed theoretical pathway | Dietary and nutrition outcomes | SCC Situation |
|---|---|---|---|---|---|---|---|
| Balhara et al., 2017[86] | Sumanović-Glamuzina, 2013[98] | **S-care:**<br>• Breastfeeding practice | Ⅳ-8 | NA | NA | **D-child feeding** | Conflict |
| Rabbani et al., 2020[74] | Ndungu et al., 2017[77] | **S-care:**<br>• IYCF practices<br>• Behaviour-change services | Ⅳ-8 | NA | NA | **D-diversity**<br>**D-quantity** | Conflict |
| Dall'Oglio et al., 2020[65] | Assefa et al., 2008[67] | **S-care:**<br>• Active support for breastfeeding | Ⅳ-8 | NA | NA | **D-child feeding** | Natural disaster |
| Dall'Oglio et al., 2020[65] | Castillo et al., 2016[68] | **S-care:**<br>• Breastfeeding support<br>• Kangaroo mother care<br>• IYCF<br>• Postnatal care of mothers and newborns | Ⅳ-8 | NA | NA | **D-child feeding** | Natural disaster |
| Dall'Oglio et al., 2020[65] | Ayoya et al., 2013[69] | **S-care:**<br>• Provide tents to offer a safe place for mothers to breastfeed | Ⅳ-8 | NA | NA | **D-child feeding** | Natural disaster |
| Bridge et al., 2024[23] | Worku et al., 2020[40] | **S-care:**<br>• Enhance community-based nutrition (focus on IYCF)<br>• Familiarise with nutrition-sensitive agriculture. | Ⅳ-8 | NA | **C-behaviour**<br>**C-awareness** | **D-diversity** | SCC-sensitive country |
| Ghodsi et al., 2021[58] | Zaman et al., 2008[64] | **S-care:**<br>•Training health workers (how to counsel the mother) | Ⅳ-9 | **C-awareness** | **C-behaviour** | **D-quality**<br>**D-child feeding**<br>**N-anthropometry** | SCC-sensitive country |
| Dall'Oglio et al., 2020[65] | UNICEF, 2016[70] | **S-care:**<br>• Promote breastfeeding and IYCF | - | **C-awareness** | NA | NA | Conflict |
| Dall'Oglio et al., 2020[65] | UNICEF, 2016[72] | **S-care:**<br>• IYCF training for pregnant and lactating woman<br>• Mother support groups<br>• One-to-one counselling sessions | - | **C-awareness** | NA | NA | Natural disaster |
| **Composite S-health/care/social/others (2):**<br>There are a total of 2 studies involving composite S-health/care/social/others, with 1 showing improved nutrition outcome and the other demonstrating enhanced consumer awareness. | | | | | | | |
| Balhara et al., 2017[86] | Brentlinger et al., 1999[100] | **S-social + S-others:**<br>• Postwar social and economic assistance programmes | Ⅳ-5 | NA | **F-availability** | **N-anthropometry** | Conflict |
| Dall'Oglio et al., 2020[65] | Fänder et al., 2015[73] | **S-health + S-care:**<br>• Breastfeeding counselling<br>• IYCF training to health staff<br>• Community volunteers training<br>• Refugee education on IYCF practices and support group | Ⅳ-6 | **C-awareness** | NA | NA | Conflict |

**Legend:** In the columns "Types of interventions" and "Dietary and nutrition outcomes", abbreviations correspond to subcomponents of the analytical food systems framework (Table S1): F-: subcomponents of Food supply chains and Food environment; C-: subcomponents of Consumer behaviour; D-: subcomponents of Dietary outcomes; S-: subcomponents of Supporting systems; N-: subcomponents of Nutrition and health outcomes. "NA" indicates that no direct food system mechanism was measured or reported. "SCC situation" refers to the type of shock, conflict or crisis context.
**Note:** Reference numbers in this table refer to the original studies included in the systematic review (available here; link to be added upon publication @ NRF repository) and do not correspond to the main reference list.

***Table S5b.*** *Summary of impact pathways of different types of nutrition interventions on dietary/nutrition outcomes through food systems, data retrieved from the 71 interventions discussed in the 3 additional review articles.*

| Types of intervention | No. of pathway | Effects of interventions on food system | Dietary and nutrition outcomes |
|---|---|---|---|
| **Review #1: Yosef et al., 2015 (SCC-sensitive country)** [101] | | | |
| **Agriculture as a Source of Food** | | | |
| **F-production:**<br>• Ricefield-based fish seed production (1) | Ⅴ-1 | NA | **D-quality (1)**<br>**D-quantity (1)** |
| **F-production:**<br>• Large-scale, crop-diversification project (1) | Ⅴ-1 | **F-production (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **F-production:**<br>• Crop production & diversification (1) | Ⅴ-1 | **F-production (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **F-production:**<br>• Homestead food production model (1) | Ⅴ-2 | NA | **D-quality (1)**<br>**D-quantity (1)**<br>**N-malnutrition status (1)** |
| **F-production:**<br>• Vegetable production programme (1) | Ⅴ-2 | NA | **D-quality (1)**<br>**D-quantity (1)**<br>**N-anthropometry (1)** |
| **F-production + C-awareness:**<br>• Nutrition education and seed distribution project (1) | Ⅴ-10 | NA | **D-quality (1)**<br>**D-quantity (1)**<br>**N-malnutrition status (1)** |
| **Agriculture as a source of income for food and non-food expenditures** | | | |
| **F-accessibility:**<br>• Agricultural employment for household income (2) | Ⅱ-1 | **F-affordability (1)**<br>**C-behaviour (1)** | **D-diversity (1)**<br>**N-anthropometry (1)** |
| **F-production:**<br>• Integrate fish and vegetable production into aquaculture systems (1) | Ⅴ-6 | **F-accessibility (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **F-production:**<br>• Backyard poultry raising (1) | Ⅴ-6 | **F-accessibility (1)**<br>**F-production (1)**<br>**C-behaviour (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **F-production + F-other:**<br>• Farmer training and dissemination of low-cost aquaculture technologies (1) | Ⅴ-11 | **F-production (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **Agriculture policy and food prices affecting food consumption** | | | |
| **F-accessibility + S-policy:**<br>• Bangladesh's targeted food programmes (1) | Ⅱ-7 | **F-accessibility (1)** | **D-quantity (1)** |
| **S-policy:**<br>• Rice expenditure (1) | Ⅳ-1 | **F-affordability (1)**<br>**C-behaviour (1)** | **D-diversity (1)**<br>**N-anthropometry (1)** |
| **S-policy:**<br>• Food price volatility (1) | Ⅳ-2 | **F-affordability (1)** | **D-quantity (1)** |
| **S-policy:**<br>• Trade liberalisation (1) | Ⅳ-4 | **F-production (1)**<br>**F-affordability (1)** | NA |
| **Women empowerment in intrahousehold decision making and resource allocation for health and nutrition** | | | |
| **F-production + C-awareness:**<br>• Vegetable gardens and nutrition education (1) | Ⅴ-10 | **C-behaviour (1)** | **D-quantity (1)**<br>**N-malnutrition status (1)** |
| **F-production + C-awareness:**<br>• Women's empowerment/ training in using agricultural technologies (1) | Ⅴ-10 | **C-behaviour (1)** | **N-anthropometry (1)** |
| **F-production + C-awareness:**<br>• Women empowerment/ training in horticultural programmes (1) | Ⅴ-11 | **F-production (1)**<br>**C-behaviour (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **Female employment in agriculture in relation to child care and feeding** | | | |
| **F-other:**<br>• Mothers serving as agricultural workers (1) | - | NA | **D-child feeding** [b] **(1)** |

| Types of intervention | No. of pathway | Effects of interventions on food system | Dietary and nutrition outcomes |
|---|---|---|---|
| **Women in agriculture and maternal nutrition and health status and agriculture-associated health hazards** | | | |
| **D-intake + F-other + S-health:**<br>• Iron supplementation and anthelmintic treatments provided to female tea pluckers (1) | Ⅰ-5 | **F-production (1)** | NA |
| **F-other:**<br>• Mothers serving as pluckers in tea plantations (1) | Ⅱ-6 | NA | **D-quantity (1)** |
| **Review #2: Kadiyala et al., 2014 (SCC-sensitive country)** [102] | | | |
| **Agriculture as a source of food** | | | |
| **F-production:**<br>• Crop production & diversification (1) | Ⅴ-1 | **F-production (1)** | **D-diversity (1)** |
| **F-production:**<br>• Irrigation and farm size (1) | Ⅴ-1 | **F-production (1)** | **D-diversity (1)** |
| **F-production:**<br>• Cow and buffalo production & ownership (3) | Ⅴ-1 | **F-production (3)** | **D-quality (3)**<br>**D-quantity (3)** |
| **F-production:**<br>• Crop production & diversity (1) | Ⅴ-2 | NA | **D-diversity (1)**<br>**N-anthropometry (1)** |
| **F-production:**<br>• Dairy production and joining cooperatives (1) | Ⅴ-4 | **F-production (1)**<br>**F-market (1)** | **D-quality (1)** |
| **Agriculture as a source of income** | | | |
| **F-accessibility:**<br>• Income from agricultural activities (5) | Ⅱ-3 | **F-accessibility (5)** | **D-diversity (2)**<br>**D-quantity (3)** |
| **Agriculture policy including food prices** | | | |
| **S-policy:**<br>• Rice or wheat prices (1) | Ⅳ-3 | **F-accessibility (1)**<br>**F-affordability (1)** | NA |
| **S-policy:**<br>• Rice or wheat prices (2) | - | **F-affordability (2)** | **D-quality** [b] **(1)**<br>**D-quantity** [b] **(1)** |
| **S-policy:**<br>• Coarse grain prices (1) | - | **F-accessibility** [a] **(1)** | **D-quantity** [a] **(1)** |
| **S-policy:**<br>• Trade liberalisation (2) | - | **F-affordability** [b] **(1)** | **D-quantity** [b] **(1)** |
| **Women empowerment in intrahousehold decision making and resource allocation for health and nutrition** | | | |
| **C-behaviour:**<br>• Women empowerment (2) | Ⅲ-1 | **C-behaviour (2)** | **D-diversity (1)**<br>**N-malnutrition status (1)** |
| **Maternal employment in agriculture in relation to child care and feeding** | | | |
| **F-other:**<br>• Mothers engaged in agricultural activities (2) | - | **C-behaviour** [b] **(1)** | **N-acute malnutrition** [b] **(1)** |
| **Women employment in agriculture in relation to energy expenditure and maternal nutrition and health status** | | | |
| **F-other:**<br>• Women engaged in agricultural activities (1) | - | **C-behaviour** [a] **(1)** | **D-quantity** [b] **(1)**<br>**N-anthropometry** [a] **(1)** |
| **F-other:**<br>• Women employment in agriculture (1) | - | **C-behaviour** [b] **(1)** | **N-anthropometry** [b] **(1)** |
| **Review #3: Bakker et al., 2021 (Climate change)** [103] | | | |
| **Resilient livestock breeds for animal-source foods** | | | |
| **F-production:**<br>• Production of the improved small ruminant breeds (1) | Ⅴ-3 | **F-production (1)**<br>**F-market (1)**<br>**C-behaviour (1)** | **D-quality (1)**<br>**D-quantity (1)**<br>**N-malnutrition status (1)** |
| **F-production:**<br>• Camel management (as an adaptation strategy to climate change) (2) | Ⅴ-5 | **F-production (1)**<br>**F-availability (1)** | NA |

| Types of intervention | No. of pathway | Effects of interventions on food system | Dietary and nutrition outcomes |
|---|---|---|---|
| **Biofortification (richer in essential micronutrients than traditional varieties)** | | | |
| **F-production:**<br>• Biofortification programmes (4) | Ⅴ-6 | **F-production (3)**<br>**F-accessibility (1)** | **D-quality (1)**<br>**N-malnutrition status (1)** |
| **Use of climate change adaptation to minimise nutrient loss at production stage** | | | |
| **F-production:**<br>• Climate-smart agriculture (an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change) (1) | Ⅴ-7 | **F-production (1)**<br>**F-accessibility (1)** | NA |
| **Conservation agriculture** | | | |
| **F-production + C-awareness:**<br>• Nutrition-sensitive conservation agriculture (2) | Ⅴ-11 | **F-production (1)**<br>**F-availability (1)**<br>**F-accessibility (1)**<br>**C-awareness (1)** | **D-quality (1)**<br>**D-quantity (1)**<br>**D-child feeding (1)** |
| **Crop and livestock diversification** | | | |
| **F-production:**<br>• Farm diversity (6) | Ⅴ-8 | **F-production (1)**<br>**F-availability (5)** | **D-diversity (1)** |
| **F-production:**<br>• Seed and voucher fairs (1) | Ⅴ-9 | **F-availability (1)** | **N-malnutrition status (1)** |
| **Irrigation addressing water shortage and dietary diversity** | | | |
| **F-production:**<br>• Solar-powered drip irrigation technology (1) | Ⅴ-8 | **F- availability (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **Nutrition-sensitive agriculture** | | | |
| **F-production:**<br>• Livestock ownership (1) | Ⅴ-1 | **F-production (1)** | **D-quality (1)**<br>**D-quantity (1)** |
| **F-production + C-awareness:**<br>• Nutrition-sensitive agriculture (1) | Ⅴ-10 | NA | **D-quality (1)**<br>**D-quantity (1)**<br>**D-diversity (1)**<br>**N-malnutrition status (1)** |
| **F-production + C-awareness:**<br>• Women's empowerment (1) | Ⅴ-11 | **F-production (1)** | **D-diversity (1)** |
| **Reducing food waste and losses along the value chain** | | | |
| **F-waste:**<br>• Reducing post-harvest losses and food waste (2) | - | **F-availability (2)** | NA |
| **F-waste:**<br>• Targeting women in campaigns to reduce food loss and waste (1) | - | **F-waste (1)** | NA |
| **Social protection** | | | |
| **F-accessibility:**<br>• Cash transfer (1) | Ⅱ-3 | NA | **D-quantity (1)** |

**Legend:** In the columns "Types of intervention" and "Dietary and nutrition outcomes", abbreviations correspond to subcomponents of the analytical food systems framework (Table S1): F-: subcomponents of Food supply chains (production, processing, market, waste) and Food environment (availability, accessibility, affordability, utilisation and related dimensions); C-: subcomponents of Consumer behaviour (behaviour, preferences, awareness); D-: subcomponents of Dietary outcomes (quality, quantity, diversity, child feeding); S-: subcomponents of Supporting systems (social protection, health, childcare, policy, governance and enabling systems); N-: subcomponents of Nutrition and health outcomes (malnutrition status, anthropometry, acute malnutrition, mortality).

In the column "No. of pathway", Roman numerals indicate the stage of the food system at which the intervention operates: Ⅰ: consumption-stage interventions; Ⅱ: food environment interventions (accessibility, affordability and related dimensions); Ⅲ: consumer awareness and behaviour interventions; Ⅳ: supporting systems interventions; Ⅴ: food production-stage interventions. The accompanying number identifies the specific pathway within each category.

"NA" indicates that no direct food system mechanism was measured or reported; "SCC-sensitive country" refers to contexts characterised by shocks, conflicts or crises.

Superscripts [a] and [b] indicate, respectively, no positive effect and negative effect.

Abbreviations: CSB = corn–soya blend; HEB = high-energy biscuits; iCCM = integrated community case management; IYCF = infant and young child feeding; LNS = lipid-based nutrient supplement; MAM = moderate acute malnutrition; RUSF = ready-to-use supplementary food; RUTF = ready-to-use therapeutic food; SAM = severe acute malnutrition; WASH = water, sanitation and hygiene.