frontiers in Sustainable Food Systems

TYPE Review
PUBLISHED 16 June 2026
DOI 10.3389/fsufs.2026.1818978

OPEN ACCESS

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RECEIVED 27 February 2026
REVISED 20 May 2026
ACCEPTED 30 May 2026
PUBLISHED 16 June 2026

CITATION
Mazzocchi A, Sinarinzi P, Agostoni C and Berti C (2026) Sustainable complementary feeding in low-resource countries: bridging global recommendations and local food systems.
Front. Sustain. Food Syst. 10:1818978.
doi: 10.3389/fsufs.2026.1818978

Sustainable complementary feeding in low-resource countries: bridging global recommendations and local food systems

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Complementary feeding is a critical window for child growth and long-term health. Yet, practices remain suboptimal in many low-resource settings, where undernutrition and food insecurity are prevalent and pose a significant threat to child survival and well-being. This narrative review examines the key barriers to adequate complementary feeding and explores feasible, sustainable strategies to improve its quality, with particular attention to locally available food resources. Major constraints to adherence to global complementary feeding recommendations include structural poverty; fragile agro-food and health systems; weak enabling environments; limited caregiver time, resources, and knowledge; and established socio-cultural norms. In alignment with global commitments to nutrition and climate action, sustainable complementary feeding approaches that prioritize locally produced, nutrient-dense, and safe foods offer a promising pathway to enhance nutrition while strengthening local economies and community resilience. Emerging evidence, including intervention studies, across several low-resource countries indicates that strategic combinations of traditional, affordable food resources, such as indigenous crops, insects, and products from small-scale fisheries, together with appropriate processing techniques, can improve the nutritional adequacy and acceptability of complementary foods. These approaches have demonstrated potential to support optimal growth and overall health outcomes in children aged 6–23 months. Context-sensitive, culturally aligned, and community-centered interventions, integrated with caregiver education and supported by coordinated, multisectoral, and holistic strategies, are more likely to achieve lasting and equitable improvements in child nutrition and food system resilience.

KEYWORDS
acceptability, complementary feeding, food insecurity, local food, low-resource setting, nutritional quality, pediatric malnutrition, sustainability

1 Introduction

Complementary feeding (CF) refers to the gradual transition from an exclusive milk-based diet (breast milk or formula), which becomes insufficient to meet the infant's increasing nutritional requirements, to the introduction of additional foods and liquids that ensure adequate growth and development (Capra et al., 2024). CF is important not only from a nutritional perspective, in terms of meeting dietary needs, but also for child's neuromotor development and early taste experiences, shaping healthy dietary patterns that can last throughout life (Campoy et al., 2018).

Global guidelines and indicators for optimal infant and young child feeding (IYCF) have been established to promote healthy growth, development, and behavior in children under 2 years of age (WHO, 2023; WHO and UNICEF, 2021). As shown in Figure 1, key recommendations emphasize introducing proper soft, semi-solid, and solid foods at 6 months, consuming a diverse diet, and eating meals at an adequate frequency and variety, encouraging the intake of minimally processed nutrient-dense foods while limiting those high in salt and sugars.

In an ideal situation characterized by good health conditions, economic stability, and environmental richness, including biodiversity and fertile land, a child should be exclusively breastfed for the first 6 months of life and then introduced to other foods through a parental approach guided by the principles of dietary diversity and responsive feeding (Figure 1). However, in certain regions of the world with high risk exposure and limited institutional and social coping capacity, economic and environmental instability, along with poor access to education and healthcare, undermine food security. As a result, severe forms of undernutrition remain widespread, particularly among children under 5 years of age (under-5 s). Globally, 150.2 million under-5 s are stunted (23.2%), and 42.8 million (6.6%) are wasting, including 12.2 million with severe form (UNICEF, WHO, and World Bank, 2025). Children aged 0–4 years also burden the highest rates of major nutritional deficiencies, including protein–energy malnutrition, vitamin A deficiency, iodine deficiency, and dietary iron deficiency (Liu et al., 2025). Childhood undernutrition is concentrated in low-resource regions, particularly across African and Asian sub-regions (UNICEF, WHO, and World Bank, 2025; Liu et al., 2025). Stunting and wasting, along with undernourishment (insufficient caloric intake) and mortality (the mortality rate of under-5 s), are key indicators used to assess the nature and severity of hunger at global, regional, and national levels. These components are combined into a composite measure known as the Global Hunger Index, which in 2025, identified alarming levels in seven countries (i.e., Burundi, the Democratic Republic of the Congo, Haiti, Madagascar, Somalia, South Sudan, and Yemen), and serious levels in 35 others, mainly in Sub-Saharan Africa and South Asia (Concern Worldwide and Welthungerhilfe, 2025).

1.1 IYCF practices across low-resource countries

Recent global estimates indicate that suboptimal CF practices among children are widespread in low-resource countries, with many children aged 6–23 months not meeting recommended IYCF standards (Table 1).

Over half of under-5 s live in food poverty, lacking access to diverse and nutritious diets that include at least five of the eight essential food groups, with 27% experiencing severe child food poverty, that is consuming only 0–2 food groups daily (UNICEF, 2024). Alarmingly, surveys from 92 low- and middle-income countries (LMICs) (from 2010 to 2022) estimated that 14 million (10.4%) children aged 6–23 months received no animal milk, formula, or complementary food in the previous 24 h, with the highest prevalence in South Asia

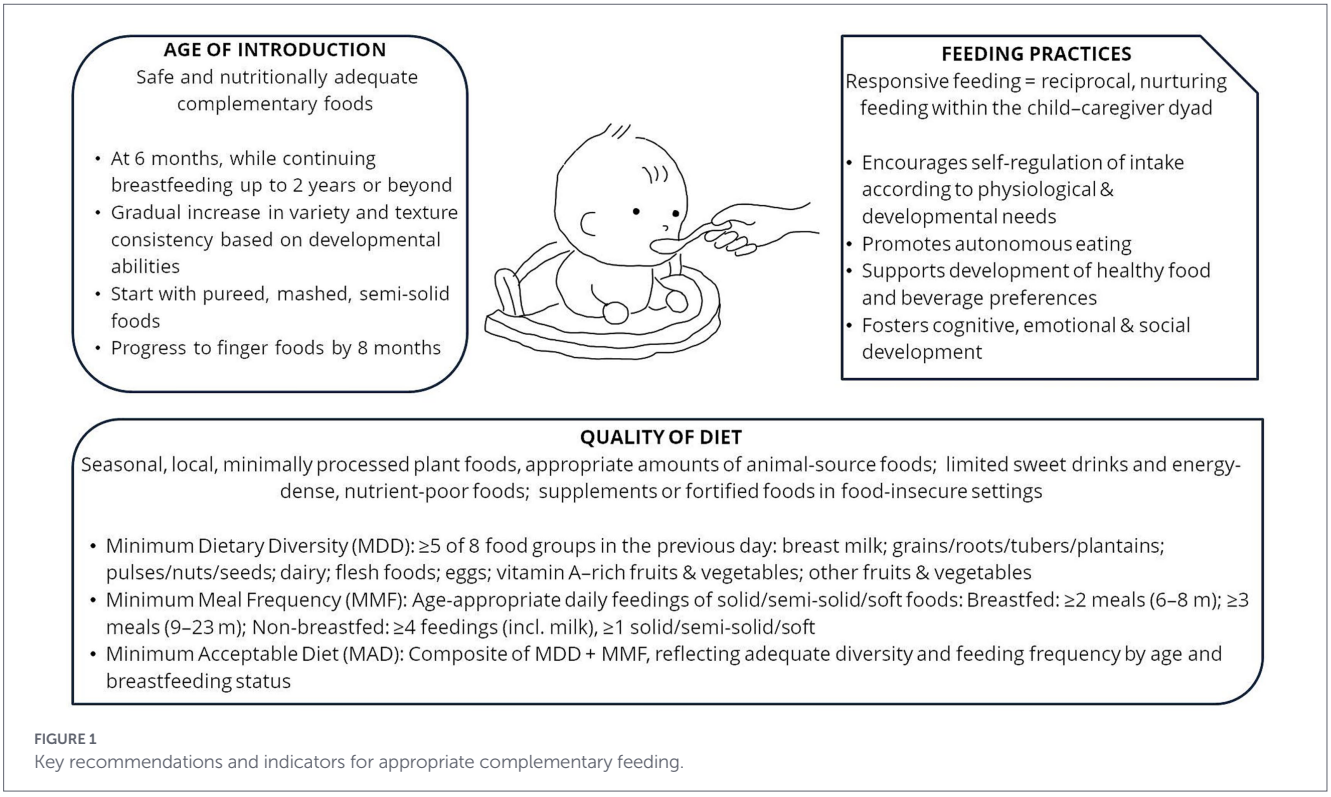

FIGURE 1
Key recommendations and indicators for appropriate complementary feeding.

TABLE 1 Global indicators and metrics relating to complementary feeding practices and diet quality among children aged 6–23 months.

Issue/indicator	Key global or regional findings	Source
Timely introduction of solid, semi-solid, and soft foods (6–8 months)	Pooled analyses from household surveys (from 101 countries; 2010–2016; UNICEF global database) indicated that approximately one in three infants are introduced to complementary foods either before 6 months or at 6–8 months, deviating from WHO recommendations. Highest rates of early introduction in Latin America & the Caribbean and in East Asia & the Pacific.	White et al. (2017)
Minimum acceptable diet (MAD), minimum dietary diversity (MDD), and minimum meal frequency (MMF)	Surveys from 80 low- and middle-income countries (LMICs) (2010–2019) showed that only 8 countries achieved ≥50% MAD, 17 achieved ≥50% MDD, and 45 achieved ≥50% MMF. One in four children consumed a sufficiently diverse diet and one in two received the recommended number of meals. Lowest prevalence in Western & Central Africa, followed by South Asia and Eastern & Southern Africa.	Gatica-Domínguez et al. (2021)
Child food poverty	In 2024, 440 million children (two in three children; 66% total) under five experienced child food poverty globally, encompassing 181 million (more than one in four; 27% total) experiencing severe child food poverty. Over 70% on breast milk and/or starchy staples, with very limited intake of nutrient-rich foods such as eggs, fish, poultry, meat, pulses, nuts, fruits, and vegetables More than 60% lived in South Asia and sub-Saharan Africa.	UNICEF (2024)
Fruit and vegetable consumption	Demographic and Health Surveys from 64 LMICs (2006–2020) found that 45.7% of children aged 6–23 months consumed no fruits or vegetables in the previous 24 h. Highest prevalence in West & Central Africa.	Allen et al. (2023)
Animal-source food consumption	Between 2014 and 2019, fewer than 50% of children aged 6–23 months in 73 LMICs consume any animal-source food on the previous day, with lowest prevalence in sub-Saharan Africa and South Asia.	WHO (2023)

and West and Central Africa (Karlsson et al., 2024). In these regions, CF typically relies on starchy staples, with limited consumption of nutrient-dense foods such as animal products, fruits, vegetables. Complementary foods are mostly homemade due to the high cost of commercial products, and are based on locally available staples, dominated by bulky, starchy foods with low nutrient density and poor-quality protein, primarily cereals, roots, and tubers such as maize, teff, rice, wheat, sorghum, millet, and cassava (Gudeta et al., 2021; Sirkka et al., 2022; Ngadze et al., 2023; Tura et al., 2025). Concurrently, a significant proportion of children, particularly in Indonesia and India, are consuming energy-dense/nutrient-poor snacks and sugary drinks during the CF period (Sirkka et al., 2022).

In these countries, the early introduction of foods and liquids other than breast milk prior to 6 months of age is prevalent, which not only increases the risk of nutritional deficiencies but also heightens susceptibility to infections, such as diarrhea, due to suboptimal hygiene and food safety conditions. In addition, low dietary diversity is associated with a higher risk of anemia among children aged 0–5 years (Li et al., 2025). These factors exacerbate weight loss and malnutrition, and impaired physical and cognitive development (White et al., 2017; UNICEF, 2022), in association with the immaturity of the renal, gastrointestinal, and neurodevelopmental systems (Ikobah et al., 2023; Makhavhu et al., 2025). Therefore, CF in these settings fail to meet nutritional needs not only in terms of quality (frequency and diversity) but also in terms of timeliness.

2 Objectives and methods

Within international commitments on nutrition and climate action, including the Sustainable Development Goals (SDGs) and climate adaptation agendas, adopting a sustainable approach based on locally produced, nutritious, and safe foods is recommended as a key part of the solution to improve young child nutrition, while also strengthening local economies and fostering greater independence and empowerment within these communities (Hollis et al., 2021; Kunlere, 2025). This perspective was reflected in the Regional Dialogue held in Dakar (December 1–3, 2024), which addressed the nutritional needs of 64 million African children by promoting stronger local food systems, improved regulatory frameworks, expanded access to finance for local producers, and greater consumer trust in regional brands. These priorities directly informed the 2025 Nutrition for Growth Summit in Paris (March 27–28, 2025), where governments and partners pledged a record $27.5–$30.5 billion to fight malnutrition, emphasized nutrition as a cross-cutting development priority linked to health, climate, and gender equality, and reinforced accountability through a shared monitoring framework, outlining a global roadmap to scale up sustainable and nutritious local food solutions.

Accordingly, this narrative review explores critical issues related to CF in low-resource countries, with the overall goal of improving this process in terms of nutritional adequacy, health outcomes, and sustainability. Specifically, it aims to (1) identify the main barriers hindering the adoption of adequate CF practices; (2) examine studies assessing the nutritional potential of locally available ingredients; and (3) discuss key evidence from intervention studies targeting the CF period. By doing this, the manuscript intends to provide all the stakeholders with actionable insights and help shape future CF-focused research agendas and policies. The review addresses the following questions: What are the major obstacles to optimal CF? What feasible and acceptable interventions can enhance CF to help ensure children rights to healthy, sustainable, and equitable nutrition?

A literature search was conducted across major bibliographic databases (e.g., PubMed, Scopus, and Google Scholar) and the keywords used included: "local food," "traditional foods," "indigenous foods," "sustainable diet," "complementary feeding," "complementary feeding practices", "infant and young child feeding", "IYCF", "fragile countries", "low- and middle-income countries" and "low-resource countries." Studies conducted in LMICs were included, while those focused on emergency contexts were excluded, such as climate-induced events (e.g., earthquakes, drought, floods, hurricanes) or conflict-related crisis settings, since these situations require

rapid-response approaches aimed at addressing immediate critical needs. The search was limited to articles published in English up to February 2026.

3 Results and discussion

3.1 Determinants and barriers to optimal CF in low-resource settings

CF practices in low-resource countries are influenced by interconnected structural, economic, sociocultural, and food system constraints that collectively limit the feasibility of meeting global recommendations (Abdullahi et al., 2021). Table 2 summarizes evidence on factors influencing CF practices. Economic vulnerability remains a pervasive underlying driver. Limited household resources restrict access to diverse and nutrient-dense foods (Asare et al., 2022), while food prices, seasonal scarcity, and market instability further narrow dietary options, reinforcing reliance on low-cost staples and monotonous diets (Paro et al., 2025; Osendarp et al., 2016). Food system fragility compounds household-level constraints. Disrupted supply chains, weak market integration, and seasonal variability in local food availability reduce consistent access to fruits, vegetables, and animal-source foods. Although subsistence agriculture and home food production may partially buffer market dependence, unequal access to land, water, and agricultural inputs limits the reach of these strategies, particularly for the poorest households (Shrestha et al., 2025; Issahaku et al., 2023). Sociocultural contexts shape feeding decisions through shared norms, beliefs, and expectations around appropriate foods, textures, and timing of introduction. Diets that align with local and familiar culinary traditions and taste preferences are more

TABLE 2 Determinants and barriers influencing complementary feeding (CF) practices in low-resource countries settings.

Determinant/ barrier	Evidence
Economic Constraints and Food Affordability	Limited financial resources constrain caregivers' ability to procure diverse foods, particularly animal-source foods, which are consistently associated with improved linear growth and micronutrient adequacy among children aged 6–23 months (Asare et al., 2022). In many fragile and low-resource settings, animal-source foods remain inaccessible due to high cost, seasonal scarcity, and market instability (Paro et al., 2025). Complementary diets are frequently dominated by low-cost staple cereals and roots, with limited inclusion of nutrient-dense ingredients. Children from the poorest households are 2 times less likely to meet minimum dietary diversity compared with those from the wealthiest households (White et 2017). Even when locally available foods are used and diets are optimized, important micronutrient gaps, especially iron and zinc often persist, reflecting biological and compositional limitations of many traditional diets (Osendarp et al., 2016; Tura et al., 2025).
Food System Constraints and Availability of Diverse Foods	Low-resource settings commonly experience disrupted supply chains, limited local production capacity, poor market integration, and high seasonal variability in food availability (Rojas-Reyes et al., 2024). Evidence from rural and vulnerable populations indicates that households dependent on subsistence agriculture frequently experience cyclical food shortages, with pronounced declines in dietary diversity during lean seasons (Shrestha et al., 2025; Issahaku et al., 2023). Although home food production may reduce reliance on markets, access to land, water, agricultural inputs, and labor is highly unequal. Households headed by women, those affected by disability, and the poorest families are often least able to benefit from food production opportunities, reinforcing existing inequities in diet quality (Shrestha et al., 2025; Issahaku et al., 2023).
Sociocultural Norms, Acceptability, and Food Beliefs	Cultural and traditional beliefs, customs, social expectations, and religious practices influence caregivers' CF choices (Makwela and Mashaba, 2025). Qualitative evidence from indigenous and marginalized populations indicates that complementary foods are often introduced early based on perceived breastmilk insufficiency or infant interest in family foods or social pressure (Vera-Becerra et al., 2024; Tapera et al., 2017; Makwela and Mashaba, 2025). Acceptability is further shaped by taste preferences, ease of preparation, and familiarity. Foods that align with local culinary traditions are more likely to be adopted and sustained, whereas unfamiliar or culturally incongruent foods may be rejected regardless of nutritional value. Studies of locally formulated complementary foods using indigenous ingredients demonstrate that sensory acceptability and cultural familiarity are critical determinants of consistent use (Affonfere et al., 2021; Houngbédji et al., 2025).
Caregiver Workload, Gender Roles, and Time Constraints	In low-resource settings, women typically shoulder primary responsibility for childcare alongside agricultural labor, household tasks, and income-generating activities. Time-intensive food preparation practices may therefore be impractical, limiting meal frequency, dietary diversity, and responsive feeding (Sanghvi et al., 2025). Community-based peer and volunteer support models have been increasingly promoted to improve CF practices; however, recent synthesis evidence indicates that their sustainability is strongly shaped by structural and system-level factors, including unstable financing, limited supervision, high volunteer turnover, and weak integration into routine health services (Irenso et al., 2026).
Knowledge–Practice Gaps and Enabling Environments	Children's diet quality is shaped by interacting determinants, including household wealth, caregiver education, food prices, local food environments, and access to services (Makwela and Mashaba, 2025; Gassmann et al., 2022). Behavior change efforts are therefore most effective when embedded within enabling environments that address structural and economic barriers concurrently (Sanghvi et al., 2025). Beyond household-level determinants, policy and governance constraints represent critical barriers to improving CF at scale. Recent reviews of maternal and child nutrition programmes highlight persistent challenges related to fragmented coordination, limited domestic financing, weak accountability mechanisms, and inconsistent translation of national policies into frontline service delivery (Okoye et al., 2026).

readily accepted and sustained (Vera-Becerra et al., 2024; Tapera et al., 2017; Affonfere et al., 2021). Caregiving occurs within highly constrained time and labor environments. Caregiver time availability represents an important but often under recognized constrain, particularly in contexts where women balance income-generating activities with caregiving responsibilities (Sanghvi et al., 2025; Tapera et al., 2017). Community-based peer support models have shown promise, yet their sustainability is often undermined by weak integration into health systems, limited supervision, and unstable financing (Irenso et al., 2026). Finally, improving caregiver knowledge alone is insufficient to achieve sustained behavior change. Children's diet quality is shaped by broader enabling environments, including service coverage, program coordination, and policy implementation capacity (Gassmann et al., 2022; Okoye et al., 2026). Where these systems are weak, CF practices are frequently adapted to immediate survival priorities rather than optimal nutritional standards (Sanghvi et al., 2025).

Overall, the evidence indicates that suboptimal CF in low-resource settings is primarily a reflection of constrained environments rather than caregiver neglect. Recognizing these determinants is essential for interpreting the effectiveness of CF interventions and for designing strategies that are feasible, acceptable, and sustainable in low-resource settings.

3.2 Towards implementation of CF: local food-based approaches

Globally, it is increasingly recognized that effective and right food system solutions must be locally grounded, climate-resilient, and nutrition-sensitive (Rockström et al., 2025). In CF programs, prioritizing nutrient-rich foods that are locally available and culturally accepted could offer benefits, such as improving child nutrition, strengthening community food sovereignty, and empowering small-scale producers while advancing equity, resilience, and sustainability (Codjia et al., 2024). Several approaches have been proposed to enhance the nutritional quality of complementary foods and to ensure that young children have access to affordable, nutrient-dense, and varied diets. These interventions generally focus on foods that are easy to prepare, store, and use, even in settings with poor hygiene and sanitation, while also aiming to enhance child nutrition, support maternal empowerment, and benefit local community economies. In particular, food-based strategies include the use of locally available ingredients in complementary foods' recipes to enrich diet diversity, and fortification options such as micronutrient powders and small-quantity lipid-based nutrient supplements (SQ-LNS).

Fortification is a key strategy for filling micronutrient gaps in weaning foods, helping reduce undernutrition and support the United Nations SDG2 ("Zero Hunger"). In high-income countries, fortified complementary foods are commonly produced using advanced technologies such as roller drying and extrusion, which are often not feasible in low-resource settings. In many low-resource regions, simpler methods, including germination, malting, and roasting, are used instead to improve nutritional quality (Kabeer et al., 2024; Bechoff et al., 2023).

Specifically, food-to-food fortification, an approach that uses locally available and accessible plant or animal foods to enrich other foods, takes into account the dietary habits of the target population and aims to improve nutritional quality and nutrient intake while preserving the acceptability of meals (Chadare et al., 2019; Kruger et al., 2020).

3.2.1 Nutritional profile

In LMICs, a wide range of indigenous plant-based ingredients, including cassava, orange-fleshed sweet potato, amaranth, legumes, nuts, oilseeds, *Moringa* leaves, banana, and baobab are important sources of carbohydrates, energy, and key micronutrients (Chadare et al., 2018; Ngadze et al., 2023; Sokhela et al., 2023; Anwar et al., 2024; Tura et al., 2025). Pulses, nuts, and oilseeds offer higher-quality protein than cereals, and strategic combinations can improve amino acid balance (McDermott and Wyatt, 2017; Berti et al., 2026). In Tanzania, porridges formulated from blends of pumpkin seed, extrusion-cooked soybean, orange-fleshed sweet potato, and germinated extrusion-cooked amaranth met recommended standards for energy, protein, zinc, iron, and vitamin A, with processing methods such as germination and extrusion enhancing nutrient density (Marcel et al., 2021). In Madagascar, combining cassava flour with sesame paste and *Moringa* leaf powder produced an energy-dense, low-cost infant flour that met CF standards in terms of energy and minerals and was simple to prepare (Randrianantenaina et al., 2020). Similarly, cassava–tempe porridges in Indonesia showed higher protein content and digestibility than commercial rice-based products, supporting local food diversification (Utami et al., 2025). Soybean tempe is a high-quality plant protein obtained through soybean fermentation, widely consumed in Indonesia as a meat substitute due to its greater affordability and accessibility compared with animal protein sources (Romulo and Surya, 2021).

Animal-source foods, including insects, fish, and crustaceans, offer unique advantages in terms of protein quality and micronutrient density. Insect-based ingredients are increasingly recognized as a sustainable and affordable source of high-quality protein and potential functional benefits (Berti et al., 2026). Incorporating insect flours into traditional cereal-based porridges represents an innovative approach to improving protein quality and micronutrient density while leveraging locally available resources. For example, adding roasted termite powder to fermented maize- and sorghum-based complementary foods in Nigeria increased protein, fat, calcium, iron, zinc, and vitamins B3, B6, B12, and β-carotene contents, while keeping anti-nutrient levels low (Adepoju and Kayode, 2016). In Ethiopia, extrusion-cooked teff- and maize-based blends enriched with bee larvae improved protein, fat, iron, calcium, and vitamin contents while maintaining microbiological safety and sensory acceptability (Mekuria et al., 2021). Further evaluation in BALB/c mice demonstrated more positive effects for this grain–bee larvae complementary foods on growth, hematological indices, and zinc bioavailability compared with soybean-based and commercial complementary foods (Mekuria et al., 2022). While these findings from the mouse model support the nutritional plausibility of the grain–bee larvae formulation, caution is warranted in extrapolating results from animal models to human populations, given differences in physiology, metabolic rates, and dietary context. Small dried fish and crayfish provide other examples of locally sourced, climate-adaptive foods with significant nutritional potential. Widely consumed small fish species across East and West Africa are rich in omega-3 fatty acids, high-quality protein, and essential nutrients (calcium, iodine, iron, zinc), even in small portions (Robinson et al., 2025). Similarly, crayfish is promising for enhancing the nutritional quality of plant-based complementary foods (Adegbusi et al., 2024). In Sprague Dawley rats, Nigerian maize–soybean–crayfish complementary foods

increased protein and mineral content, reduced anti-nutrients, supported better growth, and improved biochemical outcomes compared with plant-only or commercial formulations, with no adverse health effects (Adegbusi et al., 2023). As with the insect-based formulations discussed above, these findings provide preliminary experimental evidence for the nutritional potential of crayfish as a locally sourced ingredient, but clinical validation in humans remains necessary. These examples highlight the importance of animal sources for addressing nutrient gaps in plant-based complementary diets, especially in regions with limited access to conventional livestock products.

3.2.2 Interventional studies using locally available foods

Several intervention studies across low-resource settings have explored the potential of locally developed complementary foods to improve child nutrition and growth.

3.2.2.1 Complementary food recipes based on local ingredients

Evidence from Indonesia consistently shows that locally based CF approaches, combined with caregiver training, can improve child growth and feeding practices. A 9-week pilot program in rural Indonesia (Nursing Feeding Center "Posyandu Plus") tested a CF model among 109 children aged 6–36 months, integrating caregiver education, cooking sessions, recipe manuals, and growth monitoring (Susanto et al., 2017). Families followed diversified weekly menus using locally available foods. The intervention led to significant improvements in weight-for-age z-score (WAZ), weight-for-height z-score, and body mass index-for-age z-score and reduced underweight and wasting, while mothers reported greater knowledge, cooking skills, recipe variety, and child appetite, with high acceptability due to low-cost local ingredients. Consistent findings emerged from a small study of 52 infants aged 6–12 months receiving a traditional vegetable-based porridge, *Tinutuan Tinu Key*, once daily for 14 days, which showed a significant reduction in the proportion of children classified as short and improved length-for-age status, alongside better appetite and acceptance linked to menu variety and appropriate feeding practices (Solang et al., 2024). Similarly, a quasi-experimental study using complementary foods based on local functional ingredients such as tempeh, *Moringa* leaves, and mung beans in stunted children aged 6–24 months reported significantly greater gains in WAZ after 3 months compared with standard feeding alone (Wahyuni, 2025). Extending this line of evidence, a larger training-focused intervention involving 180 mothers demonstrated that a structured nine-week program using local recipes and practical modules significantly improved maternal food preparation, CF, and responsive feeding behaviors (all $p < 0.001$), indicating that locally based, skill-focused training can strengthen mothers' capacity to feed young children appropriately (Hastuti et al., 2025).

Drawing on this evidence, locally based CF interventions show the greatest potential when they go beyond the mere provision of nutritious foods to encompass caregiver education in nutrition, culinary skills, and child growth monitoring. When caregivers are equipped with practical knowledge and supported in translating it into daily feeding practices, improvements in both dietary quality and child growth outcomes appear achievable, even in low-resource settings.

3.2.2.2 Fortification using locally derived powders

In rural Cambodia, a randomized trial compared culturally adapted rice-porridge-based complementary foods enriched with small fish or edible spiders to fortified corn–soy blends distributed by the World Food Programme among 419 infants aged 6 months over 9 months (Skau et al., 2015). Both locally developed and standard fortified products showed similar efficacy on growth, body composition, and iron status. Similarly, in Tanzania, newly formulated extruded sorghum–cowpea, sorghum–soy, and corn–soy fortified blended foods in children aged 6–53 months improved hemoglobin and reduced anemia and vitamin A deficiency compared with no intervention, although anthropometric outcomes were comparable across interventions (Delimont et al., 2019). In Southern Malawi, a trial tested legume-based complementary foods using cowpea or common bean flour in 355 infants aged 6–12 months over a 24-week period (Stephenson et al., 2017). Cowpea supplementation modestly reduced declines in length-for-age z-scores, indicating a small benefit in linear growth, whereas common bean flour had no significant advantage over standard corn–soy blends. Another Cambodian six-month cluster-randomized trial tested *Moringa* and cricket powder supplementation alongside nutrition counseling in children aged 6–23 months (Menasria et al., 2018). While growth indicators did not differ from counseling alone, the supplemented children achieved higher intakes of energy, iron, and zinc, and a greater proportion were classified as healthy. In West Africa, a study in Benin developed an affordable complementary food supplement from locally available *Moringa oleifera* leaf, *Adansonia digitata* fruit pulp, and *Cochlospermum tinctorium* root powders, which successfully increased iron intake for children 6–59 months and demonstrated high acceptability when added to maize and sorghum porridges (Affonfere et al., 2021). Its low cost and the accessibility of the ingredients further support its potential for widespread community adoption. A similar approach was tested in Nigeria in 40 children aged 6–23 months over 90 days, where maize–soybean-based complementary foods enriched with termite flour, fishbone powder, pawpaw, and pumpkin leaves improved growth and micronutrient status, particularly when animal-source ingredients were included (Nnam et al., 2025). Finally, the Child Health, Agriculture and Integrated Nutrition (CHAIN) trial in rural Zimbabwe evaluated an "IYCF-Plus" strategy in infants aged 5–6 months, combining SQ-LNS with locally sourced powders including egg, *Moringa*, biofortified sugar beans, and maize. Acceptability testing showed high caregiver approval for taste, texture, and preparation, while the products substantially increased intakes of key micronutrients and high-quality protein, filling dietary gaps not fully addressed by standard supplementation (Chagwena et al., 2024).

Taken together, these findings demonstrate the potential of locally available foods to enhance the nutritional quality and accessibility of complementary foods, thereby promoting beneficial effects on pediatric growth and health outcomes. Traditionally consumed plant-, animal-, and insect-based foods can provide adequate energy, protein, and micronutrients, when appropriately combined and processed,

with complementary nutrient profiles enhancing overall diet quality. Simple, small-scale household methods, such as cooking, roasting or toasting, steaming, dehulling, milling, and cooking, soaking, fermentation or malting, and germination or sprouting, can reduce antinutritional factors and increase nutrient bioavailability (Ngadze et al., 2023; Anwar et al., 2024; Vissamsetti et al., 2023; Tura et al., 2025); smoking, drying, and spontaneous fermenting can work as preservation techniques (Adesogan et al., 2026).

However, several gaps remain. Data from trials in humans involving children aged 6–23 months, particularly those with long-term follow-up, are still limited, since many existing findings rely on experimental formulations rather than real-world studies assessing growth, acceptability, affordability, and health outcomes. In addition, most of the available human evidence comes from Sub-Saharan Africa, Cambodia, and Indonesia, limiting the generalizability of findings to other low- and middle-income contexts with different food systems, cultural practices, and agroecological conditions. Context-specific approaches are needed as nutrient value and ingredient suitability vary across agroecological zones (Chadare et al., 2018). Moreover, research addressing food safety and quality concerns, including contamination risks, microbial hazards, aflatoxins, and potential allergenicity remains scarce (Tura et al., 2025; Vissamsetti et al., 2023).

4 From barriers to action: advancing locally sourced food-based CF

4.1 Enhancing the availability and affordability of nutritious foods

Revisiting agriculture, livestock, and fisheries is key to advancing SDG 2: Ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture (Scirocco et al., 2026). Although central to food security in many low-income and climate-vulnerable setting, indigenous foods, small-scale fisheries and informal markets are frequently disregarded in national food policies, investments, and research (Shafiq et al., 2025; Kaur et al., 2025). This hinders their integration into CF programs.

A people-centered approach, that includes technical support, awareness campaigns, and investments in climate-resilient species, agroecology, horticulture, agroforestry, and small-scale systems based on native plants and animals can enhance dietary diversity, ecosystem resilience, climate adaptation, and local empowerment, while reducing dependence on globalized markets and vulnerability to external shocks (Reyes et al., 2021; Iannotti et al., 2023; Iannotti et al., 2024; Kunlere, 2025).

Promoting underutilized crops such as millets, teff, amaranth, buckwheat, quinoa, adzuki bean, cowpea, velvet bean, mung bean, chickpea, bambara groundnut, *Moringa oleifera*, orange-fleshed sweet potato, taro, yams, cassava can improve child nutrition while enhancing crop diversification and stress tolerance (Li et al., 2020; Popoola et al., 2022; Kaur et al., 2025; Kimaiyo et al., 2025; Purba and Krishnaswamy, 2025; Tura et al., 2025; Amagloh et al., 2026). Expanding community-level production, optimizing post-harvest processing, and encouraging consumption of non-livestock foods, such as poultry, small fish, or insects can further enlarge access to animal-source foods for infants and young children, improving nutritional outcomes (Iannotti et al., 2023; Adegbusi et al., 2024; Robinson et al., 2025). Home gardening and small livestock keeping, such as poultry, goats (for eggs and milk, respectively, beyond meat), rabbits, and guinea pigs can increase year-round access to nutrient-rich foods thereby enhancing household dietary diversity (Codjia et al., 2024; Flores et al., 2025; Adesogan et al., 2026). Agricultural diversification in LMICs has also been associated with modest improvements in young child linear growth (Jones, 2017). Furthermore, these approaches may strengthen women's economic empowerment through improved control over household resources and income generation, improving household nutrition and well-being (Flores et al., 2025; Adesogan et al., 2026).

Fiscal and social protection measures can help improve food security by addressing food affordability pathways (HLPE, 2020; Iannotti et al., 2024). For instance, subsidies for fruits, vegetables, and whole grains can improve access, while taxes on sugary drinks, low-nutrient-dense foods, and snacks can discourage consumption (Kumar et al., 2023). Furthermore, food assistance programs, cash transfers, community-based safety nets, and support for local markets can increase the availability and accessibility of nutritious diets (Reyes et al., 2021; Iannotti et al., 2024; Kunlere, 2025; Rockström et al., 2025).

4.2 Enhancing knowledge and practices

Availability and affordability alone are insufficient to ensure healthy diets. Food choices are shaped by culture, social norms, marketing, convenience, and taste preferences, highlighting the importance of culturally grounded and place-based interventions (Kunlere, 2025). Programs aligned with local dietary habits, seasonal foods, traditional production practices and cooking methods are more likely to be sustainable and effective (Reyes et al., 2021; Kuhnlein and Chotiboriboon, 2022; Ogunniran et al., 2024). Interventions promoting dietary change should therefore preserve and revitalize indigenous knowledge and food traditions, as shown in studies from Indonesia (Susanto et al., 2017; Wahyuni, 2025; Hastuti et al., 2025), the Zimbabwean CHAIN trial (Chagwena et al., 2024), and initiatives involving diverse Indigenous Peoples, such as Awajún people in tropical rain forest of Peru or the Dalit communities in India (Kuhnlein et al., 2013). They should provide practical guidance on food preparation and preservation (i.e., fermentation, soaking, germination, drying, ingredients mixing, fuel-saving cooking methods) and hygienic practices (Humphrey et al., 2019). Community-centered strategies can also strengthen social support for IYCF. For example, the Zimbabwean CHAIN trial found that engaging grandmothers and elderly women through culturally valued foods improved maternal support (Chagwena et al., 2024). Programs in Bangladesh and Nigeria also highlighted the importance of fathers' involvement in food provision, feeding practices, and childcare (Sanghvi et al., 2025). Sustainable nutrition initiatives should therefore combine practical nutrition education, community engagement, and health-service to improve families' IYCF practices (Kuhnlein et al., 2013; Keats et al., 2021; Harrison et al., 2023).

Ensuring universal access, from infancy onward, to sufficient, safe, nutritious, affordable, and culturally acceptable diets within sustainable food systems requires a holistic approach integrating health, environmental, economic, and social equity goals (Fanzo et al., 2022; Gallegos, 2025; Rockström et al., 2025). Progress depends on policy coherence and coordinated collaboration among

TABLE 3 Cross-cutting actions applying broadly across contexts to be prioritized in policies and programs in low- and middle income countries.

Strategic area	Priority recommendation
Dietary diversification	Encourage the regular inclusion of locally available, nutrient-dense foods such as legumes, animal-source foods (e.g., small fish, eggs), nuts, fruits and vegetables in starchy staple-based complementary foods to promote *dietary diversification*.
Nutritional quality	Improve *nutritional quality* of complementary foods through simple household and community practices (e.g., fermentation, germination, food enrichment, and energy-dense preparation) that enhance nutrient bioavailability and adequacy.
Nutrition education	Scale up community-based *nutrition education* and behavior change interventions to improve caregiver knowledge, feeding practices, and hygiene while ensuring cultural acceptability.
Food system and access	Strengthen *food systems and access* by supporting resilient local value chains, small-scale production, fortification strategies, and affordable micronutrient powders for home use, particularly for low-income households.
Structural policies	Integrate nutrition into broader *structural policies* by linking agriculture, social protection, and maternal–child health and education services to address underlying determinants such as poverty, weak infrastructure, and service delivery gaps.

researchers, policymakers, producers, health and education sectors, civil society, Non-Governmental Organizations, and communities (Fanzo et al., 2022; Agostoni et al., 2023; Sanghvi et al., 2025). Because no single solution fits all contexts, interventions must be tailored to local cultural preferences, seasonal availability, resources, and technologies (HLPE, 2020; Kunlere, 2025; Rockström et al., 2025; Sanghvi et al., 2025). Table 3 summarizes key recommendations for translating these principles in context-specific action.

5 Limitations

Several limitations of this review should be acknowledged. First, as a narrative review, the selection and interpretation of the literature reflects the authors' judgment and is not based on a pre-registered protocol, which introduces the risk of selection bias in both the inclusion of studies and the synthesis of findings. Second, the search was restricted to articles published in English, which may have led to the exclusion of relevant studies published in other languages, particularly those conducted in Latin America or francophone Africa, where CF research is also active. Third, studies conducted in emergency or conflict-affected settings were deliberately excluded, as these contexts require rapid-response approaches that differ substantially from the sustainable, locally grounded strategies examined in this review. While this exclusion is methodologically justified, it limits the generalizability of the findings to stable low-resource settings. Fourth, publication bias cannot be ruled out, as studies reporting positive or statistically significant results are more likely to be published, potentially leading to an overestimation of the effectiveness of locally based CF interventions. Finally, the available evidence remains geographically concentrated in Sub-Saharan Africa and Southeast Asia, with limited representation from Latin America, South Asia, and other low-resource regions, further constraining the global applicability of the conclusions drawn.

6 Conclusion

In many low-resource countries, suboptimal CF is widespread and largely reflects structural and environmental rather than individual caregiver neglect. Growing evidence supports the potential of locally grounded, culturally aligned, and community-centered CF approaches to improve child nutrition outcomes in a sustainable and equitable way. Beyond their nutritional value, strategies that integrate indigenous crops, edible insects, and small-scale fisheries contribute to preserving traditional food cultures and safeguarding intergenerational knowledge related to the cultivation, harvesting, processing, and preparation of local foods, a dimension that extends the impact of nutrition interventions well beyond the health sector. In translating this evidence into action, a stepwise approach is recommended: first identifying the specific nutrient gaps within the target population, then selecting context-sensitive food-based interventions that align with local dietary habits, available resources, and feasible processing techniques, and finally integrating caregiver education and practical training as a cornerstone of implementation. Future research should prioritize diverse combinations of locally available ingredients, evaluating their safety, sensory acceptability, nutrient bioavailability, and long-term growth outcomes in children aged 6–23 months across a broader range of geographic and agroecological contexts.

Author contributions

AM: Conceptualization, Methodology, Writing – original draft, Visualization, Writing – review & editing, Funding acquisition. PS: Writing – review & editing. CA: Supervision, Writing – review & editing. CB: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Funding

The author(s) declared that financial support was received for this work and/or its publication. This project was funded by the APC

central fund of the University of Milan (Milan, Italy) and by the Department of Clinical Sciences and Community Health, University of Milan (Milan, Italy) through the APC initiative.

Acknowledgments

The authors acknowledge support from the University of Milan through the APC initiative.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author AM declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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