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Long-term sustainability of African school feeding programs, a review

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Sustainable school feeding programs (SFPs) in sub-Saharan Africa play a vital role in addressing malnutrition and poor educational outcomes among children. It is critical to contextualize SFPs to local needs and resources, while retaining the twin universal goals of alleviating hunger and promoting education, and the associated strengthening of health, nutrition and social protection. The effective implementation and continuity of such programs, however, present challenges. Key hurdles to establishing and maintaining effective SFPs in sub-Saharan Africa were assessed, as well as strategies to address these challenges. We searched three databases for articles published between 2012 and 2023 with combinations of the keywords: "school feeding," "school meals," "sustainability," "sustainable," and "long-term." Of >25,000 identified articles, 21 focused on quantitative and qualitative evaluations of sustainability in primary school SFPs with children aged 6–14. Themes discussed in these articles fall into four broad areas: policy, operations, community involvement and ancillary activities. Successful SFPs in sub-Saharan Africa differ substantively from those in higher income countries. Home grown SFPs are a common route to follow to transition from external donor support, and increase community involvement. The SMP+ meal planner from the World Food Program is widely used to develop nutritious, acceptable meals based on locally available foodstuffs. School gardens and means to access sufficient fuel, usually firewood, for cooking are important concerns in sub-Saharan Africa, but are not usually a concern in higher income countries. By utilizing locally sourced foods and involving students in school gardens and meal planning activities, more comprehensive nutrition education can occur and students can better understand ways to utilize the food available to their household. In conclusion, we provide target areas for policymakers and practitioners to address when designing SFPs that can be sustained for the long term in sub-Saharan Africa and other low and middle-income countries.

KEYWORDS

school meals, sustainable development goals, school gardens, nutrition education, nutrition policy, student retention, community involvement

1 Introduction

School feeding programs (SFPs) are important tools for enhancing student livelihoods and academic performance in primary school. These programs have different goals and expectations in high-income countries (HICs) and low- and middle-income countries (LMICs) (dos Santos et al., 2022). In HICs, SFPs often focus on increasing dietary diversity and minimizing childhood obesity. These programs often are supported by robust funding and infrastructure. Conversely, SFPs in LMICs usually focus on combatting malnutrition and increasing school attendance. These programs often rely heavily on external donor support and local community involvement (Gelli et al., 2019). The differences underscore the need for context-specific strategies to ensure sustainability. For example, adapting menus to local realities is a prime example of a context-specific strategy required for sustainability. We adopt the definition of sustainability of O'Loughlin et al. (1998), with its focus on the capacity of a program to continue delivering its intended benefits for an extended period after initial funding or support ends. This definition encompasses several key characteristics: institutionalization, maintenance of benefits, financial and resource stability, and community and stakeholder engagement. Additionally, we use "school feeding" and "school meals" interchangeably.

O'Loughlin et al. (1998) identified three key themes regarding the sustainability of interventions such as SFPs. First is organizational fit, i.e., how well does an intervention align with the organization's existing practices and culture. Second, how capable is the organization of adapting or reinventing the intervention to better suit their specific context. Finally, how effective is the organization in securing the ongoing funding and support needed to ensure the financial stability essential for maintaining a long-term intervention effort. Funding SFPs is a critical factor with HICs and LMICs facing very different challenges for their long-term success and sustainability (Bundy et al., 2009). According to the Global Child Nutrition Foundation (2022), low-income countries provided an average of 24% of the funding required by SFPs (those in sub-Saharan Africa average 46% in-country support) with the remaining funds provided by external development partners. In contrast, the average HIC SFP receives 98% of its funding from in-country sources.

Multiple stakeholders have recently been highlighting the importance of SFPs globally and within the region. In Africa, the African Union (AU) designated March 1 as the African Day of School Feeding, as school meals may be the only meal that some pupils have all day, and the need for and benefits of school feeding programs need to be prominent. The School Meals Coalition, which was established during the United Nations Food Systems Summit in 2021, aims to ensure that by 2030 every child has the opportunity to receive a healthy, nutritious meal at school and received $48 billion in funding commitments from countries worldwide. The School Meals Coalition Research Consortium complements these efforts by generating data and developing best practices to inform policy and programmatic decisions. This consortium includes researchers and academic institutions dedicated to studying various aspects of SFPs, such as their nutritional, educational, and economic impacts. Their work helps to build the robust evidence base that supports global scale-up of effective school feeding interventions. The World Food Program (WFP) supports SFPs in many countries

and received the 2020 Nobel Peace Prize for its efforts to reduce global hunger. The Global Child Nutrition Foundation (GCNF), established in 2006, focuses on the fight against child hunger and malnutrition and conducts biennial surveys to monitor the status of national SFPs worldwide (African Union, 2018; Global Child Nutrition Foundation, 2022; WFP, 2021, 2023). Nascent Solutions has implemented the McGovern-Dole Food for Education program, funded by the United States Department of Agriculture (USDA), in Cameroon (2018–2023) and in Malawi (2019–2024). The McGovern-Dole program has contracted with multiple collaborating NGOs to provide school meals in countries in Asia, Africa and the Americas and is one of the largest on-going sources of support ($220 million for 2022) for these efforts globally. Such efforts are essential to establishing and sustaining SFPs that meet the needs-education, health, nutrition and social protection-of all school-going children, especially those in conflict zones and hard-to-reach areas.

Driven by the Sustainable Development Goals (SDGs), the Millennium Development Goals (MDGs) before them, and a host of regional and country specifications, SFPs now reach 418 million of approximately 724 million children enrolled in primary schools globally, an 8% increase from 388 million in 2020 (WFP, 2021, 2023). Unfortunately, the number of schoolchildren receiving meals at schools in low income countries, especially sub-Saharan Africa, decreased by 4% as a result of COVID-19 restrictions. Fifty percent of the children participating in SFPs are in five countries (Brazil, Russia, India, China and South Africa). Funding and management of SFPs differ in high- and low-income countries with WFP and government support playing the largest roles. The drop in the proportion of school-age children receiving school meals in sub-Saharan Africa is a concern. The children in this region are in dire need of the school meal as it may be the only meal some students have all day (African Union, 2018). To withstand shocks, e.g., conflict, pandemics and crop failures, when these meals are of even greater importance, SFPs need to be resilient and sustainable.

SFPs for school children aged 6–14 temporarily alleviate hunger, and increase energy intake, micronutrient status, and class enrollment and attendance (African Union, 2018; Destaw et al., 2022). SFPs also are part of nutritional, health and educational intervention programs such as deworming, micronutrient fortification and supplementation, and enhanced curricular programs and improved academic achievement. Overall benefits of SFPs are several times greater than the returns on public health alone with the overall return on investment in SFPs ranging from 7–35 fold over the student's life. SFPs have increased enrollment of both sexes in classes. The combination of take-home rations (THR) with on-site school feeding options has sustained school enrollment of girls in sub-Saharan Africa and reduced the gender gap in education by addressing barriers to schooling that are particularly prominent for girls (Aurino et al., 2020; Destaw et al., 2022; Kaur, 2021; Verguet et al., 2020; Wall et al., 2022; Wineman et al., 2022).

A critical question is, "What is a sustainable school feeding program?" Numerous studies describe and evaluate different aspects of school feeding, but there is no universally sustainable model (Fernandes et al., 2016). In-school meals and THR are the common forms in which assistance is provided, but the proportion of programs providing a particular type of assistance varies as does the frequency

at which the assistance is provided (range from five times per week to once per quarter). Program operation is not always year-round or every day of the week, as some programs operate only during the lean season or at other times when food shortages may be particularly critical. According to the latest data from Global Child Nutrition Foundation (2022), in-school meals are served by 80% of programs, and snacks, in the form of milk, fruits and fortified biscuits prepared either at the school or offsite, by 29% of the programs. THR, commonly flour, oil and other items to prepare meals at home, are provided by 39% of programs. Meals provided when a program is operating include: breakfast (40% of programs), lunch (89% of programs), and dinner (11% of programs, most commonly in boarding schools). The frequency at which THR are provided; however, varies widely, from as frequently as five times per week in 22% of programs, to weekly/biweekly (11% of programs), monthly (19% of programs), and quarterly/biannually (21% of programs). Program success depends on both timing and the proper selection of features from many different models. These features depend on external contextual factors and the goals set, and take into consideration both the local situation and potential trade-offs. Thus SFPs, like sustainable food systems, depend heavily on diverse elements such as human and natural resources, the food supply chain, waste management, and socio-economic activity (FAO and INRAE, 2020).

In sub-Saharan Africa, meals provided through SFPs usually are quite basic and their overall quality low. A school breakfast commonly is a low-cost porridge that incorporates a maize and soybean flour blend, sometimes without any sweetener (Roothaert et al., 2021; Eustachio Colombo et al., 2021; Balzaretti et al., 2020). Lunch often is a stiff porridge and some legumes, usually pigeon peas or beans, and vegetables. Fruit is scarce and included only when in season. Meat and dairy products are very rarely included, and by default most meals are vegetarian, even though including meat and dairy in these meals is known to increase standard test scores (Hulett et al., 2014). The THR usually is a combination of cereals, often maize and rice, intended for student consumption at home (Roothaert et al., 2021). The amount of grain provided usually is less than 20 kg per month and the amount may be based on school attendance. This simple, spare diet is still much better than not having any food at all while in school. Schools with SFPs usually have increased enrollments as evidenced by a spike in enrollment of new pupils and those migrating from other schools (Coughenour et al., 2021; Vyas, 2021). Although the amount of food provided is limited, many families in rural sub-Saharan Africa cannot afford even the basic lunch described above on a daily basis.

Our objective in this study was to review and analyze the literature on the sustainability of school feeding programs in sub-Saharan Africa. We hypothesize that there are parallel challenges and opportunities encountered by SFPs globally even if the response to these challenges and opportunities varies by location. This study advances the field by identifying conditions required for a school feeding program to be scalable, and by explicitly examining the strategies and approaches that underlie sustainable school feeding programs in LMICs, such as those found in sub-Saharan Africa. Practitioners will make more informed decisions about how to design, implement, and sustain SFPs if they understand common challenges and opportunities these programs face and can identify responses that have been successfully applied elsewhere.

2 Materials and methods

The present scoping review followed the reporting style outlined in the Preferred Reporting Items for Systematic Reviews and Meta-analyses Extension for Scoping Reviews (PRISMA-ScR) checklist (Tricco et al., 2018). The PRISMA flow chart of the selection process is in Figure 1.

2.1 Data sources and search strategies

The search strategy for this review on sustainable school feeding programs in sub-Saharan Africa was designed to ensure a comprehensive and unbiased collection of relevant studies. We searched three primary online databases: Thomson Reuters' Web of Science, Research4Life, and PubMed. Web of Science's multidisciplinary nature supports the review of educational, social, and environmental impacts. Research4Life's emphasis on low- and middle-income countries ensures the inclusion of contextually pertinent studies. PubMed's concentration on health and nutrition is critical for assessing sustainability in terms of nutritional outcomes and health benefits associated with SFPs. The credibility of these databases is well-established in the academic community, ensuring the reliability and validity of the studies sourced from them. Web of Science, Research4Life, and PubMed are widely used by researchers for systematic reviews and meta-analyses, and their rigorous indexing standards enhance the trustworthiness of the review's findings (Garg et al., 2008).

Identified article citations were exported to Microsoft Access 2016, and a "duplicates" query was performed to eliminate any duplicates. Subsequently, a search query was created to filter out articles that did not include one of "school feeding," "school meals," "sustainability," "sustainable," and "long-term" in their title, keyword list, or abstract.

The search strategies incorporated a variety of techniques to ensure comprehensive, precise retrieval of relevant studies. These techniques included the use of truncation (*) to capture multiple forms of a word, Boolean operators ("OR" and "AND") to combine search terms, and phrase searching ("…") to locate exact sequences of words.

The initial search results were manually reviewed to eliminate articles that did not specifically mention school feeding or those related to school feeding outside of primary schools. To maintain the focus and relevance of our review, the search was restricted to articles published in English from January 2012 to March 2023. This timeframe was chosen to include recent, pertinent studies, ensuring that our review reflects current practices and developments in the field.

2.2 Inclusion and exclusion criteria

Eligible studies included articles that quantitatively and qualitatively evaluated sustainability of primary school feeding or primary school meals programs for children between 6 and 14 years of age. All articles were published in English in peer-reviewed journals between January 2012 and March 2023, with studies conducted in multiple geographic regions and in various contexts. Specifically

FIGURE 1
Flow chart of study identification process.
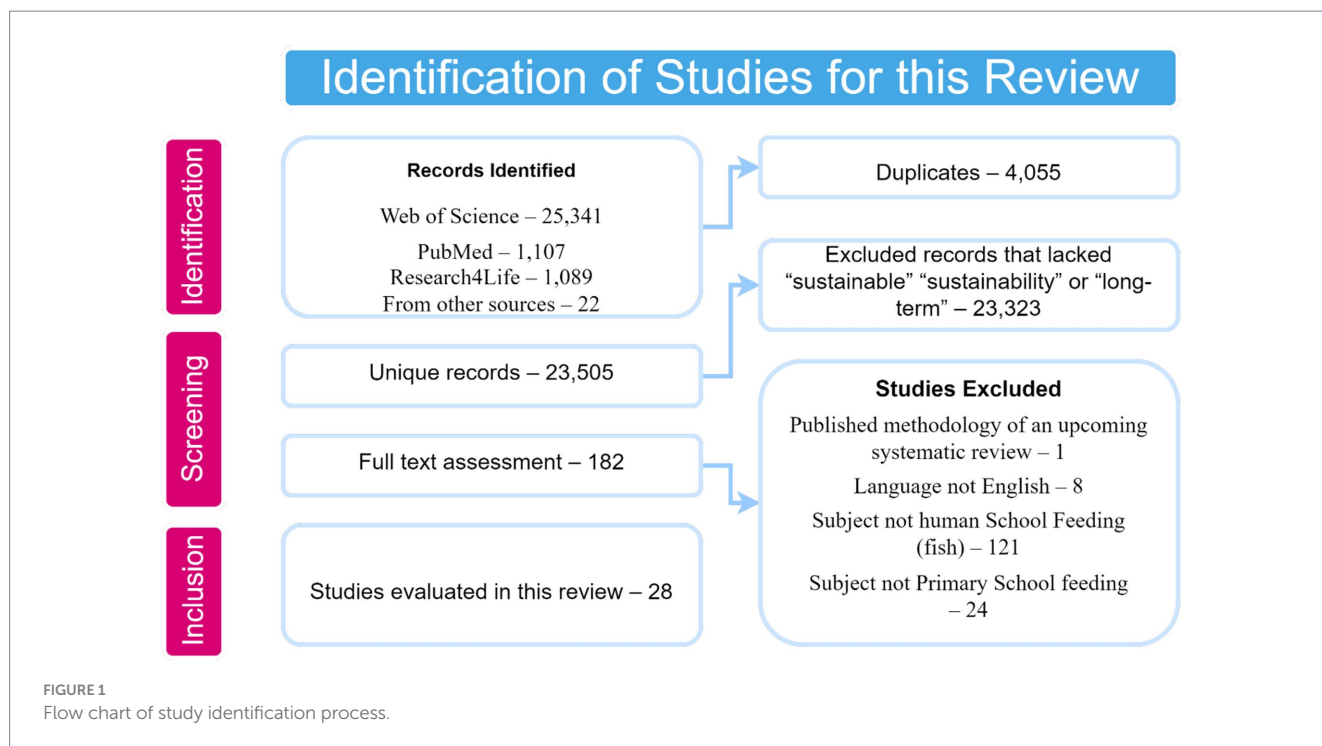
excluded were non-English articles, articles published before 2012, meta-analyses, protocols, methodologies, and cross-sectional studies about preschool or high school students.

2.2.1 Inclusion criteria

We used a rigorous set of inclusion criteria to ensure the relevance, quality, and consistency of the studies evaluated. First, only studies published in English were included, even though French and Portuguese are official languages in some African countries. We made this decision for several reasons. First, by utilizing only English articles quality assessment tools could be applied uniformly, increasing the consistency and reliability of the evaluation process. Non-English articles also could introduce variation in quality appraisal due to translation inaccuracies. English is the dominant language in scientific publications and international discourse, making it the most accessible language for a broad audience, including policymakers, practitioners, and researchers. English-language journals often have high impact factors and are more likely to be indexed in major databases, ensuring that the most relevant and highest-quality studies were included.

The geographic focus was intentionally not limited to sub-Saharan Africa to ensure a broad consideration of various strategies and outcomes across different locations. This approach allows for the inclusion of diverse experiences and practices, and provides a richer and more holistic view of sustainable school feeding initiatives. Depending on the geographic context, unique challenges and innovative solutions may occur that might not be considered if the scope were limited to a specific region. This inclusivity ensured that the findings are more generalizable and could be applied to different settings within Africa, acknowledging the continent's broad socio-economic and cultural diversity. This wider scope facilitates the identification of common themes and differences across regions and increases the understanding of what constitutes sustainability in school feeding programs under different circumstances.

The review considered articles published between January 2012 and March 2023, providing a comprehensive overview of current developments and challenges in school feeding programs. By focusing on recent data, the review aimed to offer insights that are current and relevant.

Both quantitative and qualitative studies were included, provided they offered empirical data or substantial theoretical insights into the sustainability of school feeding programs. Systematic reviews and meta-analyses specific to the topic were also considered to provide a broader context. The studies needed to focus on primary school children aged 6–14 years, aligning with the target age group for most school feeding programs in sub-Saharan Africa. Furthermore, articles had to address aspects of sustainability in school feeding programs, including, but not limited to funding, community involvement, nutritional outcomes, and operational challenges.

2.2.2 Exclusion criteria

Exclusion criteria were used to filter out studies that did not align with the objectives of this review, ensuring that only relevant, high-quality studies were included. Articles published in languages other than English were excluded to avoid translation inaccuracies and to enable consistent quality appraisal.

Publications prior to January 2012 were excluded so we evaluated only current practices and challenges in school feeding programs. We also excluded non-empirical articles, i.e., reports not published in peer-reviewed journals, such as opinion pieces, editorials, commentaries, and grey literature. Protocols and methodologies without primary data also were excluded. Studies focusing on preschool or high school students were not considered to maintain a consistent focus on primary school children aged 6–14 years. Finally, articles that did not address sustainability aspects of school feeding programs were excluded, as they did not contribute to the primary objective of understanding long-term program viability.

2.2.3 Data extraction

From the selected studies, key information was systematically extracted into a standard table (Supplementary Table S1). This included details on study design, methodologies, sustainability outcomes measured, findings, and risk of bias. We focused on information related to sustainability. The extracted data were organized into a structured format to facilitate further analysis.

2.2.4 Thematic analysis

A thematic analysis was performed on the extracted data to identify common themes and patterns. We encoded the data to highlight recurring concepts and other issues related to the sustainability of school feeding programs. The coding process was iterative, with initial codes being refined and grouped into broader themes through multiple rounds of analysis.

2.2.5 Identification of subthemes

Within the broader themes, specific subthemes were identified based on their relevance and frequency in the literature (Figure 2). For example, under the broader theme of "operations," subthemes such as meals planner, menu acceptability, portion sizes, and food waste management emerged as critical operational aspects. Each subtheme was carefully defined and described to capture the nuances of the various factors influencing the sustainability of school feeding programs.

2.2.6 Grouping into categories

The identified subthemes were then grouped into four main categories to provide a coherent and structured framework for the review (Figure 2). The policy category included overarching policies and supply chain management, emphasizing policies to ensure continuity and scalability. The operations category encompasses critical operational aspects such as meal planning, menu acceptability, portion sizes, and food waste management, highlighting the importance of efficient operations. The community involvement category includes funding and costs, stakeholder participation, and perceptions of children and parents, underscoring the role of

community engagement in securing resources and acceptance. Finally, the ancillary activities category includes nutrition education, school gardens, and energy sources, reflecting the support role of these activities in nutritional education, sustainable agriculture, and renewable energy use.

2.2.7 Validation and refinement

To ensure the robustness of the identified themes and categories, the preliminary findings were reviewed and validated by multiple authors. These authors cross-checked the themes against the original studies and sought feedback from experts in the field, especially from Nascent Solutions. Discrepancies were resolved through discussion, and the themes and categories were refined accordingly.

3 Results

The initial search (Figure 1) of the three databases (Thomson Reuters' Web of Science, Research4Life, and PubMed) identified 27,559 articles that contained the phrases "school feeding" or "school meals." After removing duplicates, 25,512 articles remained. Abstracts were screened for the terms "sustainable," "sustainability," and "long term," with records without one of these terms excluded. This screen reduced the number of articles to be evaluated to 182. The full text of these articles was assessed in detail, and 154 additional articles were excluded from further consideration, primarily because they did not evaluate school feeding for primary school children between 6 and 14 years of age. The remaining 28 studies (Supplementary Table S1) originated from six continents and 13 countries—Australia, Brazil, Canada, Chile, Ghana, India, Italy, South Korea, Spain, Sweden, Tanzania, the United Kingdom, and the United States. There was one study per country except for Brazil (2), Italy (3), Sweden (3) and the United States (2). Two studies (Fernandes et al., 2016; Kretschmer et al., 2014), contained general frameworks for school feeding programs and were not associated with any particular country. The other seven studies are systematic reviews of published articles on sustainable school feeding recommendations.

FIGURE 2
A model illustrating the interconnectedness of the elements identified in the review.
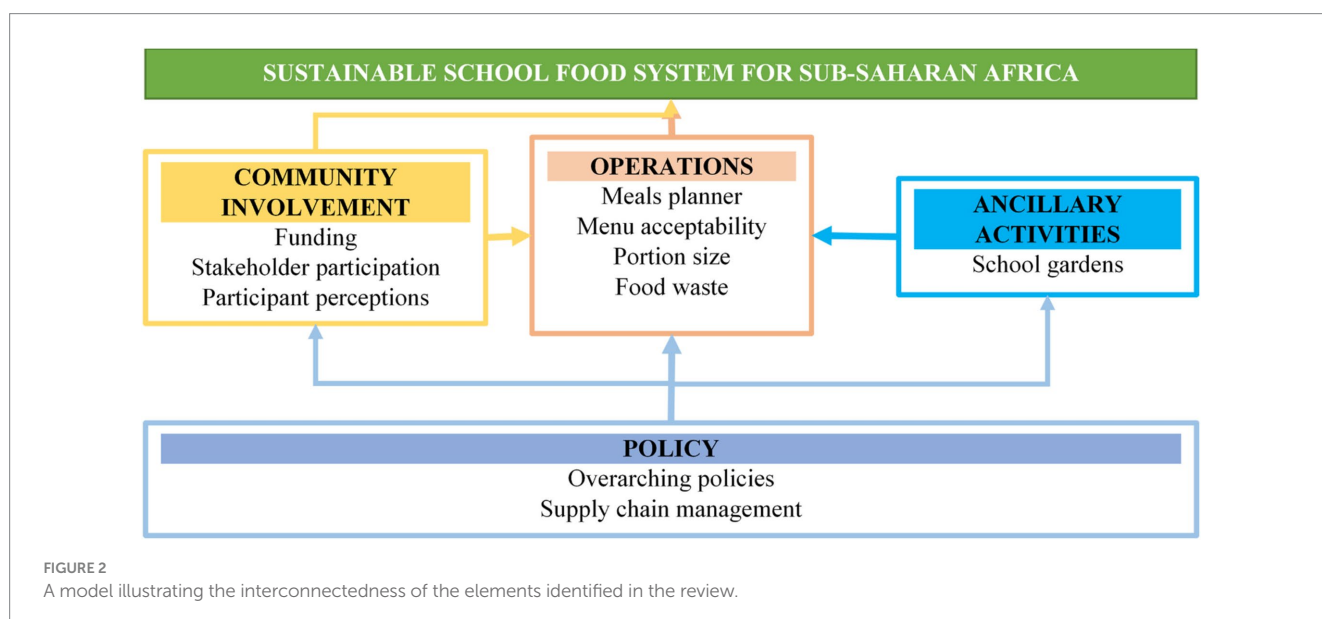
Nineteen of the 28 studies were assessed for bias as described by Boutron et al. (2019). Two studies could not be assessed as they were frameworks, and seven were systematic reviews. Ten items in/properties of each article were assessed to determine the risk for bias in the article: (i) clear definition of research question or objective, (ii) appropriate study design; (iii) adequate description of study participants; (iv) exposure or intervention of interest accurately measured; (v) outcomes accurately measured; (vi) potential confounding factors adequately accounted for; (vii) sufficient follow-up period; (viii) appropriate statistical analyses; (ix) results consistent across multiple studies; and (x) assessment of potential biases by authors. For each of the above criteria that an article met, a single point was awarded (maximum of 10 points). Of the 19 articles evaluated, 13 had a moderate risk of bias, and six had a low risk of bias (Supplementary Table S1).

A number of common issues run through this set of articles. These issues can be grouped into several general categories (Figure 2): policy (overarching policies and supply chain management), operations (meals planner, menu acceptability, portion size, and food waste), community involvement (funding, stakeholder participation, participant perceptions, and nutrition education), and ancillary activities (school gardens and energy sources). These activities are not independent of one another. For example, community involvement interacts directly with the operations activities at the schools to enable a sustainable food system. Ancillary activities work as enablers to ensure that the operations function smoothly. At the base of the model, the policy and supply chain activities must address the demands of all of the activities in an integrated food systems approach.

3.1 Policy

3.1.1 Supply chain management theoretical framework

Context-specific supply chain strategies are needed to determine priorities, targeting and modality, and to maintain sustainability (Kretschmer et al., 2014). These strategies must account for all of the factors that an SFP might face (Figure 3). Externally, these include beneficiaries, suppliers and aid providers, e.g., international organizations, donors, local and national governments, and local communities. Internally, these factors include program priorities and targeting, ease of program implementation, and methods and materials that improve community outreach and education.

The supply chain must be based as much as possible on sourcing food from local farmers and producers. This strategy promotes local food production, food security, sustainable agriculture practices, and economic resilience within the community, increases farmers' incomes, and enables SFPs to become catalysts for local economic development and more inclusive food systems (Kluczkovski et al., 2022). For local procurement of food by SFPs to be a priority, implementing agencies should establish effective communications with local suppliers, e.g., through farmer cooperatives or similar organisations, and link them to the SFPs to ensure a structured demand process between the farmers and the schools.

To shorten supply chains and minimize food waste at the distribution stage, the WFP piloted the Purchase for Progress (P4P) initiative in Tanzania from 2011 to 2016 (Roothaert et al., 2021). This program transitioned traditional school meal programs that relied on external cash and/or in-kind support to home grown school feeding

programs (HGSFPs). In HGSFPs, food grown or procured locally is incorporated into school meals. This transitioning mechanism provides a model for local communities to use to supply food to schools even after the project's completion. Although not all SFPs can be transitioned to HGSFPs, the P4P initiative now includes over 28,000 students across 40 schools, who receive a nutritious mid-day meal comprised of maize and beans. The food provided to a student daily was 120 g of maize, 30 g of beans, and 5 g of vitamin fortified oil, providing 20 g of protein and 500 calories. The meal was complemented with nutrition and health education programs, and programs to address water and sanitation issues. Imported vegetable oil fortified with vitamins A and D was used to meet nutritional requirements, as locally-produced oil did not meet the quality standards set by the government and the WFP. Developing local capacity to produce high quality, fortified oil for use in these programs remains an unmet challenge. School food committees at each school implemented the program, including commodity management, menu development, food preparation and distribution, and the recruitment and payment of cooks. The P4P initiative not only provided school meals, but also enhanced the ability of schools to source their food locally and thereby improve the local economy, enabling school and community advances to build on and complement one another.
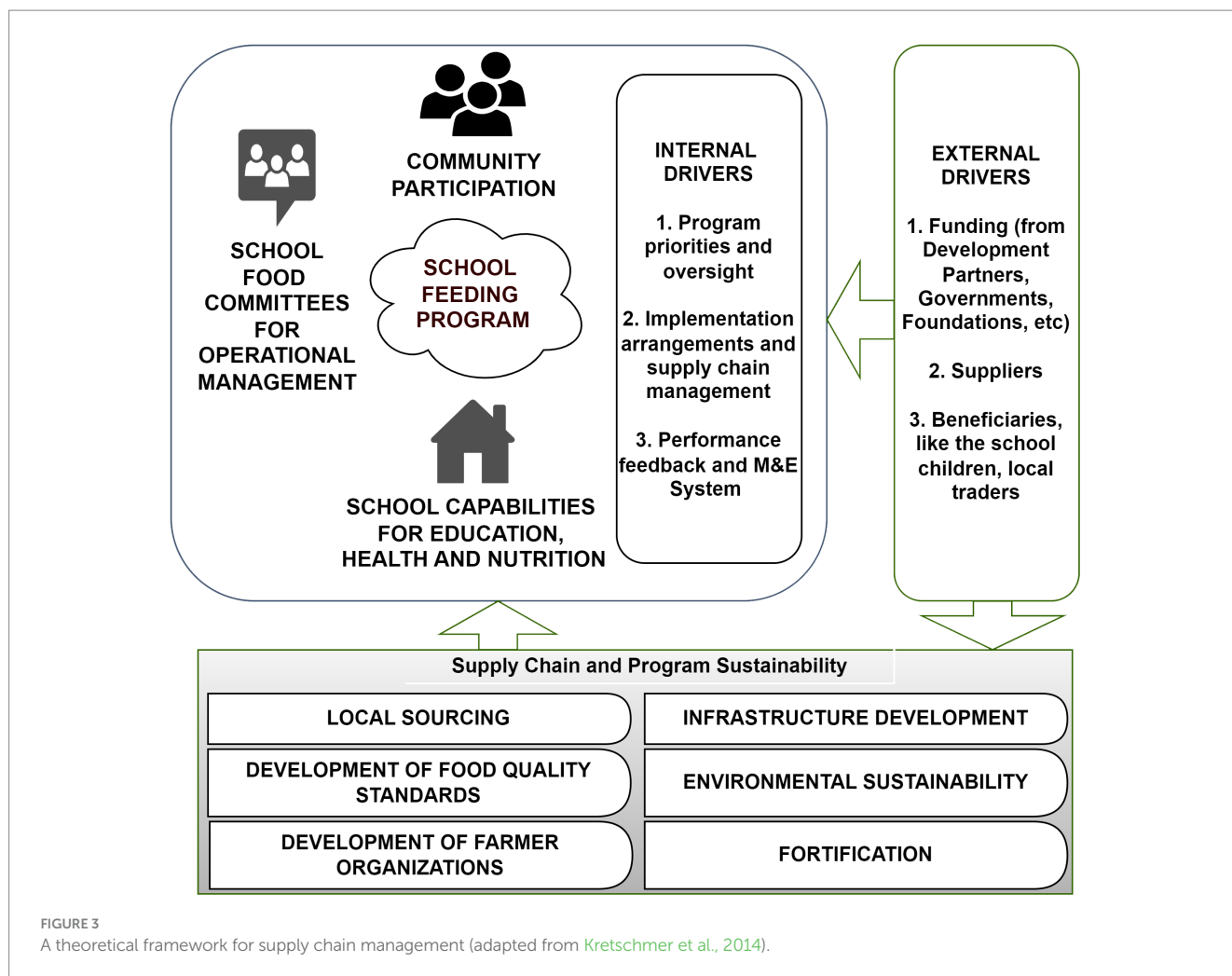
3.2 Operations

3.2.1 School meals planner

A school meals planner, i.e., software or materials that list the locally available foodstuffs and their nutritional value, and include local eating habits and customs, should be used to develop acceptable menus that meet program and nutrient RDAs for meals. The SMP+ planner developed by the World Food Program[1] is the world's first global school menu creation platform. It is free for use after a 2–4 h on-line training session. By using an artificial intelligence (AI) approach, SMP+ optimizes local school lunches for nutrition and affordability. The platform has options for managing menus and for including local community members in the meal planning process. Meal planner utilization strengthens HGSFP programming by increasing the transparency of SFP requirements and providing information on how to fulfill them for caterers and local procurement entities, including farmers (Fernandes et al., 2016). Planners help balance food costs and nutritional value to ensure that calories, protein quality and micronutrient bioavailability all meet program requirements. Tailoring meals to the local context encourages their consumption and has multiple benefits including upgrading the local food system and enhancing food security. A planner must be scalable to enable the SFP to serve more people, especially in times of heightened humanitarian need. Flexibility is the final key and enables the inclusion of more recipes and foods, thereby increasing program sustainability and better serving the community (Benvenuti and de Santis, 2020; Eustachio Colombo et al., 2019).

3.2.2 Overarching school meals policy

Policies for a sustainable SFP should include: (i) leadership and public awareness; (ii) operational considerations, (iii) parental

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1 https://innovation.wfp.org/project/smp-plus#

FIGURE 3
A theoretical framework for supply chain management (adapted from Kretschmer et al., 2014).

contributions, and (iv) food diversity and nutrition (Roothaert et al., 2021). The World Bank's Manual for SABER-SF Exercise (World Bank, WFP, and The Partnership for Child Development, 2016) provides a good set of guidelines for developing a successful SFP that has been successfully used for the last 10 years (Schultz et al., 2024). Schools should participate in initiatives to increase nutritional awareness among the general public and thereby influence the diets of everyone in the community. SFP policies should include certification standards, and protocols for adopting new supply chains and for sustainable local sourcing of ingredients (Gaddis and Jeon, 2020). Comprehensive implementation support is essential for long-term adherence to school nutrition policies with a goal for schools to adhere to established nutrition policies in the absence of external support for at least 12 months (Wolfenden et al., 2019), and then regularly re-evaluate their status and their policies.

School feeding policies should explicitly state and provide clear guidelines on inter-sectoral collaboration throughout the planning and implementation processes to ensure that each sector involved understands its expected role, minimizes duplication, and avoids neglected activities. These policies should intentionally prioritize reaching the most vulnerable schoolchildren, ensuring that the benefits of SFPs are directed towards those who need them the most. Clear provisions regarding the source of food, the mandatory nature of the school feeding program, funding sources, rationing, and quality
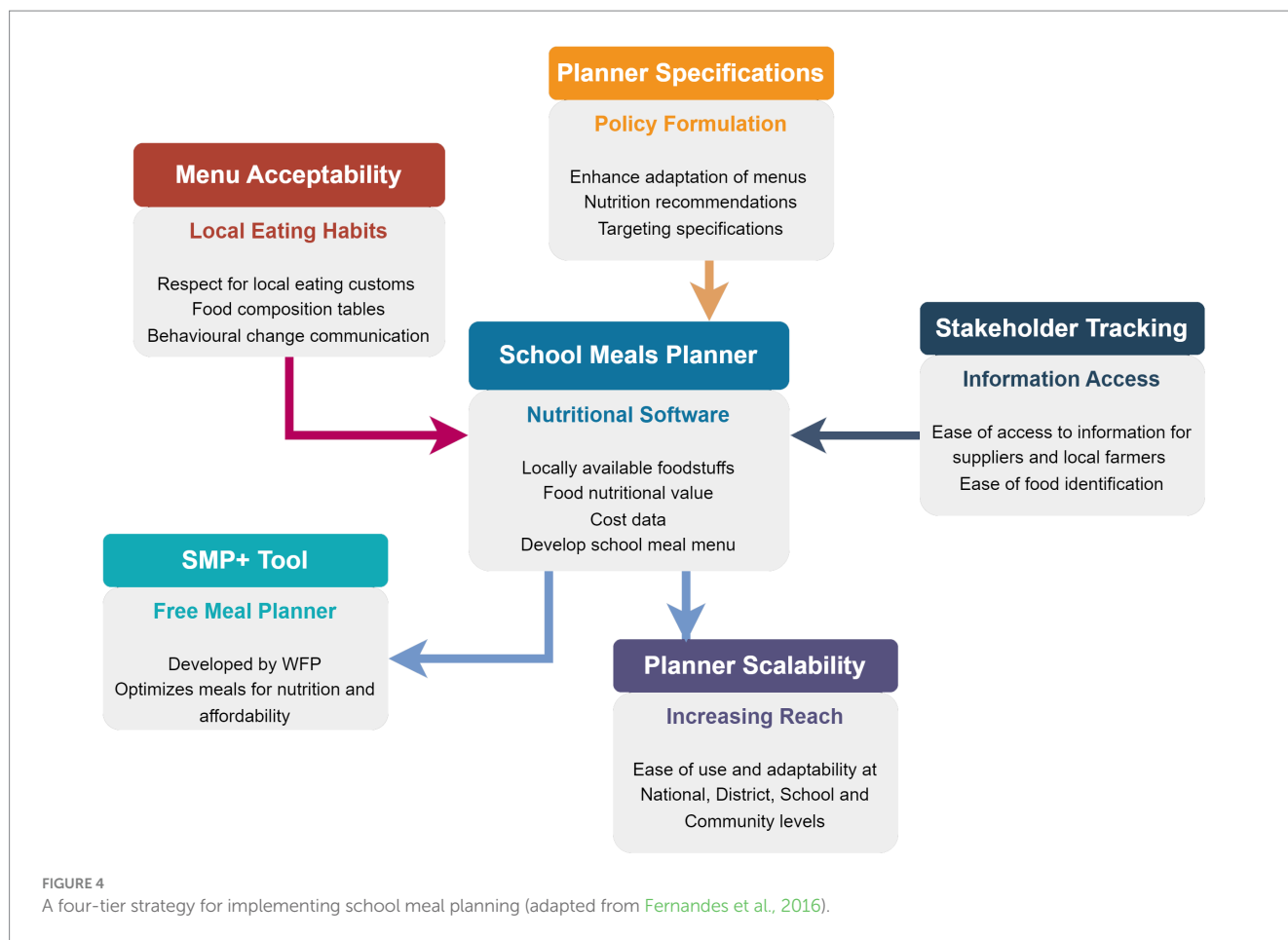
standards are essential components that should all be explicitly outlined in the policies. These measures contribute to transparency, accountability, and overall effectiveness of SFPs (Fernandes et al., 2016; Gaddis and Jeon, 2020).

Policies must ensure robust readiness for implementation, which involves adequate resources, leadership support, and effective communication strategies (McLoughlin et al., 2021). Furthermore, engaging stakeholders at multiple levels (school, district, and national) and using low-cost, accessible tools to measure policy implementation are critical for sustainability. However, lengthy tools with insufficient validity data may limit broader applicability and transferability, impacting long-term sustainability.

School policies must emphasize the development of standardized assessment methods to monitor and improve the school food environment, incorporating comprehensive measures that account for physical, economic, and policy factors, and ensuring context-specific interventions to address diverse school settings (O'Halloran et al., 2020; Bicalho et al., 2021). Robust data collection and evaluation should be specified to enhance the effectiveness and sustainability of healthy food initiatives in schools.

3.2.3 Menu acceptability

Sustainable SFPs optimize the best options amongst different, potentially competing, demands, which include cultural acceptability of

FIGURE 4
A four-tier strategy for implementing school meal planning (adapted from Fernandes et al., 2016).

menus (Eustachio Colombo et al., 2020). The process may initially be developed by using a computer model, but empirical observations of food consumption may drive decisions more than the models. These observations can be used to refine programs as they develop and mature. Menus must be designed with acceptability in mind (Figure 4), since poor menu acceptability leads to serving waste, or food that is prepared but not eaten and then discarded. Optimized meal plans utilize culturally acceptable recipes to produce attractive meals that conform to local eating habits (Benvenuti and de Santis, 2020). A target for an optimized school lunch could be: 720 kcal of energy, 100 g of carbohydrates, 32 g of protein, 22 g of fat, 23 g of sugar, 11 g of fiber, and 335 mg of sodium, again in a form consistent with local eating habits (Rossi et al., 2021).

In addition to sufficient fiber, carbohydrate and protein, fortification will likely be needed to ensure that meals contain sufficient micronutrients, e.g., magnesium, zinc, and vitamins such as A, C, and B_{12}, to meet dietary requirements (Best et al., 2010; Hurrell et al., 2010). Calcium and iron can be sourced from dairy products, probably cheese, and meat, respectively, but if these foods are not consistently available, then external fortification with these minerals is needed as well.

3.2.4 Portion sizes

School meal policies and dietary guidelines prescribe portion sizes to ensure that students receive recommended amounts of calories and nutrients every day (Roothaert et al., 2021). These sizes should differ, as a portion adequate for students aged 6–8 could be as much as 40% too small for students aged 9–13 (Blondin et al., 2022; Kluczkovski et al., 2022). Each portion must contain the correct mix of prescribed

foods and not be skewed to foods that are preferred over others. Ensuring that a balanced meal is consumed in its entirety, i.e., not just carbohydrates but also the vegetables and protein sources, e.g., fish or beans, is important for nutritional integrity (Balzaretti et al., 2020). Effective portion control requires planning and monitoring efforts that go beyond just the design of the content of the meals being served.

3.2.5 Food waste management

Food waste comes in two general categories—serving waste, i.e., food that was prepared but not served, and plate waste, i.e., food served to pupils but not consumed (Eustachio Colombo et al., 2020). Engaging students in menu planning can reduce food waste by ensuring that desirable recipes are used for food preparation. Making a game of this process by having the students include foods with different nutrient contents in potential meals teaches students the value of a balanced diet and helps them understand constraints that are critical to planning adequate meals at home as well. Including factors influencing food refusal in the menu planning process also can reduce food waste (Davis et al., 2015; Eustachio Colombo et al., 2020; dos Santos et al., 2022).

3.3 Community involvement

3.3.1 Funding and costs of school meals

Governments should ensure that SFPs are universal and free to achieve higher participation rates, better diet quality, and

improvements in academic performance, particularly among lower-income students (Cohen et al., 2021). Additionally, these programs may help reduce stigma associated with free or reduced-price meals, making the programs more inclusive and accessible. Furthermore, universally free school meals can have positive financial outcomes for schools in lower-income areas by streamlining administrative processes and improving household income for families. However, governments should conduct thorough research into the long-term financial implications for both schools and families to ensure sustained support and viability for such programs.

Community engagement is critical for the finances of an SFP. As noted above, implementing agencies must leverage local sourcing through good communications with farmers' groups, local businesses and other organizations to secure resources that go beyond government or donor provided materials. Donations or in-kind contributions are particularly important in resource-constrained contexts and to sustain programs when externally funded support programs finish and transition to local resources is expected (dos Santos et al., 2022; Roothaert et al., 2021). Government involvement is crucial in the establishment of SFPs and formulating school feeding policies. These policies must include allocation of funds for school feeding in the government budget as most SFPs are not sustainable without this support. The estimated cost for some SFPs could potentially increase to 70% of the current total budget for primary education. Cost containment is required for school meal menu rationalization, i.e., designing a menu that is nutritionally balanced, cost-effective, and culturally appropriate. In Benin, for example, the costs of a school meal for a student was reduced substantially through effective programming changes and school menu rationalization (Gelli and Daryanani, 2013). Dramatic reductions in local costs also could come from government or donor subsidies to support community-established HGSFPs.

3.3.2 Stakeholder participation

Parents and the community surrounding a school are essential partners with schools, government and benefactors of SFPs in ensuring a program's sustainability (Roothaert et al., 2021). Parent and community groups can make significant contributions to a SFP and are essential for a SFP to be sustainable. For grassroots developmental initiatives to take off, communities must be aware of the need for infrastructure, e.g., kitchens and warehouses or storerooms at the schools, and should work with government authorities at national and local levels and with parents to develop the necessary facilities. School communities usually provide the labor to prepare school meals. Paying cooks and other personnel would increase the number of applicants for these positions and increase the status of those who hold them within the community. Schools also must safeguard human and environmental health, develop resource-efficient supply chains, support regional food cultures, and ensure safe and healthy local food production and consumption, regardless of a student's socioeconomic class or identity (Black et al., 2015; Davis et al., 2015; Eustachio Colombo et al., 2021; Jones et al., 2012; Kluczkovski et al., 2022; Pagliarino et al., 2021). Nascents' experience is that the involvement of local women in the SFP is especially important for the long-term success of a SFP.

Leadership is essential for SFP success and sustainability. Well-structured school food committees at the grassroots level that are accountable to parents and school management can play an active role

in fundraising and resource mobilization in locations where SFPs are not fully funded by the government or other donors. Initiatives, often government or donor sponsored, should provide opportunities for schools to participate in professional development workshops, receive guidance and support from multiple, varied stakeholders, and access resources and guides specifically designed to facilitate SFP implementation (Kretschmer et al., 2014; Roothaert et al., 2021; Rossi et al., 2021; Wolfenden et al., 2019).

Stakeholder engagement and strong leadership are important in promoting healthy eating within schools (Thorpe et al., 2021). Programs that involve school administrators, food service staff, and parents tend to show greater sustainability. Additionally, ensuring that healthier food options are cost-effective and financially viable for schools helps maintain long-term success. Regular monitoring and evaluation should be carried out to measure the success of these programs in both health and business outcomes, ensuring that they can be adapted and scaled effectively over time. Importantly, the study suggests that financial incentives and providing clear evidence of profitability can encourage schools to adopt healthier, more sustainable food options.

3.3.3 Perceptions of children and parents

Deliberate measures that encourage positive perceptions of an SFP by children and their parents results in better acceptance of the food provided and reduces waste. Food provided must suit the students' tastes without compromising the dietary requirements for adequate nutrition on the one hand and promoting environmental health on the other (Eustachio Colombo et al., 2021; Gaddis and Coplen, 2017; Roothaert et al., 2021).

To succeed, communications and education efforts are needed to increase and diversify students', parents', and communities' limited knowledge about the environmental sustainability of food production and consumption. Introducing concepts of environmental care and providing age-appropriate messaging can help students understand the connection between their food choices, their health, and the well-being of the larger communities around them. Classroom activities, e.g., sustainability-focused projects and meal planning, will enhance students' understanding and attitudes towards sustainable food choices (Fretes et al., 2021; Gopal and Nagaraju, 2013). Schools must use low-cost nudge interventions (subtle changes in the school meal environment or in how food is presented) like altering the layout of cafeterias, promoting healthier food options, and using visual cues or social influence to encourage better dietary habits. Further, schools should adapt these strategies to different settings, regularly evaluating outcomes, involving stakeholders, and integrating nutritional education to ensure long-term behavior change and program success (Metcalfe et al., 2020).

3.3.4 Nutrition education to influence knowledge, attitudes, and practices toward healthy eating

Interventions that improve student's diets in schools must be combined with components such as education and environmental changes to be effective (Black et al., 2015; Eustachio Colombo et al., 2020; Gopal and Nagaraju, 2013). Schools must educate students about environmental conservation and nutrition for them to understand the need to care for energy plantations and bio-intensive gardens. School gardens and associated educational activities are both an accessible and practical way to increase students' ecological understanding of the environment beyond their immediate experience. Increasing skills-based food preparation education and

fruit and vegetable gardening in schools goes with increased provision of school meals and is accompanied by increases in the scale, integration, and range of educational sustainable food activities (Jones et al., 2012; Roothaert et al., 2021; Rossi et al., 2021; dos Santos et al., 2022).

3.4 Ancillary activities

3.4.1 School gardens and complementary food sources

School gardening programs consistently improve dietary behaviors linked to increased fruit and vegetable intake with the associated long-term health benefits (Davis et al., 2015). Schools should have both a garden where vegetables, fruits, herbs and medicinal plants are grown, with the exact composition dependent upon governmental requirements and local needs and desires. Schools also should have a compost system that provides compost for the school garden. This compost system should model utilization of waste from school meals, increase the carbon content of the soil, and minimize the use of inorganic fertilizers (Black et al., 2015; dos Santos et al., 2022). In general, fresh produce from school gardens should be used to supplement the food at the school. School gardens also should model irrigation options appropriate to local conditions, often drip irrigation, to enhance the output from the school-based vegetable and fruit garden. Alternatively, items from the garden could be dedicated to the schools SFP. Whatever use is determined for the produce from the gardens the distribution process should be transparent and agreed to in advance.

School gardens at urban and rural schools face different challenges (Joshi et al., 2008; FAO, 2010; Morgan et al., 2010). Rural schools will usually have access to sufficient land for a viable school garden. In urban areas, land prices and the need to expand school infrastructure for non-agricultural purposes may limit available space. Students, families and communities associated with rural schools will generally come from an agricultural background and can benefit directly and immediately from information generated through a school gardens program. In an urban setting, the community may have few, if any families directly involved in agriculture. These families also may have limited space for a garden and lack basic knowledge on how to manage plants grown for food. These families could contribute financially to support the program and might also be able to help manage the supply chain for food and other materials not available through a local market. Schools with sufficient space in their school garden areas may want to rent small plots of land to people who lack land of their own that could be used for such purposes. Produce from the rented plots could be shared with the SFP or be retained by the renter depending on agreements made prior to the start of the growing season. To provide space for fruit trees, these trees could be planted along the edges of the vegetable garden to enable some fruit to be included in the SFP and to demonstrate optimal cultural techniques for families with sufficient space to be able to plant fruit trees of their own (Gopal and Nagaraju, 2013; Roothaert et al., 2021).

3.4.2 Energy sources

Fuel for cooking is a critical resource that often is not carefully considered (Pastorino et al., 2023). In some communities and some programs there will be enough money to purchase gas for cooking. Although a fossil fuel in origin, it burns cleanly and consistently while leaving little residue or taste on the food. About 90% of SFPs in sub-Saharan Africa, however, rely on fire wood or charcoal to cook the food prepared as part of the SFP. Reliance on wood from uncontrolled forests increases Africa's deforestation and exposes the women collecting the wood to higher risks of gender-based violence in relatively isolated settings. To combat deforestation, schools should establish an energy plantation dedicated to the cultivation of fire wood to provide a sustainable, renewable energy source for cooking and food preparation. If the energy plantation is near the village then it will be both more convenient and safer for those collecting the wood than it is to collect in an uncontrolled forest. The type of trees that can be cultivated and the type of stove to use for cooking both influence the cooking time and the amount of biomass used in the process (Black et al., 2015; Gopal and Nagaraju, 2013).

4 Discussion

Numerous studies demonstrate that hungry students learn more poorly than those who are not (Destaw et al., 2022; Verguet et al., 2020). This problem can be mitigated in a number of different ways, with SFPs being a broadly applicable success story. Sustainable SFPs come with multiple expectations that depend on the context in which they are located for definition. Societal economics play a major role (Bundy et al., 2009; Gelli et al., 2019). In high income countries, "sustainable" programs often are expected to help mitigate climate change issues and to encourage more plant-based diets. These programs ensure that students receive one or more nutritionally adequate meals per day, but also provide education on food production systems and dietary alternatives not available in low income countries. In low-income countries, a sustainable program is one that can persist for multiple years. Our focus is on this latter situation where the challenge is ensuring that the program is sustained through time.

In low income countries community buy-in and support is the first critical test for sustainability. In these countries, especially in rural areas, direct community involvement is essential. The community must believe that going to school is important and be willing to give their children, especially their daughters, the time it takes to attend. The free school meal can be an important incentive for school attendance. Sourcing food locally is all but imperative, which requires participation by local farmers. Meal preparation requires community members to do the cooking, serving and clean-up, sometimes for little or no pay.

Research consistently underscores the pivotal role women play in enhancing the effectiveness and sustainability of SFPs. Women's involvement leads to better outcomes due to their expertise in household food preparation and child nutrition, ensuring that meals are well-planned and nutritionally adequate (Alderman and Headey, 2017; Quisumbing et al., 2018). Empowering women through these programs has broader socio-economic benefits, including increasing the number of women in the workforce, enhancing decision-making power in communities, and promoting gender equality. Community-driven programs that involve women often garner higher levels of local support and engagement, which is crucial for long-term SFP sustainability (Smith et al., 2003; World Bank, 2013). Additionally,

women's participation aligns with social protection and poverty alleviation goals, providing employment opportunities and helping lift families out of poverty, thus ensuring better educational and health outcomes for children (FAO, 2011; WFP, 2021, 2023).

Alternatives exist for sustainable SFPs in sub-Saharan Africa in terms of planning tools and energy sources. Notably, the School Meals Planner Plus (SMP+) developed by the WFP is being increasingly adopted globally to enhance the efficiency and effectiveness of SFPs, supporting evidence-based menu planning and nutritional adequacy (https://www.wfp.org/publications/2019-malawi-factsheets; Global Child Nutrition Foundation, 2022). E-cooking, or the use of electric cooking appliances, is widely recognized as a sustainable and efficient method for meal preparation in SFPs, particularly in LMICs. The transition to e-cooking can reduce reliance on traditional biomass fuels, thereby lowering carbon emissions and improving indoor air quality in classrooms. Moreover, e-cooking solutions can enhance the scalability and efficiency of these programs by offering more consistent and controlled cooking environments (Batchelor et al., 2018; Leary et al., 2019). A major challenge faced for e-cooking is the availability of electricity to power the e-cooking equipment. Upgrading the electrical grid is an obvious solution, but batteries charged from solar or wind generators also are being tested with e-cooking appliances in different forms (Coulentianos et al., 2024; Leary et al., 2021).

In many LMICs traditional biomass fuels such as wood, charcoal, and agricultural residues are commonly used for cooking food for SFPs. While these sources usually are readily available and affordable, they pose significant environmental and health challenges. Their use contributes to deforestation, greenhouse gas emissions, and indoor air pollution, all of which adversely affect human health and the environment (Batchelor et al., 2018). In contrast, transitioning to cleaner energy sources like liquefied petroleum gas (LPG), solar cookers, and e-cooking solutions can mitigate these negative impacts. LPG, for example, burns more efficiently and emits fewer pollutants than biomass fuels, reducing greenhouse gas emissions and improving indoor air quality (Rosenthal et al., 2018). Solar cookers and e-cooking solutions offer renewable energy alternatives that further decrease the carbon footprint of SFPs (Batchelor et al., 2018).

Successfully transitioning from an externally funded program, e.g., McGovern-Dole Food for Peace, to a locally supported program means that a leadership group in the community takes responsibility for the program in all ways—setting policy for materials acquisition, guiding menu development, identifying relevant educational curricula, and managing the school garden to both demonstrate optimal cultivation techniques, introduce new foods and new varieties of old ones, and provide at least some of the fresh food for the meals. Developing this expertise requires time and sensitivity to local conditions, and the transition does not occur quickly. For example, Kenya's national HGSFP began transitioning from being donor-funded in 2009 when 500,000 students were transferred from WFP programs, with the number of transferred students increasing by 50,000 per year until the HGSFP is solely government-funded (Langinger, 2011). External funding should expose the community to the multiple facets of running a program and provide leadership training for effectively managing them.

In low income settings, where food sufficiency within a household often is lacking, the focus should be on meals served at school rather than take-away programs. Food taken home is likely to serve as food for the entire family group and not just for the student whose school efforts resulted in the opportunity for the take-home food in the first place.

All food programs face the problem of food waste. Involving students in the menu planning process can be educational and reduce the amount of food wasted. If students are provided options for menus that provide calories and other essential nutrients in different combinations they can use the knowledge gained to prepare better meals and to optimize the resources available for the school lunch program. This menu buy-in also should reduce wastage in terms of food not consumed from the meals served as students will be more likely to be served meals that they have recommended.

Lower-income countries have two significant issues that usually are of minimal importance for higher-income programs. One of these is a school garden. Depending on the land available, a school garden could provide a significant proportion of the fresh produce used in the school lunches. Equally important is that it serve as a demonstration plot for the community at large to be able to observe and participate in "best practices" cultivation of indigenous and conventional foods. Fostering a more diverse diet is one of the best strategies for increasing nutritional sufficiency. A second issue for many low-income programs is an energy source for doing the cooking. If electric or gas-fired stoves and ovens are available, then the problem is one of financing. If wood is the primary energy source, then obtaining sufficient charcoal or firewood is frequently problematic. The ideal solution is a dedicated wood lot, preferably managed to provide sufficient wood in an ecologically and financially sustainable manner. Such management approaches could include biodiversity components as well as cultivation of rapidly growing tree varieties developed specifically to meet the need for firewood in the region.

Financing is an ongoing problem. When funding from external donor programs ends, then local, and often national, governments will need to assist to ensure program continuation. Planning for this transition is important for the long-term sustainability of the program since decisions made at the time of transition often are perpetuated for years afterwards through inertia, if nothing else. Outside funding is more readily justified if the community can clearly describe the value of the program, can point to the items they are contributing, and identify needs that cannot readily be met from local resources.

Evidence-based justification, including Monitoring and Evaluation (M&E), is vital to ensure that SFPs are effective and can be scaled sustainably. Strong political leadership and government involvement, driven by demand, are also crucial for securing funding and ensuring the long-term sustainability of these programs. The importance of evidence-based justification in SFPs cannot be overstated. Rigorous M&E processes allow for the collection of data on program implementation and outcomes, which can be used to make informed decisions, optimize resource allocation, and demonstrate the impact of the programs. Effective M&E systems help identify best practices, address challenges, and scale-up successful interventions. SFPs with strong M&E components tend to be more effective and sustainable (Aurino and Morrow, 2018; Gelli et al., 2019). For instance, Gelli et al. (2019) emphasize the importance of M&E in ensuring that SFPs achieve their intended educational and nutritional outcomes.

Strong political leadership and government involvement are critical for the success and sustainability of SFPs. Government commitment often translates into the allocation of necessary resources, the establishment of supportive policies, and the integration of school feeding into broader national development agendas. Political

leaders play a pivotal role in mobilizing support, both domestically and internationally, and ensuring that SFPs are prioritized (Bundy et al., 2018; Drake et al., 2017). Government demand-led approaches are also essential, as they ensure that the programs are tailored to the specific needs of the communities they serve. This demand-driven model can enhance program relevance and acceptance, leading to better outcomes and greater sustainability. The WFP highlights that national ownership and political will are among the most critical factors for the success of SFPs (WFP, 2021, 2023). Furthermore, frameworks, such as SABER, developed by the World Bank, provide a comprehensive tool for evaluating and strengthening education systems, including SFPs. SABER assesses policy domains such as policy goals, implementation, and sustainability, enabling governments to develop evidence-based and context-specific strategies. By leveraging the SABER framework, policymakers can ensure that school feeding policies are not only effectively designed but also aligned with broader educational and nutritional objectives, promoting long-term sustainability and impact (International Development Association, 2018; WFP, 2021, 2023).

5 Conclusion

In conclusion, sustainable SFPs in the LMICs in sub-Saharan Africa will differ from those found in HICs. The meals served will be simple, based on locally obtained foods to the greatest extent possible, and generally vegetarian in nature due to the relative unavailability of meat and dairy products, with programs focused on in-school meals rather than THRs. Sub-Saharan African programs will share with their high-income country counterparts the fundamental assumption that a student who is not hungry learns better, that the greater the community buy-in the more successful the program is likely to be, a continuing need for external financing and fund-raising, and the utility of the program for teaching nutritional essentials across class, income and other barriers within the community. Local teams that can manage and advocate for programs will be essential for long-term success and relevance. Recognizing the fundamental differences in expectations for these programs in high-income and low-income countries will be critical to developing relevant programs and applying previous "lessons learned" in the proper context as new programs are developed.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

MM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing, Software, Visualization. LM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing, Funding acquisition, Resources, Supervision. JH: Funding acquisition, Writing – review & editing. HP: Supervision, Writing – review & editing. AG: Writing – review & editing. AP: Writing – review & editing. IP: Writing – review & editing. RC: Validation, Writing – review & editing. BW: Validation, Writing – review & editing. PG: Validation, Writing – review & editing. ER: Validation, Writing – review & editing. JL: Writing – review & editing, Conceptualization, Data curation, Investigation, Supervision, Validation, Visualization, Writing – original draft.

Conflict of interest

RC, BW, PG, and ER were all employed by Nascent Solutions, Inc. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

LM and JFL 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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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1424354/full#supplementary-material

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