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Program pathways for sustainable, nutrition sensitive school meals: An updated framework

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Contents

1. Background

Global burden of disease analyses estimate that 20% of deaths are due to unhealthy diets (Afshin et al., 2019). Micronutrient deficiencies impair children's physical and mental development (Bailey et al., 2015). The prevalence of obesity in children and adolescents increased from less than 1% in 1975 to 6% for girls and 8% for boys in 2016 (NCD Risk Factor Collaboration (NCD-RisC), 2017). The modernization of food systems in low- and middle-income countries (LMIC) has led to rapid shifts to unhealthy diets and reductions in physical activity that have contributed to the global increase in rates of overweight and obesity (Popkin et al., 2020). Moreover, current dietary and population trends will exacerbate risks to people and the planet (Willett et al., 2019).

Attention to nutrition during all stages of child and adolescent development is necessary to ensure that children can thrive over the 8,000-day period spanning infancy to adulthood, and to protect investments made earlier in the life cycle (Black et al., 2013). School feeding programs, or school meals, is a widely implemented intervention with documented impacts across social protection, education, health and nutrition (Alderman et al., 2024). Globally, programs reach about 368 million children for a total investment of about $70 billion a year (World Food Programme, 2020).

As school feeding programs operate in nearly every country in the world, they can provide platforms to reach school-age children at scale to also improve food choices and diet quality (Hawkes et al., 2020). Experiences in high- and middle-income countries, including over half a century of programming in the USA and more recent experiences in large-scale programs in Brazil and India, involve school meals in food system transformation, where food procurement for school meals is used as an outlet for commercial farmers to market their surplus (FAO, 2021). National governments in LIMCs have also shown interest in explicitly linking food system transformation with the market for school feeding, through what has become known as "home-grown" school feeding (HGSF) (Espejo and Galliano, 2009). In HGSF, the demand for food and services from school feeding is channeled to smallholders and other supply chain actors with the intent of stimulating agricultural productivity, increasing incomes, improving diets and reducing food insecurity (FAO, ABC & UFRGS, 2021). There is little rigorous empirical evidence, however, on the effects on smallholders of participation in the market of school feeding programs (Sumberg and Sabates-Wheeler, 2011). In addition, school meal programs are increasingly being designed to also include objectives related to environmental boundaries and sustainability, though to date these links have yet to be extensively studied (Singh & Fernandes, 2018).

Importantly, the links between school meals and all the program outcomes across social protection, education, health and nutrition, agriculture and environmental dimensions, hinge on the quality of school meals as actually delivered to school children. Implementing school meals that meet quality standards, including food, nutrition, smallholder sourcing and environmental requirements is therefore an important step in realising the multiple benefits from the program (Pastorino et al., 2023).

In this paper we extend the school meals framework presented in (Galloway, 2010; Bhatia, 2013; and Fernandes et al., 2016) to describe some of the processes involved in the design and implementation of school meals to meet quality standards that include food and nutrition requirements, alongside food safety, cost, smallholder sourcing and environmental

considerations. We then present some generalized high-level process maps and program impact pathways as applied to school meal programs. These process maps and PIPs can be used to develop more detailed country- and program-specific materials that better reflect the context, and programming and evaluation needs.

2. School meals that balance dietary requirements, nutritional needs and environmental boundaries

The starting point in this process involves setting the quality standards, or requirements, for the school meal service. Typically, these standards will include information on food and nutrient based targets for school meals (Box 1). For example, food-based targets build on food-based dietary guidelines, which are designed to promote healthy food choices. Nutrient-based targets reference the daily macro- and micronutrient intake requirements in specific age groups and populations. In addition, the standards can also include targets for food safety, costs, smallholder sourcing and environmental footprint. Crucially, the optimization process requires careful cross-sectoral coordination to manage decisions on the key trade-offs involved.

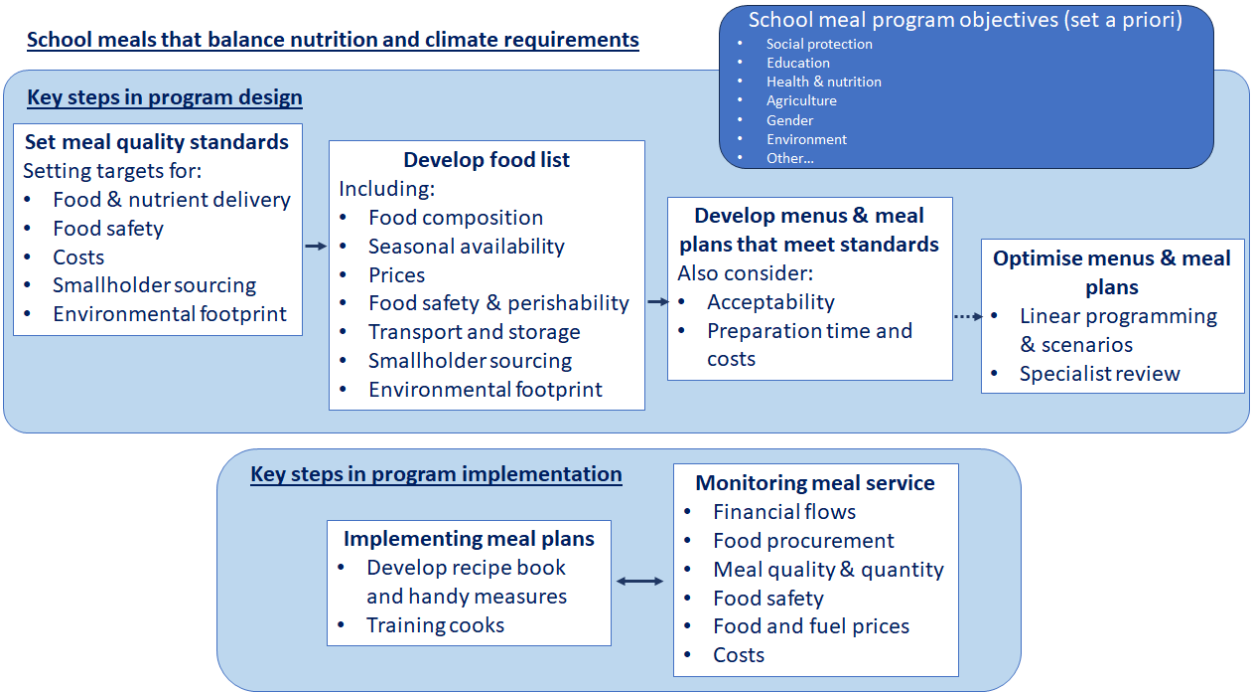


Figure 1: A framework illustrating the key steps required in balancing nutrition and climate requirements in the design and implementation of school meals (*Source: adapted from Galloway, 2010*).

Food and nutrient based requirements for school age children

Dietary needs can be characterized in terms of food-based and nutrient-based approaches. Food-based approaches typically reference food-based dietary guidelines that describe dietary patterns associated with improved health outcomes or protection against diet-related non-communicable

diseases (WHO, 2021). A review of nutrition guidelines and standards for school meals in 33 LIMCs found that most commonly, food-based standards defined portion size, preferences and restrictions for cereals, grains and tubers, followed by provisions and frequency of fruits and animal source foods, and to a lesser degree on the provision of vegetables, legumes and milk and dairy (FAO 2019). Restrictions on processed foods, including sugar sweetened products were less prominent. Fruit- and vegetable-related standards centered on frequency of consumption (ranging from twice a week to daily) and portion size requirements (ranging from 100g to 150g), with restrictions on canned or pickled vegetables. With regards to animal-source foods, frequency and portion sizes requirements varied by type of food, with restrictions typically involving processed, cured, canned and fatty meats.

Nutrient-based approaches involve the use of nutrient reference values (NRV). NRVs are used to assess the adequacy of intake in population groups and design interventions to address gaps in nutrient intake. Various sources exist for NRVs and recent efforts have been made to propose a set of harmonized NRVs for populations (Allen et al., 2019). The average requirement (AR) is defined as the average daily nutrient intake that is estimated to meet the requirements of half of the healthy individuals in a particular life stage and sex (Figure 2). Similarly, the recommended intake is the average daily nutrient intake that is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and sex. As such, using recommended intakes (e.g RDAs) will overestimate inadequacies at the population level. Though specific targets vary by context, and NRVs vary by child age and sex, school meal programs in LMICS are often designed to meet 30% of the daily nutrient requirements for primary school age children (FAO, 2019).

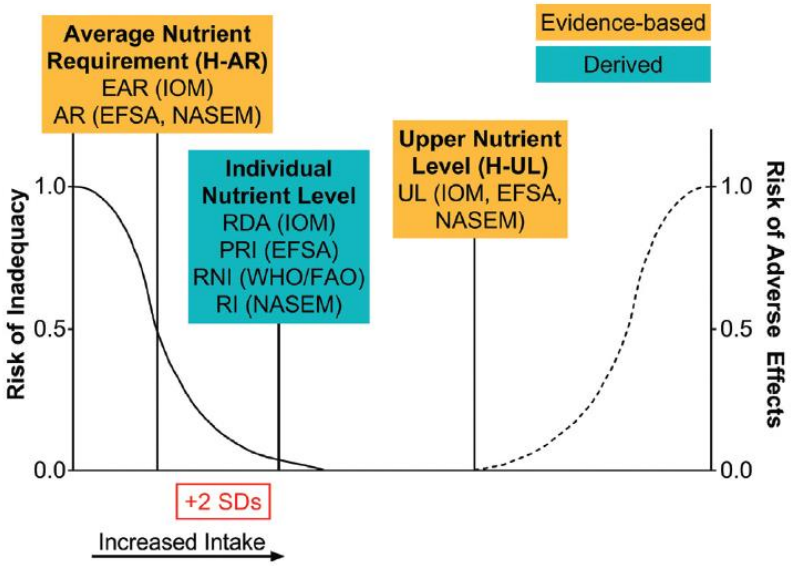


Figure 2: Distribution and terminology for nutrient reference values. IOM (1); EFSA (9); WHO/FAO (11); NASEM (16). AR, average requirement; EAR, estimated average requirement; EFSA, European Food Safety Authority; H-AR, harmonized average requirement; H-UL, harmo-

nized upper level; IOM, Institute of Medicine; NASEM, National Academies of Sciences, Engineering, and Medicine; PRI, population reference intake; RI, recommended intake; RNI, recommended nutrient intake; UL, tolerable upper intake level. *Source* (Allen et al., 2020).

Operationalizing *school meal standards through menus and meal plans*

Once targets are set, the next step is to operationalize these standards through the development of meals and menu plans(Fernandes et al., 2016). Developing menus and meal plans involves building recipes based on items from the food list that also account for local preferences and acceptability, as well as preparation time and costs. This first step entails developing a food list, including a database with information on food composition and food groupings, seasonal availability, food prices, costs of transportation and storage and cooking facilities. Other important elements to consider include food safety measures and equipment (e.g. refrigeration) and metrics on viability of small holder sourcing, and environmental footprint.

Factors to consider when developing menus and meal plans include:

- Food composition and food groupings: This involves leveraging appropriate food composition tables (FCTs) that classify food into appropriate food groups and allow conversions of food quantities into nutrients.
- Availability and seasonality of foods: Examining seasonal calendars to examine availability of nutritious foods, including fruits, leafy green vegetables and other highly seasonal foods, including under-utilized indigenous varieties. Varying menus based on seasonal foods can increase diversity and sustainability of supply. Resilience to climate risk can also be a factor to be considered when identifying foods.
- Food prices and costs of preparation: Obtaining reliable data on food prices, including variations over time and geographical contexts is key to ensuring the feasibility of the meal planning and implementation. Factoring in non-food costs in the budgeting process is also important in terms of feasibility, including costs for cooking foods which may also vary by food type(Galloway et al., 2009).
- Food transportation and storage: Relevant non-food costs to also consider include transport costs (particularly relevant for centralized or semi-decentralized models), as well as storage, particularly for perishable foods.
- Food processing requirements: Processing foods can affect shelf-life, nutrient density, cooking/preparation time.
- Food preparation: Consider limitations based on available facilities, fuel, cooking utensils, and water. Excessive cooking can also reduce levels of key vitamins and minerals, though levels of nutrient loss vary by foods and nutrient. Foods can also be prioritised based on ease of preparation, including a minimum use of fuel; for example, processed foods or cereal flours involve shorter cooking times than whole grain cereals. Ease of preparation is especially important when meals have to be served before classes start or during the mid-morning break, in half-day schools.

- Potential food safety and contamination: Regardless of the specific implementation models, developing and implementing food safety standards throughout the supply chain from production to meal distribution is key to ensure that school meals are safe for children to consume. This is particularly relevant in decentralized models where quality control capacity is limited and in contexts where cooking is undertaken by volunteers with limited capacity and training on food safety and hygiene.

- Potential for smallholder farmers sourcing: Linking school meal food provision to smallholder farmers can channel resources into the economy as well as increase the acceptability of foods that are accepted in the school communities.

- Environmental footprint of food supply chain: Food production systems involve approximately a quarter of human induced greenhouse gas emissions (GHGE). Greenhouse gas emissions of food supply chain, as well as water use in sourcing foods (e.g. blue water use, or scarcity weighted water use), can provide useful metrics to gauge the environmental boundaries involved in sourcing different types of foods.

- Acceptability and food preferences of school children: Selecting foods and recipes that meet the culinary customs of the targeted communities is key to ensure the acceptability of the school meals in the student population. However, school meals can also be used to introduce some nutritious varieties that are also undervalued, though this requires careful community level sensitization on the benefits of these foods.

It's important to note that obtaining reliable metrics for many of these dimensions may be challenging and remains an important area of ongoing research, including for example, the development of the Environmental Impact of Diets metrics (Intake, 2023).

Scenario based optimization analysis

When completed, these menus and meal plans can also provide the basis for optimization analysis, where linear programming is used to identify solutions that balance the different dimensions covered by the meal quality standards (Eustachio Colombo et al., 2019). Scenarios can also be used during the optimization analysis to examine the influence of applying different types or levels of constraints, including food and nutrient targets (e.g. as % of daily requirements), costs (e.g. budget per child per day, including projections that account for inflation), GHGE, water use and other relevant metrics. Various tools exist that allow for optimization, including the free online School Meal Planner Plus (SMP Plus).

Meal plan implementation

Once reviewed and validated by nutritionists and other program specialists, the menus and meal plans can be operationalized and integrated into the school meal program implementation (Figure 3). This typically entails developing training materials for school caterers, including recipe books and practical measurement guides for portions that can be used when preparing and serving the school meals to ensure adequate service delivery.

- Recipes books, including quantities of ingredients per child per day, can be used in combinations to develop meal plans and schedules, covering multiple days, weeks and months throughout the school term. These can include instructions for meal preparation.
- In turn, meal plans and schedules can be used to develop schedules for bulk food procurement that can be shared with potential suppliers, including smallholder farmers. These would include the types, quantities and prices for foods that are required for the school meals, and can be easily obtained by multiplying the per child per day ingredients by the number of children to be served for each meal.
- Meal plans and schedules can be complemented with guidelines to ensure that children are served adequate food portions. This often entails converting portions size measurements from grams-per-child to portions per serving using practical measures/utensils (e.g. standard sized cups, spoons or ladles) that are available to cooks and caterers serving the food to school children.
- Training for caterers and cooks can then be provided using the recipe books and guidelines for preparation and serving to ensure the meal plans are implemented as planned.

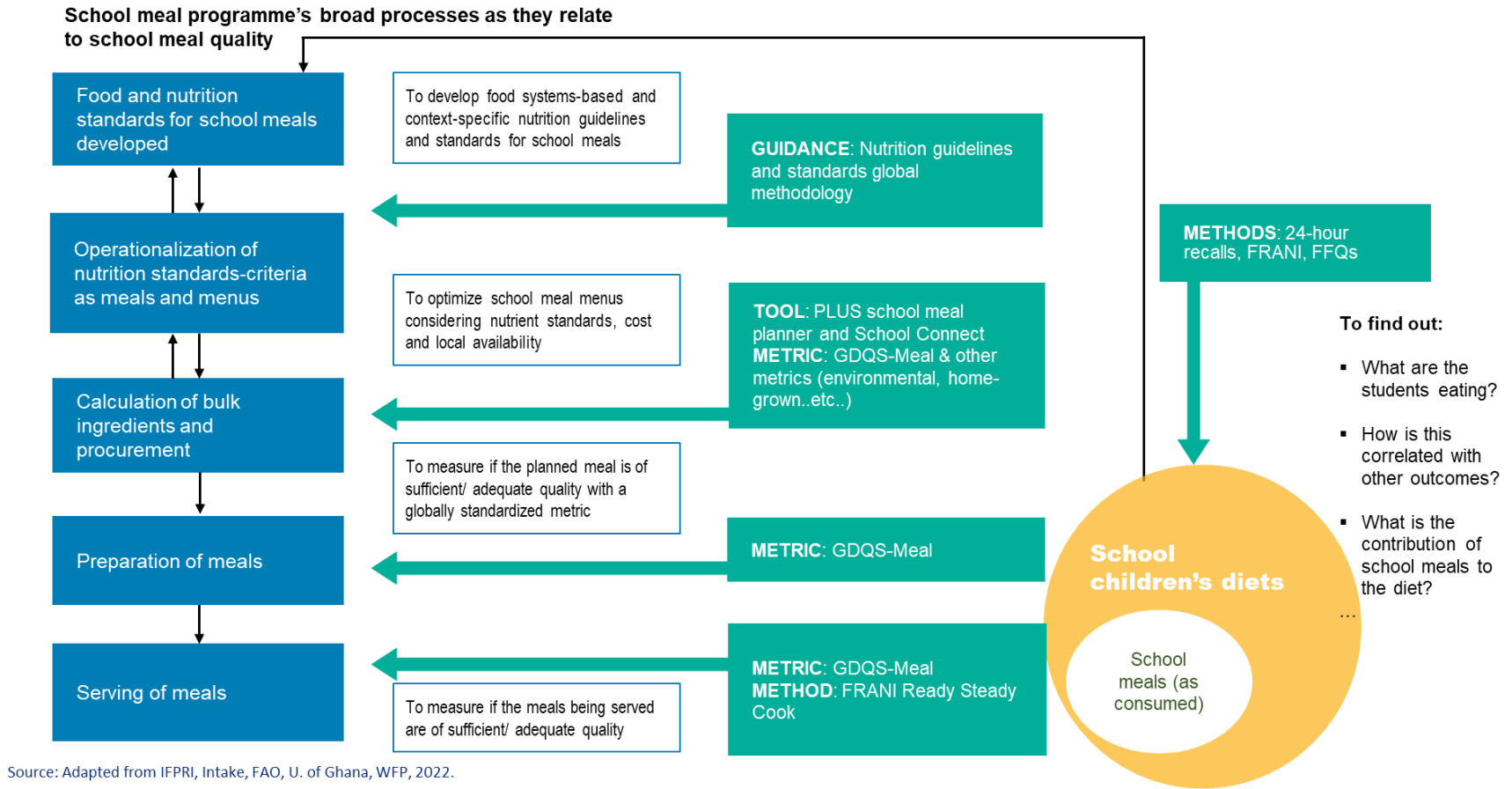


Figure 3: Stylised view of key school meal planning and implementation processes as they relate to meal quality and children's diet, and example metrics and methods for measurement. (**Source**: *Adapted from IFPRI, Intake, FAO, U. of Ghana, 2022*). GDQS: Global Diet Quality Score; FFQ, Food frequency; FRANI, Food Recognition and Nudging Insights.

Monitoring school meal quality

The last key step in the school meal planning cycle centers on monitoring the quality of the meal service provision, including data on financial flows, food procurement, meal quality and quantity, frequency, food safety, prices (food and non-food) and financial and opportunity costs (Gelli and Suwa, 2014). Measuring school meal quality as planned and implemented is key to ensure the program can deliver its multiple benefits. However, in practice there is little or no published data on day-by-day implementation, as the costs and complexity of data collection and analysis have been challenging. Integrating the environmental sustainability perspective into existing methods and metrics developed to support the design, implementation and monitoring of school meal programs is an important area of ongoing work. In addition, and where and when needed, the relative contribution of school meals relative to daily food and nutrient intake can also be measured, though the costs and complexity involved should be carefully considered.

This is an active research area that has seen some important recent innovations, including:

- The new Global Diet Quality Score-Meal and Menu metrics (GDQS-Meal and GDQS-Menu) developed by Intake/Rockefeller provides comprehensive information on the quality of the meal served in institutional settings. The initial primary application was targeted for use in school feeding programs globally and was designed to be low-cost, robust, and appropriate for use across different countries and contexts. The GDQS-Meal indicator can be used to provide a score for meal plans, and for meals as prepared and served to school children.

- Dietary assessment tools that leverage mobile technology have been proposed but these are limited by lack of feasibility and validity assessments, particularly in school-age children in LMICs (Bell et al., 2017). Another recent innovation that shows potential in this area is the PlantVillage Food Recognition Assistance and Nudging Insights (FRANI) app that can recognize foods, estimate nutrient content and provide feedback in real-time based on a picture taken with a mobile phone. Evidence generated in rigorous validation studies shows that FRANI can estimate food and nutrient intake as accurately as a dietician undertaking a dietary assessment at a fraction of the cost (Folson et al., 2023; Nguyen et al., 2022). A pilot validation study with the Ghana School Feeding Program supported by WFP suggests that PlantVillage FRANI dietary assessment is also valid in school age children and can provide feedback on meal quality in real-time (Figure 4).

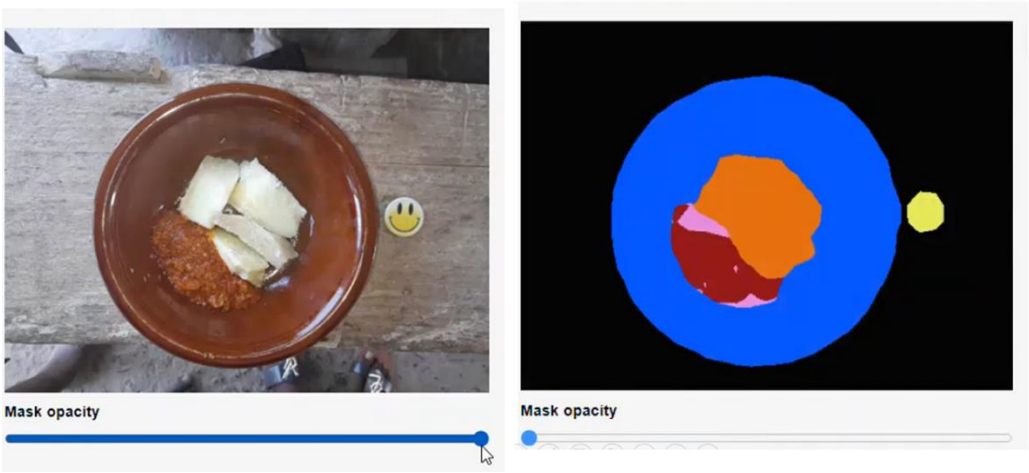


Figure 4: Example computer vision model input and output for real-time FRANI food recognition and portion size estimation of school meals in Ghana.

3. Detailed process map and program impact pathway for school meals, diets and nutrition encompassing environmental boundaries

An example process map including key program design and implementation steps for school meals, including school meal planning and food procurement, as described in the previous sections is summarized in Figure 5. These steps highlight the key program elements involved in determining the quality of the school meals and can be used to illustrate how these processes underpin the PIP (Figure 6) and link with the different potential pathways, including child health and nutrition, education and smallholder agriculture, in the case of HGSF.

An updated PIP summarizing the impact theory for school feeding is shown in Figure 6. The PIP includes several important updates, firstly, improving children's diet [box 23] is an explicit key proximal outcome in the PIP leading to improved nutrition outcomes. On this pathway, food intake will depend on what happens in school, at home and in the surrounding food environment [boxes 17-18]. The diet related outcome has been separated from the daily food consumption outcome to highlight the "habit formation" involved in shaping diets. In addition, the links to smallholder farmers is also illustrated [box 26].

It is important to note that the generic process map and PIP can be used to develop more detailed country- and program-specific materials that better reflect the context, and programming and evaluation needs. Several aspects of the process map and PIP require particular attention when undertaking the more detailed development and related analysis. Two aspects that are particularly relevant involve i) the implementation model or supply chain configuration of the school feeding service delivery and ii) the specific age-groups targeted by the school feeding programme.

Developing context specific PIPs can be an important first step in examining programming modifications/improvements, as well as supporting the design of monitoring and evaluation systems, including process and impact evaluations.

Figure 5: Key processes involved in the development of school meal quality and procurement standards. (Source: Adapted from IFPRI.WFP, 2022.)

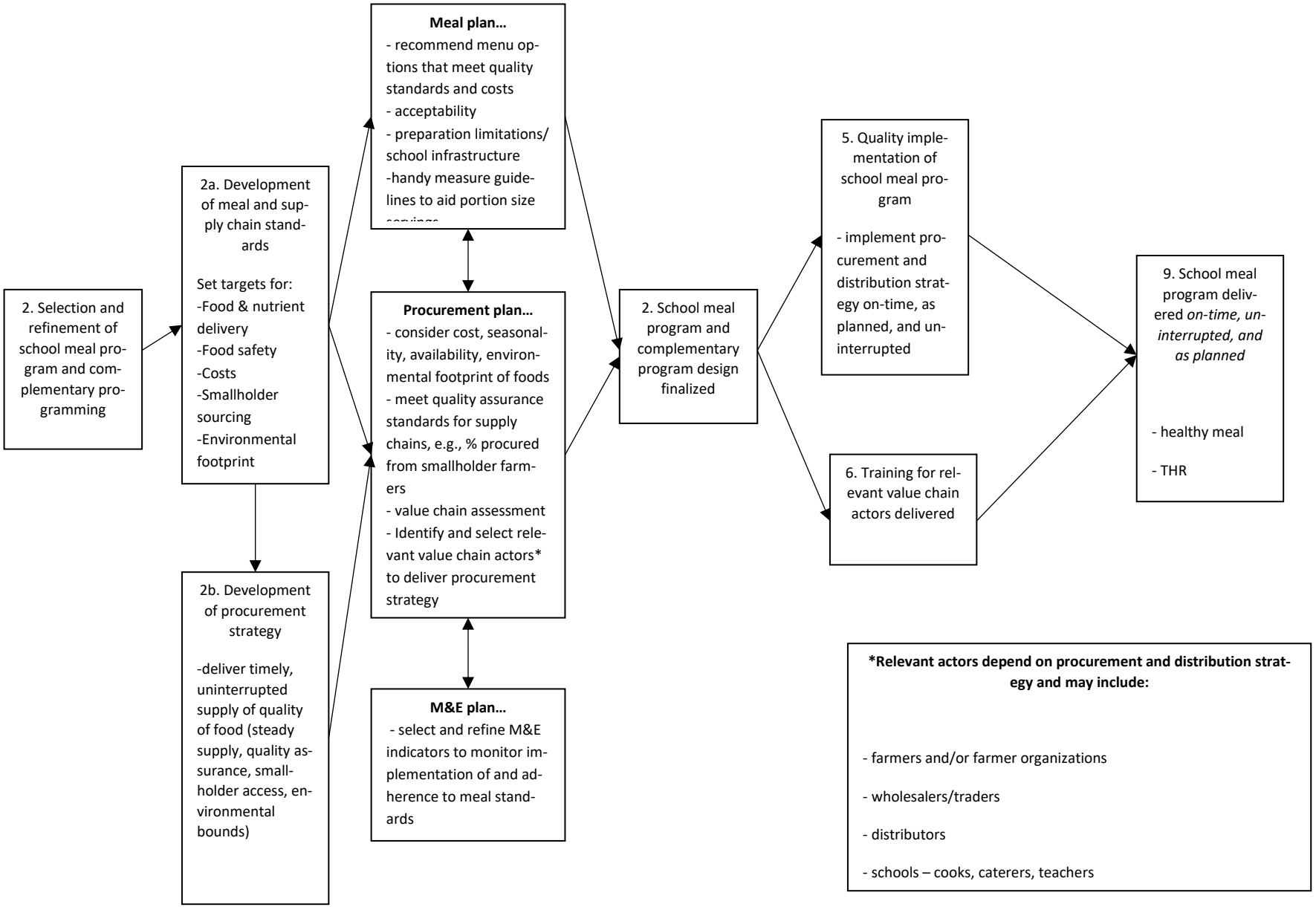
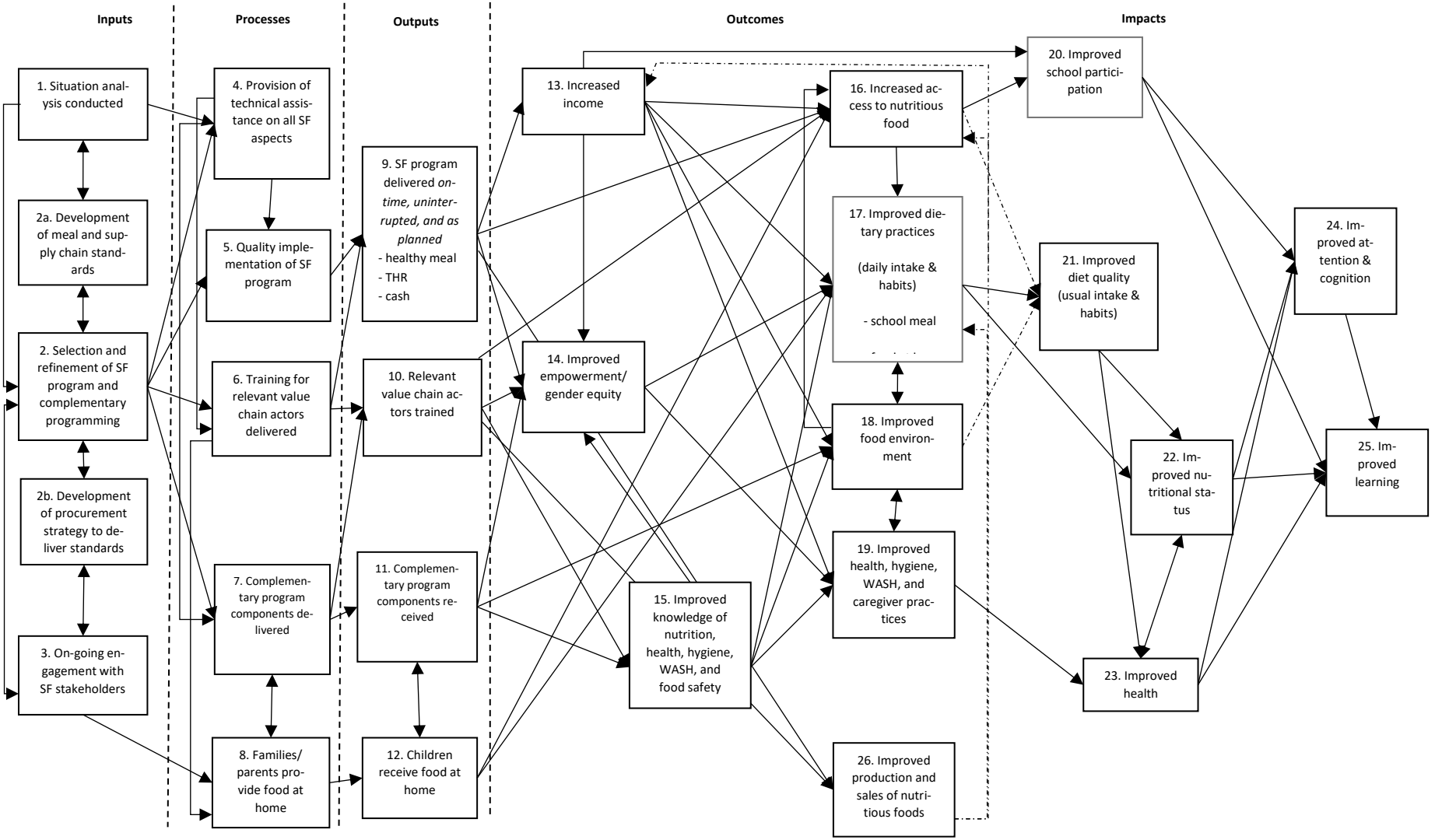


Figure 6: Generic program impact pathway for nutrition-sensitive school feeding programmes. (Source: Adapted from IFPRI.WFP, 2022.)



Note: The process moves from left to right. Box numbers and vertical order within sections do not imply higher priority/importance or earlier timing in the process. Bi-directional arrows indicate iterative and interactive activities. Dashed arrows represent theoretically plausible pathways for which evidence is lacking.

Description of the key steps (boxes)

Inputs

1. Situation analysis conducted of the vulnerabilities and needs of school-aged children, which may include pre-primary, middle childhood or adolescents depending on the context. The goal is to understand health and nutrition problems and the basic, underlying, and immediate determinants of those problems in order to help identify nutrition objectives. This may be conducted by government, or other local/national partners. Situation/context analysis may include SABER, fill the nutrient gap, assessments of food and nutrition security, poverty and inequity; and coverage, gaps, and challenges in delivery of school-based health and nutrition services, etc.
2. Design of school meal program and complementary programming components to meet needs of target group. This includes defining coverage, target groups, food basket, and procurement and distribution modalities, and the creation/selection of complementary activities under the design of a package of interventions. It also includes the adoption of the meal and procurement standards developed/revised as part of 2a and 2b. This may include the addition of new components/activities. The potential stakeholders and activities in the development of standards are described in **Figure 2**.
    a. Development of meal and supply chain standards, including standards for the quality and quantity of the meal, food safety, environmental footprint and school infrastructure. The planning process for designing school menus and standards is visualized in **Figure 1.**
    b. Development of procurement strategy to deliver standards. This involves the development of an operational strategy to deliver timely, uninterrupted supply of quality of food (steady supply, quality assurance, smallholder access and environmental bounds); identifying and selecting relevant value chain actors to deliver procurement strategy; and conducting a value chain assessment covering capacities of different actors along the value chains.. The objectives and underlying benchmarks of a SF procurement strategy are shown in **Annex Figure 1.**
3. On-going engagement with all relevant national and local school meal/education stakeholders, including parents and communities. Stakeholders will vary by context but will include all actors involved in the implementation of a full integrated package of SHN activities.
    a. The selection and refinement of the school meal program and engagement with all relevant stakeholders are closely related, iterative, and interactive processes as indicated by the bi-directional arrow
    b. Engagement with stakeholders now explicitly involves engagement with government, school staff, parents and communities

Processes

4. Provision of technical assistance on all school meal aspects. The breadth and type of technical assistance will depend on the situation analysis (#1) and school meal program (#2). It will also depend on the transition stage in contexts where external programs are transitioning to government-owned programs (see also the classification as per the WFP school feeding strategy (context 1,2, or 3)

5. Quality implementation of SF program at scale - SF program is being implemented according to SF implementation strategy and plan by relevant parties, depending on the context this may involve government, WFP and/or third parties. Regardless of delivery actor, technical assistance (#4) usually supports school meal program implementation, as demonstrated by the arrow from #4 to #5.
6. Relevant value chain actors identified/selected and school meal program training delivered. Actors may involve caterers, cooks, or other relevant value chain actors depending on the type of SF modality, e.g., HGSF, snacks, hot meals, etc. May involve international procurement, parents in HGSF or modalities where procurement is from local smallholders. The type of training delivered is informed by the SF modality and complementary program components (#2) and supported through technical assistance (#4). This box is intended to capture any support to partners involved in the program, including training needed to deliver the program meeting quality standards, e.g., food procurement. Any additional training on nutrition, hygiene, food safety, or other relevant topics would be captured by the complementary program components and go through the #2 → #7 → #11 pathway, also including community level actors.
7. Complementary program components delivered. Determined by #2 and supported by WFP technical assistance (#4). This may be delivered by government, WFP or other partners working in other sectors. Typically includes health and nutrition services for the target population.
8. Families/parents provide food at home. This box was newly added to the revised PIP to explicitly reflect the role of families and the contribution of home meals to children's diets. Broadly speaking this encompasses the food environment at home. In most LMICs setting this usually entails only the food availability and accessibility at the home, i.e., what foods/meals parents/families provide to their children at home. The box is connected to #3, which now explicitly includes engagement with parents. The latter can take various forms depending on local priorities, the school meal modality, and complementary programming. Complementary programming may explicitly include activities for parents. Complementary programming for the target population of children may influence what foods children eat at home. These relationships are indicated by the bi-directional arrow between #7 and #8. This box is also informed by #6 (training of relevant value chain factors) since in HGSF contexts parents can also be value chain actors for the SF program, e.g., parents supply the food used for the school meal.

Outputs

9. School feeding program received by targeted beneficiaries on-time, uninterrupted, and as planned.
    a. The revised PIP now explicitly breaks down the school meal program into three components that may be implemented alone or concurrently, including: (1) healthy meal received at school, (2) THRs, and (3) cash-based transfers to capture the three primary WFP SF modalities.
    b. Box is now linked to #6 (training of relevant value chain actors). Training of value chain actors can influence the quality of the meal/transfer and other food practices (e.g., food safety, hygiene) related to the preparation, storage, and distribution of the meal/transfer.
10. Relevant value chain actors trained. The type of actors will depend on the context and SF modality. The type of training will also depend on the context, modality, and complementary programming. Training only needed to deliver the SF modality goes through the #2 → #6 → #10 pathway. Training that may involve other topics (e.g., nutrition, hygiene, food safety) goes through the #2 → #7 → #11 pathway.
11. Complementary program components received by target beneficiaries on time and as planned

12. Children receive food at home. This box is directly determined by #8, what food parents provide at home. However, it can also be determined by #12, what additional programming children receive at school, which may influence their food choices and practices at home. Vice versa, the food environment at home may influence how they engage with complementary programming. These relations are indicated by the bi-directional arrow between #12 and #13.

Outcomes

13. Increased income to households whose children receive school feeding assistance.
14. Improved empowerment/ gender equity. This particular result (through income transfer (girls), participation in value chain activities (employment for women) and through BCC on role of women in decision making, for example), though aspirational is in-line with the analysis and evidence from nutrition sensitive social protection interventions.
15. Improved knowledge of nutrition, health, hygiene, WASH, and food safety – newly added is food safety knowledge as an outcome from food safety training received by relevant value chain actors (arrow from #10 to #15 added)
16. Increased access to nutritious food, from increased income at household-level, from the school meal, including the following:
    a. Newly linked to #10 since relevant value chain actors may receive nutrition training through complementary program components which may influence the types of foods they select for school meals or use to produce THRs.
    b. Newly linked to #12 since the contribution of food at home is now explicitly included in the PIP.
    c. Newly linked to #18 since improvements in the school food environment may influence access to nutritious foods, e.g., if local retailers start selling healthier foods.
17. Improved dietary practices (daily intake & habits)
    a. Newly broken down into the contributions of the school meal, food at home, and the food environment. The school meal contribution is related to the health meal received at school. The food at home contribution is related to the food children receive at home, but also to the transfer/THR assuming it is consumed at home. The food environment contribution is related to the foods children consume outside of school and home, and may be related to the transfer if children receive cash (i.e., for adolescents) or to changes in household income resulting from the SF program.
    b. Newly linked to #18 through a bi-directional arrow – dietary practices influence how children engage with the broader food environment and the food environment itself may influence children's dietary practices. The bi-directional arrow also indicates these linkages are iterative and interactive.
    c. Newly linked to #12 to explicitly show the links between food consumption and food practices at home to dietary practices.
    d. Newly linked to #23 since daily intake & habits may influence nutrition directly, such as in the case of fortified snacks/products which typically do not aim to improve usual intake & habits.
18. Improved food environment – newly added box to reflect the food environment at school. This may be influenced by any complementary program components targeted to improving the food environment around schools, e.g., changing what local retail shops sell (arrow from #11 to #18 added). Food environment actors like retailers are not depicted on the PIP. The types of actors will be determined by engaging

with relevant stakeholders and selecting and refining complementary program components. Thus, the food environment is influences through the #3 ↔ #2 → #7 → #11 → #18 pathway.

    a. Linked to #13 since changes in income may influence children's allowance which in turn may influence how they engage with the food environment.
    b. Linked to #15 since changes in knowledge may influence how children engage with the food environment.
    c. Linked to #17 to demonstrate linkages between dietary practices and the food environment as described under #17b.
    d. Linked to #20 through a bi-directional arrow to demonstrate that WASH and other practices may influence how children engage with the food environment, but the food environment can also determine these practices. The bi-directional arrow indicates linkages are iterative and interactive.

19. Improved health, hygiene, WASH, and caregiver practices
    a. Newly linked to #18 as described in #18d
20. Improved school participation (enrolment, attendance etc..)
21. Improved diet quality (usual intake & habits)
    a. Usually improved by changing daily dietary practices (e.g including dietary diversity) as illustrated by the arrow from #17 to #21
    b. #16 and #18 improve diet quality indirectly through daily dietary practices. However, direct effects of #16 and #20 on diet quality are also plausible as illustrated by the dashed arrows.
22. Improved nutritional status (of girls and boys)
23. Improved health
24. Improved attention & cognition
25. Improved learning
26. Improved nutritious food production and sales for smallholder farmers

4. Policy Relevance and Broader Implications

School meal programs are effective safety nets implemented in nearly every country in the world. Arguably, the key issues for policymakers today are not related to whether school meals programs are effective or not- rather they relate to how programs could be designed and implemented to be more cost-efficient, more effective whilst minimizing impacts on the environment. This paper extends the existing program theory for school meal programs to include some of the key processes involved in ensuring that intervention design and implementation can be optimized to deliver benefits across multiple benefit streams, including social protection, education, health and nutrition, agriculture, whilst also considering environmental bounds. The focus is on unpacking the links between the quality of school meal program delivery and program outcomes, highlighting that implementing programs that meet quality standards across food, nutrition, smallholder sourcing and environmental requirements is a critical step in realizing the multiple benefits from the program (Pastorino et al., 2023).

Key take-aways from this work include:

1. There is a need to support school program implementation and ensure the quality-of-service delivery, including setting clear quality standards supported by adequate financing and technical capacity for program implementation.
2. Decision support tools, including meal planning optimization, can be extended to incorporate environmental sustainability data and provide evidence on potential trade-offs involved in program design options
3. Mobile, AI-assisted technology can provide accurate and cost-efficient data on school meal quality that can be used to provide feedback on operational targets to program implementers in real-time.
4. Important questions remain on how to enhance school meal program cost-effectiveness, including on how to leverage existing technologies providing real-time monitoring data to strengthen monitoring and accountability, and support the quality of program delivery.

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