

Large-Scale Food Fortification Data Indicators and Use

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Joint Foreword

Micronutrient deficiencies continue to affect the health, development, and well-being of billions of people worldwide. Large-scale food fortification (LSFF) remains one of the most cost-effective and scalable approaches to address these deficiencies, delivering essential vitamins and minerals through commonly consumed foods and existing food systems.

The impact of LSFF depends not only on sound policies and effective implementation, but also on the ability to generate and use good-quality data to guide decision-making and strengthen programs over time.

As countries invest in strengthening food systems and expanding LSFF, the demand for reliable and actionable information has never been greater.

Data are needed to inform decisions on where fortification may be most relevant, identify suitable food vehicles and nutrients, track program implementation and compliance, assess coverage and quality, and understand who is being reached. However, the collection and use of LSFF data remains fragmented in many settings, making it harder to compare progress, learn from experience and strengthen accountability across programs and countries.

This guidance has been developed to address these challenges. It provides a practical and harmonized framework for selecting and using indicators across the fortification program cycle. Furthermore, it supports stakeholders to identify gaps, understand progress, and make informed decisions about where attention and investment are most needed - helping turn data into action.

The publication reflects the shared commitment of Micronutrient Forum, UNICEF, the World Food Programme and partners across the fortification community to advancing effective, accountable and sustainable fortification programs. By promoting greater alignment in how progress is measured and reported, it supports collective efforts to strengthen national systems, improve program implementation, and maximize the contribution of LSFF to nutrition goals.

We encourage governments, industry, development partners, researchers, and practitioners to use this guidance as a practical tool to strengthen monitoring, learning and action on LSFF. When good-quality data are consistently generated, understood and used, they can help drive better decisions, stronger programs and greater accountability.

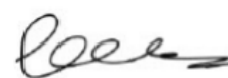
Ultimately, this can help expand access to fortified foods, improving micronutrient intake and contributing to better nutrition, health and development outcomes for children, women and populations everywhere.



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Abbreviations

Abbreviation	Meaning
24HR	24-hour dietary recall
DHS	Demographic and Health Surveys
DInA	Micronutrient Data Innovation Alliance
EFSA	European Food Safety Authority
FAO	Food and Agriculture Organization of the United Nations
FACT	Fortification Assessment Coverage Toolkit
FBS	Food balance sheets
FFQ	Food frequency questionnaire
GAIN	Global Alliance for Improved Nutrition
GFDx	Global Fortification Data Exchange
GIFNA	Global database on the Implementation of Food and Nutrition Action
HCES	Household consumption and expenditure survey
IOM	Institute of Medicine
LSFF	Large-scale food fortification
MICS	Multiple Indicator Cluster Surveys
MT	Metric tons
SUA	Supply utilization accounts
TEAM	WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring
UNICEF	United Nations Children's Fund
VMNIS	Vitamin and Mineral Nutrition Information System
WFP	World Food Programme
WHO	World Health Organization

Glossary

Definitions are intended to support consistent interpretation of terminology across all sections of the guidance, including indicator overview tables, decision pathways, reference sheets, and appendices.

Many of the definitions in the table below were adapted or copied directly from the [Micronutrient Data Innovation Alliance \(DInA\) Lexicon](#)¹, which compiles definitions of fortification-related terms from various sources including WHO's 2021 flour monitoring manual.²

Term	Definition
Access	Obtaining a fortified food or food made with fortified ingredients for household use from any source, regardless of whether it was consumed.
Compliance	The extent to which a producer, importer, product, or consignment meets applicable food fortification legislation, regulations, standards, and regulatory requirements.
Compliance cascade	A monitoring framework that tracks progression through successive stages of regulatory oversight, from eligibility and inspection through compliance determination, corrective action, and enforcement.
Cutoff	A specific quantitative value used to divide continuous biological measurements into distinct clinical groups, such as high-risk and low-risk.
Complementary interventions	Interventions that may be implemented alongside fortification to increase provision of micronutrients in the same context, including biofortification and supplementation, which may directly or indirectly affect micronutrient status.
Fortification	The practice of deliberately increasing the content of essential micronutrients (i.e. vitamins and minerals, including trace elements) in a food to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health.
Fortified foods	Foods, condiments, and beverages to which fortificants (source of vitamins and/or minerals) have been added.
Fortification standards	Technical specifications for foods that may include a section about fortification. Standards may be voluntary or compulsory with the force of law. However, manufacturers are obliged to follow the technical specifications if they wish to make a relevant claim, such as that a product is fortified.
Food vehicle	A food, condiment, or beverage (such as salt, sugar, rice, cereal flour, milk, or edible oil) that can be fortified. The term "vehicle" reflects the fact that these food products are the means by which additional vitamins and minerals are provided to those who consume them.
Fortifiable vehicle	A food, condiment, or beverage that is industrially processed and could be fortified according to national, regional, and/or local legislation and standards.
Fortification value chain	The systems, processes, and actors involved in the production, importation, distribution, sale, regulation, monitoring, and enforcement of fortification premix and fortified foods, from premix production or importation through to compliance oversight of fortified foods.
Fortification vehicle	Staple foods and condiments that are determined to be regularly consumed by the target populations, to which fortificant or premix is added.

Indicator	A measure used to assess, monitor, or evaluate a condition, process, output, outcome, or impact .
Large-scale food fortification	Fortification at an industrial scale, i.e., involving mechanization and at sufficient scale to enable consistent fortification and quality control in an efficient and low-cost manner. Governments should determine what counts as “large-scale” in their context; the definition may relate more closely to efficiency, packaging, and other factors than to output in metric tons.
Legislation	The process of making or enacting a written law through a formal procedure by a branch of government constituted to perform this process. Also termed lawmaking or statute-making.
Micronutrients	Vitamins and specific mineral elements collectively referred to as “micronutrients” because dietary requirements for these essential nutrients are relatively small compared with carbohydrates, fat, and protein, which are regarded as “macronutrients.”
Micronutrient biomarker	A measure or indicator of micronutrient exposure, status, or function measured in bodily fluids or tissue.
Micronutrient deficiency	A state of inadequate intake, absorption, and metabolic availability of micronutrients required to support basic physiological processes required for health and development. Deficiencies can be caused by insufficient amounts of a micronutrient in the diet or by disease, infection, or other factors that affect nutrient absorption, retention, or utilization, or loss.
Micronutrient sufficiency	A state of optimal intake where an individual consumes and absorbs the adequate amount of micronutrients needed to maintain normal physiological processes, growth, and homeostasis.
Micronutrient excess	A state of overconsumption where micronutrient intake exceeds the upper tolerable limits of the body and may cause harm.
Mandatory fortification	Fortification that is mandated by government legislation and regulations and enforced by monitoring and regulatory control.
Population group	Groups of individuals reached by a program that may be used to disaggregate analyses.
Quality assurance	Planned and systematic activities conducted before and during production to ensure fortified foods are consistently produced according to fortification and quality requirements.
Quality control	Activities conducted during and after production to verify that the final product meets specifications.
Regulation	A legally enforceable requirement issued under the authority of governmental legislation that specifies procedures of implementation, monitoring, and enforcement.
Regulatory framework	The set of legislation, regulations, standards, procedures, and enforcement mechanisms that govern food fortification.
Resolution of non-compliance	Corrective actions that successfully address identified non-compliance and result in verified compliance with applicable fortification requirements.
Voluntary fortification	Fortification for which standards exist but that the food industry is not required to apply. However, the industry must comply with the standards to claim that its products are fortified.



Executive Summary

Micronutrient deficiencies remain a major public health challenge worldwide, affecting the health, development, productivity, and well-being of millions of people. Large-scale food fortification (LSFF) is the addition of vitamins and minerals to industrially processed foods produced at sufficient scale to enable consistent fortification and quality control. It is a widely used and evidence-based strategy for improving micronutrient supply and reducing micronutrient inadequacy, a leading cause of deficiencies. LSFF programs have demonstrated benefits for micronutrient status and related health outcomes when they are appropriately designed, implemented, monitored, and evaluated.

Effective fortification programs depend on high-quality data. Data are needed to determine whether fortification is warranted, identify appropriate food vehicles and nutrients, assess implementation readiness, monitor compliance, and evaluate coverage and impact. However, LSFF data are often collected using different definitions, methods, and reporting practices. Although numerous tools and resources support LSFF programming, no single resource has previously provided a harmonized framework for selecting, interpreting, and using indicators across the full LSFF program cycle.

This guidance provides recommendations for the selection, calculation, interpretation, and use of indicators that support evidence-informed decision-making throughout the LSFF program cycle. The guidance is intended for governments, regulatory agencies, food producers, development partners, researchers, civil society organizations, and regional and global institutions involved in fortification policy, implementation, monitoring, evaluation, and technical support.

The guidance organizes indicators within a conceptual framework comprising four cyclical stages of LSFF programming: Design, Implement, Monitor, and Evaluate. This framework recognizes that fortification programs operate within dynamic food systems and that evidence generated through monitoring and evaluation may require programs to be adapted, strengthened, or redesigned over time. Indicators are therefore linked not only to program stages, but also to the key decisions that stakeholders must make throughout the life cycle of a fortification program.

Indicators included in this guidance were identified through a review of existing LSFF and nutrition monitoring resources and refined through a structured process involving a working group representing diverse technical expertise and stakeholder perspectives relevant to large-scale food fortification. Indicators were prioritized according to their relevance for decision-making, feasibility, applicability across settings, and potential value to LSFF programs. The resulting indicator set includes both core indicators, which are recommended for broad use across contexts, and non-core indicators, which may provide valuable information for specific programmatic questions, particular contexts, or in-depth analyses when additional data, resources, or technical capacity are available.

In addition to indicator definitions, the guidance provides practical recommendations on indicator selection, data quality, interpretation, disaggregation, methodological considerations, and adaptation to context. It highlights common LSFF data sources, discusses key assumptions underlying indicator calculations, and outlines considerations related to sample size, representativeness, resource requirements, and national differences in food systems, regulatory environments, and data availability. Special attention is given to concepts such as large-scale production, fortifiable and fortified foods (because they determine the potential reach and feasibility of fortification), and the contribution of fortified food ingredients consumed through food products (because fortified ingredients may contribute to micronutrient intake through processed foods and therefore affect estimates of program reach and impact).

A decision pathway is included to help users navigate indicator selection by linking key programmatic questions to relevant indicators at each stage of the fortification cycle. The guidance also provides an overview table of core and non-core indicators and detailed reference sheets describing the purpose, interpretation, data requirements, and application of each core indicator. The core indicators are recommended for broad use across contexts, and non-core indicators, may provide valuable information for specific programmatic questions, particular contexts, or in-depth analyses when additional data, resources, or technical capacity are available.

Ultimately, stronger and more harmonized indicator use can support better decisions, more effective fortification programs, greater accountability, and improved nutritional outcomes for populations at risk of micronutrient deficiencies. Furthermore, standardized indicators may improve consistency, comparability, and usefulness of fortification data across countries and programs.

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1

Introduction



Background and Rationale

Deficiencies of vitamins and minerals (hereafter referred to as micronutrients) remain a major global public health challenge. An estimated 56% of children 6–59 months of age and 69% of women 15–49 years of age experience at least one micronutrient deficiency.³ These deficiencies can adversely affect growth, development, health, productivity, and well-being. Large-scale food fortification (LSFF) refers to the addition of vitamins and minerals to industrially processed foods produced at sufficient scale to allow consistent fortification and quality control. As such, LSFF is one of several evidence-based public health strategies used to address the insufficient dietary intakes (i.e., inadequacy) of micronutrients, which are a main cause of micronutrient deficiencies.

Common fortification vehicles include staple foods, condiments, and beverages (hereafter referred to as foods) that are widely consumed within a population.^{4,5} By leveraging existing food systems, LSFF can improve micronutrient intake without requiring individuals to change their dietary behaviors.⁴ This approach can reach large segments of the population through established production and distribution channels and can benefit from existing food control, monitoring, and regulatory frameworks that support implementation and compliance.⁶

Through the delivery of additional vitamins and minerals in widely consumed foods, LSFF can improve micronutrient intake and thereby reduce population micronutrient inadequacy. Evidence from systematic reviews and meta-analyses demonstrates that fortification increases micronutrient intake,⁷ reduces micronutrient deficiencies,^{8–10} and contributes to improved health outcomes, including reductions in neural tube defects and other ailments associated with micronutrient deficiencies.¹¹ These findings highlight the potential public health impact

of well-designed, well-implemented, and well-monitored fortification programs.

High-quality data are essential throughout the LSFF program cycle. Data are used to determine whether fortification is warranted, identify appropriate food vehicles and nutrients, support implementation, monitor compliance with standards, and evaluate program reach and impact. Without reliable data, decision makers cannot determine whether fortification programs are functioning as intended or achieving their public health objectives.

Indicators are specific, measurable factors that convert data into information that is useful for program and policy decisions. This guidance presents indicators to support decision-making across the design, implementation, monitoring, and evaluation stages of LSFF programs and assess whether these programs are achieving their objectives. When defined and applied consistently, indicators can support evidence-informed decisions, improve comparability across settings, and strengthen accountability for program performance.

Harmonized LSFF indicators can help stakeholders:

- Design and target fortification programs more effectively;
- Identify opportunities to strengthen program implementation;
- Monitor performance and compliance over time;
- Evaluate program reach and nutritional impact;
- Support learning and comparison across countries and regions;
- Inform the targeting and coordination of complementary nutrition interventions where fortification alone may be insufficient; and
- Support learning and comparison across countries and regions.

Despite the importance of indicators for LSFF decision-making, data are usually collected using different definitions, methods, and reporting practices across countries and organizations. As a result, indicators may not be directly comparable, and decision-makers may face challenges interpreting and using available evidence. Greater harmonization of LSFF indicators can improve the consistency, quality, and usefulness of data for designing, implementing, adapting, and evaluating fortification programs, as well as for informing complementary nutrition actions.





Existing Resources and Remaining Gaps

Numerous resources support the design, implementation, monitoring, and evaluation of LSFF programs. These include the WHO and FAO Guidelines on Food Fortification with Micronutrients,⁴ the WHO-CDC eCatalogue of Indicators for Micronutrient Programmes,¹² the Fortification Assessment Coverage Toolkit (FACT),¹³ the Global Fortification Data Exchange (GFDx),⁵ and other fortification-specific tools, databases, and information systems. Collectively, these resources provide important technical guidance and strengthen the evidence base for fortification programming.

Despite these resources, data on LSFF programs are not uniformly available across all countries, food vehicles, or stages of the fortification program cycle. In many settings, data gaps limit the ability of stakeholders to assess readiness, measure implementation, monitor program performance, evaluate outcomes, and compare program performance across contexts. For example, a review of GFDx found significant gaps in LSFF program performance indicators, particularly for certain food vehicles such as edible oil and cereal grains.¹⁴

Effective LSFF programs require data from multiple sectors and stakeholders, including government agencies, food producers, regulatory authorities, researchers, and development partners. These data are often drawn from various sources, such as industry records, regulatory monitoring systems, market assessments, dietary surveys, and biomarker assessments. Differences in definitions, measurement approaches, and reporting practices across these sources can make results difficult to interpret, compare, and use for decision making. Harmonized indicators can improve the consistency of evidence generated from these diverse data sources and support decisions across LSFF programs, including the identification of populations that may require complementary nutrition interventions.

This need for prioritized, harmonized indicators extends beyond fortification: within the broader nutrition community, the [WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring \(TEAM\)](#) is consolidating a prioritized list of indicators for national and global nutrition monitoring. Although several existing resources include indicators relevant to food fortification, no single resource provides comprehensive guidance on the selection, interpretation, and use of indicators across the entire LSFF program cycle. This guidance was developed to address that gap by presenting a standardized framework of core and non-core indicators organized around the key decisions required to design, implement, monitor, and evaluate LSFF programs.



Purpose and Scope

This guidance provides standardized definitions and recommendations for the selection, calculation, interpretation, and use of indicators for LSFF programs. Its purpose is to support evidence-informed decision-making throughout the fortification program cycle and to promote greater consistency in the collection, analysis, reporting, and interpretation of LSFF data.

The guidance presents a standardized framework for organizing indicators across the four stages of an LSFF program: Design, Implement, Monitor, and Evaluate. Within this framework, indicators are linked to key programmatic questions and decisions that arise throughout the life cycle of a fortification program.

The guidance includes:

- A conceptual framework for organizing indicators across the LSFF program cycle;
- Guidance on indicator interpretation and use, including a decision pathway that links indicators to common programmatic decisions;
- A prioritized set of core and non-core indicators, presented in an overview table with a standardized definition and intended purpose for each indicator; and
- Reference sheets for each core indicator, providing the numerator, denominator, calculation method, and worked examples.

This guidance is intended to complement existing fortification frameworks, technical guidance, and tools. It should be used alongside national and global resources that support fortification policy, program implementation, monitoring, and evaluation.

The guidance does not prescribe a single approach to data collection or program implementation. Rather, it provides a common framework that countries and stakeholders can adapt to their specific context, data systems, fortification vehicles, and program priorities.

Intended Users

This guidance is intended for stakeholders involved in the design, implementation, monitoring, regulation, evaluation, and support of LSFF programs. Potential users include:

- National governments and public agencies responsible for enacting food systems, nutrition, and health standards, regulations or trade;
- Food producers and industry associations involved in the production and distribution of fortified foods;
- Regulatory and food-control authorities responsible for monitoring and enforcement;
- Development partners, donors, and implementing organizations that support fortification programs;
- Academic and research institutions conducting fortification-related analyses and evaluations;
- Regional and global organizations that compare programs across countries, support capacity strengthening, or contribute to the development of standards and guidance; and
- Civil society organizations.

Photo: WFP/Arete/Fredrik Lerneryd





Approach

This section describes the approach used to develop this guidance and select indicators included in this document. Technical experts and stakeholders from government, industry, academia, civil society, development organizations, and multilateral institutions identified, reviewed, prioritized, and refined the indicators through a multistep process.

Working Group

The Micronutrient Forum (MNF), through the Micronutrient Data Innovation Alliance (DInA), established a Secretariat to lead the development of the guidance with input from a dedicated working group that provided technical expertise and diverse stakeholder perspectives. Working group members were selected for their expertise in fortification program design, implementation, monitoring, and evaluation. The Working Group included broad geographic representation and members from the public, private, and civil society sectors (**Annex 1**).

The Working Group was consulted throughout the development of the guidance in four main phases: 1) selecting indicators, including defining the scope and conceptual framework, identifying relevant indicators and resources, and establishing and applying criteria for indicator prioritization; 2) reviewing the draft guidance, including the overview tables and reference sheets on indicator definitions, measurement, and use; 3) reaching consensus on the final guidance; and 4) providing input on dissemination.

Indicator Landscaping and Identification

In October 2025, MNF's DInA convened the Africa Regional Dialogue on Data for Action in Food Fortification in Addis Ababa, Ethiopia.¹⁵ At this convening, DInA presented a data landscaping activity that collated existing resources on LSFF indicators and data collection approaches in 13 African countries. Country stakeholders identified decisions they need to make across the LSFF program cycle and the data required to support those decisions. Through poster presentations, small-group discussions, and plenary sessions, participants considered country data needs, existing sources of information, and gaps in the available indicator landscape.

The discussions highlighted the need for clear, specific indicators, as well as practical guidance on how they can inform decision-making across the fortification data value chain. Participants determined to establish a common set of standardized indicators to be used across contexts as a clear next step for strengthening LSFF programs' routine monitoring, supporting cross-country comparison, and reinforcing regional accountability. Participants also recognized that a regionally adopted platform could further harmonize indicators across countries. The momentum and consensus built during this convening provided the foundation for DInA to develop the LSFF Indicator Guidance and informed the approach to identifying and organizing the indicators included in this guidance.

In addition to discussion notes from the convening, multiple resources were reviewed to identify potential LSFF indicators for this guidance (**Box 1**).



Box 1: Resources Reviewed to Identify Potential LSFF Indicators

WHO's eCatalogue of indicators for micronutrient programmes (2015).¹² This resource lists indicators for micronutrient programs, including several related to fortification.

Indicators for the Global Monitoring Framework on Maternal, Infant, and Young Child Nutrition by WHO (2014).¹⁶ This resource lists 21 core and 16 extended indicators. For each indicator, the document summarizes data sources, collection frequency, analysis, and indicator type.

Indicators for the Exemplars in Global Health Project by Johns Hopkins University (shared in 2025). This resource describes indicators along a program-impact pathway leading to changes in nutritional status and functional outcomes attributable to fortification.

Indicators described in the Country LSFF Data Landscape Tool by DInA (2025). This resource lists indicators across multiple topics: assessment of micronutrient status and intake, scalability, legal and regulatory frameworks, program monitoring, program implementation, and program evaluation.

Indicators in the Food Systems Dashboard compiled by the Global Alliance for Improved Nutrition (GAIN), Columbia Climate School, Cornell University, and the Food and Agriculture Organization of the United Nations (FAO) (reviewed in 2025).¹⁷ This website visualizes national and subnational data on the following topics: drivers, food supply chains, food environments, individual factors, cross-cutting issues, and outcomes.

Indicators listed in the Global Fortification Data Exchange (reviewed in 2025).⁵ This website presents national-level data on indicators categorized into three topics: fortification opportunity, foundational documents, and program performance.

A tool to support national-level program managers developed by the Iodine Global Network (2025).¹⁸ This tool focuses on salt fortification with iodine (i.e., salt iodization) and is intended to help assess program strengths and weaknesses, guide corrective actions, and track progress to ensure that success is sustained.

A methodology brief published by the International Food Policy Research Institute (2025).¹⁹ The Political Economy Diagnostic for Assessing Large-Scale Food Fortification (PEDAL) project describes several indicators to assess political will and implementation capacity.

This exercise generated 261 indicators. Of these, 144 indicators were removed because they were duplicates, 17 were deemed irrelevant based on subject matter expertise (e.g., mandatory fortification year), 14 were a subset of existing indicators and 7 were deemed low-priority indicators, thus leaving 79 potential indicators for further review.

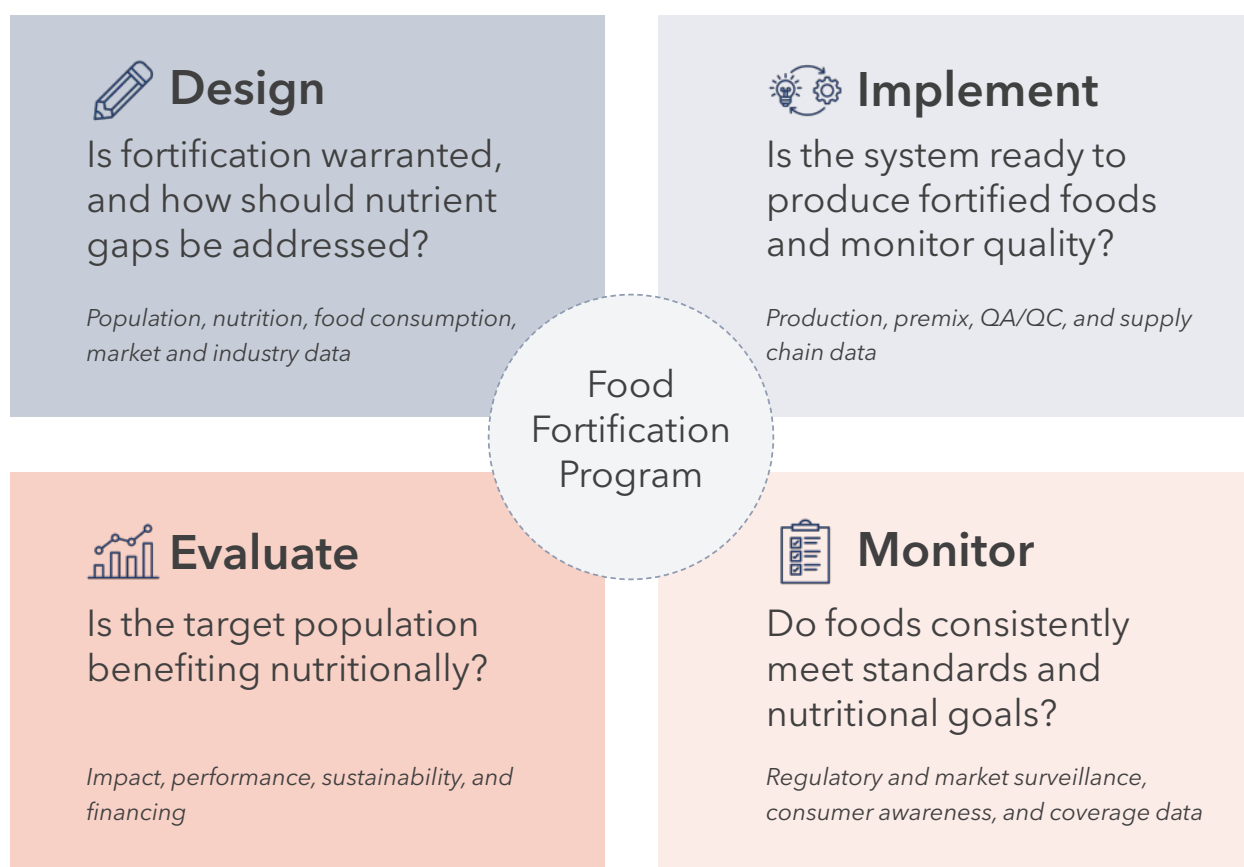
Conceptual Framework

This guidance uses a conceptual framework to organize indicators around the decisions that arise across the LSFF program cycle rather than presenting them as an unstructured list. The selected framework comprises four cyclical stages of a fortification program – Design, Implement, Monitor, and Evaluate – which repeat as needed as programs are redesigned and reimplemented over time (**Figure 1**).

Indicators in this Guidance are categorized according to the LSFF program stage(s) they inform. Users can therefore begin with the decision they need to make, identify their position in the program cycle, and then select the indicators, data sources, and reference sheets most relevant to that decision.

Several existing fortification and food system frameworks were reviewed and the final framework was selected because it provides a simple, program-focused structure for organizing indicator use across the LSFF program cycle.

Figure 1. Conceptual framework to organize large-scale food fortification indicators across four cyclical fortification program stages: Design, Implement, Monitor and Evaluate.



At each stage of a fortification program, critical questions about fortified foods are addressed:

- **The Design stage asks:** Is fortification warranted, and if so, how can it be optimally designed to address dietary nutrient gaps while considering the needs, capacities, and priorities of all stakeholders including food producers, government authorities, and consumers?
- **The Implement stage asks:** Are the necessary resources, systems, and capacities in place to produce fortified foods and effectively monitor their quality?
- **The Monitor stage asks:** Do fortified foods consistently meet fortification standards?
- **The Evaluate stage asks:** Is the fortification program delivering nutritional benefits to the target population groups?

The conceptual framework helped organize the LSFF indicators under consideration by fortification program stage they inform. Of the 79 potential LSFF indicators that were selected, 26 corresponded to Design, 28 to Implement, 8 to Monitor, and 17 to Evaluate.

Photo: World Bank/Chor Sokunthea



Selection of Indicators

Four criteria were used to generate a quantitative score for each potential indicator and facilitate the selection of indicators for inclusion in the guidance. The criteria were informed by a desk review and prioritizing indicators most relevant to fortification programs.²⁰⁻²³

- 1) **Relevance:** Does the indicator measure the targeted objective? Is the indicator informative for fortification program planning?
- 2) **Achievable:** Is the indicator feasible to collect? Can it be collected using a low-burden method?
- 3) **Specific:** Is the indicator unambiguous? Is the indicator clear and understandable for the targeted stakeholders?
- 4) **Stakeholders:** How many stakeholders need the information provided by the indicator at any stage of fortification?

The four criteria were applied to the 79 indicators using two formulae to aid indicator prioritization (**Box 2**). The results of this exercise were presented to the Working Group, which considered them when recommending indicators to include in the guidance. For each of the four program stages, the Working Group reviewed the entire set of indicators and provided a rationale for its decisions.

Box 2: Process for Applying Selected Criteria to Prioritize Identified Indicators

Three of the four criteria (Relevance, Achievable, and Specific) were rated as low, moderate, or high. The Stakeholders criterion was rated on a 0-8 scale, corresponding to the number of potential stakeholder groups to which an indicator was relevant: **advocates, consumers, designers, evaluators, managers, marketers, policymakers, and suppliers**. To standardize the categorical scale of the first three criteria and enable comparison with the fourth, values of 0, 4, and 8 were assigned to low, moderate, and high, respectively. Each of the four criteria was applied individually to all 79 indicators.

Two formulae were used to aid indicator prioritization: one which applied equal weight to all criteria, and the other weighted the Achievable and Specific criteria twice as heavily as Relevance and Stakeholders. Results from both formulae were presented to the Working Group side by side in a spreadsheet, and the absolute values derived by each formula were considered less important than their effect on indicator rankings. The list of indicators presented for discussion was ordered according to the unweighted formula, while the weighted formula results remained visible for comparison. The prioritization results supported the review, and the Working Group made the final decisions on designating indicators as core or non-core.

Of the 79 indicators considered, the Working Group selected 44 for inclusion in the guidance after the prioritization exercises. Using the conceptual framework, the indicators were organized according to four cyclical stages of an LSFF program: Design, Implement, Monitor, and Evaluate.

Indicators relevant to more than one program stage were counted once, under the earliest applicable stage, in the order: Design → Implement → Monitor → Evaluate. These stage counts sum to the core and non-core totals without double-counting. Core indicators were prioritized because of their importance for decision-making across multiple contexts and stages of the fortification program cycle. Non-core indicators may provide valuable information in specific contexts or for specific programmatic questions but may not be required in all settings.



Using and Interpreting LSFF Indicators



Overview

All indicators are included in the overview table (**Part 3: Overview Table**), and detailed reference sheets are provided for the 16 core indicators (**Part 3: Indicator Reference Sheets**). The overview table summarizes all indicators included in this guidance, while the reference sheets provide detailed information on individual indicators, including their definitions, rationales, intended uses, data requirements, interpretation considerations, and related indicators. The overview table and reference sheets are intended to support the selection, interpretation, and use of LSFF indicators throughout the fortification program cycle.

Using Indicators for Decision-Making

Users should select from the 44 core and non-core indicators based on the decision that needs to be made rather than on data availability alone. In many cases, multiple indicators are needed to answer a programmatic question and should be interpreted together.

Several principles should guide indicator selection and interpretation:

- Begin with the programmatic question or decision rather than the indicator itself;
- Select indicators that are appropriate for the program stage and context;
- Interpret indicators as part of a package rather than in isolation;
- Consider both core and non-core indicators when additional evidence is needed;
- Prioritize indicators that can inform actionable program decisions; and
- Reassess indicators periodically as food systems, consumption patterns, regulations, and program performance evolve.

Because fortification programs operate within dynamic food systems, decisions made during monitoring and evaluation may indicate a need to revisit earlier design or implementation decisions. Accordingly, the indicator framework should be viewed as cyclical rather than linear.

Adapting Indicator Selection to Context

Although the indicators included in this guidance are standardized, their application should be adapted to the national context. Countries differ substantially in their food systems, dietary patterns, fortification vehicles, industrial structures, regulatory frameworks, implementation capacity, and public health priorities. As a result, not all indicators will be equally relevant or feasible in every setting. Indicator selection should therefore be guided by the programmatic questions being addressed, the stage of the fortification program, and the local context in which decisions are being made.

Countries also vary in the availability, quality, frequency, and accessibility of data. Some countries may have recent micronutrient surveys, dietary intake data, or robust regulatory monitoring systems, while others may rely on administrative records, market assessments, or proxy measures. In such situations, users may need to prioritize a subset of indicators, beginning with the core indicators and incorporating non-core indicators as additional data and resources become available. Decisions about indicator selection should balance program needs, data availability, technical capacity, and resource constraints while maintaining transparency about any limitations in the evidence used for decision-making.

Photo: WFP/Rawful Alam





Using Indicators for Decision-Making

Common Data Sources and Repositories

The indicators included in this guidance draw on data from a variety of sources. No single data source is sufficient to answer all questions relevant to fortification programs. Instead, multiple sources are often used together to generate evidence for decision-making.

Common fortification-related repositories and information systems include:

Global Fortification Data Exchange (GFDx): A global platform that compiles and visualizes data on food fortification legislation, program performance, food vehicle coverage, fortified food coverage, industrial processing, and related indicators. Countries can use GFDx to benchmark national programs, identify data gaps, compare their progress with other countries, and access information relevant to indicator selection and interpretation.

Global database on the Implementation of Food and Nutrition Action (GIFNA): A global repository of nutrition policies, legislation, strategies, and program actions maintained by WHO. Countries can use this resource to identify existing nutrition and fortification policies, review experiences from other countries, and support the development or revision of national nutrition actions.

FAOLEX: A database of national laws, regulations, policies, and other legal instruments related to food, agriculture, and nutrition. Countries can use FAOLEX to access current fortification legislation, standards, and regulatory documents, as well as broader nutrition-sensitive legislation, food safety and food control laws, labeling requirements, and other legal instruments under which food fortification programs operate. It can also be used to compare national regulatory approaches across jurisdictions.

FAOSTAT: FAO's global statistics platform, which provides data on agricultural production, trade, food balance sheets, supply utilization accounts, and dietary intake. Countries can use FAOSTAT to assess the production, importation, exportation, and availability of potential fortification vehicles and to inform decisions about vehicle selection, program design, and program evaluation.

FortifyMIS and similar tools that support national fortification information systems:

Electronic data-management systems that compile monitoring, inspection, laboratory, and compliance information related to food fortification programs. Countries can use these systems to improve routine data collection, monitor compliance trends, support regulatory decision-making, and facilitate data sharing among stakeholders.

National fortification dashboards and monitoring platforms: Country-specific platforms that aggregate and visualize fortification data from government monitoring systems, surveys, and industry reporting. Countries can use these dashboards to track program performance, identify implementation challenges, support accountability, and communicate results to stakeholders.

National statistics repositories and survey databases: Sources of population, household, dietary, health, and economic data generated through national surveys and statistical systems. Countries can use these data to calculate LSFF indicators, assess trends over time, examine disparities across population groups, and support program design, monitoring, and evaluation.

Common Types of Data Used

Different types of data are needed to support decisions throughout the Design, Implement, Monitor, and Evaluate stages of an LSFF program. Some data describe the foods people consume and the extent to which micronutrient deficiencies are a public health concern. Other data provide information on food production, fortification practices, program implementation, regulatory oversight, market availability, and program impact. Understanding the strengths, limitations, and intended uses of different data types is important for selecting appropriate indicators and interpreting results correctly. The sections below describe common types of data used in LSFF programs, how they are collected, and the decisions they can help inform.



Photo: World Bank/Daniella Van Leggelo-Padilla

The indicators in this guidance are derived from several broad categories of data:

Dietary Intake and Food Consumption Data

These data describe what foods people consume and how much they consume. They are commonly used to determine whether fortification is warranted, identify appropriate food vehicles, estimate micronutrient intakes, predict micronutrient inadequacies, model the potential contribution of fortification programs, and assess program coverage.

Common sources that generate population-level intake estimates include:

- **24-hour dietary recalls (24HR):** Individuals report all foods and beverages consumed during the previous 24 hours. These data can be used to estimate food consumption and micronutrient intake.
- **Food frequency questionnaires (FFQs):** Individuals report how frequently specific foods are consumed over a defined period (e.g., the previous week, month, or year). These data can be used to assess usual dietary patterns and identify foods that may be suitable for fortification.
- **Food records:** Individuals record foods and beverages at the time they are consumed. These data provide detailed information on food consumption and micronutrient intake.
- **Household Consumption and Expenditure Surveys (HCES):** These nationally representative household surveys are typically conducted to assess household living standards and expenditures patterns and often include food acquisition or consumption modules. Because the content and detail of these modules vary across countries, their utility for fortification analysis also varies. HCES data can be used to estimate apparent food consumption, identify foods that may be suitable vehicles for fortification, and model the potential reach and nutritional contribution of fortification programs. In settings where aforementioned sources are unavailable, HCES data may provide a useful alternative for estimating the probable micronutrient inadequacies of the population and the potential of fortified foods to correct them, and thus informing fortification program design and evaluation.





Fortification Coverage and Household Data

These data describe whether households and individuals access, acquire, or use fortifiable or fortified foods. They are used to estimate the potential and actual reach of fortification programs, identify population groups that are not being reached, assess equity in coverage, and evaluate program performance.

- **Fortification Assessment Coverage Toolkit (FACT) surveys:** Specialized surveys that collect information on coverage of fortifiable and fortified foods, including food source, packaging, food type, and brand information where relevant. These data can be used to estimate potential reach, actual coverage, and disparities across populations and geographic areas.
- **Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), HCES, Agriculture Panel Surveys (APS), and similar population-based surveys:** Surveys that collect demographic, socioeconomic, health, and nutrition information that can be used to identify vulnerable population groups, assess equity in program reach, support indicator disaggregation, and provide contextual information for interpreting fortification indicators. In some settings, these surveys may also collect fortification-related information.

Coverage and household data are often interpreted together with industry, dietary, market, and regulatory data to better understand who is reached by fortification programs and where gaps remain.

Biological and Laboratory Data

These data measure micronutrient status directly through laboratory analysis of biological specimens such as blood or urine. They are used to determine the prevalence of micronutrient deficiencies, insufficiencies, and excesses; identify population groups at nutritional risk; determine whether nutrient interventions, including fortification, are warranted; and evaluate the impact of such programs and other interventions on nutritional status.

Common sources include:

- **Micronutrient surveys and biomarker assessments:** Specialized surveys that collect biological specimens to measure micronutrient status using validated biomarkers. These data can be used to estimate the prevalence of micronutrient deficiencies, insufficiencies, and excesses and to identify population groups most likely to benefit from fortification.
- **National nutrition surveys with biomarker modules:** Nationally representative surveys that combine biological measurements with demographic, dietary, health, or socioeconomic information. These data can be used to assess population micronutrient status, identify disparities among population groups, and evaluate changes over time.
- **Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), and similar surveys with biomarker components:** Population-based surveys that may include biomarker testing for specific micronutrients. These data can provide information on micronutrient status and support interpretation of fortification program performance within a broader public health context.
- **Laboratory-based nutrition studies:** Research studies that generate detailed information on micronutrient status, biomarker performance, nutrient metabolism, or relationships between dietary intake and nutritional status. These data may complement national survey data where available.

Biological and laboratory data are often considered the strongest source of evidence for assessing population micronutrient status because they directly measure nutritional status rather than relying on proxy measures such as food consumption or nutrient intake. However, they are typically more complex and costly to collect than dietary, household, industry, or regulatory data.

Population and Contextual Data

These data describe population characteristics and contextual factors that may influence the design, implementation, interpretation, and impact of fortification programs. Unlike fortification coverage and household data, which are used to assess whether households and individuals access or consume fortifiable or fortified foods, population and contextual data are used primarily to characterize the populations being reached and to understand factors that may influence program performance and equity. Population and contextual data can be used to identify population groups at increased risk of micronutrient deficiencies, support disaggregation of indicators, assess equity in program reach, and provide context for interpreting fortification indicators.

Common sources include:

- **Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), and similar population-based surveys:** Nationally representative surveys that collect information on population characteristics, household living conditions, health, nutrition, education, and socioeconomic conditions. These data are primarily used to characterize population subgroups and contextual conditions, support indicator disaggregation, and impact across populations and geographic areas.
- **Population censuses:** National population counts that provide information on population size, geographic distribution, urban and rural residence, and other demographic characteristics. These data can support estimation of populations reached and planning of fortification programs.
- **National statistics repositories and related surveys:** Government data systems that compile demographic, economic, social, and health information. These data can be used to support the interpretation of fortification indicators and examine differences across population groups and geographic areas.

Population and contextual data are generally interpreted alongside dietary, coverage, biomarker, industry, and regulatory data to better understand who is reached by fortification programs, who may remain underserved, and which contextual factors may influence program performance.





Industry and Market Data

Industry and market data provide information on the production, distribution, sale, and quality of foods that may be fortified. These data can be used to assess the feasibility of fortification, identify producers that are expected or required to fortify, monitor implementation of fortification activities, and estimate the availability of fortified foods in the marketplace.

Common sources include:

- **Market surveys:** Assess the availability, distribution, and characteristics of foods in retail and other commercial settings. These surveys may be used to assess compliance with fortification requirements, evaluate the availability and distribution of fortified foods, or estimate the market penetration and market share of fortified products, depending on the information collected. These data can be used to determine whether fortified foods are reaching markets and consumers.
- **Producer audits:** Assess producer practices, equipment, processes, and compliance with fortification requirements. These data can be used to determine whether producers have the capacity to fortify and are implementing fortification as intended.
- **Production records:** Document the quantities of food produced over a defined period. These data can be used to estimate the amount of food that could potentially be fortified and the contribution of different producers to the food supply.
- **Sales records:** Document the quantities of food sold through formal markets. Their usefulness for assessing fortified food availability and reach depends on whether sales data can be identified at the product level or matched with market survey, labeling, or compliance data that distinguish fortified from non-fortified products. These data can be used to estimate market share, assess the reach of fortified foods, and identify trends in food availability and consumption.
- **Premix procurement records:** Document purchases and use of vitamin and mineral premixes. These data can be used to assess whether producers have a sufficient and continuous supply of premix to support fortification activities.
- **Industry quality assurance and quality control documentation:** Includes records related to production monitoring, premix management, equipment calibration, and product testing. These data can be used to assess whether producers have systems in place to support the consistent production of fortified foods and compliance with fortification standards.

Government and Regulatory Data

Government and regulatory data provide information on the laws, systems, resources, and activities used to implement, monitor, and enforce food fortification programs. These data can be used to assess program readiness, regulatory capacity, compliance with fortification requirements, and the effectiveness of monitoring and enforcement systems. They also help identify gaps in legislation, staffing, resources, and implementation that may affect program performance.

Examples include:

- **Regulatory monitoring data:** Information collected through routine regulatory activities such as audits, inspections, sampling, testing, and compliance assessments. Samples of premix and fortified foods may be collected at production facilities, points of importation, or in the marketplace (e.g., retail outlets) to assess compliance with fortification standards and labeling requirements. Sampling at points of sale, such as retail stores, convenience stores, kiosks, and other commercial outlets, can be used to verify micronutrient content and compliance with fortification and labeling requirements, as well as to assess whether products are being distributed and marketed in accordance with national regulations. These data can be used to evaluate compliance with fortification standards, identify implementation challenges, monitor program performance over time, and inform regulatory decision-making.
- **Enforcement records:** Document actions taken in response to non-compliance, such as warnings, fines, product seizures, or other sanctions. These data can be used to assess whether monitoring findings result in corrective or enforcement actions.
- **Customs and import records:** Provide information on imported premix and fortified foods entering a country. These data can be used to assess the contribution of imports to the fortified food supply and support import monitoring activities.
- **Government staffing and budget information:** Provide information on personnel, infrastructure, equipment, and financial resources allocated to fortification monitoring activities. These data can be used to assess government capacity to monitor and enforce fortification programs.
- **National legislation, standards, and procedures:** Define the legal and technical requirements or specifications for food fortification, as well as the procedures used for monitoring and enforcement. These documents can be used to assess whether an operational and enforceable regulatory framework is in place.

Data Quality Considerations

The interpretation of indicator results and the decisions they inform depend on the quality of the underlying data. Before interpreting indicator results, users should consider the strengths and limitations of the available data and assess whether the data are fit for the intended purpose.

Factors that may affect data quality include:

- **Representativeness:** The extent to which the data reflect the population, producers, foods, or geographic areas of interest. For example, a survey may be nationally representative of women of reproductive age but not of the whole population, or regulatory monitoring data may cover only a subset of producers or specific markets. In the context of fortification, lack of representativeness can result in inappropriate decisions about whether fortification is warranted, which foods should be fortified, which populations are reached by fortification, or whether a program is achieving its intended objectives.
- **Completeness:** The extent to which all required information is available and recorded. Missing information on food consumption, micronutrient intake and status, industrial processing, compliance, or producer characteristics may limit the ability to generate indicators or interpret results. In the context of fortification, incomplete data can lead to incorrect estimates of program reach, compliance, or effectiveness.
- **Timeliness:** The extent to which data are sufficiently recent to support current decision-making. Food consumption patterns, market structures, production practices, and program implementation may change over time. In the context of fortification, outdated data may result in selection of inappropriate food vehicles, incorrect assumptions about consumption patterns, or inaccurate assessment of current program performance.
- **Reliability:** The extent to which data collection methods produce consistent results when repeated under similar conditions. Reliability may be influenced by survey design, interviewer training, laboratory methods, inspection procedures, and record-keeping practices. In the context of fortification, unreliable data make it difficult to determine whether observed differences reflect true program changes or inconsistencies in measurement.
- **Validity:** The extent to which a measure accurately captures the concept it is intended to assess. Some indicators directly measure fortification-related outcomes, while others rely on proxy measures or assumptions. In the context of fortification, poor validity may lead to incorrect conclusions about micronutrient status, dietary intake, program coverage, compliance, or impact.
- **Potential sources of bias:** Systematic errors that influence the accuracy of results, such as selection bias, reporting bias, recall bias, non-response bias, and measurement error. In the context of fortification, bias may result in overestimation or underestimation of food consumption, micronutrient intake, program coverage, compliance, or impact, potentially leading to inappropriate programmatic decisions.

The importance of each data-quality dimension varies by indicator and intended use. Users should assess whether available data are sufficiently representative, complete, timely, reliable, and valid for the decision that needs to be made. Data limitations should be documented and considered when interpreting findings and making programmatic decisions. In some situations, proxy measures may be used when preferred data are unavailable; however, any limitations associated with these measures should be explicitly acknowledged.

Disaggregation and Interpretation

Many indicators in this guidance can be disaggregated to provide a more detailed understanding of program performance, equity, coverage, compliance, and impact. Disaggregation can help identify population groups that are not being reached, geographic areas with lower coverage, producers requiring additional support or oversight, and gaps within national regulatory systems. However, disaggregation should only be undertaken when sufficient data are available to produce reliable and interpretable estimates.

The disaggregation examples presented in the reference sheets are intended to be illustrative rather than exhaustive. Countries may choose to apply additional disaggregation categories that are relevant to their context and programmatic priorities.

Population-Based Indicators

For indicators measured among individuals or households, common disaggregation variables include:

- Geographic location (national, regional, or subnational);
- Urban and rural residence;
- Socioeconomic status or wealth;
- Age group (e.g., children 6– 59 months, school-age children 5– 9 years, adolescents 10– 19 years, women of reproductive age 15– 49 years, adults ≥ 20 years, older adults ≥ 60 years);
- Sex (females and males);
- Population group (e.g., women of reproductive age, pregnant women, children, adolescents); and
- Education and other sociodemographic characteristics where relevant and available.

These disaggregated data can help identify groups at greater risk of micronutrient deficiencies, inadequate nutrient intake, lower consumption of fortifiable foods, reduced access to fortified foods, or diminished potential benefit from LSFF programs.

Producer- and Industry-Based Indicators

For indicators related to food production, fortification practices, quality systems and compliance, common disaggregation variables include:

- **Geographic region** (e.g., national, state/provincial, district, or other administrative level), where production and monitoring systems vary across locations;
- **Producer** (individual company or facility) or products to identify specific entities requiring technical assistance, monitoring, or enforcement;
- **Producer ownership type** (e.g., privately owned domestic producers, foreign-owned companies, state-owned enterprises);
- **Production scale** (e.g., large-scale, medium-scale, or other classifications used within the national context), where relevant;
- **Production-line characteristics** (e.g., facilities with single versus multiple production lines), particularly for indicators related to fortification equipment and quality systems.
- **Compliance status** (e.g., compliant, non-compliant, resolved non-compliance, unresolved non-compliance), particularly for compliance cascade indicators;
- **Inspection authority or responsible agency**, where monitoring responsibilities are distributed across multiple organizations;
- **Country of origin or importer**, for indicators related to imported premix or imported fortified foods; and
- **Type of food vehicle** (e.g., maize flour, oil, salt, or other fortified food).

Such disaggregation can help identify producers requiring additional monitoring, technical support, or enforcement activities and can inform the prioritization of regulatory resources. For example, governments may prioritize monitoring producers supplying the largest share of the market, identify geographic areas with lower compliance, or target facilities with multiple production lines where fortification equipment and quality assurance procedures may vary across lines.



Government and Regulatory Indicators

For indicators related to government capacity, regulatory oversight, and monitoring systems, common disaggregation variables include:

- **Responsible agency or institution**, such as:

- Ministry of health;
- Food control authority;
- Standards agency;
- Customs authority; or
- Border management agency.

This can help identify which institutions are responsible for specific fortification functions and where capacity-strengthening efforts may be needed.

- **Type of monitoring activity** (e.g., monitoring of domestically produced premix, imported premix, domestically produced fortified foods, imported fortified foods, or commercially sold fortified foods). This can help identify strengths and gaps within different components of a national monitoring system.

- **Level of government**, for example:

- National;
- Provincial/State;
- District; or
- Local.

This can help determine whether responsibilities, resources, and implementation capacity differ across administrative levels.

- **Staff role or function**, including:

- Inspectors;
- Auditors;
- Laboratory personnel;
- Customs officers;
- Regulatory managers; or
- Standards authorities.

This can help identify specific workforce gaps and training needs within the fortification system.

- **Monitoring-system component or competency category**, such as:

- Existence of procedures;
- Quality of procedures;
- Operational implementation; Use of monitoring results
- Training;
- Experience; or
- Performance.

This can help identify whether program weaknesses stem from inadequate procedures, insufficient capacity, poor implementation, or limited use of monitoring results.

These disaggregated data can help identify specific gaps within government monitoring and enforcement systems and guide investments in workforce development, institutional strengthening, monitoring procedures, laboratory capacity, and regulatory oversight. For example, a country may find that monitoring procedures exist but are not consistently implemented, or that capacity is adequate at the national level but insufficient at subnational levels where inspections occur.

Regulatory Framework and Monitoring-System Indicators

For indicators assessing legislation, regulations, standards, monitoring systems, and enforcement mechanisms, disaggregation is often used diagnostically to identify which components of a fortification system are present, operational, or absent. Rather than producing subgroup estimates, this approach helps identify specific gaps that may require policy, regulatory, or system-strengthening actions.

Common examples include:

- **Type of monitoring covered**, such as monitoring of:
 - Domestically produced premix;
 - Imported premix;
 - Domestically produced fortified foods;
 - Imported fortified foods; and
 - Commercially sold fortified foods.

This can help identify where monitoring procedures exist and where gaps remain.

- **Specific elements of the regulatory framework**, such as:
 - Legal authority for food fortification;
 - Technical standards for fortified foods and premix;
 - Formal linkage between legislation and standards; and
 - Enforcement mechanisms and authority for compliance monitoring and enforcement.

Assessing these components separately can help identify specific weaknesses within an otherwise functioning regulatory framework.

- **Components of monitoring systems**, including:
 - Existence and coverage of monitoring procedures;
 - Quality of procedures;
 - Operational implementation; and
 - Use of monitoring results for follow-up, corrective actions, and enforcement.Examining these components individually can help determine whether monitoring systems are established, functioning, and being used effectively.

Rather than producing subgroup estimates, this form of disaggregation helps identify actionable gaps within national fortification systems and supports prioritization of policy reforms, capacity strengthening, monitoring improvements, and enforcement activities.



Considerations When Interpreting Disaggregated Results

Whenever feasible, a standard set of disaggregation categories should be used across indicators to improve comparability within and across countries. However, disaggregated results should be interpreted in light of sample size, representativeness, and data quality considerations (see Data Quality Considerations above). Users should ensure that sufficient observations are available to generate reliable subgroup estimates and should exercise caution when interpreting results for small population groups or geographic areas.

In some cases, surveys may be nationally representative only for specific population groups, such as women of reproductive age or children, rather than for the population as a whole. Similarly, sample sizes may be insufficient to support reliable estimates for certain subgroups. Users should therefore balance the desire for detailed analyses with the need for statistical validity and interpretability.

Methodological Considerations

Validated Methods and Measurement Considerations

Several methods used to generate LSFF indicators have been widely tested, validated, and applied across diverse settings. Examples include dietary assessment methods such as 24-hour dietary recalls and food frequency questionnaires, as well as the Fortification Assessment Coverage Toolkit (FACT). However, not all indicators included in this guidance have been formally validated for LSFF-specific applications. Users should consider both the strengths and limitations of the underlying methods and the validation status of individual indicators when interpreting results. Additional information about validation and testing is

provided in the reference sheets for each indicator.

Many LSFF indicators rely on assumptions that may influence the resulting estimates and their interpretation. These assumptions should be clearly documented to support transparency, reproducibility, and comparison across settings.

Common assumptions include:

- **Food intake:** Estimates of food consumption may rely on dietary surveys, apparent consumption calculations, or food availability data. Different methods may produce different estimates of consumption and, therefore, different estimates of program reach or nutrient intake.
- **Fortification compliance:** Some indicators assume that foods are fortified according to national standards or that compliance levels observed in monitoring data apply broadly across the food supply and even households. Compliance should be assessed at the appropriate level of responsibility, such as the producer, product, batch, consignment, or shipment, depending on the indicator and monitoring system. If actual compliance differs from these assumptions, estimated program contributions may be over- or under-estimated.
- **Nutrient content:** Estimates of nutrients provided through fortification often assume specific nutrient contents in fortified foods. These contents may vary because of the nature of the food and micronutrient premixes, production practices, the normal degradation of micronutrients along the food chain, compliance levels, sampling approaches, and analytical methods.
- **Nutrient losses during processing, storage, or preparation:** Micronutrients, mainly vitamins, may be lost during manufacturing, transport, storage, cooking, or other food preparation processes. Failure to account for these losses may result in overestimation of nutrient intake from fortified foods, as well as unfair assessment of the performance of the fortification programs as the standards may not apply at each of these processes.
- **Bioavailability:** Absorption, metabolic transformation, and utilization of the micronutrients consumed vary based on the nature of the micronutrient, the health and genetic status of the individual, and the presence of infections. Bioavailability also varies according to the nutrient compound used, food composition, dietary patterns, and health status. Different assumptions about bioavailability can affect estimates of the nutritional contribution of fortification.
- **Population nutrient requirements:** Estimates of adequacy, insufficiency, and excess depend on the nutrient requirements used. Different national or international requirements may produce different estimates of population adequacy and program impact and risks.

Where possible, users should document the assumptions used, justify their selection, and assess how alternative assumptions might influence conclusions. This is particularly important for indicators that estimate micronutrient intake, nutrient adequacy, excess intake, or the contribution of fortification to meeting population nutrient requirements and potential risks.



Special Considerations for LSFF Indicators

Definition of “Large-Scale”

For the purposes of this guidance, large-scale food fortification refers to fortification conducted by food producers operating at sufficient scale, efficiency, and mechanization to enable consistent fortification and quality control.

The characteristics that constitute “large-scale” may differ across countries, food vehicles, and industries. Consequently, countries may need to adapt operational definitions to fit their national context. Throughout the reference sheets, the term should be interpreted in relation to producers that are expected or required to participate in the national fortification program.

Fortifiable, Fortified, and Adequately Fortified Foods

This guidance includes indicators related to fortifiable foods and fortified foods because these concepts are important for understanding both the potential reach and the actual reach of fortification programs. Fortifiable foods are industrially processed foods that could be fortified according to applicable legislation and standards, whereas fortified foods are foods for which there is evidence that fortification has occurred, such as through product labeling, producer records, regulatory monitoring, or laboratory testing. Together, these concepts help stakeholders understand whether a food is suitable for fortification and whether fortified foods are ultimately reaching consumers.

Indicators related to fortifiable foods are particularly useful during the Design stage because they help estimate the proportion of the population that could potentially be reached through fortification. Indicators related to fortified foods are especially useful during the Evaluate stage because they provide information on the extent to which fortified foods are available to, accessed by, or consumed by the target population.

This guidance does not include adequately fortified foods as a core concept. Determining whether a food is adequately fortified requires measuring micronutrient concentrations in food samples and comparing the results with fortification standards. Interpretation of these measurements can be affected by variability arising from sampling procedures, production variability, heterogeneity within food lots, nutrient degradation during storage and distribution, laboratory methods, and analytical uncertainty.²⁴ As a result, estimates of adequate fortification may be less comparable across settings than estimates of whether foods are fortifiable or fortified to any level.

This does not imply that information on adequate fortification lacks value. Measurements of nutrient concentrations in foods remain essential for regulatory monitoring, producer quality assurance and quality control, and assessment of compliance with fortification standards. Rather, the Working Group determined that indicators based on fortifiable and fortified foods are more consistently defined and more broadly applicable across countries and program contexts, making them more suitable as core indicators within this guidance.

Photo: UNICEF





Foods Made with Fortified Ingredients

LSFF relies on the fortification of staple food vehicles, or foods that are commonly used as ingredients in food processing or food preparation. For example, fortified wheat flour may contribute micronutrients through bread, noodles, pasta, biscuits, and other processed foods. When interpreting indicators related to food consumption, program coverage, micronutrient intake, and potential program impact, users should consider both direct consumption of fortification vehicles and consumption of foods made with fortified ingredients. Excluding foods made with fortified ingredients in the estimation of program reach and coverage may underestimate the contribution of fortification programs to population micronutrient intake and program reach.

Multiple Fortification Vehicles and Complementary Interventions

In many settings, population groups may consume more than one fortifiable or fortified food vehicle and may also be exposed to other micronutrient interventions, such as supplementation, biofortification, social protection programs, or specialized fortified foods. When selecting fortification vehicles, modeling fortification scenarios, or interpreting indicators related to micronutrient intake, adequacy, excess, and program impact, users should consider the combined contribution of all relevant dietary sources and interventions. Failure to account for overlapping sources of micronutrients may result in underestimation of total micronutrient exposure or an increased risk of excessive intake among some population groups. Conversely, considering multiple vehicles and interventions together may help identify geographic areas or population groups for which alternative or complementary interventions are needed.

Resource and Budget Considerations

The feasibility of collecting, analyzing, and using LSFF indicators varies across countries and programs. Resource requirements may include funding, personnel, laboratory capacity, information systems, training, data collection activities, and ongoing monitoring and evaluation efforts. Some indicators can be generated using existing administrative systems or routinely collected data, whereas others may require dedicated surveys, laboratory analyses, market assessments, or specialized technical expertise. Countries should consider the financial and operational implications of indicator collection when selecting indicators for routine use.

Resource constraints should not prevent countries from establishing an evidence-informed fortification program; however, they may influence the number and type of indicators that can be collected. In settings with limited resources, countries may choose to prioritize the core indicators and expand indicator collection over time as capacity, data systems, and funding improve. When making these decisions, users should consider the expected value of the information generated, the costs of data collection, and the extent to which the indicator will inform actionable program decisions.

Where possible, indicator collection should be integrated into existing surveys, monitoring systems, regulatory activities, and information platforms to reduce costs and improve sustainability. Collaboration among government agencies, industry, research institutions, and development partners may also help leverage existing data sources and reduce duplication of effort.

Ultimately, there is no single minimum set of indicators that is feasible for all countries. Indicator selection should balance programmatic priorities, technical requirements, available resources, and the need for timely evidence to support decision-making. Countries are encouraged to establish a realistic and sustainable indicator portfolio that can be strengthened as fortification programs and data systems mature.

LSFF Indicator Decision Pathway

The decision pathway is intended to help users identify indicators that are most appropriate for a specific programmatic question. In many cases, several indicators may be relevant to the same decision and should be interpreted together. Users are encouraged to begin with the indicators that provide the most direct evidence for the question being addressed and then use complementary indicators to strengthen interpretation.

Data availability varies considerably across countries. Where a preferred indicator cannot be calculated, users may need to rely on alternative indicators or triangulate findings from multiple data sources. The absence of a preferred indicator should not prevent decision-making but should be documented when interpreting results.

Indicator decision pathway: choose the stage and question

Use this overview to locate the programmatic question, then consult the expanded stage page for indicator descriptions and interpretation guidance.

Design Determine what the program should address and how.	Is the intervention warranted? 1 · 6 · 8	Which food vehicle is appropriate? 2 · 3 · 4 · 5	Can consumers access the product? 10
	Is the environment supportive? 7 · 11	Is the vehicle suitable? 9	How should the program be designed? 6 · 12 · 13
Implement Consider the legal, institutional, and production systems in place.	Is there an enabling regulatory environment? 15 · 16	Are food producers ready? 17 · 18 · 19 · 27	
	Does government have sufficient capacity? 14 · 20 · 21 · 22	Are supporting systems in place? 23 · 24 · 25 · 26	
Monitor Track implementation and identify operational gaps.	Is regulatory monitoring functioning? 28 · 29 · 30 · 31 · 32 · 20	Is fortified food available in markets? 35	
	Is fortified food entering the supply? 33 · 34	Where should monitoring be prioritized? 2	
Evaluate Assess reach, contribution, outcomes, and value.	Is the selected vehicle still appropriate? 2 · 3 · 4 · 5	Is fortification contributing nutrients? 37 · 41 · 42	How do consumers perceive fortified foods? 44
	Is the intended population being reached? 36 · 40 · 43	Is nutritional status improving? 1 · 39	Is fortification cost-effective? 38

Stage 1: Design

C Core indicator

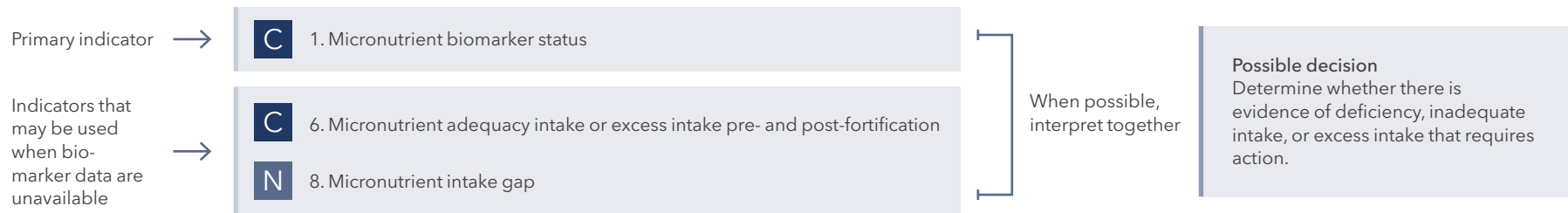
N Non-core indicator

A. Establish the need and enabling context

Key question

Is there a micronutrient problem that warrants intervention?

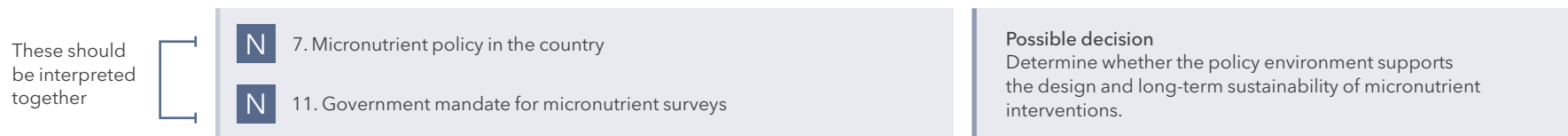
Guidance: Micronutrient biomarker data provide the most direct evidence of deficiency, insufficiency, or excess and should be prioritized when available. Dietary intake indicators can supplement or substitute for incomplete or outdated biomarker data. When possible, biomarker and dietary indicators should be interpreted together. Users should document assumptions that may affect estimates of adequacy and excess. Findings can help determine whether intervention is warranted and identify populations at greatest risk.



Key question

Is the environment supportive of action on micronutrient malnutrition?

Guidance: These indicators should be interpreted together. A supportive policy environment can facilitate action on micronutrient malnutrition, while a mandate for surveys can support the generation of data needed for decision-making. The presence of a policy or mandate does not necessarily imply implementation capacity, financing, or program performance.



Stage 1: Design, continued

C Core indicator

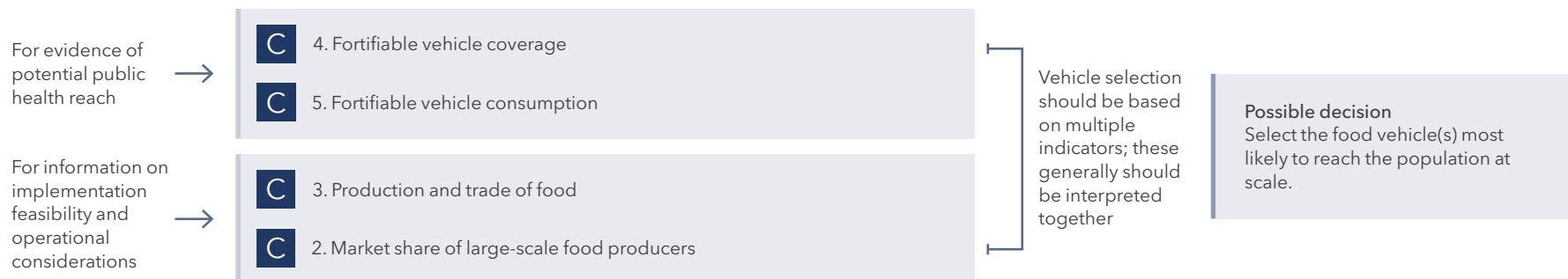
N Non-core indicator

B. Select and assess the food vehicle

Key question

Which food vehicle is most appropriate for fortification?

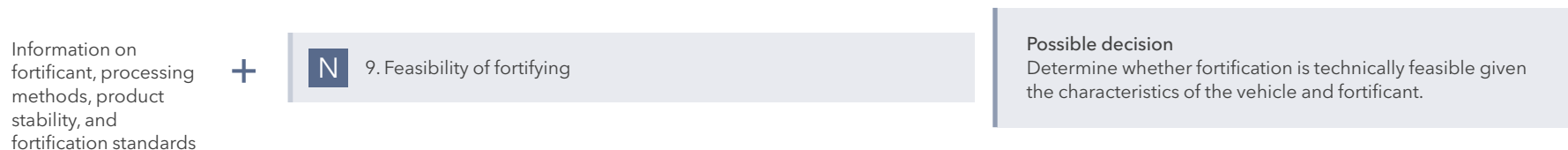
Guidance: Vehicle selection should be based on multiple indicators. Coverage and consumption provide the strongest evidence of potential public health reach, while market-share and production-and-trade indicators provide information on implementation feasibility and operational considerations. These indicators should generally be interpreted together. Vehicle selection should also consider the contribution of other fortifiable vehicles and existing micronutrient interventions within the target population to ensure that fortification complements, rather than duplicates, other sources of micronutrients.



Key question

Is the selected vehicle suitable for fortification?

Guidance: This indicator should be interpreted in conjunction with information on the characteristics of the food vehicle, the fortificant, processing methods, product stability, and fortification standards. This indicator assesses technical feasibility only and should not be used to determine whether fortification of the vehicle is warranted, appropriate, or likely to achieve public health impact. Those considerations require additional information on consumption patterns, coverage, and program objectives.



Stage 1: Design, continued

C Core indicator

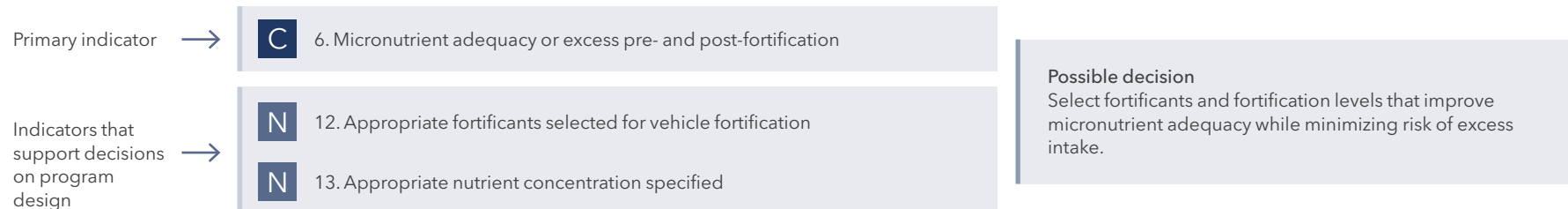
N Non-core indicator

C. Configure the program and assess access

Key question

How should the fortification program be designed?

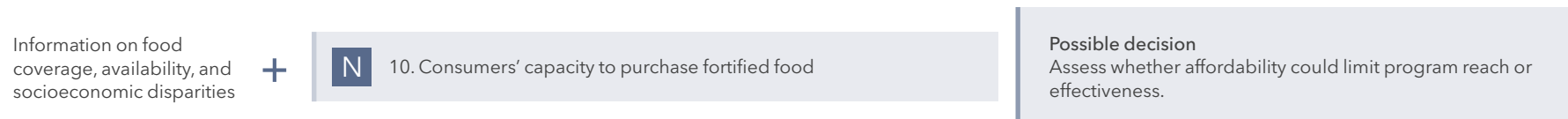
Guidance: Estimates of micronutrient adequacy and excess provide the primary evidence for selecting fortification levels. Indicators related to fortificant selection and nutrient concentrations support decisions on how the program should be designed to achieve nutritional objectives while minimizing risk of excess intake.



Key question

Will consumers be able to access the fortified product?

Guidance: This indicator should be interpreted alongside information on food coverage, market availability, and socioeconomic disparities. Consumer affordability may influence the extent to which fortified foods reach the intended population.



Stage 2: Implement

C Core indicator

N Non-core indicator

A. Assess regulatory and government readiness

Key question

Is there an enabling regulatory environment for fortification?

Guidance: These indicators should be interpreted together. A regulatory framework establishes legal authority and requirements, while monitoring procedures describe how those requirements are implemented and enforced in practice. Both are needed for effective program implementation.

These should
be interpreted
together



- C** 15. Food fortification legislation / Enforceable National Fortification Regulatory Framework
- C** 16. Government procedures for monitoring fortification

Possible decision
Determine whether the legal and procedural foundation for fortification is in place.

Key question

Does government have the capacity to implement and oversee fortification?

Guidance: Competent personnel are fundamental to regulatory oversight. Laboratory infrastructure, data systems, and financing provide important supporting capacity and should be interpreted as complementary indicators of implementation readiness.

Primary indicator →

- C** 14. Government capacity for fortification monitoring and enforcement

Complementary
indicators →

- N** 20. Accredited laboratories
- N** 21. Data systems
- N** 22. Food fortification in the national budget

Possible decision
Identify gaps in staffing, systems, laboratory capacity, or financing that may limit implementation.

Stage 2: Implement, continued

C Core indicator

N Non-core indicator

B. Assess producer and supporting systems

Key question

Are food producers ready to fortify?

Guidance: Functional equipment and quality systems are essential prerequisites for fortification. Premix availability and broader producer capacity provide supporting information on whether fortification can be sustained over time.

Primary indicators, prerequisites for fortification



- C** 17. Large-scale producers with appropriate and functional fortification-dosing equipment
- C** 18. Large-scale food producers with quality procedures

Supporting indicators for fortification sustainability



- N** 27. Large-scale food producers with capacity to fortify
- N** 19. Large-scale food producers with uninterrupted premix supply

Possible decision

Determine whether producers can consistently produce fortified foods.

Key question

Are supporting systems in place to facilitate implementation?

Guidance: These indicators represent different mechanisms that can support implementation, stakeholder engagement, consumer awareness, and producer participation. They should be interpreted together rather than hierarchically.

These should be interpreted together



- N** 26. Active multi-sector coalition for food fortification
- N** 25. Incentives for producers
- N** 24. Required fortification logo
- N** 23. Mandatory fortification for social protection programs

Possible decision

Identify opportunities to strengthen coordination, producer participation, and consumer awareness.

Stage 3: Monitor

C Core indicator

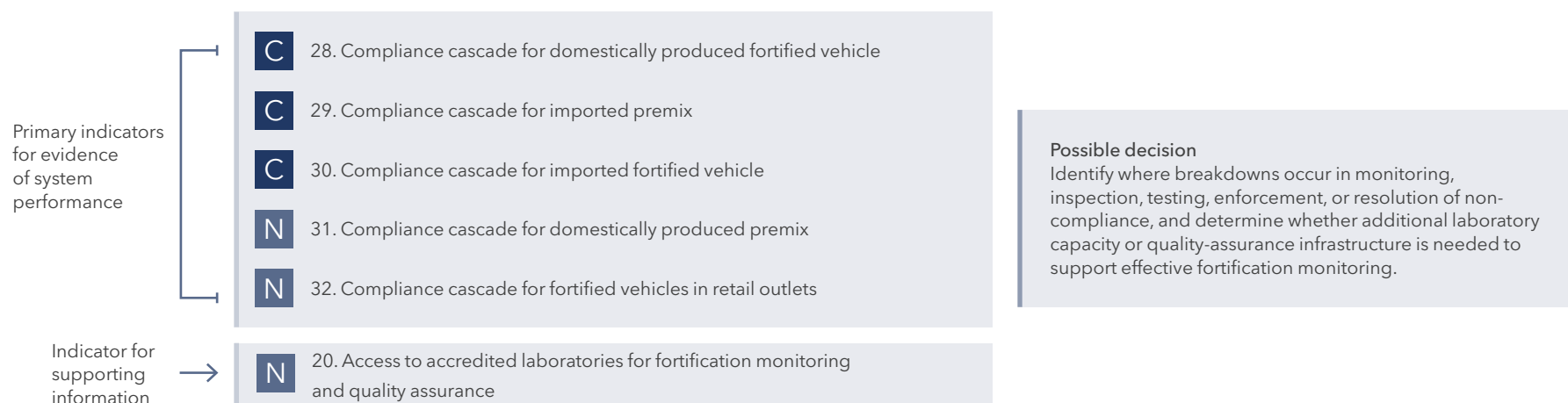
N Non-core indicator

A. Evaluate regulatory monitoring and fortified food supply

Key question

Is the regulatory monitoring system functioning as intended?

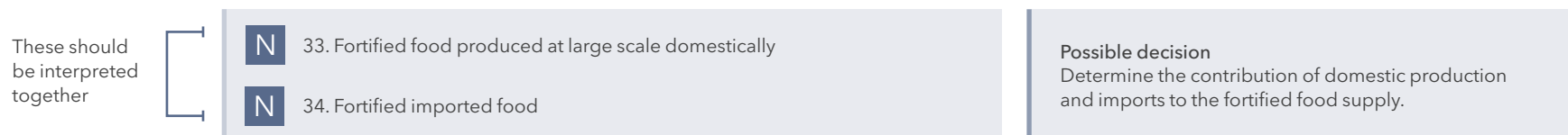
Guidance: Compliance cascade indicators provide the primary evidence of monitoring-system performance because they capture inspection, compliance determination, resolution of non-compliance, and enforcement. Laboratory capacity provides supporting information regarding the ability to verify compliance.



Key question

Is fortified food entering the food supply?

Guidance: These indicators should be interpreted together because both domestic production and imports may contribute to the availability of fortified foods in the food supply. Their relative importance will vary across countries and food vehicles.



Stage 3: Monitor, continued

C Core indicator

N Non-core indicator

B. Assess market availability and monitoring priorities

Key question

Where should monitoring resources be prioritized?

Guidance: This indicator can help prioritize monitoring resources toward producers supplying the largest proportion of the market, particularly in settings where resources are insufficient to monitor all producers.

C 2. Market share of large-scale food producers

Possible decision

Focus monitoring efforts on producers supplying the greatest proportion of the market.

Key question

Are fortified foods available in the marketplace?

Guidance: Market availability provides information on whether fortified foods are reaching commercial distribution channels and is best interpreted alongside indicators of production, imports, and compliance.

N 35. Market availability of fortified food

Possible decision

Determine whether compliant fortified foods are reaching commercial distribution channels.

Stage 4: Evaluate

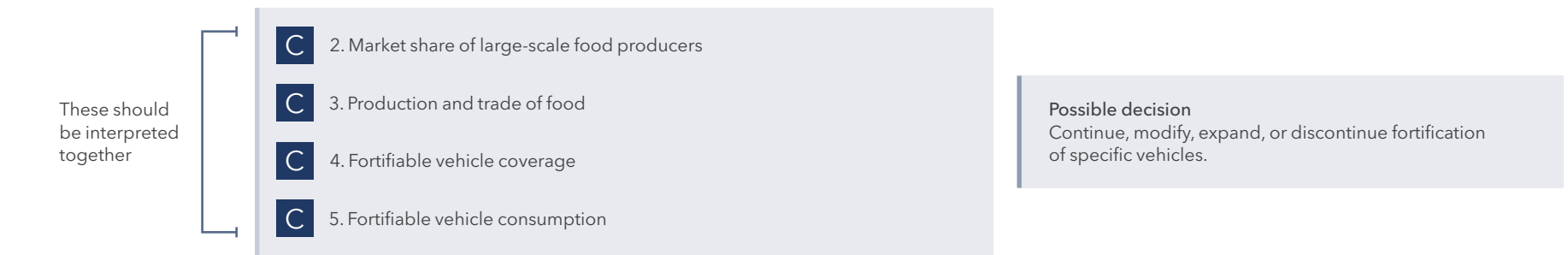
C Core indicator **N** Non-core indicator

A. Reassess vehicle suitability and population reach

Key question

Is the selected vehicle still appropriate?

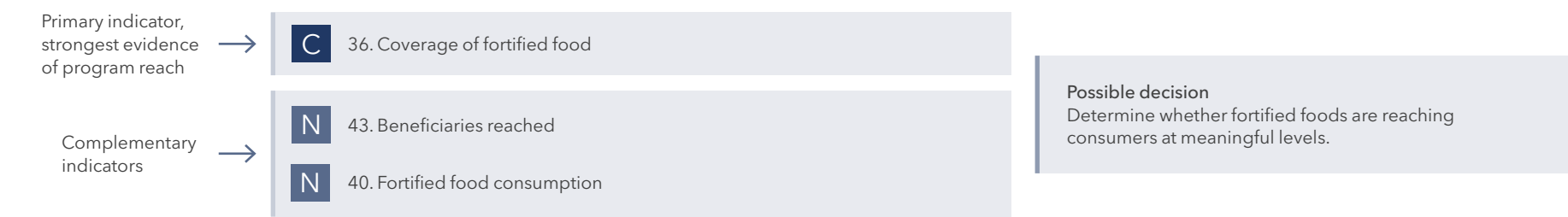
Guidance: These indicators should be interpreted together. Market share, production patterns, coverage, and consumption collectively indicate whether a vehicle remains appropriate for reaching the population and supporting program objectives.



Key question

Is the program reaching the intended population?

Guidance: Coverage provides the strongest evidence of program reach. Consumption provides information on the extent of exposure, while beneficiary estimates quantify the number of individuals likely to benefit from fortification.



Stage 4: Evaluate, continued

C Core indicator

N Non-core indicator

B. Assess nutrient contribution and nutritional outcomes

Key question

Is fortification contributing nutrients to the diet?

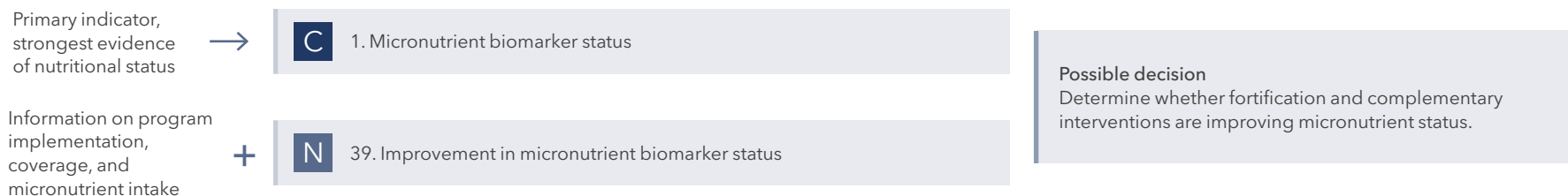
Guidance: Contribution to nutrient requirements provides the most direct assessment of the nutritional value of a fortification program because it estimates the extent to which fortification helps meet population micronutrient needs. Measures of micronutrient intake from fortified foods provide supporting evidence on the amount of nutrients consumed, while estimates of nutrients provided by fortified foods describe the quantity of nutrients entering the food supply. These indicators are most informative when interpreted together, progressing from nutrient availability, to nutrient intake, to contribution toward population nutrient requirements.



Key question

Is nutritional status improving?

Guidance: Biomarker measurements provide the strongest evidence of nutritional status. Changes over time should be interpreted together with information on program implementation, coverage, and micronutrient intake, recognizing that factors other than fortification may influence micronutrient status.



Stage 4: Evaluate, continued

C Core indicator

N Non-core indicator

C. Evaluate consumer perceptions and value

Key question

How do consumers perceive fortified foods?

Guidance: Consumer perceptions can help explain patterns of purchasing, acceptance, and consumption of fortified foods and can identify barriers that may limit program effectiveness.

N 44. Consumer perceptions

Possible decision

Identify knowledge, acceptance, or trust barriers that may limit program effectiveness.

Key question

Is fortification a cost-effective intervention?

Guidance: Cost-effectiveness should be interpreted alongside information on program coverage, nutrient contribution, and nutritional outcomes to assess whether fortification provides value relative to alternative interventions.

N 38. Cost-effectiveness

Possible decision

Assess whether fortification provides nutritional benefits at a reasonable cost relative to alternative interventions.



Indicator Tables



Overview Table: Core and Non-Core Indicators

The overview table provides a summary of all indicators included in this guidance and is intended to support rapid identification of indicators relevant to a specific programmatic question, decision, or stage of the LSFF program cycle. Indicators are organized according to the four fortification stages of Design, Implement, Monitor, and Evaluate, and are classified as either core or non-core.

Core indicators are recommended for broad use because they provide information that is important for decision-making across many contexts and are generally considered a high priority for LSFF programs. Non-core indicators may provide valuable information for specific programmatic questions, contexts, or stakeholders, but may require additional resources, data, or technical capacity to generate and interpret.

The overview table is intended to be used with the decision pathway and indicator reference sheets. The decision pathway helps users identify indicators relevant to a particular question, while the reference sheets provide detailed information on indicator definitions, calculation methods, data sources, interpretation, strengths, limitations, and related indicators. Users should therefore view the overview table as an entry point to the more detailed guidance that follows.

Core Indicators: Reference Sheets

The reference sheets provide detailed guidance on the core indicators recommended for use across LSFF programs. Each reference sheet presents a standardized description of the indicator, including its purpose, definition, data requirements, calculation or determination, interpretation considerations, strengths, limitations, validation status, and relationship to other indicators.

The reference sheets are intended to support consistent application and interpretation of indicators across countries and program contexts. While the indicators are presented individually, they are often most informative when interpreted together and in conjunction with the decision pathway, overview table, and accompanying guidance. Users should select indicators based on the programmatic question being addressed and the availability and quality of relevant data.

Throughout the reference sheets, bracketed terms are used as placeholders (see *Use of Bracketed Terms*, below). Additional information on common data sources, assumptions, disaggregation, and interpretation considerations is provided in Part 2 of this guidance.

Use of Bracketed Terms

Throughout the overview table and indicator reference sheets, terms enclosed in brackets indicate variables that should be adapted to the user's context. For example, [food], [food vehicle], [fortifiable vehicle], or [fortified vehicle] refer to the specific vehicle being assessed (e.g., oil, salt, or wheat flour); [micronutrient] and [micronutrient biomarker] refer to the nutrient (e.g., iodine, zinc, vitamin A, or folate) or biomarker of interest (e.g., serum folate or red blood cell folate); and [population group] refers to the population being evaluated (e.g., women of reproductive age, children, or adolescents). Brackets are also used to indicate context-specific values that the user must specify, such as [cutoffs for deficiency/insufficiency and excess].

In examples and calculations, bracketed terms may also distinguish scenario-specific assumptions, inputs, or groups that should be replaced with the relevant country, program, food, nutrient, or population-specific information. The use of brackets allows a single indicator definition and calculation approach to be applied consistently across food vehicles, micronutrients, populations, and country contexts.

Understanding the Reference Sheets

Each reference sheet provides standardized information to support the consistent interpretation, calculation, and use of an indicator across countries and program contexts. The rows in each reference sheet serve the following purposes:

- 1 **Fortification stage:** Identifies the stages of the LSFF program cycle in which the indicator is most useful for decision-making.
- 2 **Purpose:** Explains why the indicator is included in the guidance and how it can inform programmatic decisions.
- 3 **Definition:** Provides the standardized description of what the indicator measures.
- 4 **Numerator:** When applicable, specifies the quantity, event, or population subgroup counted in the indicator.
- 5 **Denominator:** When applicable, specifies the reference population, unit, or quantity against which the numerator is compared.
- 6 **Method of collection and data source:** Describes recommended approaches for obtaining the data needed to generate the indicator and identifies common sources of information.
- 7 **Calculation or determination:** Explains how the indicator is calculated or assessed, including any required scoring, classification, or analytical procedures.
- 8 **Special considerations for calculation:** Highlights important assumptions, methodological issues, contextual factors, and potential limitations to consider when generating or interpreting the indicator.
- 9 **Disaggregation:** Provides examples of how indicator results may be analyzed for different population groups, geographic areas, producer categories, or other relevant characteristics.
- 10 **Example:** Illustrates how the indicator may be applied in practice and how the results can be used to support decision-making.
- 11 **Strengths:** Summarizes the primary advantages of the indicator, including its usefulness, applicability, and potential value for decision-making.
- 12 **Limitations:** Identifies important constraints, data requirements, assumptions, and interpretation challenges associated with the indicator.
- 13 **Validation and testing:** Summarizes available evidence about the validity, reliability, or previous use of the indicator or the methods used to generate it.
- 14 **Further information and related links:** Directs users to additional guidance documents, tools, databases, publications, or resources that may support indicator implementation and interpretation.
- 15 **Related indicators:** Identifies and explains how other indicators in this guidance document can be used with the index indicator to support more comprehensive decision-making.

Indicator 1: Micronutrient biomarker status

1	Fortification Stage	Design and Evaluate
2	Purpose	Determine if population-level micronutrient status shows deficiency, insufficiency, or excess. In the Design stage, a high prevalence of deficiency and insufficiency may indicate a need for fortification, while a high prevalence of excess indicates that existing programs that contribute micronutrients to the diet may need to be revised. In the Evaluate stage, a high prevalence of deficiency and/or insufficiency may indicate a need for assessing the effectiveness of any programs delivering micronutrients, including fortification, and upward adjusting micronutrient levels, while a high prevalence of excess may indicate the need for downward adjustment.
3	Definition	Percentage of the population of interest with micronutrient deficiency, insufficiency, or excess. ¹
4	Numerator	Number of individuals with [micronutrient biomarker] more or less than [cutoffs for deficiency/insufficiency and excess].
5	Denominator	Number of individuals who underwent [micronutrient biomarker] test in [population group].
6	Method of collection and data source	Micronutrient concentrations are tested in various specimens (e.g., blood, breast milk, saliva, fecal excretion, urine) that are typically sent to laboratories for analysis. Micronutrient status can be determined in national surveys, program evaluations, and research studies. In rare cases, clinical data may complement other sources of information. If gathering specimens, it is important that sampling strategies facilitate data collection and analysis among representative sub-populations who may be especially at risk of deficiency, insufficiency, and/or excess.
7	Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: (Numerator / Denominator) * 100 = %
8	Special considerations for calculation	Cutoffs for deficiency, insufficiency, and excess are specific to the biomarker used (e.g., per WHO guidelines²⁰, red blood cell folate below 100 ng/mL and below 400 ng/mL in women for folate deficiency and insufficiency, respectively; there are no established cutoffs for folate excess using red blood cell folate). Appropriate measures of central tendency and spread - e.g., median and inter-quartile range of micronutrient concentrations - should be presented in addition to prevalence estimates. In the absence of current biomarker data, estimates of dietary inadequacy using 24HR or HCES survey data may be used to inform decisions at the Design and Evaluate stages.
9	Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children) and other sociodemographic factors. For surveys conducted after the start of fortification, disaggregation can be based on consumption of a vehicle (e.g., consumer, non-consumer), amount of the vehicle consumed (e.g., below and above a cutoff), and whether there is evidence the vehicle is fortified (e.g., based on brand used in the home and government monitoring data for the brand).
10	Example	In a country where the only vehicle fortified is salt with iodine, a recent nationally representative micronutrient survey sampled 1,800 apparently healthy women of reproductive age who underwent venous blood draws to measure ferritin levels (a biomarker of iron status). Among these 300 women, 64 were found to have low ferritin (<15 µg/L). (Note: for individuals with infection and/or inflammation, adjustments are required, per WHO's Guideline on use of Ferritin Concentrations to Assess Iron Status in Individuals and Populations²⁶.) (378 women with low ferritin / 1,800 women who underwent blood draws) * 100 = 21% of women Design stage: To reduce the proportion of women who are affected by low ferritin, fortification with iron should be considered. Evaluate stage: Existing fortification (and other micronutrient) interventions should be adjusted to further reduce the percentage of women affected by low ferritin.
11	Strengths	Provides quantitative estimates that are reflective of micronutrient intake, absorption, and utilization.
12	Limitations	Collecting biochemical data is complex, time-consuming, and costly, and may not be realistic in many contexts. Estimating excess may require different biomarkers than those that are used for estimating deficiency and insufficiency.
13	Validation and testing	Multiple biochemical indicators have been tested and validated for estimating the percentage of the population with micronutrient deficiencies. Few biomarkers of micronutrient status have validated cutoffs representing excess.
14	Further information and related links	The Micronutrient Survey Manual²⁷ provides guidance on the collection and reporting of micronutrient biomarker data. Using data from WHO's Vitamin and Mineral Nutrition Information System (VMNIS), the Global Fortification Data Exchange (GFDEx) visualizes status for five micronutrients that are commonly the target for fortification programs.
15	Related indicators	Indicator 6 - Micronutrient adequacy intake or excess intake pre- and post-fortification (Core): Used together with Indicator 1 to determine whether a micronutrient problem exists and whether fortification may improve nutrient adequacy.

Indicators Used Across Multiple Fortification Stages

Although each indicator is assigned to the fortification stage in which it most directly supports decision-making, some indicators provide information that is relevant to more than one stage of the LSFF program cycle. Fortification programs are inherently cyclical, and the same information may be useful when designing a program, monitoring its implementation, and evaluating whether it remains appropriate over time. For this reason, certain indicators are intentionally assigned to multiple stages. Users should select indicators based on the decision they need to make rather than solely on the stage to which the indicator is assigned.

The following indicators are assigned to more than one fortification stage:

- **Indicator 1. Micronutrient biomarker status:** Design and Evaluate. Used to determine whether micronutrient deficiencies, insufficiencies, or excesses warrant intervention and to evaluate whether micronutrient status has improved over time.
- **Indicator 2. Market share of large-scale food producers:** Design, Monitor, and Evaluate. Used during Design to assess the feasibility of large-scale fortification, during Monitor to prioritize oversight of producers supplying most of the market, and during Evaluate to determine whether selected food vehicles remain appropriate for reaching the target population.
- **Indicator 3. Production and trade of food:** Design and Evaluate. Used to determine whether domestically produced foods, imported foods, or both should be targeted for fortification and to reassess those decisions as food systems evolve.
- **Indicator 4. Fortifiable vehicle coverage:** Design and Evaluate. Used to estimate the percentage of the population that consumes a fortifiable vehicle and to determine whether selected vehicles remain relevant for reaching the target population over time.
- **Indicator 5. Fortifiable vehicle consumption:** Design and Evaluate. Used to determine whether a vehicle is consumed in sufficient quantities to support fortification and to evaluate whether consumption patterns continue to support the selected fortification strategy.
- **Indicator 6. Micronutrient adequacy intake or excess intake pre- and post-fortification:** Design and Evaluate. Used to model the potential contribution of fortification before implementation and to evaluate its contribution to micronutrient adequacy and risk of excess intake after implementation.

Additional indicators may inform decisions outside their primary assigned stage. However, the indicators listed above were formally assigned to multiple stages because their intended uses span more than one point in the LSFF program cycle.

Overview Table: Summary of Indicators for Large-Scale Food Fortification

No.	Indicator name	Definition	Purpose
Design			
Core			
1	Micronutrient biomarker status	Percentage of the population of interest with micronutrient deficiency, insufficiency, or excess ¹ .	Determine if population-level micronutrient status shows deficiency, insufficiency, or excess. In the Design stage, a high prevalence of deficiency and insufficiency may indicate a need for fortification, while a high prevalence of excess indicates that existing programs that contribute micronutrients to the diet may need to be revised. In the Evaluate stage, a high prevalence of deficiency and insufficiency may indicate a need for assessing the effectiveness of any programs delivering micronutrients, including fortification, and upward adjusting micronutrient levels, while a high prevalence of excess may indicate the need for downward adjustment.
2	Market share of large-scale food producers	Percentage of market share held by large-scale food producers in a 12-month period.	Determine the market share of vehicles held by large-scale food producers in the country. In the Design stage, this helps to assess the feasibility of large-scale fortification of a vehicle. In the Monitor stage, market share can be used to prioritize producers for oversight when resources are insufficient to monitor all producers. In the Evaluate stage, market share can be reviewed to determine whether the selected vehicles remain appropriate for reaching the target population.
3	Production and trade of food	Percentage of the total amount of food (for human consumption) that is domestically produced and imported within a 12-month period.	Determine whether fortification efforts should target domestically produced food(s), imported food(s), or both, based on their relative contribution to the national food supply available for human consumption. In the Design stage, this supports decision-making about whether domestically produced food(s), imported food(s), or both should be targeted for fortification. In the Evaluate stage, it helps determine whether shifts in the relative contribution of domestically produced and imported food(s) to human consumption require expanding, reducing, or changing fortification requirements for domestically produced food(s), imported food(s), or both.
4	Fortifiable vehicle coverage	Percentage of the population (or households) that consumed a fortifiable vehicle during the last 24 hours.	Estimate the proportion of the population that consumes a fortifiable vehicle. In the Design stage, this enables decision-making around which vehicles to fortify at large scale and provides insight into potential program reach. In the Evaluate stage, this helps determine whether fortification of specific vehicles remains relevant over time.

No.	Indicator name	Definition	Purpose
5	Fortifiable vehicle consumption	Weighted average per capita daily consumption of a fortifiable vehicle.	Determine the amount of a fortifiable vehicle (and its derivatives) consumed by a population. In the Design stage, this enables decision-making around which foods to fortify at large scale and the amount of nutrients to add. In the Evaluate stage, this helps determine whether fortification of specific vehicles remains relevant over time and whether nutrient levels should be adjusted.
6	Micronutrient adequacy intake or excess intake pre- and post-fortification	Percentage of the population with adequate intake and excess intake of a micronutrient in the pre- and post-fortification periods.	Determine whether fortification can make a meaningful contribution to population micronutrient intake without increasing risk of excess intake. In the Design stage, modeling the potential impact of fortification programs informs decision-making around which foods to fortify, what levels of micronutrients to add, and the extent to which complementary interventions may be needed to better meet micronutrient needs or avoid excessive micronutrient intakes in specific population groups. In the Evaluate stage, analyzing monitoring or survey data can help determine whether fortification made a meaningful contribution to population micronutrient intake and guide adjustments to fortification programs and complementary interventions.
Non-core			
7	Micronutrient policy in the country	Whether there is a government-issued micronutrient malnutrition policy in place.	Determine political will related to addressing micronutrient malnutrition, which is necessary to implement interventions to improve micronutrient intake and status, including fortification.
8	Micronutrient intake gap	Gap between population micronutrient intake and recommendations.	Quantify the need for improving micronutrient intakes among at-risk populations to inform the design of fortification programs and complementary interventions.
9	Feasibility of fortifying vehicle	Technical feasibility of adding, distributing, and retaining an appropriate fortificant in a food vehicle while maintaining product quality and enabling delivery through existing industrial production systems.	Determine whether a food vehicle can be fortified using available technology and appropriate fortification compounds. This includes assessment of fortificant compatibility with the vehicle, nutrient stability during processing and storage, expected bioavailability, and the ability of producers to consistently incorporate the fortificant into the food. Acceptability considerations such as changes in appearance, taste, or odor should also be assessed because they may affect consumer uptake, although they are conceptually distinct from technical feasibility.

No.	Indicator name	Definition	Purpose
10	Consumers' capacity to purchase fortified food	Percentage of households that can purchase fortified food at prevailing market prices without a substantial increase in household food expenditure.	Estimate whether the cost of fortified food may limit consumer access, particularly among lower-income households. The indicator can help determine whether fortification remains affordable and whether pricing may reduce the reach or equity of a fortification program. There is no universally accepted affordability threshold for fortified foods. Assess affordability by comparing the price of fortified and non-fortified foods and determining whether the added cost of fortification could limit access among intended beneficiaries, particularly lower-income households.
11	Government mandate for micronutrient surveys	Whether there is a government-issued mandate for an agency to conduct surveys relevant for micronutrient programs.	Determine whether there is a formal mandate from the government requiring one or more agencies to carry out periodic surveys to collect data that is required for the design, implementation, monitoring, and evaluation of micronutrient programs.
12	Appropriate fortificants selected for vehicle fortification	Whether appropriate fortificants were selected for vehicle fortification based on bioavailability, stability, and consumption .	Determine whether the fortificants selected for fortification are appropriate in terms of bioavailability, stability, compatibility with the food vehicle, consumption patterns of the vehicle, and other factors that may influence the effectiveness of fortification, such as the ability to improve micronutrient intakes and ultimately micronutrient status.
13	Appropriate nutrient concentration specified	Whether appropriate fortification concentrations are specified in government-issued standards for food fortification.	Determine whether government-issued fortification standards specify nutrient concentrations that are appropriate, meaning that they are likely to improve micronutrient adequacy, intake, and status among at-risk populations while minimizing the risk of excess intake in other populations, and that align closely with WHO recommendations for fortified foods (wheat flour, maize flour, oil, and salt).

No.	Indicator name	Definition	Purpose
Implement			
Core			
14	Government capacity for fortification monitoring and enforcement	Percentage of government personnel occupying positions required for monitoring and enforcement of food fortification who meet established competency criteria at the time of reporting.	Assess the proportion of positions required for fortification monitoring and enforcement that are filled by competent personnel and identify workforce gaps that may limit regulatory oversight.
15	Enforceable National Fortification Regulatory Framework	Degree to which a country has an operational and enforceable national regulatory framework for food fortification across the fortification value chain, including fortified foods and fortification premix, based on the presence of four core components: legal authority, technical standards, legal-technical linkage, and enforceability.	Assess whether a country has a fully operational and enforceable regulatory framework across the fortification value chain and identify specific gaps when the framework is not complete. The fortification value chain encompasses premix and fortified foods from production or importation through regulatory monitoring and enforcement.
16	Government procedures for monitoring fortification	Degree to which government procedures for monitoring and enforcing food fortification are established, meet minimum quality standards, are implemented in practice, and are used to support compliance and enforcement activities.	Assess whether government systems have the procedures needed to effectively monitor and enforce food fortification across the fortification value chain. This indicator examines whether procedures are in place, meet minimum quality standards, are implemented in practice, and are used to support compliance verification and corrective actions.

No.	Indicator name	Definition	Purpose
17	Large-scale producers with appropriate and functional fortification-dosing equipment	Percentage of large-scale producers that have appropriate, functional, and calibrated equipment installed and in use to add vitamins and minerals to a food during the last 12 months.	Assess whether large-scale food producers have appropriate, functional, and calibrated fortification-dosing equipment installed and in use. Appropriate and properly calibrated dosing equipment is a prerequisite for consistent addition of vitamins and minerals to food and supports compliance with fortification standards.
18	Large-scale food producers with quality procedures	Percentage of large-scale [food] producers with documented and functioning QA/QC procedures for fortification that meet the minimum criteria described in Appendix 2 at the time of assessment.	Assess whether large-scale food producers have minimum quality assurance and quality control (QA/QC) systems in place to support consistent food fortification.
Non-core			
19	Large-scale food producers with uninterrupted premix supply	Percentage of large-scale food producers reporting no premix stockout events during the previous 12-month period.	Assess whether large-scale food producers maintained uninterrupted premix supplies during the previous 12-month period. Premix stockouts can interrupt fortification, reduce compliance with fortification standards, and limit the consistent availability of fortified foods.
20	Access to accredited laboratories for fortification monitoring and quality assurance	Whether there are accredited laboratories in the country or region that can measure micronutrient content in fortified foods and fortification premix and are accessible for fortification monitoring and quality assurance activities.	Assess whether accredited laboratory capacity is available to support regulatory monitoring, producer quality assurance, and premix testing, either within the country or through accessible regional laboratory services.
21	Data systems	Whether there are data systems that make existing information usable and shareable across stakeholders.	Determine if there are existing data systems that allow fortification stakeholders to share, access, and use timely data and information to facilitate fortification decision-making across the program cycle.

No.	Indicator name	Definition	Purpose
22	Food fortification in the national budget	Whether food fortification is included in the national budget.	Determine the extent to which food fortification has allocated funding in national budgets, including dedicated line items to support various fortification-related activities across the project cycle, from design and implementation to monitoring and evaluation.
23	Mandatory [food] fortification for social protection programs	Whether there is a government-issued document that requires food fortification for social protection programs.	Assess whether there is a government-issued document requiring that fortification be used in social protection programs. This indicator helps determine whether fortification is being used as a mechanism to reach populations served by social protection programs and may provide insight into the equity of fortification efforts. It is also important for understanding the need to monitor and evaluate fortification activities implemented through social protection systems.
24	Required fortification logo	Whether there is a government-issued document that requires fortified vehicles to have a fortification logo on the label.	Assess whether there is a government-issued document requiring that fortified vehicles have a logo on the label, which may be important for improving consumer awareness and driving demand in contexts where fortification programs are new or unfamiliar and where lack of trust in fortified food has been identified as a barrier to uptake.
25	Incentives for producers	Whether there are incentives in place for large-scale vehicle producers to fortify.	Assess whether incentives are in place to encourage large-scale food producers to fortify vehicles, such as interest-free loans to support the purchase of micronutrient dosifiers and tax or tariff exemptions for imported premix.
26	Active multi-sector coalition for food fortification	Whether a multi-sector food fortification coalition is active,	Assess whether one or more fortification coalitions are actively working to advance the fortification agenda at the regional, national, or subnational level, which may help strengthen collaboration and coordination among government, private-sector, and civil-society stakeholders.
27	Large-scale food producers with capacity to fortify	Percentage of large-scale food producers with adequate financial and human capacity to fortify,	Assess which large-scale producers have the human and financial capacity to fortify, which is important for targeting monitoring efforts and determining which producers may require support to become compliant with mandatory fortification legislation and standards.

No.	Indicator name	Definition	Purpose
Monitor			
Core			
28	Compliance cascade for domestically produced fortified vehicle	Composite cascade indicator tracking the progression of large-scale food producers through key stages of regulatory monitoring—eligibility, inspection, compliance determination, and resolution of non-compliance—culminating in the proportion of producers that are compliant with food fortification standards in a 12-month period.	Assess compliance with food fortification standards among large-scale food producers across the full regulatory cascade—from eligibility and inspection to compliance determination and resolution of non-compliance—to support routine monitoring, guide enforcement actions, and track progress toward achieving full compliance among large-scale food producers.
29	Compliance cascade for imported premix	Composite cascade indicator tracking the progression of imported premix through key stages of regulatory monitoring—eligibility for import monitoring, inspection, compliance determination, and resolution of non-compliance—culminating in the proportion of imported premix consignments that comply with premix quality standards during a 12-month period.	Assess compliance with premix quality standards among imported premix consignments across the full regulatory cascade—from eligibility for import monitoring and inspection to compliance determination and resolution of non-compliance—to support routine import monitoring, guide enforcement actions, and track progress toward achieving full compliance among imported premix shipments.

No.	Indicator name	Definition	Purpose
30	Compliance cascade for imported fortified vehicle	Composite cascade indicator tracking the progression of imported fortified food through key stages of regulatory monitoring—eligibility for import monitoring, inspection, compliance, determination, and resolution of non-compliance—culminating in the proportion of imported fortified food consignments that comply with food fortification standards during a 12-month period.	Assess compliance with food fortification standards among imported fortified food consignments across the full regulatory cascade—from eligibility for import monitoring and inspection to compliance determination and resolution of non-compliance—to support routine import monitoring, guide enforcement actions, and track progress toward achieving full compliance among imported fortified food consignments.
Non-core			
31	Compliance cascade for domestically produced premix	Composite cascade indicator tracking the progression of domestic premix-producing facilities through key stages of regulatory monitoring—eligibility, inspection, compliance determination, and resolution of non-compliance—culminating in the proportion of facilities that are compliant with premix quality standards in a 12-month period.	Assess compliance with premix quality standards among domestic premix-producing facilities across the full regulatory cascade – from eligibility and inspection to compliance determination and resolution of non-compliance – to support routine monitoring, guide enforcement actions, and track progress toward achieving full compliance among premix producers.
32	Compliance cascade for fortified vehicles in retail outlets	Compliance cascade indicator tracking the progression of fortified vehicles in retail outlets through key stages of regulatory monitoring—eligibility, inspection, and inspection outcome—culminating in the proportion of retail outlets that align with fortification standards in a 12-month period.	Assess whether fortified vehicles available in retail outlets meet labeling specifications in fortification standards and contain micronutrients at the expected levels and identify brands and producers that may require additional auditing or investigation.

No.	Indicator name	Definition	Purpose
33	Fortified food produced at large scale domestically	Amount of domestically produced food that is fortified.	Determine the amount of domestically produced fortified food available to consumers and its contribution to the total supply of fortified food in the country, including imported fortified food.
34	Fortified imported food	Amount of imported food that is fortified.	Determine the amount of imported fortified food available to consumers and its contribution to the total amount of fortified food available in the country, including domestically produced fortified food.
35	Market availability of fortified food	Percentage of vehicle available in the market that meets fortification standards, based on government monitoring of production, imports, or retail availability, over the past 12 months.	Assess whether fortified vehicles that meet fortification standards are available in the market, an important prerequisite for consumer access to fortified foods and for the potential nutritional impact of fortification programs.
Evaluate			
Core			
36	Fortified food coverage	Percentage of households that accessed or consumed a fortified food during a defined reference period.	Assess the reach of a fortification program by measuring the proportion of households that access or consume fortified foods, including both fortified food vehicles and foods produced using fortified ingredients. The indicator provides information on program coverage, market penetration, and equity of access, and helps identify gaps between availability of fortified foods and population exposure to fortification.
37	Micronutrient requirements met by fortification	Percentage of population-level micronutrient requirement met through intake of additional micronutrient from one or more fortified vehicles.	Evaluate whether fortification is contributing meaningfully to population micronutrient intake. This helps assess fortification program performance and identify whether adjustments or complementary interventions may be needed to better meet micronutrient needs.

No.	Indicator name	Definition	Purpose
Non-core			
38	Cost-effectiveness	Cost-effectiveness of fortified food.	Assess whether food fortification delivers nutritional benefits at a reasonable cost compared with alternative interventions. This supports resource allocation and investment decision-making for fortification programs.
39	Improvement in micronutrient biomarker status	Improvement in micronutrient biomarker status due to fortification.	Assess changes in the micronutrient status of the population over time to determine whether deficiencies, insufficiencies or excesses are changing, important for evaluating the effectiveness of food fortification programs and complementary nutrition interventions.
40	Fortified food consumption	Weighted average per capita daily consumption of a fortified vehicle.	Determine the amount of a fortified vehicle consumed by a population. This provides information on whether fortified foods are reaching consumers at meaningful levels and helps assess whether fortification of specific vehicles remains relevant over time and whether program adjustments are needed.
41	Nutrients provided by fortified food	Amount of nutrients provided by one or more fortified vehicles.	Estimate the amount of micronutrients added to the food supply through fortification, which helps assess whether fortified foods are delivering nutrients at the intended levels and is required for understanding the extent to which fortification contributes to meeting dietary micronutrient requirements .
42	Micronutrient intake from fortified food	Amount of micronutrients consumed through one or more fortified vehicles.	Estimate the intake of micronutrients by consumers through fortified vehicle(s), which is required to understand the extent to which fortification contributes to meeting dietary micronutrient requirements.
43	Beneficiaries reached	Number of beneficiaries reached by one or more fortified vehicles.	Estimate the number of individuals who regularly consume fortified vehicles and are likely to benefit from them, which is important as an independent measure and is needed for estimating coverage.
44	Consumer perceptions	Consumer perceptions of fortification and fortified vehicles.	Assess consumer knowledge, attitudes, and acceptance of food fortification and fortified products, factors which may influence purchasing, consumption, and overall effectiveness of the fortification program.

¹For the micronutrient iodine, population status is defined as median urinary iodine concentration rather than the percentage of individuals below or above a cutoff.

Indicator Reference Sheets

Indicator 1: Micronutrient biomarker status

Fortification Stage	Design and Evaluate
Purpose	Determine if population-level micronutrient status shows deficiency, insufficiency, or excess. In the Design stage, a high prevalence of deficiency and insufficiency may indicate a need for fortification, while a high prevalence of excess indicates that existing programs that contribute micronutrients to the diet may need to be revised. In the Evaluate stage, a high prevalence of deficiency and/or insufficiency may indicate a need for assessing the effectiveness of any programs delivering micronutrients, including fortification, and upward adjusting micronutrient levels, while a high prevalence of excess may indicate the need for downward adjustment.
Definition	Percentage of the population of interest with micronutrient deficiency, insufficiency, or excess. ¹
Numerator	Number of individuals with [micronutrient biomarker] more or less than [cutoffs for deficiency/insufficiency and excess].
Denominator	Number of individuals who underwent [micronutrient biomarker] test in [population group].
Method of collection and data source	Micronutrient concentrations are tested in various specimens (e.g., blood, breast milk, saliva, fecal excretion, urine) that are typically sent to laboratories for analysis. Micronutrient status can be determined in national surveys, program evaluations, and research studies. In rare cases, clinical data may complement other sources of information. If gathering specimens, it is important that sampling strategies facilitate data collection and analysis among representative sub-populations who may be especially at risk of deficiency, insufficiency, and/or excess.
Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: $(\text{Numerator} / \text{Denominator}) * 100 = \%$

1. For iodine, population-level deficiency is determined only by median urinary iodine concentration, per WHO's Guide for Assessment of Iodine Deficiency Disorders.

Special considerations for calculation	Cutoffs for deficiency, insufficiency, and excess are specific to the biomarker used (e.g., per WHO guidelines²⁵, red blood cell folate below 100 ng/mL and below 400 ng/mL in women for folate deficiency and insufficiency, respectively; there are no established cutoffs for folate excess using red blood cell folate). Appropriate measures of central tendency and spread - e.g., median and inter-quartile range of micronutrient concentrations - should be presented in addition to prevalence estimates. In the absence of current biomarker data, estimates of dietary inadequacy using 24HR or HCES survey data may be used to inform decisions at the Design and Evaluate stages.
Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children) and other sociodemographic factors. For surveys conducted after the start of fortification, disaggregation can be based on consumption of a vehicle (e.g., consumer, non-consumer), amount of the vehicle consumed (e.g., below and above a cutoff), and whether there is evidence the vehicle is fortified (e.g., based on brand used in the home and government monitoring data for the brand).
Example	In a country where the only vehicle fortified is salt with iodine, a recent nationally representative micronutrient survey sampled 1,800 apparently healthy women of reproductive age who underwent venous blood draws to measure ferritin levels (a biomarker of iron status). Among these 300 women, 64 were found to have low ferritin (<15 µg/L). (Note: for individuals with infection and/or inflammation, adjustments are required, per WHO's Guideline on use of Ferritin Concentrations to Assess Iron Status in Individuals and Populations²⁶.) $(378 \text{ women with low ferritin} / 1,800 \text{ women who underwent blood draws}) * 100 = 21\% \text{ of women}$ Design stage: To reduce the proportion of women who are affected by low ferritin, fortification with iron should be considered. Evaluate stage: Existing fortification (and other micronutrient) interventions should be adjusted to further reduce the percentage of women affected by low ferritin.
Strengths	Provides quantitative estimates that are reflective of micronutrient intake, absorption, and utilization.

Limitations	Collecting biochemical data is complex, time-consuming, and costly, and may not be realistic in many contexts. Estimating excess may require different biomarkers than those that are used for estimating deficiency and insufficiency.
Validation and testing	Multiple biochemical indicators have been tested and validated for estimating the percentage of the population with micronutrient deficiencies. Few biomarkers of micronutrient status have validated cutoffs representing excess.
Further information and related links	The Micronutrient Survey Manual²⁷ provides guidance on the collection and reporting of micronutrient biomarker data. Using data from WHO's Vitamin and Mineral Nutrition Information System (VMNIS), the Global Fortification Data Exchange (GFDx) visualizes status for five micronutrients that are commonly the target for fortification programs.
Related indicators	Indicator 6 - Micronutrient adequacy intake or excess intake pre- and post-fortification (Core): Used together with Indicator 1 to determine whether a micronutrient problem exists and whether fortification may improve nutrient adequacy. Indicator 37 - Micronutrient requirements met by fortification (Core): Helps assess whether fortification is contributing sufficient micronutrients to influence population micronutrient status. Indicator 39 - Improvement in micronutrient biomarker status due to fortification (Non-core): Measures changes in biomarker status over time and complements this indicator's assessment of micronutrient status at a single point in time.

Indicator 2: Market share of large-scale food producers

Fortification Stage	Design, Monitor, and Evaluate
Purpose	Determine the market share of vehicles held by large-scale food producers in the country. In the Design stage, this helps to assess the feasibility of large-scale fortification of a vehicle. In the Monitor stage, market share can be used to prioritize producers for oversight when resources are insufficient to monitor all producers. In the Evaluate stage, market share can be reviewed to determine whether the selected vehicles remain appropriate for reaching the target population.
Definition	Percentage of market share held by large-scale food producers in a 12-month period.
Numerator	Volume of [food vehicle] (e.g., expressed in metric tons, MT) sold by large-scale producers in the country in a 12-month period.
Denominator	Total volume of [vehicle] (in MT) sold in the country in a 12-month period.
Method of collection and data source	Producer associations, industry reports, administrative records, production statistics, market assessments, or information provided directly by producers. Where available, market share may also be estimated using sales or revenue data.
Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: $(\text{Numerator} / \text{Denominator}) * 100 = \%$
Special considerations for calculation	Ensure producers are correctly classified as large-scale. Market share can also be calculated using production volume, sales volume, sales value, or revenue. However, sales and revenue data are often commercially sensitive and may be difficult to obtain from producers. When such data are unavailable, production volume or producer association data may provide a more feasible basis for estimation. Large-scale producers of a fortification vehicle can be characterized in other ways, including the number and/or percentage of large-scale producers.
Disaggregation	Geographic region, producer ownership type (e.g., privately owned domestic producers, state-owned enterprises, foreign-owned companies), producer, and brand.

Example	Twenty-five large-scale oil producers (with a rated capacity of 5 MT/day or more) produced 1.2 million MT in a 12-month period. The total amount of edible oil produced in the country in the same year was 22.4 million MT. Dividing the amount produced by the large-scale producers by the total amount produced in the country and converting that to a percent $[(1.2/22.4) * 100]$, large-scale producers' market share was 5.4%. Design stage: Because large-scale producers account for only 5.4% of the edible oil market, edible oil may not be a priority vehicle for large-scale fortification. Monitor stage: If mandatory fortification is implemented despite low market share, monitoring efforts can focus inspections on the 25 large-scale producers to maximize oversight with limited resources. Evaluate stage: Market share should be reassessed periodically. If the share of oil produced by large-scale producers increases or decreases substantially, the suitability of edible oil as a fortification vehicle should be reconsidered.
Strengths	Can be calculated using existing administrative or commercial data (e.g., producer association records). Provides a useful proxy for the potential reach of large-scale fortification efforts.
Limitations	Depends on information that may be incomplete (i.e., due to limited coverage of informal markets) or proprietary (e.g., disaggregated sales data) as producers may be reluctant to share commercially sensitive information—raising concerns about feasibility, bias and representativeness.
Validation and testing	Not known to be formally tested or validated.
Further information and related links	WHO's manual for flour fortification monitoring² emphasizes the need to determine market share to prioritize producers that supply larger volumes in regulatory sampling plans (see section 4.3.2.1) and suggests that calculations of the fortification content of flour be weighted by market share (see section 4.4.3), supporting the Monitor stage. However, this indicator is also relevant in the Design and Evaluate stages to assess feasibility of LSFF and appropriateness for reaching the target population over time, as detailed above.

Related indicators	Indicator 3 - Production and trade of food (Core): Used together with Indicator 2 to determine whether domestically produced foods, imported foods, or both should be targeted for fortification. Indicator 4 - Fortifiable vehicle coverage (Core): Used together with Indicator 2 to determine whether a food vehicle can reach a sufficiently large proportion of the population through large-scale fortification. Indicator 5 - Fortifiable vehicle consumption (Core): Used together with Indicator 2 to determine whether a food vehicle is consumed in sufficient quantities to serve as an effective fortification vehicle. Indicator 28 - Compliance cascade for domestically produced fortified vehicle (Core): Used together with Indicator 2 to prioritize monitoring and enforcement activities toward producers supplying the largest share of the market.
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Indicator 3: Production and trade of food

Fortification Stage	Design and Evaluate
Purpose	Determine the amount of food that is domestically produced and imported and their relative contribution to the national food supply available for human consumption. In the Design stage, this supports decision-making about whether domestically produced food(s) should be fortified, also taking into consideration the amount of the food(s) which is imported and thus would need to be fortified in countries where fortification is (or may become) mandatory. In the Evaluate stage, it helps determine whether shifts in the relative contribution of domestically produced and imported food(s) to human consumption require expanding, reducing, or changing fortification requirements for domestically produced food(s), imported food(s), or both.
Definition	Percentage of the total amount of food (for human consumption) that is domestically produced and imported within a 12-month period.
Numerator	1. Amount of domestically produced [food vehicle] (for human consumption). 2. Amount of imported [food vehicle] (for human consumption).
Denominator	Total amount of [food vehicle] (for human consumption)
Method of collection and data source	National food balance sheets may compile: 1) production and trade data, obtained through direct inquiries, records, or estimated by government agencies; 2) information on stock changes, available from marketing authorities and factories or from farm stock surveys; 3) information on industrial uses, obtained from industrial censuses and surveys; 4) feed and seeding rates obtained from cost-of-production surveys or estimated by government agencies; 5) losses occurring during processing, obtained from manufacturing surveys. Production and trade data can be used to estimate the amounts of domestically produced and imported food. Information on stock changes, industrial uses, feed and seed uses, and losses can then be used to adjust these amounts so that only the amount available for human consumption is included. Amount of domestically produced food available for human consumption = domestic production – exports – amounts used for industrial purposes – amounts used for feed and seed – losses ± stock changes.

Method of collection and data source	Amount of imported food available for human consumption = imports – amounts used for industrial purposes – amounts used for feed and seed – losses ± stock changes. Total amount of food available for human consumption (denominator) = amount of domestically produced food available for human consumption + amount of imported food available for human consumption. In cases where this information cannot be compiled at the national level, data compiled by FAO may be useful. FAO sends standardized questionnaires annually to country governments, the responses of which are used to populate FAOSTAT's Food Balance Sheets (FBS) and Supply Utilization Accounts (SUA). While SUAs provide information on items suitable for human consumption (e.g., wheat flour, bread), FBS provide information on agricultural commodities at the macro level (e.g., wheat and products). Production, import, export, utilization, and loss data available through these systems can be used to estimate the amounts of domestically produced and imported food available for human consumption.
Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: $(\text{Numerator} / \text{Denominator}) * 100 = \%$
Special considerations for calculation	Production can be measured in the form of raw ingredients (e.g., wheat, maize) or as derivatives suitable for human consumption (e.g., flours). FAOSTAT includes both. When estimating the amount of domestically produced food available for human consumption, subtract exports, industrial uses, feed and seed uses, and losses, and adjust for stock changes as appropriate. When estimating the amount of imported food available for human consumption, subtract industrial uses, feed and seed uses, and losses, and adjust for stock changes as appropriate. The denominator should equal the sum of the amounts of domestically produced food and imported food available for human consumption. The same definitions, adjustment factors, and reporting period should be used for domestic production and imports to ensure comparability. The total amount of a food produced (for human consumption) in a country is needed for calculating the percentage that is produced at large scale and could be fortified (see Indicator 4: Fortifiable vehicle coverage).
Disaggregation	If production, importation, and exportation statistics are available on different characteristics of the food that are meaningful for fortification (e.g., white maize is destined for human consumption versus yellow maize which is destined for animal feed), disaggregate by these characteristics.

Example	In a country, annual rice production is 32 million MT and rice imports are 1.5 million MT. For domestically produced rice: Production = 32 million MT Exports = 0.5 million MT Industrial uses = 0.5 million MT Feed and seed uses = 0.5 million MT Losses = 0.5 million MT Stock decrease = 1 million MT Amount of domestically produced rice available for human consumption: $32 - 0.5 - 0.5 - 0.5 - 0.5 + 1 = 31$ million MT For imported rice: Imports = 1.5 million MT Industrial uses = 0.3 million MT Feed and seed uses = 0.2 million MT Losses = 0.2 million MT Stock increase = 0.5 million MT Amount of imported rice available for human consumption: $1.5 - 0.3 - 0.2 - 0.2 - 0.5 = 0.3$ million MT Total amount of rice available for human consumption: $31 + 0.3 = 31.3$ million MT Percentage of rice available for human consumption that is domestically produced: $(31 / 31.3) \times 100 = 99.0\%$ Percentage of rice available for human consumption that is imported: $(0.3 / 31.3) \times 100 = 0.96\%$ Design stage: Because 99% of the rice available for human consumption is domestically produced and only 1% is imported, fortification efforts should focus on domestically produced rice. Evaluate stage: If, over time, imported rice increases its contribution to the rice supply available for human consumption (e.g., from 1% to 30%), fortification requirements will need to be expanded to include imported rice in addition to domestically produced rice.
Strengths	At the national level, government agencies leverage direct relationships with actors across the food supply chain and thus data gathered and synthesized by government agencies may be more timely and cost-effective than data collected by global organizations. At the global level, FAOSTAT uses a rigorous and systematic process to collect and analyze food production, import, and export data for nearly 250 countries.

Limitations	To accurately generate these estimates, information is needed from various sources and is therefore subject to inconsistencies. The required data may be difficult to obtain for the same time period or at all. There may be reporting delays resulting in a lag in data availability for the current or previous year of interest. Data may not be disaggregated for important characteristics of the food (such as color, variety, etc.).
Validation and testing	FAO has been collecting and utilizing agricultural data for nearly 100 years, with continuous refinement of its tools and approach.
Further information and related links	Data accounts can be accessed directly via the FAOSTAT's Food Balance Sheets (FBS) and Supply Utilization Accounts (SUA). WHO's eCatalogue includes an indicator for "The total amount of wheat or maize flour produced for domestic human consumption." However, this indicator was written prior to the launch of Supply Utilization Accounts by FAO, which provide a direct estimate of items suitable for human consumption without the need to apply extraction rates.
Related indicators	Indicator 2 - Market share of large-scale food producers (Core): Used together with Indicator 3 to determine whether a food vehicle is suitable for large-scale fortification and whether monitoring efforts should focus on domestic producers. Indicator 4 - Fortifiable vehicle coverage (Core): Used together with Indicator 3 to determine whether a food vehicle is likely to reach a large proportion of the population. Indicator 5 - Fortifiable vehicle consumption (Core): Used together with Indicator 3 to determine whether a food vehicle is consumed in sufficient quantities to make fortification effective. Indicator 36 - Coverage of fortified food (Core): Used together with Indicator 3 during program evaluation to assess whether the relative contribution of domestically produced and imported foods remains consistent with observed program reach. Indicator 6 - Micronutrient adequacy intake or excess intake pre- and post-fortification (Core): Used together with Indicator 3 when selecting foods for fortification and assessing whether changes in the food supply may influence the nutritional impact of fortification programs.

Indicator 4: Fortifiable vehicle coverage

Fortification Stage	Design and Evaluate
Purpose	Estimate the proportion of the population that consumes a fortifiable vehicle. In the Design stage, this enables decision-making around which vehicles to fortify at large scale and provides insight into potential program reach. In the Evaluate stage, this helps determine whether fortification of specific vehicles remains relevant over time.
Definition	Percentage of the population (or households) that consumed a fortifiable vehicle during the last 24 hours.
Numerator	Number of individuals (or households) that consumed [fortifiable vehicle] during the last 24 hours.
Denominator	Total number of individuals (or households) surveyed in the population group.
Method of collection and data source	For data on individuals: nationally representative surveys using 24HR and/or FFQ, or fortification-specific coverage tools focused on the individual's intake. For data on households: 24HR, FFQ, and fortification-specific coverage tools that collect information about household intake, as well as nationally representative household consumption and expenditure surveys (HCES).
Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: $(\text{Numerator} / \text{Denominator}) * 100 = \%$
Special considerations for calculation	May be difficult to distinguish the intake of fortifiable vehicles (e.g. branded, packaged) from non-fortifiable vehicles (e.g., artisanally produced) based on information provided by respondents, especially when the vehicle is consumed outside of the home (e.g., eatery). In the Evaluate stage, interpret coverage estimates in the context of the scope of fortification legislation, including which food types, origins (domestically produced and/or imported), and uses (household consumption and/or processed foods) are covered, as well as any exemptions. These factors may affect the proportion of the population that can be reached through fortification.
Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children), and other sociodemographic factors.

Example	In a nationally representative survey, 24HR were conducted among 1,800 women aged 15-49 years. They were asked to report the consumption of rice from various sources, and the amount of rice that was home-produced was excluded. Interviewers also documented packaging, brands, and fortification logos to determine if the rice present in the household was fortifiable. Among those surveyed, 1,575 reported consuming fortifiable rice in the past 24 hours. $(1,575 / 1,800) * 100 = 87.5\%$ of women aged 15-49 years consumed fortifiable rice. The survey was applied to urban and rural dwellers and fortifiable rice consumption varied between these settings: Urban: $(1185 / 1200) * 100 = 98.8\%$ of urban-residing women aged 15-49 years consumed fortifiable rice Rural: $(390 / 600) * 100 = 65.0\%$ of rural-residing women aged 15-49 years consumed fortifiable rice Design stage: Rice fortification is recommended as coverage of fortifiable rice is high, although additional interventions may be needed to meet the needs of rural-residing women who consume fortifiable rice less frequently. Evaluate stage: While coverage of fortifiable rice is high among urban-residing women, efforts should be made to improve coverage among rural-residing women.
Strengths	May not require additional data collection if existing dietary data collected for other purposes are available. Captures the portion of the vehicle that is feasible to fortify and is relatively simple to monitor as it is produced at large scale.
Limitations	Up-to-date, nationally representative dietary assessment data are frequently unavailable in many countries and are costly to collect. When available, these data are subject to the limitations of self-report (e.g., recall bias, social desirability bias) and prone to measurement error. Challenging to distinguish between fortifiable and non-fortifiable vehicles, due to participant recall error and because foods that may be fortified are not always labeled (e.g., they may be repackaged from bulk into smaller packages).
Validation and testing	The Fortification Assessment Coverage Toolkit (FACT) survey has been validated .

Further information and related links	Dietary data are available in the Global Dietary Database and FAOSTAT's "food and diet domain" under "intake (based on individual quantitative dietary surveys)." In the same domain, proxy dietary data are available and labeled as "apparent intake (based on household consumption and expenditure surveys)." Example survey questions for assessing fortifiable food coverage are available in Table 3 of this document 'Measuring food fortification coverage in household surveys: formative research findings from Bangladesh and Ethiopia'²⁸. The GFDx visualization for, "Maximum potential coverage of fortified food," which integrates data on population consumption and fraction of the vehicle that is industrially processed (i.e. fortifiable). The GFDx visualization for, "Scope of mandatory fortification," which integrates information from national legislation on the food types, origins, uses, and exemptions covered by mandatory fortification requirements.
Related indicators	Indicator 2 - Market share of large-scale food producers (Core): Used together with Indicator 4 to determine whether a food vehicle can reach the population through large-scale fortification. Indicator 3 - Production and trade of food (Core): Used together with Indicator 4 to identify food vehicles that are available in sufficient quantities and are appropriate candidates for fortification. Indicator 5 - Fortifiable vehicle consumption (Core): Used together with Indicator 4 to determine whether a food vehicle is both widely consumed and consumed in sufficient quantities to support fortification. Indicator 36 - Coverage of fortified food (Core): Used together with Indicator 4 to compare the potential reach of fortification (fortifiable vehicle coverage) with the actual reach of fortified foods after program implementation.

Indicator 5: Fortifiable vehicle consumption

Fortification Stage	Design and Evaluate
Purpose	Determine the amount of a fortifiable vehicle (and its derivatives) consumed by a population. In the Design stage, this enables decision-making around which foods to fortify at large scale and the amount of nutrients to add. In the Evaluate stage, this helps determine whether fortification of specific vehicles remains relevant over time and whether nutrient levels should be adjusted.
Definition	Weighted average per capita daily consumption of a fortifiable vehicle.
Numerator	Sum each individual's daily consumption of the vehicle multiplied by the individual's unique sampling weight.
Denominator	Sum of all sampling weights.
Method of collection and data source	If collecting new dietary data (via 24HR, quantitative FFQ, food records, and other validated tools), ensure that the questionnaire is designed to estimate fortifiable food consumption as opposed to any food consumption. This may involve, for example, asking about the source of the food (e.g., purchased in a formal market vs. home-produced), packaging, brands, and examining and documenting fortification logos or labels (see the example questions in FACT household questionnaire template). If using dietary data that has already been collected and that does not specify the fortifiable portion, estimates should be adjusted for the proportion of the food that is fortifiable (i.e., industrially processed). This information may be obtained from industry insights or, less frequently, via regulatory data and market assessments (e.g., supply chain assessments).

Calculation or determination	Nationally representative survey data from individuals are aggregated to determine the average per capita daily consumption of the fortifiable vehicle, applying survey sampling weights to correct for over/under sampling and nonresponse, thus reducing bias in estimates. Formula: (Numerator / Denominator) = Weighted average If using dietary data that were collected for other purposes that do not contain information on the fortifiable portion, the result must be multiplied by the proportion of the vehicle that is industrially processed. Formula: (Numerator / Denominator) * Proportion that is industrially processed = Weighted average
Special considerations for calculation	May be difficult to distinguish the intake of fortifiable vehicles (e.g., branded, packaged) from non-fortifiable vehicles (e.g., artisanally produced) based on information provided by respondents, especially when the vehicle is consumed outside of the home (e.g., eatery). In the Evaluate stage, consider the existing regulatory framework, particularly whether fortification of specific vehicles is mandatory or voluntary. Where mandatory, determine whether legislation is applicable to all versions of a vehicle or only certain types (e.g., table salt vs. salt used in the food industry). Including these elements in estimations of fortifiable vehicle consumption will help to improve accuracy. Where food consumption data are lacking, information on food availability (e.g., from FAOSTAT's Food Balance Sheets and Supply Utilization Accounts) may be used as a proxy. It is also possible to calculate apparent consumption using data from household consumption and expenditure surveys (HCES). HCES data frequently include food quantities consumed and/or acquired by the household during a reference period but require manipulation and assumptions (e.g., application of the Adult Female Equivalent method) to approximate individual-level food consumption data. Further, it may be difficult or impossible to determine the proportion of the vehicle that was fortified using HCES data, and thus adjustment by the proportion that is industrially processed is needed.
Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children), and other sociodemographic factors.

Example

Example 1:

A recent, nationally representative survey included women aged 15-49 years who completed a single 24HR. The survey asked about the intake of foods made with maize flour and wheat flour, and enumerators asked additional questions (e.g., related to food source, brand, and packaging) to determine what proportion of the food was fortifiable. Individual weights were generated, multiplied by each individual's consumption, and summed (numerator), then divided by the sum of all weights (denominator), yielding a weighted average per capita daily consumption of 80g for fortifiable wheat flour and 10g for fortifiable maize flour.

Design stage: In this scenario, wheat flour would be prioritized for fortification because consumption of fortifiable wheat flour is higher than fortifiable maize flour.

Evaluate stage: Based on these data, wheat flour still appears to be an appropriate fortification vehicle because consumption of fortifiable wheat flour remains high, whereas maize flour appears less suitable due to its relatively low consumption. If consumption patterns change over time, the choice of fortification vehicle and nutrient levels may need to be adjusted.

Example 2:

In the past year, a database was released for a recent, nationally representative survey of women aged 15-49 years who completed a single 24HR. The survey asked about the intake of foods made with maize flour and wheat flour rather than the intake of foods made with fortifiable flour. Individual weights were generated, multiplied by each individual's consumption, and summed (numerator), then divided by the sum of all weights (denominator), yielding a weighted average per capita daily consumption of 120g for maize flour and 20g for wheat flour. In this country, recent industry insights estimated that 60% of maize flour is industrially processed while 95% of wheat flour is industrially processed.

$120 \text{ g/p/d maize flour} \times 60\% = 72 \text{ g/p/d}$
 $20 \text{ g/p/d wheat flour} \times 95\% = 19 \text{ g/p/d}$

Design stage: In this scenario, maize flour would be prioritized for fortification because consumption of fortifiable maize flour is higher than fortifiable wheat flour.

Evaluate stage: Based on these data, maize flour still appears to be an appropriate fortification vehicle because consumption of fortifiable maize flour remains high, whereas wheat flour appears less suitable due to its relatively low consumption. If consumption patterns change over time, the choice of fortification vehicle and nutrient levels may need to be adjusted.

Strengths	May not require additional data collection if existing dietary data collected for other purposes are available. Captures the amount of the consumed vehicle that is fortifiable and relatively simple to monitor as it is the portion produced at large scale.
Limitations	Up-to-date, nationally representative dietary intake data are frequently unavailable in many countries and are costly to collect. When available, these data are subject to the limitations of self-report (e.g., recall bias, social desirability bias) and prone to measurement error. Using dietary data that were collected for non-fortification purposes, and that do not include information on the proportion that is fortifiable, is a challenge that must be addressed by adjusting estimates by the proportion that is fortifiable.
Validation and testing	Dietary assessment methods have been widely tested, validated, and used across contexts^{29,30}. The Fortification Assessment Coverage Toolkit (FACT) survey has been validated .
Further information and related links	WHO guidelines (e.g., for maize flour, wheat flour, and salt) provide recommendations for fortification (including nutrients, compounds, and the amount to be added) based on daily population-level consumption. However, for salt, WHO also recommends monitoring urinary iodine concentrations to allow adjustment of the selected fortification concentrations. The GFDx visualizes, "Daily food intake/availability per capita," using food intake data at the country level when available and otherwise using proxy data such as food availability data calculated by FAO and described in food balance sheets. FAOSTAT also enables download and visualization of apparent intake based on HCES. The GFDx and FAOSTAT data on food intake, food availability, and apparent intake could be adjusted for the proportion of the food that is fortifiable by using estimates on the percentage of food that is industrially processed (i.e., fortifiable) as reported in the GFDx, "Quantity and proportion of food vehicle industrially processed by country."

Related indicators	Indicator 2 - Market share of large-scale food producers (Core): Used together with Indicator 5 to determine whether a food vehicle can be effectively fortified and distributed through large-scale producers. Indicator 3 - Production and trade of food (Core): Used together with Indicator 5 to identify food vehicles that are sufficiently available in the food supply and consumed by the target population. Indicator 4 - Fortifiable vehicle coverage (Core): Used together with Indicator 5 to determine whether a food vehicle is both widely consumed and consumed in sufficient quantities to support fortification. Indicator 6 - Micronutrient adequacy intake or excess intake pre- and post-fortification (Core): Used together with Indicator 5 to model the potential nutritional impact of fortification and assess whether consumption levels are sufficient to improve micronutrient adequacy without increasing risk of excess intake.
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Indicator 6: Micronutrient adequacy intake or excess intake pre- and post-fortification

Fortification Stage	Design and Evaluate
Purpose	Determine whether fortification can make a meaningful contribution to population micronutrient intake without increasing risk of excess intake. In the Design stage, modeling the potential impact of fortification programs informs decision-making around which foods to fortify, what levels of micronutrients to add, and the extent to which complementary interventions may be needed to better meet micronutrient needs or avoid excessive micronutrient intakes in specific population groups. In the Evaluate stage, analyzing monitoring or survey data can help determine whether fortification made a meaningful contribution to population micronutrient intake and guide adjustments to fortification programs and complementary interventions .
Definition	Percentage of the population with adequate intake and excess intake of a micronutrient in the pre- and post-fortification periods.
Numerator	Calculate separately for adequacy and excess in the pre- and post-fortification periods: · Number of individuals with adequate intake of [micronutrient] in the pre-fortification period · Number of individuals with excess intake of [micronutrient] in the pre-fortification period · Number of individuals with adequate intake of [micronutrient] in the post-fortification period · Number of individuals with excess intake of [micronutrient] in the post-fortification period
Denominator	Calculate separately for the pre- and post-fortification periods: · Total number of individuals surveyed in the pre-fortification period. · Total number of individuals surveyed in the post-fortification period.

Method of collection and data source	Nationally representative surveys that use 24HR, quantitative FFQ, food records, and other validated tools to estimate food intake. Food composition tables: if country-specific food composition tables are unavailable, consider using tables from a neighboring country with similar food intake patterns or the FAO/INFOODS Food Composition Database. Age- and sex-specific nutrient references from the country's normative body. If such references do not exist, either at all or for a particular micronutrient, other recommendations may be used, such as the harmonized nutrient reference values proposed by Allen et al. 2020, which draw from the standards set by the European Food Safety Authority (EFSA) (for Europe) and the Institute of Medicine IOM (for the United States and Canada).
Calculation or determination	Divide each numerator by its corresponding denominator and multiply the result by 100. Percentage with adequate intake in the pre-fortification period = (Pre-fortification adequacy numerator / pre-fortification denominator) × 100 Percentage with excess intake in the pre-fortification period = (Pre-fortification excess numerator / pre-fortification denominator) × 100 Percentage with adequate intake in the post-fortification period = (Post-fortification adequacy numerator / post-fortification denominator) × 100 Percentage with excess intake in the post-fortification period = (Post-fortification excess numerator / post-fortification denominator) × 100
Special considerations for calculation	If multiple 24HR are available, the NCI method may be used to estimate the distribution of usual food and micronutrient intakes for a population and determine the proportion that falls above or below specific thresholds. If only a single 24HR is available, it may still be possible to estimate usual intake distributions - refer to the methodology described by Luo et al 2019. Other available methods for estimating usual intake when multiple days of recall are available include the EAR cut-point method and the probability approach (Murphy and Poos, 2002). However, these methods are analytically intensive and the capacity for their use may be limited in some contexts. Where intake data are lacking, it is possible to calculate apparent intake using data from household consumption and expenditure surveys (HCES). HCES data frequently include food quantities consumed and/or acquired during a reference period but require manipulation and assumptions to approximate individual dietary intake data. See Adams et al. 2022 for an update on analytical methods in the use of HCES data to inform fortification programs.

Special considerations for calculation	Any assumptions made (e.g., about coverage of fortifiable/fortified vehicles, nutrient losses during storage and preparation, bioavailability and absorption, and other factors) should be explicitly documented. In contexts where multiple foods are fortified with one or more of the same micronutrients, the additive contribution to micronutrient intakes should be calculated. In contexts where other micronutrient interventions are implemented (e.g., supplementation, biofortification, social protection programs, specialized fortified foods, or other nutrition programs), their contribution to micronutrient intake should also be considered. Modeling should estimate the combined contribution of fortification and other interventions to identify population groups at risk of inadequate intake or excess intake and to determine where complementary interventions may still be needed. In the Evaluate stage, if longitudinal data are available, it is possible to calculate the change in population nutrient adequacy from the pre-fortification period to the post-fortification period.
Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children), and other sociodemographic factors.
Example	Example 1: A recent survey included a nationally representative sample of women of reproductive age (15-49 years, n=1,800) who completed a single 24HR. Iron intake was compared to the harmonized nutrient reference values for iron (average requirement: 11.2 mg/day, assuming moderate absorption; upper level: 40 mg/day). It was determined that, among these women, 245 had intakes of 11.2 mg/day or higher, but below 40 mg/day, while 10 had intakes above 40 mg/day. $(576 \text{ women} / 1,800 \text{ women}) * 100 = 32\%$ of women with adequate iron intake $(36 \text{ women} / 1,800 \text{ women}) * 100 = 2\%$ of women with excess iron intake Design stage: Micronutrient interventions – including fortification – should be strongly considered to support women of reproductive age and other at-risk populations to achieve micronutrient adequacy. Evaluate stage: Existing programs – including fortification – may need adjustment to improve the percentage of women with adequate iron intake.

Example	Example 2: In the absence of individual dietary intake data, HCES data and the Adult Female Equivalent are used to determine that 35% of households have adequate intakes of zinc in the pre-fortification period. Using the same data to model the potential contribution of fortification, the analysis indicates that, if 85% of maize flour is industrially processed, fortifying maize flour with zinc at 55 mg/kg (per WHO guidelines where intakes are 75-149 g/day) could result in adequate intakes among 85% of households. A second scenario is modeled, assuming intakes of 150-300 g/day and a zinc addition rate of 40 mg/kg, which would result in 70% of households achieving adequate intakes. An analysis was conducted, using the Adult Male Equivalent, and it was determined that fortification at 55 mg/kg and 40 mg/kg would result in 7% and 4% of men, respectively, exceeding the zinc upper level. Design stage: Maize flour is selected for fortification with zinc at a rate of 40 mg/kg, which could have a substantial positive impact on zinc intakes in households without putting a large proportion of men at risk for excess intakes.
Strengths	May not require additional data collection if existing dietary data collected for other purposes are available. The use of individual dietary intake (or proxy) data enables estimation of nutrient adequacy.
Limitations	Up-to-date, nationally representative dietary intake data are frequently unavailable in many countries and are costly to collect. When available, these data are subject to the limitations of self-report (e.g., recall bias, social desirability bias) and prone to measurement error.
Validation and testing	Dietary assessment methods have been widely tested, validated, and used across contexts. See Bailey 2022 and Gibson 2024 for an overview of these methods.
Further information and related links	Tang et al. 2021 modeled the contribution of food fortification, under different scenarios, to micronutrient intake requirements in Malawi using HCES data. Engle-Stone et al. 2017 conducted two representative surveys before and after the introduction of wheat flour fortification to assess the impact on micronutrient status. For recent examples of estimation of micronutrient intakes, see two relevant articles from Passarelli and colleagues from 2022 and 2024.

Related indicators	Indicator 1 - Micronutrient biomarker status (Core): Used together with Indicator 6 to determine whether a micronutrient problem exists and whether fortification may improve micronutrient adequacy without increasing risk of excess intake. Indicator 12 - Appropriate fortificants selected for vehicle fortification (Non-core): Used together with Indicator 6 to assess whether the selected fortificants are likely to improve micronutrient adequacy and support program objectives. Indicator 13 - Appropriate nutrient concentration specified (Non-core): Used together with Indicator 6 to assess whether proposed fortification levels will improve micronutrient adequacy while minimizing risk of excess intake. Indicator 37 - Micronutrient requirements met by fortification (Core): Used together with Indicator 6 to evaluate the contribution of fortification to micronutrient intake and adequacy. Indicator 5 - Fortifiable vehicle consumption (Core): Used together with Indicator 6 to model the potential nutritional impact of fortification based on the amount of vehicle consumed.
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Indicator 14: Government capacity for fortification monitoring and enforcement

Fortification Stage	Implement
Purpose	Assess the proportion of positions required for fortification monitoring and enforcement that are filled by competent personnel and identify workforce gaps that may limit regulatory oversight.
Definition	Percentage of government personnel occupying positions required for monitoring and enforcement of food fortification who meet established competency criteria at the time of reporting. Competency criteria should be nationally defined and include, at a minimum, knowledge of fortification regulations and standards, completion of formal or supervised on-the-job training, ability to conduct monitoring activities, and ability to apply enforcement procedures.
Numerator	Number of required government personnel positions for fortification monitoring and enforcement that are filled by individuals who meet nationally or institutionally defined competency criteria as of the reporting date.
Denominator	Total number of government personnel positions required for monitoring and enforcement of food fortification as of reporting date.
Method of collection and data source	Administrative records including staff rosters, job descriptions, supervision records, training records, certification records, and competency assessment logs. Information may be compiled from multiple government entities involved in fortification monitoring and enforcement, including ministries of health, industry, standards authorities, food control agencies, customs agencies, and other relevant governmental bodies. Where competency assessments are unavailable, records of formal training in food fortification inspection and enforcement procedures may be used as supporting evidence.

Calculation or determination	A government staff member is included in the numerator only if all minimum competency criteria are met: · Knowledge of food fortification legislation, regulations, standards, and monitoring procedures relevant to the individual's role. · Completion of formal training and/or supervised on-the-job training in food fortification monitoring and enforcement. · Demonstrated ability to conduct assigned monitoring activities (e.g., inspections, audits, sampling, documentation review, import controls, or commercial monitoring). · Demonstrated ability to apply enforcement and follow-up procedures in accordance with government requirements. Divide the numerator by the denominator and multiply the result by 100. Formula: (Numerator / Denominator) * 100 = %
Special considerations for calculation	This is a point-in-time indicator and should be assessed regularly (ideally annually) using a consistent reporting date. Additional assessments may be warranted following major changes in staffing, institutional responsibilities, or monitoring systems. Identify all government personnel responsible for fortification monitoring and enforcement, including those involved in external, import, and commercial monitoring. Responsibilities may be distributed across multiple government agencies and levels of government. Competency criteria should be defined by the responsible institution(s). At a minimum, competency should include: (i) Knowledge of relevant food fortification legislation, regulations, standards, and monitoring procedures; (ii) Completion of formal training and/or supervised on-the-job training in fortification monitoring and enforcement; (iii) Demonstrated ability to conduct assigned monitoring activities such as inspections, audits, sampling, and documentation review; and (iv) Demonstrated ability to apply enforcement and follow-up procedures. Countries may establish additional competency requirements based on national needs and institutional responsibilities. Avoid double counting individuals across roles. The denominator should reflect the number of positions required to adequately implement fortification monitoring and enforcement functions, as defined in the organizational structure, staffing norms, workload assessments, or other official workforce planning documents from the responsible institution(s).

Special considerations for calculation	Required positions may exceed currently funded or filled positions. Personnel capacity should be interpreted alongside financial capacity. Competent personnel may not be able to conduct monitoring and enforcement activities if resources for inspections, travel, laboratory analyses, equipment, and other operational requirements are insufficient. Consider staff turnover and vacancies when defining the denominator. Refresher training is not required annually for all personnel; however, systems should ensure competencies are maintained over time. The indicator is intentionally expressed as a percentage of required positions rather than an absolute count so that results are comparable across countries and institutional structures.
Disaggregation	By agency or institutional role (e.g., health inspectors, food control authorities, customs/border agents), type of monitoring (external, import, commercial), level of government (national, subnational), and competency criteria (training, experience, performance).
Example	A country has determined that 210 positions are required to effectively conduct fortification monitoring and enforcement. At the time of reporting, 170 of these positions are filled. Among the personnel occupying these positions, 150 meet the established competency criteria based on knowledge of fortification regulations and standards, completion of training, and demonstrated performance in monitoring and enforcement activities. Twenty personnel occupying required positions do not meet the competency criteria, and 40 required positions remain vacant. $(150 / 210) * 100 = 71.4\%$ of required positions are filled by competent personnel. The government also tracks that 60% of competent personnel received refresher training in the past two years to support maintenance of competencies. With 71.4% of required positions filled by competent personnel, the government has substantial but incomplete capacity for fortification monitoring and enforcement, indicating a need to address workforce gaps through training, mentoring, recruitment, and other capacity-strengthening measures.
Strengths	Reflects actual operational capacity rather than recent training events. Captures multiple pathways to competence. Aligns with real-world systems where experience plays a critical role. Supports workforce planning and strengthening.

Limitations	Estimating the number of positions required may be subjective and depend on the staffing model, workload assumptions, and institutional arrangements used by the responsible authorities. Requires clear and standardized definitions of competence. May rely on subjective assessments if competency criteria are not well defined. Information may be dispersed across multiple government agencies and not consistently maintained. May not capture differences in performance quality across personnel. This indicator assesses workforce competency and staffing capacity rather than whether monitoring activities are routinely implemented. Evidence of routine inspections, audits, and enforcement activities should be assessed using Indicators 16, 28, 29, and 30.
Validation and testing	Not known to be formally tested or validated as a standardized indicator; however, it draws on widely used workforce and capacity assessment concepts.
Further information and related links	World Health Organization. Sufficient resources to carry out regulatory monitoring of large-scale fortification of flour. eCatalogue of indicators for micronutrient programmes. https://extranet.who.int/indcat/TemplateView.aspx?id=45 WHO's eCatalogue assesses whether adequate technical, human, material, and financial resources are available for regulatory monitoring and is scored as a binary yes/no measure. In contrast, this indicator specifically measures the proportion of personnel responsible for fortification monitoring and enforcement who meet competency criteria.
Related indicators	Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 14 to determine whether government institutions have both the legal authority and the competent workforce required to implement and enforce food fortification. Indicator 16 - Government procedures for monitoring fortification (Core): Used together with Indicator 14 to assess whether government personnel have the capacity to implement monitoring and enforcement procedures effectively. Indicator 20 - Accredited laboratories (Non-core): Used together with Indicator 14 to assess whether governments have the technical infrastructure and qualified personnel needed to support fortification monitoring and enforcement. Indicator 21 - Data systems (Non-core): Used together with Indicator 14 to assess whether government monitoring and enforcement personnel have access to systems that support effective data collection, management, and use. Indicator 22 - Food fortification in the national budget (Non-core): Used together with Indicator 14 to assess whether sufficient resources are available to support and sustain fortification monitoring and enforcement activities.

Indicator 15: Enforceable National Fortification Regulatory Framework

Fortification Stage	Implement
Purpose	Assess whether a country has a fully operational and enforceable regulatory framework across the fortification value chain and identify specific gaps when the framework is not complete. The fortification value chain encompasses premix and fortified foods from production or importation through regulatory monitoring and enforcement.
Definition	Degree to which a country has an operational and enforceable national regulatory framework for food fortification across the fortification value chain, including fortified foods and fortification premix, based on the presence of four core components: legal authority, technical standards, legal-technical linkage, and enforceability.
Numerator	N/A
Denominator	N/A
Method of collection and data source	Review of official legislation, regulations, decrees, and standards; government enforcement procedures; documentation of inspection authority and compliance mechanisms; and verification through relevant ministries, regulatory agencies, and standards bodies.
Calculation or determination	Score the country on a scale from 0 to 4 based on the number of core components present and operational: 0 = No components present 1 = One component present 2 = Two components present 3 = Three components present 4 = All four components present The four components are: · Legal authority: Legislation or regulations mandating or supporting food fortification. · Technical standards: Official fortification standards for fortified foods and premix. · Legal-technical linkage: Formal legal connection between legislation and standards. · Enforceability: Defined enforcement mechanisms and authority for compliance monitoring and enforcement. In addition to the overall score, record which components are present and absent to identify specific regulatory gaps and monitor progress over time.

Special considerations for calculation	Review all relevant legislation, regulations, standards, and enforcement documents that apply to the fortification value chain. Multiple documents may satisfy a domain together. A component should only be scored as present if sufficient evidence demonstrates that it is operational. Partial fulfillment of a component should not receive partial credit. Where responsibilities are distributed across institutions, assess the framework collectively rather than evaluating individual agencies separately. Absence of evidence should not be interpreted as absence of a component unless all reasonable sources have been reviewed.
Disaggregation	Report the status of each component separately: · Legal authority (Yes/No) · Standards for premix (Yes/No) · Standards for fortified foods (Yes/No) · Legal-technical linkage (Yes/No) · Enforcement mechanisms (Yes/No) These component-level results should accompany the overall 0-4 score.
Example	A country has (1) legislation mandating or allowing fortification of wheat flour and oil, including authority for auditing, inspection, and penalties. Fortification standards define nutrients, levels, and compounds for (2b) both foods but not for (2a) their respective premix; the food fortification standards (3) are legally referenced in the legislation. (4) Monitoring documentation lists the roles of various enforcement agencies to conduct audits and inspections of domestic food producers and premix importers. The country has: · Legal authority: Yes · Standards for fortified foods: Yes · Standards for premix: No · Legal-technical linkage: Yes · Enforceability: Yes Overall score = 3 of 4 The gap is the absence of premix standards. Adoption of premix standards would increase the country's score from 3 to 4 and result in a fully operational and enforceable regulatory framework.
Strengths	Provides a comprehensive assessment of the regulatory environment; integrates legal, technical, and enforcement components. Identifies actionable gaps when the framework is incomplete.

Limitations	Requires detailed document review and interpretation. May be challenging where documents are not publicly available. Does not measure the quality or effectiveness of implementation. This indicator assesses whether regulatory frameworks exist and are operational. It does not assess whether fortification standards are aligned with WHO recommendations, national micronutrient intake or deficiency data, or whether standards are feasible for producers to implement.
Validation and testing	Not known to be formally validated; based on synthesis of established regulatory best practices.
Further information and related links	WHO's eCatalogue contains the indicator "Legislation in place for mandatory large-scale fortification of wheat or maize flour," which is similar to the indicator presented here. However, the WHO indicator is focused only on flour and whether mandatory legislation exists (yes/no). The GFDx relies on official government-issued documents for the following relevant visualizations: Countries with mandatory or voluntary legislation status Scope of mandatory fortification Cumulative number of countries with mandatory fortification by year The FAOLEX database provides direct links to country-level legislation documents and other important fortification-related documents. Marks et al. 2018 conducted a comprehensive review of grain fortification legislation, standards, and monitoring documents.
Related indicators	Indicator 14 - Government capacity for fortification monitoring and enforcement (Core): Used together with Indicator 15 to assess whether government institutions have the human capacity required to implement and enforce the fortification regulatory framework. Indicator 16 - Government procedures for monitoring fortification (Core): Used together with Indicator 15 to determine whether the regulatory framework is supported by documented procedures for monitoring and enforcement. Indicator 17 - Large-scale producers with appropriate, functional, and calibrated fortification-dosing equipment (Core): Used together with Indicator 15 to assess whether producers have the capacity to comply with the requirements established by the regulatory framework. Indicator 18 - Large-scale food producers with quality procedures (Core): Used together with Indicator 15 to assess whether producers have quality systems in place to support compliance with fortification requirements established by the regulatory framework.

Indicator 16: Government procedures for monitoring fortification

Fortification Stage	Implement
Purpose	Assess whether government systems have the procedures needed to effectively monitor and enforce food fortification across the fortification value chain. This indicator examines whether procedures are in place, meet minimum quality standards, are implemented in practice, and are used to support compliance verification and corrective actions.
Definition	Degree to which government procedures for monitoring and enforcing food fortification are established, meet minimum quality standards, are implemented in practice, and are used to support compliance and enforcement activities.
Numerator	N/A
Denominator	N/A
Method of collection and data source	Document review of official standard operating procedures for all forms of fortification monitoring required under the country's enforceable fortification regulatory framework.
Calculation or determination	Score the country on a scale from 0 to 4 based on the number of criteria met for each type of monitoring required under the country's fortification regulatory framework, including monitoring of domestically produced premix, imported premix, domestically produced fortified food, imported fortified food, and commercially sold fortified food. One point is assigned for each criterion met: (1) Existence and coverage, (2) Quality, (3) Operational implementation, and (4) Use of results. Record both the overall score and the status of each criterion to identify specific gaps and monitor progress over time. Existence and coverage: Procedures are current, officially endorsed, documented, and cover the relevant monitoring and enforcement activities. Quality: Procedures meet the minimum quality criteria described in Appendix 1: Minimum Quality Criteria for Government Monitoring Procedures (e.g., clearly define scope, roles and responsibilities, monitoring processes, and enforcement actions).

Calculation or determination	Operational implementation: There is evidence that the procedures are routinely applied in monitoring and enforcement activities. Evidence may include publicly available or shareable information such as monitoring reports, annual program reports, regulatory agency summaries, published inspection results, or other official communications demonstrating implementation. Where accessible, internal administrative records may also be used to verify implementation. Use of results: There is evidence that monitoring results are used to verify compliance and inform follow-up, corrective, or enforcement actions. Evidence may include publicly available or shareable reports, summaries of enforcement activities, publication of monitoring outcomes, or other official communications demonstrating that monitoring findings are acted upon.
Special considerations for calculation	Each component should be assessed independently. A component should only be scored as met when sufficient evidence is available. Partial fulfillment of a component should not receive partial credit. Where multiple monitoring types are required under the regulatory framework (e.g., imported premix, domestically produced fortified foods, commercially sold fortified foods), the component should be considered met only if the requirement is satisfied for all applicable monitoring types. Monitoring and enforcement responsibilities may be distributed across multiple government agencies (e.g., food control authorities, standards agencies, ministries, customs or border authorities). Ensure procedures are current, officially endorsed, and aligned with national legislation and standards. Assess quality by comparing procedures to the minimum quality criteria provided in Appendix 1: Minimum Quality Criteria for Government Monitoring Procedures. Assess as operational when there is evidence that procedures are implemented in practice, based on publicly available or shareable information and, where accessible, administrative records.
Disaggregation	Report the status of each component separately for each required monitoring type: · Existence and coverage (Yes/No) · Quality (Yes/No) · Operational implementation (Yes/No) · Use of results (Yes/No) These component-level results should accompany the overall 0-4 score to identify specific gaps and track improvements over time.

Example

Officially endorsed procedures are in place for monitoring domestically produced fortified salt by the Ministry of Industry and for imported fortified salt and imported premix by the Border Management Authority. Monitoring of commercially sold fortified salt and domestically produced premix is not required under the country's regulatory framework and is therefore not applicable.

Existence and coverage:

Procedures exist and are current and officially endorsed for domestically produced fortified salt and for imported fortified salt and imported premix.

Quality - procedures exist but are incomplete:

For domestically produced fortified salt, all external monitoring protocol criteria are met, including:

- Protocol specifies fortification monitoring (standalone or within broader inspection);
- Responsible government agency is identified;
- Roles and responsibilities are clarified where multiple agencies are involved;
- Frequency of inspections is specified;
- Auditing checklist is included;
- Sample collection protocol (including when to take samples) is defined;
- Sample analysis procedures are specified;
- Procedures for non-compliance are clearly described.

For imported fortified salt and imported premix, most import monitoring protocol criteria are not met, including:

- Protocol does not clearly specify whether import monitoring is specific to fortification;
- Responsible agency for import monitoring is not clearly identified;
- Roles and responsibilities across agencies are not defined;
- Frequency of inspections or criteria for shipment selection (e.g., risk-based) are not specified;
- No auditing checklist is included;
- No clear sample collection protocol is described;
- Sample analysis procedures are not specified;
- Reporting procedures are not defined;
- Procedures for non-compliance are absent.

Operational implementation:

For domestically produced fortified salt, there is documented evidence of routine implementation (e.g., completed inspection reports using standard checklists).

For imported fortified salt and premix, there is little or no evidence that procedures are routinely applied.

Example	Use of results: For domestically produced fortified salt, monitoring results are used to verify compliance and trigger corrective actions. For imported fortified salt and premix, there is no clear evidence that monitoring results lead to compliance actions or follow-up enforcement. Final determination: · Existence and coverage: Yes · Quality: No · Operational implementation: No · Use of results: No Overall score = 1 of 4 Although procedures exist for all required monitoring activities, deficiencies in procedure quality, implementation, and use of monitoring results limit the effectiveness of the monitoring system. Priority should be given to strengthening these components to improve the score over time.
Strengths	Provides a comprehensive and actionable assessment of monitoring systems by evaluating existence, quality, implementation, and use of results across all required monitoring types. Aligns with established best practices while identifying specific gaps that can guide targeted improvements in regulatory systems.
Limitations	Does not measure implementation quality or fidelity to procedures.
Validation and testing	Not known to be formally tested or validated.
Further information and related links	WHO's eCatalogue includes the indicator, "Standard operating procedures available for monitoring and enforcement by food control agency," which focuses on the existence of procedures. Indicator 16 extends beyond existence to assess procedure quality, implementation, and use of monitoring results for compliance and enforcement.

Related indicators	Indicator 14 - Government capacity for fortification monitoring and enforcement (Core): Used together with Indicator 16 to assess whether government institutions have both the procedures and the competent personnel needed to implement fortification monitoring and enforcement. Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 16 to determine whether documented monitoring procedures are supported by an operational and enforceable regulatory framework. Indicator 28 - Compliance cascade for domestically produced fortified vehicle (Core): Used together with Indicator 16 to assess whether monitoring procedures are being implemented and resulting in regulatory oversight of domestically produced fortified foods. Indicator 29 - Compliance cascade for imported premix (Core): Used together with Indicator 16 to assess whether procedures for import monitoring are being implemented and resulting in oversight of imported premix. Indicator 30 - Compliance cascade for imported fortified vehicle (Core): Used together with Indicator 16 to assess whether procedures for import monitoring are being implemented and resulting in oversight of imported fortified foods.
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Indicator 17: Large-scale producers with appropriate, functional and calibrated fortification-dosing equipment

Fortification Stage	Implement
Purpose	Assess whether large-scale food producers have appropriate, functional, and calibrated fortification-dosing equipment installed and in use. Appropriate and properly calibrated dosing equipment is a prerequisite for consistent addition of vitamins and minerals to food and supports compliance with fortification standards.
Definition	Percentage of large-scale producers that have fortification-dosing equipment that is appropriate, installed, functional, calibrated and in use to add vitamins and minerals to a food during the last 12 months.
Numerator	Number of large-scale producers with fortification-dosing equipment that is appropriate, installed, functional, calibrated, and in use for production.
Denominator	Total number of large-scale producers.
Method of collection and data source	Facility inspections, audits, installation records, maintenance records, calibration records, production records, and other administrative records that confirm fortification-dosing equipment is appropriate, installed, functional, calibrated, and in use during production.
Calculation or determination	For this indicator: · Appropriate means suitable for the food vehicle and fortificant being used. · Installed means physically connected and available for use in the production line. · Functional means operating as intended and capable of delivering fortificant during production. · Calibrated means calibration has been conducted according to manufacturer recommendations, national guidelines, or producer procedures, with documented evidence that the equipment delivers fortificant at the intended rate. · In use means actively used during production rather than merely present at the facility. A producer is included in the numerator only if all five criteria are met. Divide the numerator by the denominator and multiply the result by 100. Formula: $(\text{Numerator} / \text{Denominator}) * 100 = \%$

Special considerations for calculation	A producer is included in the numerator only when all five criteria (appropriate, installed, functional, calibrated, and in use) are met for every production line used for fortification. Should be compiled at least annually using evidence collected during the preceding 12-month period. Intended for large-scale food fortification programs; only producers meeting the country-defined criteria for large-scale production should be included. If a facility has multiple production lines, each production line should have a dedicated dosifier. Avoid double counting facilities assessed multiple times or with two or more production lines. Calibration should be assessed using documented calibration records or direct verification during an inspection or audit. Equipment that is installed and functional but lacks evidence of calibration should not be included in the numerator.
Disaggregation	Geographic region by number of production lines (e.g. single and multiple) and producer ownership type (e.g., privately owned domestic producers, state-owned enterprises, foreign-owned companies).
Example	A government auditing and inspection of 50 large-scale edible-oil refineries at least once in the past 12 months indicated that 30 operate a single production line and 20 operate multiple production lines. Among the single-line facilities, 25 had dosing equipment that was appropriate, installed, functional, calibrated, and in use with documented evidence of its use for vitamin and mineral premix, while 5 did not ($25/30 \times 100 = 83\%$). Among the facilities with multiple lines, 15 had dosing equipment that was appropriate, installed, functional, calibrated, and in use on all production lines, while 5 lacked functioning or calibrated equipment on one or more lines ($15/20 \times 100 = 75\%$). Overall, 40 out of 50 refineries had appropriate, installed, functional, and calibrated dosing equipment that was in use ($25 \text{ single-line} + 15 \text{ multi-line} = 40$; $40/50 \times 100 = 80\%$), while 10 facilities lacked functioning and/or calibrated equipment for at least one of their production lines. Regulators should prioritize targeted enforcement and support to ensure all production lines, especially in multi-line facilities, are equipped with functional, properly calibrated dosing systems to achieve full compliance.

Strengths	Measures a critical prerequisite for successful food fortification: the presence of fortification-dosing equipment that is appropriate, installed, functional, calibrated, and in use. Relies on observable and documentable criteria that can be independently verified during inspections and audits. Helps identify specific equipment-related barriers to compliance, supporting targeted corrective actions, technical assistance, and regulatory follow-up. Can be applied consistently across vehicles and production settings when equipment requirements are clearly defined. Complements compliance indicators by providing information on producer capacity that may explain non-compliance with fortification standards.
Limitations	Does not confirm continuous correct operation between inspections and audits, even when equipment is documented as calibrated and functional. Calibration records may not reflect equipment performance throughout the entire production period.
Validation and testing	Not known to be formally tested or validated.
Further information and related links	The WHO eCatalogue indicator, “Industrial mills with equipment for fortification installed and properly working,” captures whether facilities have dosing equipment installed and operational at the facility level, but it does not assess whether each production line—particularly in multi-line facilities—has dedicated, functional equipment with documented evidence of use.
Related indicators	Indicator 18 - Large-scale food producers with quality procedures (Core): Used together with Indicator 17 to assess whether producers have both the equipment and quality systems needed to consistently fortify foods. Indicator 27 - Large-scale food producers with capacity to fortify (Non-core): Used together with Indicator 17 to assess whether producers have the technical, human, and financial capacity required to fortify foods. Indicator 19 - Large-scale food producers with uninterrupted premix supply (Non-core): Used together with Indicator 17 to assess whether producers have the inputs and equipment needed to maintain continuous fortification. Indicator 28 - Compliance cascade for domestically produced fortified vehicle (Core): Used together with Indicator 17 to assess whether the presence of appropriate fortification equipment is associated with compliance with fortification standards. Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 17 to assess whether producers have the equipment needed to comply with national fortification requirements.

Indicator 18: Large-scale food producers with quality procedures

Fortification Stage	Implement
Purpose	Assess whether large-scale food producers have minimum quality assurance and quality control (QA/QC) systems in place to support consistent food fortification.
Definition	Percentage of large-scale [food] producers with documented and functioning QA/QC procedures for fortification that meet the minimum criteria described in Appendix 2 at the time of assessment.
Numerator	Number of large-scale [food] producers with minimum QA/QC procedures for fortification in place (e.g., premix management, recordkeeping) as of the reporting date.
Denominator	Total number of large-scale [food] producers assessed for QA/QC procedures as of the reporting date.
Method of collection and data source	Assessment of documented QA/QC procedures through interviews with facility personnel, review of facility records, internal monitoring records, internal or second-party audit reports, third-party audit reports, structured questionnaires, or facility visits. Information may be collected by government authorities, technical assistance organizations, auditors, or other qualified entities using standardized assessment criteria.
Calculation or determination	Only producers whose QA/QC procedures meet the minimum quality criteria described in Appendix 2: Minimum Quality Assurance (QA) and Quality Control (QC) Criteria for Food Fortification Producers are included in the numerator. Divide the numerator by the denominator and multiply the result by 100. Formula: $(\text{Numerator} / \text{Denominator}) * 100 = \%$
Special considerations for calculation	Assess QA/QC procedures by comparing them to the minimum criteria provided in Appendix 2: Minimum Quality Assurance (QA) and Quality Control (QC) Criteria for Food Fortification Producers. This point-in-time indicator should be assessed regularly (ideally annually) using a consistent reporting date. Evidence of functioning QA/QC procedures should be based on records and activities from the preceding 12-month period.

Special considerations for calculation	Distinguish between presence of procedures and effective implementation. Avoid double counting producers assessed multiple times. Ensure producers are correctly classified as large-scale. Document the entity collecting the information (e.g., government authority, technical assistance organization, third-party auditor, industry self-report). Where self-reported information is used, independent verification should be sought whenever feasible.
Disaggregation	By producer ownership type (e.g., privately owned domestic producers, state-owned enterprises, foreign-owned companies).
Example	A technical assistance organization conducted assessments of 60 large-scale wheat flour mills using a standardized QA/QC assessment tool. Information was collected through interviews with facility personnel and review of records related to premix management, feeder calibration, production monitoring, and product testing. Of the 60 mills assessed, 42 had documented and functioning QA/QC procedures that met all minimum criteria, with records demonstrating their routine implementation. The remaining 18 mills had gaps such as incomplete calibration records, inconsistent documentation, or missing quality control testing records. $(42 / 60) * 100 = 70\%$ of producers with minimum quality procedures in place and functioning. The assessment findings were used to identify areas requiring targeted technical support to strengthen fortification quality systems.
Strengths	Assesses whether producers have the systems needed to consistently produce fortified foods that meet fortification standards. Provides a comprehensive assessment of producer QA/QC practices, including premix management, process control, recordkeeping, and product verification. Identifies specific areas where technical assistance or corrective action may be needed to strengthen fortification quality. Can be verified through facility records, audits, and inspections using standardized assessment criteria. Complements Indicators 17 and 28 by helping explain why producers may or may not achieve compliance with fortification standards.

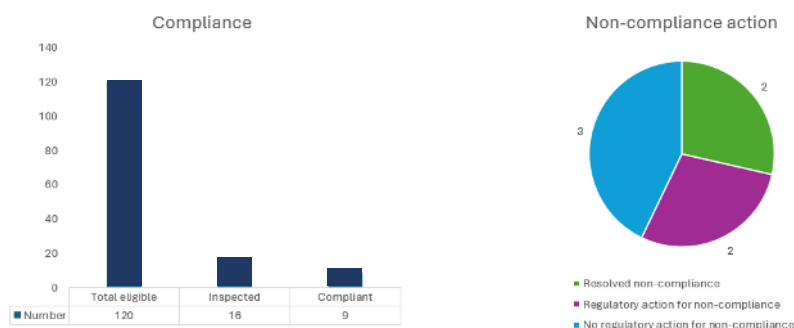
Limitations	The presence of documented QA/QC procedures does not guarantee their consistent implementation. Results may be influenced by the completeness of records provided and the assessment method used.
Validation and testing	Not known to be formally tested or validated.
Further information and related links	Quality procedures are documented in manuals such as Monitoring flour fortification to maximize health benefits: a manual for millers, regulators, and programme managers by the World Health Organization and Rice Fortification Toolkit by the Global Alliance for Improved Nutrition and PATH.
Related indicators	Indicator 17 - Large-scale producers with appropriate, functional and calibrated fortification-dosing equipment (Core): Used together with Indicator 18 to assess whether producers have both the equipment and quality systems needed to consistently fortify foods. Indicator 27 - Large-scale food producers with capacity to fortify (Non-core): Used together with Indicator 18 to assess whether producers have the technical, human, and financial capacity needed to implement and maintain QA/QC procedures. Indicator 19 - Large-scale food producers with uninterrupted premix supply (Non-core): Used together with Indicator 18 to assess whether producers have the inputs and quality systems needed to sustain fortification activities. Indicator 28 - Compliance cascade for domestically produced fortified vehicle (Core): Used together with Indicator 18 to assess whether producer QA/QC procedures are associated with compliance with fortification standards. Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 18 to assess whether producers have quality systems in place to comply with national fortification requirements.

Indicator 28: Compliance Cascade for Domestically Produced Fortified Vehicle

Fortification Stage	Monitor
Purpose	Assess compliance with food fortification standards among large-scale food producers across the full regulatory cascade, i.e. from eligibility and inspection to compliance determination and resolution of non-compliance, to support routine monitoring, guide enforcement actions, and track progress toward achieving full compliance among large-scale food producers.
Definition	Composite cascade indicator tracking the progression of large-scale food producers through key stages of regulatory monitoring—eligibility, inspection, compliance determination, and resolution of non-compliance—culminating in the proportion of producers that are compliant with food fortification standards in a 12-month period.
Numerator	N/A
Denominator	N/A
Method of collection and data source	Data for this indicator are collected through routine government monitoring and enforcement activities targeting large-scale food producers. These include audits and inspections, compliance assessments, and follow-up enforcement actions conducted by the responsible regulatory authority. Primary data sources include: · Inspection and audit reports documenting producer visits, including verification of eligibility, evidence of inspection, and compliance assessment results. · Compliance determination records indicating whether producers meet food fortification standards. · Follow-up inspection reports and administrative records tracking resolution of non-compliance. · Enforcement records documenting regulatory actions taken for unresolved non-compliance (e.g., warnings, fines, product seizure, suspension of operations, or legal action). · Where applicable, data may be compiled from multiple regulatory bodies involved in monitoring food production (e.g., food control authorities, standards agencies, ministries of health or industry). Data should reflect all producers subject to monitoring during the defined reporting period.

Six data points are graphed in the figure with placeholder values below: three in the left panel and three in the right panel.

Compliance Cascade for Domestically Produced Fortified Food



Left panel: among eligible large-scale food producers

1. Total Eligible Large-Scale Food Producers

- Count: Number of large-scale food producers that meet eligibility criteria for regulatory monitoring during the reporting period.
- Reference group: Number of large-scale food producers.

2. Large-Scale Food Producers Inspected

- Count: Number of eligible large-scale food producers inspected by the responsible authority during the reporting period.
- Reference group: Number of eligible large-scale food producers.

3. Large-Scale Food Producers Found Compliant

- Count: Number of large-scale food producers that are compliant with food fortification standards at the time of compliance determination.
- Reference group: Number of large-scale food producers for which compliance with food fortification standards was determined during the reporting period.

Right panel: among non-compliant large-scale food producers

4. Resolved Non-Compliance

- Count: Number of initially non-compliant large-scale food producers that subsequently resolved non-compliance and achieved compliance within the reporting period.
- Reference group: Number of initially non-compliant large-scale food producers.
- Reference group: Number of initially non-compliant large-scale food producers.

Calculation or determination	5. Regulatory Action for Non-Compliance - Count: Number of initially non-compliant large-scale food producers that did not resolve non-compliance and for which regulatory enforcement actions were taken during the reporting period (e.g., fines, closures, legal action). - Reference group: Number of initially non-compliant large-scale food producers. 6. No Regulatory Action for Non-Compliance - Count: Number of initially non-compliant large-scale food producers that did not resolve non-compliance and for which no regulatory enforcement action was taken during the reporting period. - Reference group: Number of initially non-compliant large-scale food producers.
Special considerations for calculation	Clearly define eligibility criteria for large-scale food producers and apply these consistently over time. Ensure that each step in the cascade uses the appropriate reference group and reflects the sequential process (e.g., eligible → inspected → compliant). Apply a standardized definition of compliance with food fortification standards and a clear definition of resolution of non-compliance based on verified evidence rather than self-report. In the right panel, calculate all outcomes using the same reference group (total non-compliant producers). Define and consistently document regulatory enforcement actions, including only formal, documented actions. Avoid double counting producers by counting each producer once per reporting period using the most recent status.
Disaggregation	Geographic region (e.g., national and subnational levels), inspection authority or responsible agency, and producer ownership type (e.g., privately owned domestic producers, state-owned enterprises, foreign-owned companies).

Example	Government monitoring records show that 120 large-scale rice producers met eligibility criteria for regulatory oversight during a 12-month period. Of these, 16 producers were inspected by the Bureau of Standards. Among those inspected, compliance with rice fortification standards was determined for all producers. At the time of compliance determination, 9 producers were found to be compliant with food fortification standards, while 7 producers were identified as non-compliant. Of these, 3 non-compliant producers did not receive regulatory action during the reporting period. In this scenario, the low inspection coverage means that the compliance status of most eligible fortified rice producers remains unknown. Government authorities may wish to increase inspection coverage and ensure timely follow-up of identified non-compliance to strengthen the effectiveness of the monitoring system.
Strengths	Provides a comprehensive view of regulatory monitoring by capturing the full cascade from eligibility to compliance and resolution of non-compliance. Distinguishes between different stages of enforcement, enabling identification of where breakdowns occur in the monitoring system. Highlights not only compliance levels but also the effectiveness of follow-up and enforcement actions. Supports program management by identifying gaps in inspection coverage, compliance determination, and enforcement. Aligns closely with routine government data systems and can be generated from existing administrative records.
Limitations	Requires complete and well-linked administrative data across all stages of the cascade, which may not be available in all settings. May be sensitive to inconsistent definitions of compliance, resolution, and enforcement across inspectors or regions. Interpretation can be complex, as changes in compliance may reflect changes in inspection coverage rather than true performance. Time lags between initial non-compliance and follow-up assessment may affect classification of resolved versus unresolved producers. Does not directly measure the quality or accuracy of audits and inspections, compliance assessments, or enforcement actions.

Validation and testing	Not known to be formally tested or validated.
Further information and related links	The World Health Organization's indicator, " Samples of flour from mills meet fortification specifications according to country standards. " The WHO indicator focuses primarily on whether food samples meet fortification specifications, whereas this cascade indicator tracks the full regulatory process at the producer level—covering inspection, compliance determination, resolution of non-compliance, and enforcement actions—which the WHO indicator does not capture.
Related indicators	Indicator 16 - Government procedures for monitoring fortification (Core): Used together with Indicator 28 to assess whether monitoring procedures are being implemented through inspection, compliance determination, and enforcement activities. Indicator 17 - Large-scale producers with appropriate, functional and calibrated fortification-dosing equipment (Core): Used together with Indicator 28 to assess whether producers have the equipment needed to comply with fortification standards. Indicator 18 - Large-scale food producers with quality procedures (Core): Used together with Indicator 28 to assess whether producer QA/QC systems support compliance with fortification standards. Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 28 to assess whether an operational regulatory framework is resulting in compliance monitoring and enforcement. Indicator 14 - Government capacity for fortification monitoring and enforcement (Core): Used together with Indicator 28 to assess whether government capacity is sufficient to support inspection, compliance determination, and enforcement activities.

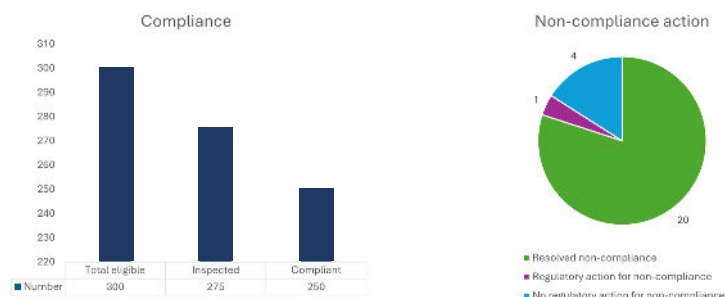
Indicator 29: Compliance cascade for imported premix

Fortification Stage	Monitor
Purpose	Assess compliance with premix quality standards among imported premix consignments across the full regulatory cascade—from eligibility for import monitoring and inspection to compliance determination and resolution of non-compliance—to support routine import monitoring, guide enforcement actions, and track progress toward achieving full compliance among imported premix shipments.
Definition	Composite cascade indicator tracking the progression of imported premix through key stages of regulatory monitoring—eligibility for import monitoring, inspection, compliance determination, and resolution of non-compliance—culminating in the proportion of imported premix consignments that comply with premix quality standards during a 12-month period.
Numerator	N/A
Denominator	N/A
Method of collection and data source	Data for this indicator are collected through routine government import monitoring and enforcement activities targeting imported premix. These include document reviews, border inspections, sampling, and testing of imported consignments, compliance assessments, and follow-up enforcement actions conducted by the responsible regulatory authority. Primary data sources include: · Import inspection reports documenting review of imported premix consignments, including verification of eligibility for monitoring, evidence of inspection, and compliance assessment results. · Compliance determination records indicating whether imported premix consignments meet national premix quality standards. · Follow-up inspection reports and administrative records tracking resolution of non-compliance. · Enforcement records documenting regulatory actions taken for unresolved non-compliance (e.g., detention of shipments, rejection at import, product seizure, fines, return to origin, destruction, suspension of import licenses, or legal action). · Customs, port, and border-control records documenting imported premix consignments. Where applicable, data may be compiled from multiple regulatory bodies involved in import monitoring (e.g., customs authorities, border management agencies, food control authorities, standards agencies, and ministries of health or industry). Data should reflect all imported premix consignments subject to monitoring during the defined reporting period.

Calculation or determination

Six data points are graphed in the figure with placeholder values below: three in the left panel and three in the right panel.

Compliance Cascade for Imported Premix



Left panel: among eligible imported premix consignments

1. Total Eligible Imported Premix Consignments

- Count: Number of imported premix consignments that meet eligibility criteria for regulatory monitoring during the reporting period.
- Reference group: Number of imported premix consignments.

2. Imported Premix Consignments Inspected

- Count: Number of eligible imported premix consignments inspected by the responsible authority during the reporting period.
- Reference group: Number of eligible imported premix consignments.

3. Imported Premix Consignments Found Compliant

- Count: Number of imported premix consignments that comply with premix quality standards at the time of compliance determination.
- Reference group: Number of imported premix consignments for which compliance was determined during the reporting period.

Right panel: among non-compliant imported premix consignments

4. Resolved Non-Compliance

- Count: Number of initially non-compliant imported premix consignments that subsequently resolved non-compliance and achieved compliance within the reporting period.
- Reference group: Number of initially non-compliant imported premix consignments.

5. Regulatory Action for Non-Compliance

- Count: Number of initially non-compliant imported premix consignments that did not resolve non-compliance and for which regulatory enforcement actions were taken during the reporting period (e.g., detention, seizure, rejection, return to origin, or legal action).
- Reference group: Number of initially non-compliant imported premix consignments.

Calculation or determination	6. No Regulatory Action for Non-Compliance - Count: Number of initially non-compliant imported premix consignments that did not resolve non-compliance and for which no regulatory enforcement action was taken during the reporting period. - Reference group: Number of initially non-compliant imported premix consignments.
Special considerations for calculation	Clearly define eligibility criteria for imported premix consignments and apply these consistently over time. Ensure that each step in the cascade uses the appropriate reference group and reflects the sequential process (eligible → inspected → compliant). Apply a standardized definition of compliance with premix quality standards and a clear definition of resolution of non-compliance based on verified evidence rather than self-report. In the right panel, calculate all outcomes using the same reference group (total non-compliant imported premix consignments). Define and consistently document regulatory enforcement actions, including only formal, documented actions. Avoid double counting by counting each imported premix consignment only once per reporting period using the most recent status.
Disaggregation	Disaggregate by: - Geographic entry point (e.g., border crossing, port, airport). - Inspection authority or responsible agency. - Country of origin. - Premix importer.
Example	Government import monitoring records show that 300 imported premix consignments met eligibility criteria for regulatory oversight during a 12-month period. Of these, 275 consignments were inspected only by the responsible authority through review of a Certificate of Analysis. Among those inspected, compliance with national premix quality standards was determined for all consignments. At the time of compliance determination, 250 consignments were found to be compliant with premix quality standards, while 25 consignments were identified as non-compliant.

Example	Among the 25 non-compliant consignments, 20 subsequently resolved non-compliance and achieved compliance within the reporting period. Of the remaining 5 consignments that did not resolve non-compliance, regulatory action was taken for 1 consignment, while 4 consignments did not receive regulatory action during the reporting period. In this scenario, the cascade shows that most eligible imported premix consignments underwent document-based inspection through review of a Certificate of Analysis, and most inspected consignments were compliant. Among the smaller number of non-compliant consignments, the majority successfully resolved their non-compliance. However, several unresolved consignments remained, including four for which no regulatory action was taken, indicating a potential gap in follow-up and enforcement of imported premix requirements.
Strengths	Provides a comprehensive view of import monitoring by capturing the full cascade from eligibility to compliance and resolution of non-compliance. Distinguishes between different stages of enforcement, enabling identification of where breakdowns occur in the import monitoring system. Highlights not only compliance levels but also the effectiveness of follow-up and enforcement actions. Supports program management by identifying gaps in inspection coverage, compliance determination, and enforcement. Aligns closely with routine government import monitoring systems and can be generated from existing administrative records.
Limitations	Requires complete and well-linked administrative data across all stages of the cascade, which may not be available in all settings. May be sensitive to inconsistent definitions of compliance, resolution, and enforcement across agencies or points of entry. Interpretation can be complex, as changes in compliance may reflect changes in inspection coverage rather than true performance. Time lags between initial non-compliance and follow-up assessment may affect classification of resolved versus unresolved consignments. Does not directly measure the quality or accuracy of inspections, compliance assessments, laboratory analyses, or enforcement actions.
Validation and testing	Not known to be formally tested or validated.

Further information and related links	The WHO indicator, "Premix meets national regulations and requirements for large-scale fortification," measures the proportion of premix shipments that have documentation (e.g., a Certificate of Analysis) confirming that the premix meets national regulations for fortification. The cascade indicator goes beyond documentation to track the full regulatory process at the domestic facility level—covering inspection, compliance determination, resolution of non-compliance, and enforcement actions.
Related indicators	Indicator 16 - Government procedures for monitoring fortification (Core): Used together with Indicator 29 to assess whether import monitoring procedures are being implemented through inspection, compliance determination, and enforcement activities. Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 29 to assess whether an operational regulatory framework is resulting in effective monitoring of imported premix. Indicator 14 - Government capacity for fortification monitoring and enforcement (Core): Used together with Indicator 29 to assess whether government institutions have sufficient capacity to inspect imported premix and follow up on non-compliance. Indicator 20 - Accredited laboratories (Non-core): Used together with Indicator 29 to assess whether laboratory capacity exists to support compliance determination for imported premix. Indicator 30 - Compliance cascade for imported fortified vehicle (Core): Used together with Indicator 29 to provide a comprehensive assessment of import monitoring across both premix and fortified foods.

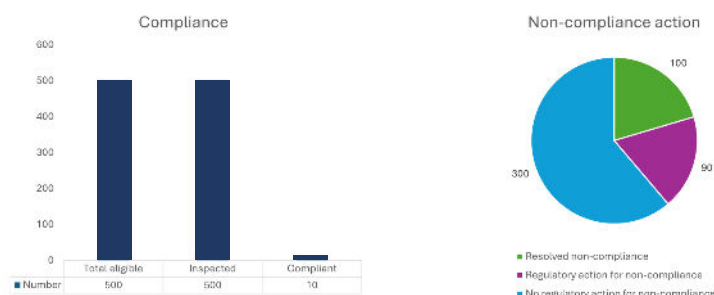
Indicator 30: Compliance cascade for imported fortified vehicle

Fortification Stage	Monitor
Purpose	Assess compliance with food fortification standards among imported fortified food consignments across the full regulatory cascade—from eligibility for import monitoring and inspection to compliance determination and resolution of non-compliance—to support routine import monitoring, guide enforcement actions, and track progress toward achieving full compliance among imported fortified food consignments.
Definition	Composite cascade indicator tracking the progression of imported fortified food through key stages of regulatory monitoring—eligibility for import monitoring, inspection, compliance determination, and resolution of non-compliance—culminating in the proportion of imported fortified food consignments that comply with food fortification standards during a 12-month period.
Numerator	N/A
Denominator	N/A
Method of collection and data source	Data for this indicator are collected through routine government import monitoring and enforcement activities targeting imported fortified food. These include document reviews, border inspections, sampling, and testing of imported consignments, compliance assessments, and follow-up enforcement actions conducted by the responsible regulatory authority. Primary data sources include: · Import inspection reports documenting review of imported fortified food consignments, including verification of eligibility for monitoring, evidence of inspection, and compliance assessment results. · Compliance determination records indicating whether imported fortified food consignments meet national food fortification standards. · Follow-up inspection reports and administrative records tracking resolution of non-compliance. · Enforcement records documenting regulatory actions taken for unresolved non-compliance (e.g., detention of shipments, rejection at import, product seizure, fines, return to origin, destruction, suspension of import licenses, or legal action). · Customs, port, and border-control records documenting imported fortified food consignments. · Where applicable, data may be compiled from multiple regulatory bodies involved in import monitoring (e.g., customs authorities, border management agencies, food control authorities, standards agencies, and ministries of health or industry). Data should reflect all imported fortified food consignments subject to monitoring during the defined reporting period.

Calculation or determination

Six data points are graphed in the figure with placeholder values below: three in the left panel and three in the right panel.

Compliance Cascade for Imported Fortified Food



Left panel: among eligible imported fortified food consignments

1. Total Eligible Imported Fortified Food Consignments

- Count: Number of imported fortified food consignments that meet eligibility criteria for regulatory monitoring during the reporting period.
- Reference group: Number of imported fortified food consignments.

2. Imported Fortified Food Consignments Inspected

- Count: Number of eligible imported fortified food consignments inspected by the responsible authority during the reporting period.
- Reference group: Number of eligible imported fortified food consignments.

3. Imported Fortified Food Consignments Found Compliant

- Count: Number of imported fortified food consignments that comply with food fortification standards at the time of compliance determination.
- Reference group: Number of imported fortified food consignments for which compliance was determined during the reporting period.

Right panel: among non-compliant imported fortified food consignments

4. Resolved Non-Compliance

- Count: Number of initially non-compliant imported fortified food consignments that subsequently resolved non-compliance and achieved compliance within the reporting period.
- Reference group: Number of initially non-compliant imported fortified food consignments.

5. Regulatory Action for Non-Compliance

- Count: Number of initially non-compliant imported fortified food consignments that did not resolve non-compliance and for which regulatory enforcement actions were taken during the reporting period (e.g., detention, seizure, rejection, return to origin, or legal action).
- Reference group: Number of initially non-compliant imported fortified food consignments.

Calculation or determination	6. No Regulatory Action for Non-Compliance - Count: Number of initially non-compliant imported fortified food consignments that did not resolve non-compliance and for which no regulatory enforcement action was taken during the reporting period. - Reference group: Number of initially non-compliant imported fortified food consignments.
Special considerations for calculation	Clearly define eligibility criteria for imported fortified food consignments and apply these consistently over time. Ensure that each step in the cascade uses the appropriate reference group and reflects the sequential process (eligible → inspected → compliant). Apply a standardized definition of compliance with food fortification standards and a clear definition of resolution of non-compliance based on verified evidence rather than self-report. In the right panel, calculate all outcomes using the same reference group (total non-compliant imported fortified food consignments). Define and consistently document regulatory enforcement actions, including only formal, documented actions. Avoid double counting by counting each imported fortified food consignment only once per reporting period using the most recent status.
Disaggregation	Disaggregate by: - Geographic entry point (e.g., border crossing, port, airport). - Inspection authority or responsible agency. - Country of origin. - Importer.
Example	Government import monitoring records show that 500 imported fortified salt consignments met eligibility criteria for regulatory oversight during a 12-month period. All 500 consignments were inspected by the responsible authority. Among those inspected, compliance with national salt fortification standards was determined for all consignments. At the time of compliance determination, 10 consignments were found to be compliant with food fortification standards per the Certificate of Analysis, while 490 consignments were identified as non-compliant. Among the 490 non-compliant consignments, 100 subsequently resolved non-compliance and achieved compliance within the reporting period. Among the 390 consignments that did not resolve non-compliance, 90 consignments were subject to regulatory action, while 300 consignments did not receive regulatory action during the reporting period.

Example	In this scenario, the cascade shows that inspection coverage was complete, as all eligible imported fortified food consignments were inspected. However, compliance with food fortification standards was extremely low, with only 10 of 500 consignments found to be compliant at the initial assessment. Although 100 non-compliant consignments subsequently resolved their non-compliance, 390 consignments remained non-compliant at the end of the reporting period. Of these unresolved consignments, only 90 were subject to regulatory action, while 300 did not receive regulatory action. These findings suggest substantial weaknesses in importer compliance and regulatory follow-up. Government authorities may wish to investigate the causes of widespread non-compliance, strengthen importer awareness and accountability, and ensure that enforcement actions are consistently applied to imported fortified food consignments that remain non-compliant.
Strengths	Provides a comprehensive view of import monitoring by capturing the full cascade from eligibility to compliance and resolution of non-compliance. Distinguishes between different stages of enforcement, enabling identification of where breakdowns occur in the import monitoring system. Highlights not only compliance levels but also the effectiveness of follow-up and enforcement actions. Supports program management by identifying gaps in inspection coverage, compliance determination, and enforcement. Aligns closely with routine government import monitoring systems and can be generated from existing administrative records.
Limitations	Requires complete and well-linked administrative data across all stages of the cascade, which may not be available in all settings. May be sensitive to inconsistent definitions of compliance, resolution, and enforcement across agencies or points of entry. Interpretation can be complex, as changes in compliance may reflect changes in inspection coverage rather than true performance. Time lags between initial non-compliance and follow-up assessment may affect classification of resolved versus unresolved consignments. Does not directly measure the quality or accuracy of inspections, compliance assessments, laboratory analyses, or enforcement actions.
Validation and testing	Not known to be formally tested or validated.

Further information and related links	The World Health Organization indicator, "Imported iodized salt is adequately fortified," measures the percentage of imported salt consignments that meet national fortification standards at the point of importation. In contrast, the cascade indicator tracks the full regulatory process for imported fortified food consignments—from inspection and compliance determination through resolution of non-compliance and enforcement actions.
Related indicators	Indicator 16 - Government procedures for monitoring fortification (Core): Used together with Indicator 30 to assess whether import monitoring procedures are being implemented through inspection, compliance determination, and enforcement activities. Indicator 15 - Enforceable National Fortification Regulatory Framework (Core): Used together with Indicator 30 to assess whether an operational regulatory framework is resulting in effective monitoring of imported fortified foods. Indicator 14 - Government capacity for fortification monitoring and enforcement (Core): Used together with Indicator 30 to assess whether government institutions have sufficient capacity to inspect imported fortified foods and follow up on non-compliance. Indicator 20 - Accredited laboratories (Non-core): Used together with Indicator 30 to assess whether laboratory capacity exists to support compliance determination for imported fortified foods. Indicator 29 - Compliance cascade for imported premix (Core): Used together with Indicator 30 to provide a comprehensive assessment of import monitoring across both premix and fortified foods.

Indicator 36: Fortified vehicle coverage

Fortification Stage	Evaluate
Purpose	Assess the reach of a fortification program by measuring the proportion of households that access or consume fortified foods, including both fortified food vehicles and foods produced using fortified ingredients. The indicator provides information on program coverage, market penetration, and equity of access, and helps identify gaps between availability of fortified foods and population exposure to fortification.
Definition	Percentage of households that accessed or consumed a fortified food during a defined reference period. Fortified food includes: (1) a fortified food vehicle (e.g., fortified wheat flour, maize flour, edible oil, rice, salt) where fortification is confirmed through product identification, label verification, brand registry, regulatory records, product testing, or other recognized verification methods; and (2) food products manufactured using a fortified food vehicle as an ingredient (e.g., bread, pasta, noodles, biscuits, baked products, condiments, or other processed foods), where the fortified ingredient can be reasonably confirmed. For this indicator, access refers to obtaining a fortified food or food made with fortified ingredients for household use from any source, regardless of whether it was consumed.
Numerator	Number of households that report access to or consumption of a specified fortified food during the reference period, where fortification is confirmed through product label verification; brand identification and registry information; regulatory records; producer documentation; and/or product testing. This may include households consuming processed foods made with fortified ingredients when such fortification can be verified.
Denominator	Total number of households surveyed in the target population group.

Method of collection and data source	The Fortification Assessment Coverage Toolkit (FACT) questionnaire has been updated; it now contains eight items that can be applied where respondents are asked about household-level consumption of specific foods, including details such as type, source, packaging, and brand. Survey-based coverage estimates may be complemented with secondary data sources, including regulatory records, national fortification registries, industry production and sales data, and routine monitoring reports, where available. To strengthen confidence in coverage estimates, information from household surveys should be triangulated with data generated through internal monitoring conducted by producers, external monitoring conducted by regulatory authorities, and independent verification through product testing. These complementary data sources can help confirm whether foods reported as fortified are in fact fortified and, where relevant, whether they meet established fortification standards.
Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: (Numerator / Denominator) * 100 = %
Special considerations for calculation	This indicator measures coverage and exposure to fortified foods, not micronutrient intake, adequacy, or health impact. Coverage estimates should specify whether they reflect household availability, access, consumption, or a combination of these. Fortification status should be confirmed, where possible, through product labels, brand registries, regulatory records, producer information, or product testing. For some fortification vehicles, substantial consumption may occur through processed foods made with fortified ingredients (e.g., bread, pasta, noodles, and biscuits); excluding these foods may underestimate coverage. Survey findings should be interpreted alongside data from producer monitoring, regulatory monitoring, and independent product testing to strengthen confidence in coverage estimates. Recall bias, product misclassification, and incomplete information on ingredients used in processed foods may affect results.
Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children), and other sociodemographic factors.
Example	In a nationally representative household survey, 600 households were surveyed about rice consumption using the FACT questions. Among them, 420 households reported consuming rice likely to be fortified (based on brand identification). $(420 / 600) * 100 = 70\%$ of households consumed fortified rice.

Strengths	Directly measures program coverage and population exposure to fortified foods. Captures consumption of both fortified food vehicles and foods made with fortified ingredients. Provides actionable information for identifying gaps in access, coverage, and fortification quality. Can be disaggregated to identify inequities across population groups and geographic areas. Can be strengthened through triangulation with regulatory monitoring, producer monitoring, and product testing data.
Limitations	Population-based survey may be costly and infrequent. Does not directly measure micronutrient intake, nutrient adequacy, or health impact. Confirmation of fortification status may be challenging, particularly for processed foods made with fortified ingredients. Self-reported consumption and product identification are subject to recall bias and misclassification. Imported or informally produced foods may be difficult to verify. Estimates may be sensitive to assumptions regarding the use of fortified ingredients in processed foods. Does not provide information on the amount of fortified food consumed or whether the food meets fortification standards unless complemented by monitoring and product testing data.
Validation and testing	The Fortification Assessment Coverage Toolkit (FACT) survey has been validated.
Further information and related links	The WHO eCatalogue includes a related indicator, "Households consuming fortified flour (fortified flour coverage)," which measures the percentage of households with flour confirmed to be fortified. Indicator 36 expands this concept beyond flour to include other fortification vehicles (e.g., milk, rice, edible oil, and salt), as well as foods made with fortified ingredients. Scott S, C Myers E, Jungjohann S et al. Measuring food fortification coverage in household surveys: formative research findings from Bangladesh and Ethiopia [version 1]. VeriXiv 2025, 2:432 (https://doi.org/10.12688/verixiv.2491.1) (Table 3).

Related indicators	Indicator 4 - Fortifiable vehicle coverage (Core): Used together with Indicator 36 to compare the potential reach of a fortification program (fortifiable vehicle coverage) with its actual reach after implementation. Indicator 37 - Micronutrient requirements met by fortification (Core): Used together with Indicator 36 to assess whether population exposure to fortified foods is sufficient to make a meaningful contribution to micronutrient intake. Indicator 40 - Fortified food consumption (Non-core): Used together with Indicator 36 to assess not only whether fortified foods are reaching the population, but also the amounts being consumed. Indicator 42 - Micronutrient intake from fortified food (Non-core): Used together with Indicator 36 to assess whether coverage of fortified foods translates into increased micronutrient intake. Indicator 43 - Beneficiaries reached (Non-core): Used together with Indicator 36 to quantify the number of individuals reached by fortified foods and assess overall program reach.
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Indicator 37: Micronutrient requirements met by fortification

Fortification Stage	Evaluate
Purpose	Evaluate whether fortification is contributing meaningfully to population micronutrient intake. This helps assess fortification program performance and identify whether adjustments or complementary interventions may be needed to better meet micronutrient needs.
Definition	Percentage of population-level micronutrient requirement met through intake of additional micronutrient from one or more fortified vehicles.
Numerator	Mean additional intake of [micronutrient] from [fortified vehicle(s)] among [population group].
Denominator	Dietary [micronutrient] requirement of [population group].
Method of collection and data source	Numerator: Food consumption data obtained via 24HR, quantitative FFQ, food records, and other validated tools to estimate food intake and captures both the food item and the quantity consumed by an individual, or; apparent food intake approximated from household consumption and expenditure survey (HCES) or comparable method (see Indicator 5 for guidance on calculating Fortifiable vehicle consumption). Concentration of micronutrient in the fortifiable vehicle. Information may be obtained from government monitoring and enforcement records, including laboratory analyses of food samples. Additional sources include producer QA/QC records, program evaluations, research studies, and other independently verified laboratory analyses. Where direct measurements are not available, fortification standards and compliance data may be used as proxy estimates. Intrinsic micronutrient concentration of the vehicle before fortification obtained from food composition tables. If country-specific food composition tables are unavailable, consider using tables from a neighboring country with similar food intake patterns or the FAO/INFOODS Food Composition Database. To estimate the additional amount of micronutrient attributable to fortification, subtract the intrinsic amount of the micronutrient in the food from the total micronutrient amount in the food.

Method of collection and data source	Denominator: Age- and sex-specific nutrient references from the country's normative body. If such references do not exist, either at all or for a particular micronutrient, other recommendations may be used, such as harmonized nutrient reference values proposed by Allen et al. 2020 which draw from the standards set by the European Food Safety Authority (EFSA) (for Europe) and the Institute of Medicine IOM (for the United States and Canada).
Calculation or determination	Divide the numerator by the denominator and multiply the result by 100. Formula: (Numerator / Denominator) * 100 = %
Special considerations for calculation	Where food consumption data are lacking, information on food availability (e.g., from FAOSTAT's Food Balance Sheets and Supply Utilization Accounts) may be used as a proxy. It is also possible to calculate apparent consumption using data from household consumption and expenditure surveys (HCES). HCES data frequently include food quantities consumed and/or acquired by the household during a reference period but require manipulation and assumptions (e.g., application of the Adult Female Equivalent method) to approximate individual-level food consumption data. May be difficult or impossible to determine the proportion of the vehicle that was fortified using HCES data, and thus adjustment by the proportion that is industrially processed is needed. Where multiple fortified vehicles contribute the same micronutrient, estimate the cumulative contribution from all fortified sources while avoiding double counting of vehicles or micronutrients.
Disaggregation	Geographic region, socioeconomic status, urbanicity, population group (e.g., women, children), and other sociodemographic factors.
Example	Wheat flour is mandated to be fortified with iron at 40 mg/kg ³¹. Among females aged 15–49 years, wheat flour intake attributable to the fortification program is estimated at 50 g/day (see Indicator 5). National food composition tables indicate that unenriched all-purpose flour contains 12 mg iron/kg, while recent laboratory analysis shows fortified wheat flour from nationally representative household samples contains 45 mg iron/kg. The additional iron provided by fortification is therefore 33 mg/kg [45 - 12 mg/kg]. Multiplying the daily intake of 50 g/day by the additional amount of iron provided by fortification (33 mg/kg) yields 1.7 mg/day of iron [(50g/day x 33mg/kg) x1kg/1000g]. Compared with the harmonized nutrient reference value for iron (11.2 mg/day, assuming moderate absorption) for females aged 15–49 years, fortification provides 15% [(1.7mg/day / 11.2mg/day) × 100] of the recommended iron intake for this population group. This amount should be compared with the program's intended goal toward meeting iron requirements to determine whether adjustments are needed.

Strengths	May not require additional data collection if existing dietary data collected for other purposes are available. By combining information on the concentration of the micronutrient in the food with the intrinsic amount of micronutrient present in the vehicle prior to fortification, it is possible to isolate the specific contribution made by fortification.
Limitations	Up-to-date, nationally representative dietary intake data are frequently unavailable in many countries and are costly to collect. When available, these data are subject to the limitations of self-report (e.g., recall bias, social desirability bias) and prone to measurement error. Using dietary data that were collected for non-fortification purposes, and that do not include information on the proportion that is fortifiable, is a challenge that must be addressed by adjusting estimates by the proportion that is fortifiable. When national food composition tables are not available and alternatives must be used, estimates may be less accurate.
Validation and testing	Not known to be formally tested or validated.
Further information and related links	The GFDx visualization, “Potential nutrient intake as a result of fortification,” incorporates many data elements including vehicle intake, nutrient addition concentrations from fortification standards, nutrient requirements, extent of industrial processing, and compliance. However, this visualization does not account for the intrinsic amount of the micronutrient found in the food. The WHO eCatalogue has a similar indicator which reflects only the numerator of the indicator we propose, and only for flour, “Average additional amount of micronutrients delivered daily by consumption of fortified flour.” Chapter 30: Consumption Monitoring: Coverage, Provision, and Utilization in Food Fortification in a Globalized World provides an overview of micronutrient contribution from fortified food, including calculation of the additional amount of micronutrients attributable to fortification.
Related Indicators	Indicator 36 - Fortified food coverage (Core): Used together with Indicator 37 to assess whether fortified foods are reaching the population and contributing meaningfully to micronutrient intake. Indicator 40 - Fortified food consumption (Non-core): Used together with Indicator 37 to determine whether fortified foods are being consumed in sufficient quantities to contribute meaningfully to micronutrient requirements.

Related indicators

Indicator 41 - Nutrients provided by fortified food (Non-core): Used together with Indicator 37 to estimate the amount of micronutrients added to the food supply through fortification.

Indicator 42 - Micronutrient intake from fortified food (Non-core): Used together with Indicator 37 to estimate the amount of micronutrients consumed from fortified foods and quantify the contribution of fortification to micronutrient requirements.

Indicator 6 - Micronutrient adequacy intake or excess intake pre- and post-fortification (Core): Used together with Indicator 37 to assess whether the contribution of fortification to micronutrient intake is sufficient to improve micronutrient adequacy without increasing risk of excess intake.

4

Conclusion

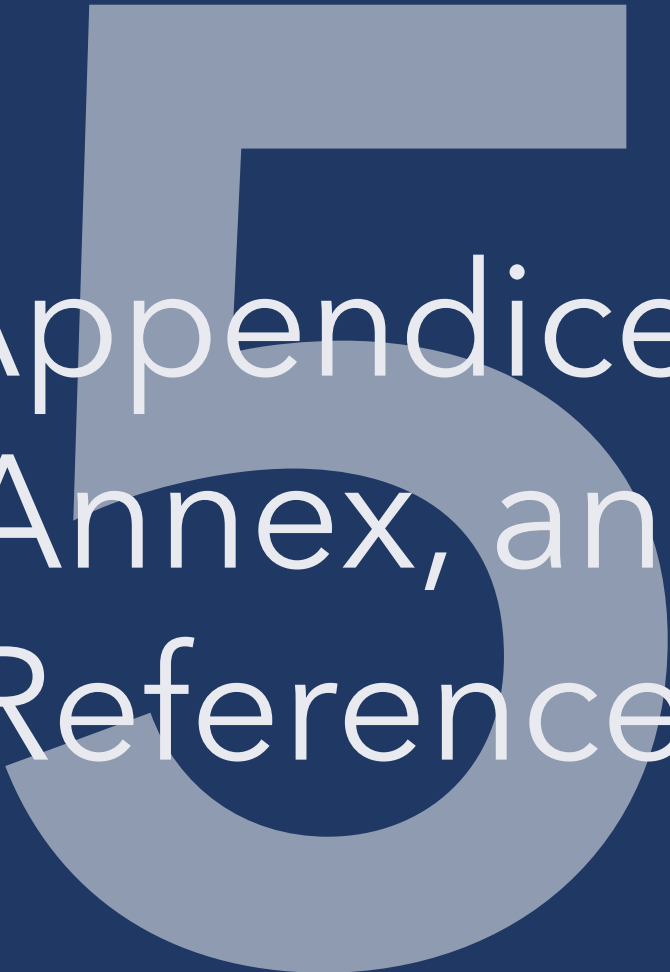
Conclusion and Way Forward

LSFF can improve micronutrient intake and nutritional status at population scale when programs are appropriately designed, implemented, monitored, and evaluated. Achieving these objectives requires not only strong policies and implementation systems, but also high-quality data that can support evidence-informed decision-making throughout the program cycle. By providing a standardized framework of indicators organized across the Design, Implement, Monitor, and Evaluate stages of LSFF programs, this guidance seeks to strengthen the consistency, comparability, and usefulness of fortification data across countries and contexts.

The indicators presented in this guidance are intended to support a common approach to assessing LSFF program performance while recognizing that countries differ in their food systems, regulatory environments, implementation capacities, and data availability. The guidance therefore promotes both standardization and flexibility. Users are encouraged to apply the indicators in ways that address national priorities and programmatic questions, while maintaining transparency regarding data sources, assumptions, and methodological limitations. As countries gain experience with these indicators, additional opportunities for refinement and harmonization are likely to emerge.

This guidance should be viewed as a living resource. Future work should focus on documenting country experiences with indicator implementation, strengthening routine LSFF data systems, and improving the availability and quality of data required for indicator calculation and interpretation. Additional efforts are also needed to further validate selected indicators and measurement approaches. Continued collaboration among governments, industry, researchers, development partners, and global organizations will be essential for advancing these efforts.

The next phase of work should emphasize testing and application of the indicator framework in diverse country settings, gathering feedback from users, and identifying opportunities to simplify indicator collection while preserving decision-making value. Lessons learned from implementation should inform future revisions of the guidance, periodic updates to indicator definitions and reference sheets, and greater alignment with global nutrition monitoring initiatives and fortification information systems. Through ongoing refinement, dissemination, and adoption, this guidance can contribute to stronger LSFF programs, more effective use of data, and ultimately improved micronutrient nutrition and health outcomes worldwide.



Appendices, Annex, and References

Appendix 1. Minimum Quality Criteria for Government Monitoring Procedures

This appendix is a resource for **Indicator 16: Government procedures for monitoring fortification**.

In 2018, [Marks and colleagues](#) published a 44-item checklist of the minimum information to be included in documents that make up a country's fortification regulatory framework, including legislation, standards and monitoring protocols. The Global Fortification Data Exchange selected a subset of 20 items to include in its [foundational document details](#) visualization. The monitoring-specific items from the GFDx and Marks et al. 2018 (from [Supplement 3](#)) were adapted and are listed below.

External monitoring protocol for domestically produced premix or fortified food

1. Is there a document that states which government agency is responsible for conducting external monitoring at the production site to ensure compliance with standards and regulations?
2. If two or more government agencies are involved in external monitoring, does the document clarify the roles and responsibilities between different government agencies in external monitoring?
3. Does the document(s) specify each of these?:
 - Frequency of audits and inspections;
 - How producers are selected for audits and inspection;
 - Auditing checklist;
 - Sample collection protocol, including when to take samples;
 - Sample analysis procedures;
 - Procedures for non-compliance.

Import monitoring protocol for imported premix or fortified food

1. Is there a document that states which government agency is responsible for conducting import monitoring at the importation/border site to ensure compliance with standards and regulations?
2. If two or more government agencies are involved in import monitoring, does the document clarify the roles and responsibilities between different government agencies in import monitoring?
3. Does the document specify each of these?:
 - Frequency of audits and inspections;
 - How shipments are selected for audits and inspection;
 - Auditing checklist;
 - Sample collection protocol, including when to take samples;
 - Sample analysis procedures;

- Reporting procedures;
- Procedures for non-compliance.

Commercial monitoring protocol for commercially sold fortified food

1. Is there a document that states which government agency is responsible for conducting commercial monitoring at retail locations to ensure compliance with standards and regulations?
2. If two or more government agencies are involved in commercial monitoring, does the document clarify the roles and responsibilities between different government agencies in commercial monitoring?
3. Does the document specify each of these?:
 - Frequency of inspections;
 - How retail locations are selected for inspection;
 - Sample collection protocol, including when to take samples;
 - Sample analysis procedures;
 - Reporting procedures;
 - Procedures for non-compliance?

Appendix 2. Minimum Quality Assurance (QA) and Quality Control (QC) Criteria for Food Fortification Producers

This appendix is a resource for **Indicator 18: Large-scale food producers with quality procedures**.

The Food Fortification Initiative together with the Global Alliance for Improved Nutrition and Kansas State University developed an [on-line fortification monitoring training series](#), which includes a module on internal monitoring. This module describes the minimum systems and procedures before and during production to ensure quality fortified food is produced (i.e., quality assurance) and checks and testing completed after fortified food production to confirm quality (i.e., quality control).

Quality Assurance (QA) activities:

- Using only premix that is provided by a certified supplier and accompanied by a Certificate of Analysis (COA);
- Storing premix appropriately and using it by the expiration date;
- Installing and maintaining a quality feeder;
- Checking premix feed rate;
- Packaging, labeling, and storing fortified food according to specifications of the fortification standard;
- Verifying premix usage against production of food that should have been fortified.

Quality Control (QC) activities:

- Confirming that food is fortified using a qualitative test;
- Confirming with quantitative analysis that the amount of each micronutrient in the fortified food is within the allowable range according to the fortification standard.

Annex 1. Secretariat and Working Group Members for LSFF Indicator Guidance

No.	Name	Organization	Country
Secretariat			
1.	Helena Pachón (Working Group Chair)	Independent	USA
2.	Mica Jenkins	Independent	USA
3.	Shruthi Cyriac	Micronutrient Forum	Canada
4.	Sorrel Namaste	Micronutrient Forum	USA
Working Group Members			
1.	Arnold Timmer	Iodine Global Network	Canada
2.	Arturo Juan Pardo Navarrete	Former World Food Programme (WFP), current Independent	Peru
3.	Chika Hayashi	UNICEF	USA
4.	Emily Keats	Johns Hopkins University	USA
5.	Frank Wieringa	French National Research Institute for Sustainable Development (IRD)	France
6.	Laura Rowe	Nutrition International	Canada
7.	Manita Jangid	WFP	Italy
8.	Manpreet Kaur Chadha	UNICEF	Kenya
9.	Mduduzi Mbuya	Global Alliance for Improved Nutrition	USA
10.	Mónica Guamuch-Castañeda	Former Nutrition Institute of Central America and Panama (INCAP), current Independent	USA
11.	Nelly Zavaleta	Former National Peruvian Center for Food and Nutrition (CENAN), current Nutrition Research Institute	Peru
12.	Padde Musa	Former Uganda Bureau of Standards, current Georgia Southern University	Uganda/ USA

13.	Pawan Agarwal	Independent	India
14.	Rachel Adeyemi	Nutrients Innovation Tech Ltd.	Nigeria
15.	Sabri Bromage	Mahidol University	Thailand
16.	Samet Sertas	Food Beverage and Agricultural Policies Research Center, former government	Turkey
17.	Sergio Moreno	Mexican Salt Production Association	Mexico
18.	Suresh Lakshminarayanan	WFP	India
19.	Vaia Karapanou	Organisation for Economic Co-operation and Development (OECD)	France
20.	Yvonne Mavhunga	Food and Nutrition Council	Zimbabwe
21.	Naïl Lazrak	Organisation for Economic Co-operation and Development	France

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