PATH

LARGE SCALE FOOD FORTIFICATION INSIGHTS FROM THE GLOBAL SOUTH

DATA, POLICIES, PROGRESS AND LEARNINGS ACROSS AFRICA, ASIA, AND LATIN AMERICA

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PATH Contact
PATH India Country Program
india@path.org
www.path.org/india

Dr. Ankur Mutreja
Director - External Affairs and Health Security
PATH
amutreja@path.org
+91 114064000

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Authors

1. Dr. Danie Shajie A, Lead, Food Fortification, Nutrition, PATH
2. Olivia Mawunyo Timpo, Director – Nutrition, Ghana Health Service
3. Dr. Kuassi Virgil Lokossou, Director - Directorate of Health Care Services, West African Health Organization (WAHO)
4. Ladidi K. Bako-Aiyegbusi, mni, Retired Pioneer Director/Head, Nutrition Department Federal Ministry of Health and Social Welfare, Abuja, Nigeria
5. Trishali Khanna, Program Associate, Food Fortification, Nutrition, PATH
6. Dr. D.A. Nimal Dharmasena, Professor, Postharvest Engineering & Technology, Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Sri Lanka
7. Dr. Sachin Gupte, Senior Advisor, PATH
8. Fatoumata Danfakha, Ministry of Industry, Senegal
9. Dr. Felah Rasoarahona, Enseignante chercheuse, Ecole Supérieure des Sciences Agronomiques, Madagascar
10. John Randriarivony, Conseiller Technique en Fortification Alimentaire, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Madagascar
11. Britney Havannah Rasolonirina Andrianjanaka, LSFF Program Manager, Helen Keller International, Madagascar
12. Dr. Abhishek Kumar, Senior Program Officer, Food Fortification, Ex-PATH
13. Yusmanetti Sari, Food System Specialist - Nutrition & SDGs Focal Point, FAO, Indonesia
14. Gulshan Ara, Associate Scientist, Maternal and Child Nutrition, Nutrition Research Division, icddr, b, Bangladesh
15. Shruti Arora, Program Associate, Ex-PATH
16. Atul Upadhyay, Nepal Food Scientists and Technologists Association Advisory Committee, Vertex Group, Nepal
17. Raj N. Mandal, Helen Keller International, Nepal
18. Thida Lin, Myanmar Country Program, PATH
19. Sonalini Khetrapal, Team Lead, Health Sector (India), Human and Social Development Sector Office, Asian Development Bank, Manila, Philippines
20. Mawuli Sablah, Global Technical Advisor - Multisectoral Nutrition and Food Systems, Catholic Relief Service, Baltimore, USA
21. Dr. Ankur Mutreja, Director - External Affairs and Health Security, PATH - Corresponding Author

Contributors (Technical Inputs and Editing)

1. Natia Mgeladze, Platform Lead, Food Safety, Food Loss Prevention, Food Fortification Advisory, Farming and Agribusiness, Solutions & Impact, IFC, World Bank Group
2. Kateryna Onul, IFC, World Bank Group
3. Dr. Tran Khanh Van, IFC, World Bank Group
4. Uy Duc Pham, Operations Officer, Viet Nam Safe, ESG/Sustainable Agri-Food Systems & Forestry Technical Assistance and Project Development, World Bank Group
5. Dr. Abner Elkan Daniel, Health and Nutrition Manager, Sri Lanka Country Office, UNICEF
6. Lt. Dr. Oluwatoyin Oyekenu, Senior Manager, GAIN-Nigeria

Preface

Micronutrient deficiencies remain an important public health challenge, particularly among populations with limited access to diverse and nutritious diets. Large-Scale Food Fortification (LSFF) offers an effective and scalable approach to addressing these deficiencies through commonly consumed foods. Sustaining its impact, however, requires strong policy and regulatory systems, quality assurance and quality control, industry capacity, reliable supply chains, and effective programme implementation.

Recognizing that countries can learn from one another's experiences, PATH facilitated a Global South Knowledge Exchange Immersion Visit from 21 to 31 January 2025. The exchange brought together government representatives and technical experts from seven countries - Burkina Faso, Côte d'Ivoire, Ghana, Madagascar, Nigeria, Senegal, and Sri Lanka, to learn from India's experience in food fortification. Through discussions and field visits, participants explored policy and regulatory systems, fortified rice production, quality assurance and quality control, digital systems and traceability, social protection, industry engagement, and programme implementation.

The exchange generated valuable country-level insights and practical lessons that extended beyond the visit itself. This compendium builds on learning by bringing together experiences from sixteen countries across Africa, Asia, and Latin America. *Large Scale Food Fortification (LSFF) Insights from the Global South: Data, Policies, Progress and Learnings Across Africa, Asia, and Latin America* documents different approaches, achievements, and implementation challenges, providing a broader perspective on the evolution of LSFF across diverse settings.

For the Ghana Health Service, sharing and learning from such experiences is an important part of strengthening evidence-informed policy and implementation. The experiences presented in this publication offer practical lessons that countries can consider and adapt to their own contexts.

I commend the governments, institutions, experts, practitioners, and partners who contributed to this work. I hope this compendium will serve as a useful resource for policymakers, programme implementers, regulators, researchers, industry, and development partners, and contribute to continued learning and collaboration towards improved access to quality fortified foods and better nutrition outcomes.

OLIVIA M. TIMPO
Director - Nutrition
Ghana Health Service

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Foreword

Micronutrient malnutrition remains one of the most persistent public health challenges facing countries across the Global South. It affects health, learning, productivity and human capital, with women, children and vulnerable households bearing a disproportionate burden. Large-scale food fortification offers a practical, equitable and scalable opportunity to address these challenges through foods that people already consume.

It is therefore a pleasure to introduce *Large Scale Food Fortification (LSFF) Insights from the Global South: Data, Policies, Progress and Learnings Across Africa, Asia, and Latin America*. This publication brings together valuable experiences from 16 countries across Africa, Asia and Latin America, documenting the policies, institutions, delivery platforms, partnerships and implementation realities that shape fortification programs. From a West African perspective, this comparative approach is especially timely and relevant. The publication demonstrates that countries may differ in their food systems, regulatory environments, industrial structures and levels of economic development, yet often confront similar challenges including limited dietary diversity, inadequate quality assurance, fragmented markets, supply-chain constraints and gaps between policy adoption and effective implementation.

The experiences presented from Ethiopia, Ghana, Madagascar, Nigeria and Senegal offer important lessons for the ECOWAS region. They highlight the value of strong political commitment, harmonized standards, functional regulatory systems, reliable premix supply, capable laboratories, private-sector engagement and sustained monitoring. They also underscore the importance of linking fortification with school feeding, social protection, public procurement and other platforms capable of reaching populations most at risk. For WAHO, these lessons reinforce the need for regional cooperation, knowledge exchange and coordinated action to advance nutrition security across West Africa.

The publication's Global South perspective is one of its principal strengths. Learning across regions enables countries to adapt tested approaches rather than develop solutions in isolation. Experiences from South Asia, Southeast Asia and Latin America provide useful insights into the design of delivery systems, the use of fortified rice and other food vehicles, public–private partnerships, regulatory enforcement, consumer awareness and local production capacity. Such South–South learning can help countries identify solutions that are technically sound, financially realistic and responsive to their own contexts.

I commend the authors, contributors and partners for compiling this important resource. I hope it will serve as a practical reference for policymakers, programme managers, researchers, industry actors, development partners and civil society. WAHO expects that the publication will stimulate further dialogue within ECOWAS and beyond, support evidence-informed policy and investment decisions, and encourage stronger regional mechanisms for standard harmonization, quality assurance and shared technical capacity.

May this volume contribute to renewed commitment and collective action so that fortified foods reach those who need them most—and so that every country in the Global South can move closer to a healthier, more resilient and well-nourished population.

WAHO remains committed to this agenda and to the broader conviction that countries of the Global South stand to gain considerably from one another's experience. I extend our appreciation to PATH for convening this collaborative effort, and to the authors and contributors across sixteen countries whose rigour and candour give this volume its enduring value. It is my hope that this book will serve African policymakers, regulators, and practitioners as a genuinely useful reference in the continued work of translating fortification policy into measurable impact.

Dr Lokossou Kuassi Virgil
Director Healthcare Services
West African Health Organisation (WAHO)

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This publication is the result of a collaborative effort that brings together expertise, field experience, and strategic insights from a diverse group of authors, contributors, and partners committed to advancing large-scale food fortification across the Global South.

We extend our sincere gratitude to all authors and co-authors for their invaluable technical input, country perspectives, and unwavering commitment to shaping this comprehensive knowledge resource by drawing on country experiences and synthesizing global learnings. Their contributions have been instrumental in shaping this knowledge resource into a comprehensive and practical guide for policymakers, practitioners, and development partners.

We acknowledge the invaluable inputs from global and regional development partners, including multilateral agencies, financial institutions, and technical organizations, whose perspectives on financing, implementation models, and system strengthening have enriched the analysis. Special appreciation is extended to partners who supported the Global South learning exchange, which served as a critical platform for cross-country dialogue and knowledge sharing. We also acknowledge the technical inputs provided by the World Bank Group's Global Food Safety Advisory Platform in reviewing selected country chapters (Bangladesh, Ethiopia, India, and Vietnam), and in general comments on the report structure. The review was limited to these specified sections and did not constitute a comprehensive review of the full report.

We also express our sincere gratitude to governments and national institutions across the 16 countries featured in this report, partners, and other stakeholders, for their continued commitment to advancing nutrition and food system transformation. Their investments enable knowledge generation, cross-country learning, and scalable solutions to address micronutrient deficiencies globally.

Finally, we express our deep gratitude to the team at PATH for their diligence and sustained efforts in developing this publication.

Abbreviations

Acronym	Full form
ACSQDA	Agence de Contrôle de la Sécurité Sanitaire et de la Qualité des Denrées Alimentaires (Authority for the Control of Quality and Safety of Food, Madagascar)
ADB	Asian Development Bank
AFFORD	Advancing Food Fortification and Nutrition Outcomes through Research and Development*
ANFA	National Alliance for Food Fortification
ANMAT	Administración Nacional de Medicamentos, Alimentos y Tecnología Médica
ANSD	Agence Nationale de la Statistique et de la Démographie
ANVISA	Agência Nacional de Vigilância Sanitária (Brazilian Health Regulatory Agency)
APTINDO	Asosiasi Produsen Tepung Terigu Indonesia
ASN	Association Sénégalaise de Normalisation (Senegalese Association for Normalization)
ASEAN	Association of Southeast Asian Nations
BAPPENAS	Ministry of National Development Planning, Indonesia
BGN	Badan Gizi Nasional (National Nutrition Agency, Indonesia)
BISA	Better Investment for Stunting Alleviation
BPOM	Badan Pengawas Obat dan Makanan (National Agency of Drug and Food Control, Indonesia)
BRAC	Bangladesh Rural Advancement Committee
BULOG	Badan Urusan Logistik (State Logistics Agency, Indonesia)
CAA	Código Alimentario Argentino
CAF	Development Bank of Latin America and the Caribbean
CAISAN	Câmara Interministerial de Segurança Alimentar e Nutricional (Inter-Sectoral Coordination of Food and Nutrition Security)
CCT	Conditional Cash Transfer
CCSS	Costa Rican Social Security Fund
CET	Common External Tariffs
CECANE	Centro Colaborador em Alimentação e Nutrição do Escolar
CIMMYT	International Maize and Wheat Improvement Center
CNDN	Conseil National de Développement de la Nutrition (National Nutrition Development Council)
CNNS	Comprehensive National Nutrition Survey
CONAFOR	National Commission for Food Fortification, Enrichment, and/or Equivalence
CONAL	Comisión Nacional de Alimentos (National Food Commission)
COSFAM	Comité Sénégalais pour la Fortification des Aliments en Micronutriments (Senegalese Committee for the Fortification of Foods in Micronutrients)
DALYs	Disability-adjusted life years
DFPD	Department of Food and Public Distribution
DFTQC	Department of Food Technology and Quality Control
DHS	Demographic and Health Survey
EAR	Estimated Average Requirement
ECOWAS	Economic Community of West African States
ENANI	Estudo Nacional de Alimentação e Nutrição Infantil (National Survey on Child Nutrition, Brazil)
ePoS	Electronic Point-of-Sale
EPHI	Ethiopian Public Health Institute

FAO	Food and Agriculture Organization
FACT	Fortification Assessment Coverage Tool
FANTA	Food and Nutrition Technical Assistance
FAS	Foreign Agricultural Service
FCI	Food Corporation of India
FCCPC	Federal Competition and Consumer Protection Commission
FFI	Food Fortification Initiative
FFRC	Food Fortification Resource Centre
FoRTrace	Fortified Rice Traceability
FoSCoS	Food Safety Compliance System
FRK	Fortified Rice Kernels
FRQMS	Fortified Rice Quality Management System
FSSAI	Food Safety and Standards Authority of India
GAIN	Global Alliance for Improved Nutrition
GCNF	Global Child Nutrition Foundation
GFDx	Global Fortification Data Exchange
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HACCP	Hazard Analysis and Critical Control Point
HCES	Household Consumption and Expenditure Survey
HITA	Huilerie Industrielle de Tamatave
HKI	Helen Keller International
ICDS	Integrated Child Development Services
IDD	Iodine Deficiency Disorders
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
ILAC	International Laboratory Accreditation Cooperation
INCAP	Institute of Nutrition of Central America and Panama
INCIENSA	Instituto Costarricense de Investigación y Enseñanza en Nutrición y Salud
INDEC	Instituto Nacional de Estadística y Censos (Argentina)
INTI	Instituto Nacional de Tecnología Industrial
INTA	Instituto Nacional de Tecnología Agropecuaria
IOT	Internet of Things
IYCF	Infant and Young Child Feeding
LEAP	Livelihood Empowerment Against Poverty
LMICs	Low- and Middle-Income Countries
LSFF	Large-Scale Food Fortification
MBG	Makan Bergizi Gratis
MEAL	Monitoring, Evaluation, Accountability, and Learning
MERCOSUR	Mercado Común del Sur
MIDES	Ministry of Social Development
MRI	Medical Research Institute
MS-NPAN	Multi-Sectoral National Plan of Action on Nutrition
MSPAS	Ministerio de Salud Pública y Asistencia Social
NABL	National Accreditation Board for Testing and Calibration Laboratories
NAC-MDN	National Advisory Committee for the Control of Micronutrient Deficiencies in Nigeria
NAFDAC	National Agency for Food and Drug Administration and Control

NASSCO	National Social Safety Nets Coordinating Office
NCFN	National Committee on Food and Nutrition
NCP	National Code of Practice*
NDDB	National Dairy Development Board
NDHS 2024	Nigeria Demographic and Health Survey 2024
NFCMS 2021	National Food Consumption and Micronutrient Survey 2021
NFFA	National Food Fortification Alliance
NFHS	National Family Health Survey
NFSA	National Food Security Act
NFI	Nutrition Foundation of India
NGCP	National Goiter Control Programme
NIPN	National Information Platform for Nutrition
NIPORT	National Institute of Population Research and Training
NITI	National Institution for Transforming India
NNP	National Nutrition Program
NNS	National Nutrition Services
NNTWG	National Nutrition Technical Working Group
NSMP	National School Meal Program
NSPAN II	National Strategic Plan of Action for Nutrition II
NSO	National Statistics Office
NTD	Neural Tube Defects
NVASP	National Vitamin A Supplementation Program
OAA	Organismo Argentino de Acreditación
OEC	Observatory of Economic Complexity
OECD	Organisation for Economic Co-operation and Development
PAHO	Pan American Health Organization
PANEA	Programa de Alimentación y Nutrición del Escolar y del Adolescente
PDS	Public Distribution System
PESAN	Strategic Plan for Food and Nutritional Security*
PFJ	Planting for Food and Jobs
PLANSAN	Plano Nacional de Segurança Alimentar e Nutricional
PM POSHAN	Pradhan Mantri Poshan Yojana
PMV	Plan Más Vida
PNAE	Programa Nacional de Alimentação Escolar
PNBSF	Programme National des Bourses de Sécurité Familiale
PNSAN	Política Nacional de Segurança Alimentar e Nutricional
PRiFN	Promoting Rice Fortification in Nigeria
PSNP	Productive Safety Net Program
PSMN	Multisectoral Strategic Plan for Nutrition
RDC	Resolução da Diretoria Colegiada
RPJPN	Rencana Pembangunan Jangka Panjang Nasional
SAGyP	Secretariat of Agriculture
SAARC	South Asian Association for Regional Cooperation
SEPAN	Secretaría de la Política Nacional de Alimentación y Nutrición
SENASA	Servicio Nacional de Sanidad y Calidad Agroalimentaria
SESAN	Secretaría de Seguridad Alimentaria y Nutricional

SFA	Société Sénégalaise des Filières Alimentaires
SICA	Sistema de la Integración Centroamericana (Central American Integration System)
SISAN	Sistema Nacional de Segurança Alimentar e Nutricional
SISVAN	Food and Nutrition Surveillance System
SNI	Standar Nasional Indonesia (Indonesian National Standard)
SON	Standards Organisation of Nigeria
SPPG	Satuan Pelayanan Pemenuhan Gizi (Nutrition Fulfilment Service Units)
SSGI	Survei Status Gizi Indonesia (Indonesian Nutritional Status Survey)
SUN	Scaling Up Nutrition
TPDS	Targeted Public Distribution System
UEMOA	Union économique et monétaire ouest-africaine (West African Economic and Monetary Union)
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USDEC	U.S. Dairy Export Council
USI	Universal Salt Iodization
WAHO	West African Health Organization
WASH	Water, Sanitation, and Hygiene
WFP	World Food Programme
WHO	World Health Organization
WRA	Women of Reproductive Age

Executive Summary

Micronutrient deficiencies remain one of the most persistent and consequential public health challenges across the Global South, affecting diets, health outcomes, learning potential, productivity, and long-term economic development. Often described as hidden hunger, these deficiencies continue to affect populations even where food systems have improved. This is because dietary quality has not kept pace with population needs or with the scale of nutrition vulnerability. This book comes at an important inflection point for global nutrition. Across the 16 countries examined, food fortification is no longer a peripheral technical option; it is increasingly being used as a core instrument to address anemia, vitamin A deficiency, iodine deficiency, zinc inadequacy, folate gaps, and the wider human-capital losses associated with hidden hunger. More importantly, the book shows something else: the difference between a fortification program that exists on paper and one that changes diets at scale depends on the architecture behind it-standards, procurement, testing, premix supply, social programs, industry structure, and political commitment.

The purpose of this volume is not simply to catalog fortification policies; rather, it aims to explain, through the experiences of 16 countries, how large-scale food fortification is being designed, financed, regulated, and operationalized, and, in some cases, implemented across Africa, Asia, and Latin America. The book fulfills that objective by moving beyond policy statements to examine the actual vehicles used: salt, wheat flour, maize flour, edible oil, rice, sugar, milk, and complementary foods, as well as the standards that govern them, the industries that produce them, the safety nets that can scale them, and the constraints that still prevent nutritional impact from reaching the most vulnerable populations.

What makes the book especially compelling is its comparative depth. It brings together countries that have achieved mature and measurable impact, such as Costa Rica, alongside countries that have built scale through public systems, such as India and Indonesia. It also includes countries with deep regulatory experience but uneven compliance, such as Nigeria and Senegal, and countries where the next phase of growth will depend on solving supply-chain, testing, and affordability bottlenecks, such as Ethiopia, Ghana, Madagascar, Myanmar, and Vietnam. For readers looking for practical insight rather than abstract advocacy, this book offers a rare combination of policy detail, implementation realism, and forward-looking strategy.

Africa

Africa's chapters show why fortification remains indispensable in settings where cereal-based diets dominate, and micronutrient deficiencies remain stubbornly high. Across Ethiopia, Ghana, Madagascar, Nigeria, and Senegal, anemia among children and women remains high. Diets in these areas are heavily staple-based, presenting significant opportunities to use wheat flour, edible oil, salt, and, increasingly, rice to improve micronutrient intake through both markets and public programs.

Ethiopia presents one of the most consequential recent policy shifts in the region. The country moved from pilot programs to mandatory fortification in 2022 for wheat flour and edible oil, anchored in the National Food and Nutrition Strategy 2021–30 and the Seqota Declaration's wider ambition to end child stunting. The scale argument is compelling: Ethiopia's Productive Safety Net Programme reaches about 8 million people, and various school feeding platforms offer additional

delivery channels, while edible oil coverage is already reported at about 89% through large refiners, creating a strong base for enforcing standards more effectively. The chapter is especially valuable because it does not romanticize the transition; it shows how foreign-exchange shortages restrict premix imports, how compliant processors are undercut by illicit imports of unfortified oil and flour, and how the absence of a strong decentralized testing infrastructure weakens enforcement despite national policy momentum. It also points to a strategically important inflection point: the planned Sanku premix facility in Kilinto could reduce import dependence, stabilize supply, and reposition Ethiopia from a vulnerable importer to a regional hub for fortification inputs.

Ghana is a particularly instructive case because it stands at the intersection of maturity and opportunity in nutrition. The country has had mandatory salt iodization since 1996, and mandatory fortification of wheat flour and vegetable oil was introduced through Gazette No. 92 of 2010, with standards such as GS 811 for fortified flour and GS 812 for fortified oil under the Ghana Standards Authority and enforcement by the Food and Drugs Authority. However, the chapter's real contribution lies in showing where the system falls short: 41% of women of reproductive age and about 49% of children under five are anemic. Although rice consumption in Ghana has reached roughly 40 kg per person per year, domestic production meets only about 40% of demand, resulting in a reliance on about 950,000 tons of imports, which represents a highly attractive fortification entry point. FACT-related findings cited in the book indicate that, while household consumption of industrial flour and oil is high, only about 23% of wheat flour samples met the required fortification standards in earlier monitoring rounds. This illustrates a gap between legislation and nutrient delivery. The World Food Programme-led rice pilots, the Ghana School Feeding Programme, and LEAP 1000 together make Ghana one of the clearest examples of a country where imported rice, public procurement, and social protection could be aligned into a mandatory rice fortification strategy with immediate scale-up potential.

Nigeria demonstrates the scale and complexity of a more mature fortification system. Mandatory salt fortification commenced in 1993, followed in the early 2000s by mandatory fortification of wheat flour, maize flour, and edible oil. Since then, the large-scale food fortification (LSFF) system has been implemented and reinforced by the NAFDAC Food Fortification Regulations 2021. NAFDAC and the Standards Organisation of Nigeria jointly oversee the standards. The nutritional need is significant: more than half of women and young children are anemic, 40% of children under five years old are stunted, folate inadequacy exceeds 90%, vitamin A inadequacy affects 26–58% of the population, and rice consumption averages about 104 kg per person per year. Coverage data reveal both strengths and weaknesses. Salt reaches about 99% of households and edible oil about 90%, yet fortified wheat flour reaches only about 28% and maize flour about 57%. In 2023, only 54% of sampled wheat flour, 40% of maize flour, and 31% of oil samples met standards according to 2023 compliance data. The fortified rice story is promising but still in its early stages. In 2023, six millers produced over 12,000 tons of fortified rice under the GAIN-WFP-TechnoServe project. Pilot programs in Kebbi schools have shown the feasibility of scaling up through the National Home-Grown School Feeding Programme, which already serves more than 10 million pupils daily. Likewise, fortification of bouillon cubes is promising, and ongoing discussions with relevant stakeholders point to phased implementation, starting with voluntary fortification. Nigeria's chapter is one of the strongest in the book because it shows how large-scale policy commitment can coexist with uneven quality, fragmented milling, weak state-level laboratory capacity, and incomplete integration of fortified staples into the very social programs that could create the most predictable demand.

Senegal offers a different but equally relevant lesson: long-standing mandates do not automatically produce universal reach. The country mandated salt fortification beginning in 2000 and extended mandatory fortification to wheat flour and edible oil in 2009, aligning standards with ECOWAS and UEMOA and making it one of West Africa's earlier movers. However, the book highlights that while Senegal has made progress in fortifying flour and oil, it still faces urban-rural disparities and limited integration into large-scale government safety nets, which constrain more equitable coverage. The Senegal chapter is important for regional readers because it shows how harmonized standards can facilitate regional trade and enforcement. However, it also emphasizes that these gains remain incomplete without stronger domestic monitoring, broader market penetration beyond formal urban channels, and a deliberate pathway toward rice expansion.

Taken together, the African chapters show that the next frontier is not merely expanding mandates. It is more thorough implementation, which includes border enforcement to block unfortified imports, tax and foreign-exchange relief for premix and dosing equipment, expanded laboratory systems beyond capitals, and stronger use of school feeding and safety-net procurement to build predictable demand for compliant producers.

Asia and Southeast Asia

The Asian and Southeast Asian chapters present a diverse range of fortification models, ranging from near-mass scale to public systems and pilot-based or fragmented approaches constrained by geography, governance, and industry structure. These chapters also show why Asia matters to the future of fortification: the region has population scale, staple consumption, and social protection infrastructure that, if systems are aligned, could make fortification transformative.

India is a prime example of how fortification can expand from a pilot program to a national public system at scale. The book documents that fortified rice distributed through the public distribution system, integrated child development services, and PM POSHAN reaches over 800 million beneficiaries, supported by the Food Safety and Standards Authority of India regulations, the FoRTrace digital monitoring, the Fortified Rice Quality Management System, state-level technical support, and a rapidly growing ecosystem of fortified rice kernels (FRKs) manufacturers and equipped rice mills. This chapter adds value because it does not stop at scale; it also highlights the implementation strains beneath it, including a 2–5% procurement cost differential, challenges in the public distribution system, inconsistent state performance, and quality assurance bottlenecks, highlighting the need for additional support at the district level. India, therefore, functions in the book as both a success story and a systems lesson: scale is achievable when government procurement creates demand, but sustaining impact requires continuous investment in monitoring, storage, traceability, and state-level execution.

Indonesia is one of the most analytically rich chapters due to its structurally unique challenges. The country mandates the fortification of salt, wheat flour, and palm cooking oil. Additionally, rice fortification began through social safety nets and, by mid-2023, was integrated into the Bantuan Pangan Beras program, reaching 21.353 million beneficiary families and covering around 24% of national rice requirements. The chapter shows why this is both impressive and insufficient: Indonesia is home to more than 270 million people spread across over 17,000 islands; 55.9% of the population lives on Java, and remote islands face persistent disadvantages in access, transport, quality maintenance, and inspection frequency. Iodized salt fortification poses a significant challenge for public health fortification programs. Despite being the oldest fortification program, only

37.2% of households have access to iodized salt at 15 ppm or above. This shortfall largely stems from thousands of small producers operating outside effective quality-control systems. In contrast, wheat flour fortification is far stronger because approximately six firms control 70–80% of the market under SNI 3751, while palm cooking oil fortification under SNI 7709-2019 has advanced but remains undermined by nonfortified bulk oil. The policy implication is clear: in Indonesia, fortification success depends on aligning enforcement and supply-chain design with the geography of the archipelago, decentralizing mini-lab and regional testing capacity, simplifying fragmented regulations, and using social protection programs to compensate where open-market delivery cannot reach consistently.

Bangladesh, Nepal, Sri Lanka, Vietnam, and Myanmar together illustrate different degrees of institutional readiness. Bangladesh has built a strong edible oil platform and reached around 15 million vulnerable individuals through targeted programs, making it a useful example of how a few concentrated vehicles can generate broad nutritional value even when market-wide coverage remains inconsistent. Nepal's chapter is especially relevant for delivery-system integration: its National School Meal Programme covers about 3.3 million children in 29,000 public schools across all 77 districts and is framed as a platform for fortified rice, lentils, vitamin A-fortified oil, and iodized salt. Sri Lanka shows a promising blend of institutional learning and operational realism: the school meal system reaches about 1.07 million children, and a pilot program for locally produced fortified rice has successfully distributed 735 tons. Additionally, the Thriposha initiative reaches more than 1 million pregnant and lactating women, infants, and preschoolers. Universal salt iodization has significantly helped reduce goiter prevalence from 18.6% to 2.1% by 2016. The chapter highlights Sri Lanka's strong foundation for advancing food fortification while identifying areas for continued system strengthening, including expanding accredited testing capacity for folic acid, enhancing regulatory coordination across fortified food commodities, and undertaking comprehensive assessments of the rice fortification initiative to support evidence-based program optimization and future expansion

Vietnam is especially important because it demonstrates strong policy commitment, with significant opportunities to further strengthen implementation and expand population-level impact. Decree 09/2016 mandated the fortification of salt, wheat flour, and vegetable oil; however, implementation has remained limited for more than five years. As a result, rice, consumed at about 135 kg per person per year, lacks a large-scale mandatory pathway, even though it represents a high-impact vehicle. On a positive note, Vietnam also has one of the most promising delivery systems available: the National School Meal Program. This program covers all kindergartens and about 90% of primary schools, reaching 4.2 million students across 62 provinces by 2022. It incorporates digital menu tools and hazard analysis and critical control point-aligned kitchens in many settings. This chapter highlights an important opportunity for policymakers: alongside ongoing efforts to strengthen market-based fortification systems, school meal and social protection platforms can serve as effective pathways to accelerate nutrition impact and expand population reach.

Myanmar represents a different end of the continuum, where salt iodization is more commonly implemented compared with other vehicles, while rice and oil fortification are largely at the pilot stage. The market is characterized by a diverse private sector landscape and evolving social protection platforms, presenting opportunities to further expand the reach of food fortification interventions. Including Myanmar in the discussion strengthens the book's argument by reminding readers that policy transfer is not straightforward: countries with weaker regulatory capacity need phased, vehicle-specific pathways rather than imported blueprints.

Latin America

Latin America offers the book's clearest examples of what occurs when food fortification is institutionalized over decades. The region's chapters are less about novel policy experiments and more about durability; they show how legislation, laboratory systems, and public-health monitoring evolve together when given time to mature.

Costa Rica is the book's benchmark case. The country has long maintained mandatory fortification across multiple vehicles, including salt, sugar, wheat flour, milk, and rice. Rice fortification was mandated in 2001, and the book highlights both reductions in neural tube defects and broader gains in anemia control and micronutrient status. Costa Rica's achievement cannot be attributed to a single commodity; rather, it results from a well-functioning system that includes a centralized industry, steady government stewardship, evidence-based nutrient reformulation, and strong institutional support from bodies such as INCIENSA and the Ministry of Health. For readers from countries still working to achieve compliance with flour or oil fortification, Costa Rica shows what fortification looks like when it becomes part of national governance rather than a donor-supported project.

Guatemala, in contrast, illustrates both the power and the unfinished agenda of fortification efforts. The country's vitamin A sugar fortification program has helped reduce deficiency to about 5%, highlighting the public health benefits of using a carefully selected vehicle for fortification. However, Guatemala still faces extremely high stunting, which affects 47% of its population. The book argues that to combat deeper inequities among Indigenous and rural communities, it will be necessary to explore additional vehicles, such as maize- and wheat-based vehicles, strengthen school feeding, and improve evidence generation. Guatemala, therefore, illustrates that success in one vehicle does not eliminate the need for a broader systems strategy.

Argentina and Brazil present valuable yet diverse lessons. Argentina's practice of mandatory wheat flour fortification and Brazil's well-developed regulatory architecture demonstrate that while having industrial capacity is necessary, it is not sufficient; enforcement intensity, equity of reach, and alignment with social programs still determine whether fortification improves population nutrition or remains concentrated in formal markets. These chapters enrich the book by linking fortification to the modern issue of the double burden of malnutrition, where persistent micronutrient deficiencies coexist with rising rates of overweight and obesity.

Specific Challenges

One of the book's most significant contributions is identifying the specific structural problems that repeatedly limit the effectiveness of fortification programs across countries.

The first is **supply-chain** optimization. For example, Ethiopia's forex crisis constrains premix imports and pushes producers into irregular production or under-dosing. At the same time, imported unfortified products can undercut domestic firms that comply with fortification standards. In Indonesia, the situation is somewhat different. Even with standards in place, transporting fortified foods while maintaining quality across more than 17,000 islands requires logistics, storage, and inspection systems that are far more sophisticated than those needed in contiguous geographies. Additionally, Nigeria and Madagascar show how dependence on imported premix or FRK inputs keeps these countries exposed to exchange-rate volatility, delayed procurement, and high costs, which discourage smaller producers from entering the market.

The second aspect is the **incremental cost and unattractive business incentives** associated with fortification. In Ghana, smaller producers view the costs of premix and dosifier as a recurring burden, especially where enforcement is inconsistent and consumers do not show a preference for fortified products. In Madagascar, high premix taxes make voluntary fortification commercially unattractive. Similarly, in India, even a relatively modest 2–5% procurement cost differential can have significant impacts when scaled through massive public systems. The book repeatedly shows that when compliant firms bear visible costs but compete with cheaper noncompliant products, fortification loses traction unless policy actively corrects the market.

The third challenge is the need **for local production capacity.** Countries that depend entirely on imported premix, fortificants, or FRK remain vulnerable to global price shocks and procurement delays. Ethiopia's planned Kilinto facility, Sri Lanka's local FRK production, and India's expansion of domestic FRK and premix ecosystems are presented in the book as strategic turning points because they reduce import dependence and create regional learning and trade opportunities.

The fourth aspect is **quality control and quality assurance.** Inconsistent fortification is not just a minor technical defect; it directly erodes health impact, regulatory credibility, and consumer trust. For example, Ghana found that only around 23% of wheat flour samples met the established standards in earlier monitoring efforts. Similarly, Nigeria showed low compliance rates across wheat flour, maize flour, and oil, while Ethiopia, Sri Lanka, Bangladesh, Nepal, and several regions in Africa have limited accredited testing capacity. These findings show that programs cannot be judged by policy adoption alone. The book is particularly strong in emphasizing that laboratory systems, rapid test protocols, accreditation, and market surveillance are not back-end technicalities but central determinants of whether fortification actually delivers nutrients.

The fifth issue is **distribution inequity.** Urban formal markets are easier to regulate and fortify than rural and informal channels. This discrepancy is visible in Senegal's urban-rural disparities, Indonesia's outer-island gaps, Nigeria's low flour coverage among poorer and rural populations, and Ghana's dependence on formal industrial channels for vehicles that are not yet reaching all households adequately. As a result, the populations with the highest micronutrient risk are often the hardest to reach through open-market fortification alone.

Strategic Directions

The recommendations emerging from the book are strongest when read not as generic guidance but as direct responses to these constraints. Countries facing import dependence should move fortification inputs into protected policy categories through foreign-exchange priority windows, duty waivers, pooled procurement, or domestic premix and FRK production. This is crucial because supply instability is now a frontline nutrition risk, not just a trade issue. For example, Ethiopia's premix bottleneck, Madagascar's tax burden, Ghana's equipment costs, and Nigeria's imported premix dependence all point in the same direction: fortification systems need industrial policy support, not just health-sector endorsement.

Countries with fragmented production systems should adopt tailored implementation models. Large, centralized vehicles such as imported rice, industrial wheat flour, edible oil, and packaged foods should carry the first burden of mandatory compliance, while smaller producers need phased pathways that combine technical assistance, cooperative models, shared equipment, third-party certification, and simplified compliance mechanisms. This is especially relevant for Ghana's

domestic rice mills, Indonesia's salt producers, Madagascar's small rice and salt actors, and Nigeria's fragmented milling sector.

In areas where market penetration is uneven, governments may use **public procurement as a form of market architecture.** The book repeatedly demonstrates that school meals, food aid, social transfers, and other institutional channels can create guaranteed demand, accelerate producer investment, and reach nutritionally vulnerable populations more reliably than waiting for open-market demand to mature. Examples include Ghana's school feeding program, Ethiopia's school feeding and Productive Safety Net Program platforms, Nigeria's National Home-Grown School Feeding Programme, Indonesia's Bantuan Pangan Beras, Nepal's school meal platform, Sri Lanka's school meals and Thriposha, and Vietnam's school meal system. These examples illustrate how social welfare platforms can become engines of scale.

Quality assurance requires a more deliberate redesign. The book supports investment in accredited national and regional laboratories, rapid-test authorization, digital traceability, decentralized inspection, and a stronger use of risk-based surveillance. Countries do not need to build complete laboratory ecosystems all at once, but they should create realistic roadmaps that include central reference labs, regional hubs, temporary use of private or regional testing services, and digital quality systems that reduce the lag between production and corrective action. Without these measures, coverage claims will continue to exceed the actual nutritional reality.

Finally, the book ultimately suggests a more ambitious future: integrating fortification into food-system transformation rather than treating it as a stand-alone nutrition intervention. The most successful examples come from countries where fortification is linked to school meals, social protection, domestic industry development, regulatory modernization, and South-South learning. That is why this book matters. It not only demonstrates that fortification is effective but also illustrates, on a country-by-country basis, what it takes to make it work at scale and why the next generation of progress will belong to countries that can align public health goals with supply chains, standards, and state capacity.

Food Fortification Ecosystem across Countries

The ecosystem flowcharts presented in the chapters of each respective country illustrate the complete fortified food value chain—starting from agricultural production and extending to how fortified foods reach people through markets and safety nets. They also illustrate how government policies and systems ensure quality and assess the impact of these foods. Each heading serves as a "lens" to describe the fortification ecosystem in a structured, comparable manner across all 16 countries.

Africa	Page No.
Ethiopia:	40
Ghana:	51
Madagascar:	67
Nigeria:	81
Senegal:	99

Asia

Bangladesh:	118
India:	137
Indonesia:	151
Myanmar:	165
Nepal:	180
Sri Lanka:	194
Vietnam:	204

Latin America

Argentina:	219
Brazil:	238
Costa Rica:	256
Guatemala:	270

Fortification Ecosystem Structure

Column 1: Nutrition, Diet, and Policy Snapshot

This heading summarizes the nutrition context, diets, and policy foundation for fortification. It highlights key indicators (such as anemia, stunting, and micronutrient deficiencies), main staples, fortification legislation (mandatory or voluntary), and core national nutrition policies or strategies.

Column 2: Food Production and Processing

This section outlines where and how staple foods and oils are produced and processed before fortification. It includes key crops (such as rice, wheat, maize, cassava, oilseeds, and salt), the basic processing steps involved (drying, milling, refining, parboiling), and the structure of the milling/refining sector (large versus small- and medium-sized mills). The section also summarizes how micronutrient premix and FRK are sourced (imported or domestically) and where fortification and blending occur (at large mills, oil refineries, salt producers, and specialized blending units).

Column 3: Fortified Food Vehicles

This section outlines the food vehicles fortified in the country, specifying the nutrients added and whether fortification is mandatory, voluntary, or in the pilot stage. Examples include iodized or double fortified salt, fortified wheat or maize flour, edible oil, rice (often through FRKs), complementary foods, and, in some cases, sugar or milk.

Column 4: Food Distribution and Delivery Channels

Here, the text focuses on how fortified foods move from producers to consumers through commercial and public channels. It usually distinguishes between the open market (retailers, wholesalers, general consumers) and program-linked channels such as procurement for school meals, humanitarian assistance, or institutional feeding.

Column 5: Public/Social Safety Net and Institutional Programs

This heading describes the primary government- or partner-run programs that incorporate fortified foods into their delivery platforms. Typical examples include school feeding programs, public food distribution systems, cash or food transfer schemes, maternal and child nutrition programs, and humanitarian food assistance using fortified commodities (e.g., fortified rice, blended foods, or Super Cereal).

Column 6: Government Stewardship and Oversight

This section provides an overview of the ministries and national bodies responsible for the stewardship of nutrition and food fortification. It highlights the lead institutions involved in nutrition policy and coordination, as well as cross sector platforms or alliances (e.g., national fortification alliances and nutrition councils). Additionally, it explains how different sectors (health, agriculture, education, and social protection) coordinate around fortification.

Column 7: Regulatory, Program Monitoring, Evaluation, and Compliance

This section explains how compliance with fortification standards is monitored and enforced across the value chain. It includes factory inspections, documentation and process checks, laboratory testing of micronutrient levels, program specific quality checks in safety nets, and any digital or routine systems used to track quality and coverage in a timely and effective manner.

1. Introduction

1.1 The Burden of Micronutrient Deficiencies

Micronutrient deficiencies, commonly termed “hidden hunger”, remain a widespread global health challenge, affecting over 2 billion people, predominantly in low- and middle-income countries (LMICs) (Yilmaz and Yilmaz 2025). These deficiencies are associated with significant adverse outcomes, including impaired physical growth and cognitive development, weakened immune responses, and increased risks of illness and premature death (for details, see Box 1). Despite progress in global food systems and dietary patterns, vulnerable groups in some regions still fail to consume sufficient levels of essential micronutrients such as iron, vitamin A, iodine, zinc, vitamin B12, and folic acid (vitamin B9).

Box 1: Vitamins and Minerals: Essential Functions, Deficiency Risks, and Fortification's Cost-Effectiveness

Vitamins and minerals (collectively known as micronutrients) are required in small amounts, yet their impact on health is critical; deficiency in any of them can cause severe, even life-threatening conditions. They perform essential functions, enabling the body to produce enzymes, hormones, and other substances needed for normal growth and development. For example, **vitamin A** deficiency is a leading cause of preventable childhood blindness and increases the risk of death from severe infections. **Iodine** deficiency can cause birth defects, an increased risk of stillbirth and infant mortality, cognitive and neurological impairment including cretinism, hypothyroidism, and goiter, with universal salt iodization remaining the primary global prevention strategy. Iron deficiency reduces cognitive performance, work performance, and endurance. Worldwide, the three most common forms of micronutrient malnutrition are iron, vitamin A, and iodine deficiency, together affecting at least one-third of the world's population, with an estimated 2 billion people being anemic, just under 2 billion having inadequate iodine nutrition, and 254 million preschool-aged children being vitamin A deficient. Folate (vitamin B9) deficiency is a risk factor for neural tube defects and other birth defects, elevated plasma homocysteine, heart disease and stroke, impaired cognitive function, and depression. **Vitamin B12** (cobalamin) deficiency can cause developmental delays, poor neurobehavioral performance and growth in infants and children, nerve demyelination, and neurological dysfunction. **Vitamin D** deficiency, associated with limited sun exposure, results in rickets in children and osteomalacia in adults. **Zinc** deficiency impairs growth and increases susceptibility to infections such as diarrhea, while adequate intake supports immune function and cellular growth.

Taken together, adequate and sustained consumption of these micronutrients, whether through dietary diversity or fortified staple foods, supports normal growth and cognitive development, strengthens immune function, improves maternal and child health outcomes, and reduces the population-level burden of anemia, birth defects, and preventable disability. WHO economic evaluations, using the CHOosing Interventions that are Cost-Effective (CHOICE) model, have found that fortification programs achieve relatively low costs per disability-adjusted life year (DALY) saved compared with other interventions like supplementation.

Source: World Health Organization (WHO) (n.d.a); WHO and FAO (2006).

The burden of micronutrient deficiencies varies across countries, with particularly high prevalence in Sub-Saharan Africa, South Asia, and parts of Central America, where dietary diversity is limited and access to nutrient-rich foods remains constrained. In these regions, hidden hunger significantly affects human capital: it hampers children's cognitive performance, reduces educational attainment, and lowers adult productivity, ultimately affecting economic growth and societal well-being. Countries with high rates of anemia, vitamin A deficiency, and iodine deficiency disorders experience disproportionate losses in workforce efficiency, maternal and child health outcomes, and long-term development indicators. To address this, food fortification (the deliberate addition of essential vitamins and minerals to staple food items) has gained recognition as a highly cost-effective and scalable public health strategy to combat micronutrient malnutrition (Thakur et al. 2023).

1.2 Food Fortification: Policy Context and Global Landscape

In response to the documented public health burden of micronutrient deficiencies, food fortification (the deliberate addition of essential vitamins and minerals to staple food items) has gained recognition as a highly cost-effective, scalable, and sustainable intervention (World Health Organization 2023). The Copenhagen Consensus (2008) ranked micronutrient fortification (particularly iron and iodine fortification of staple foods) among the top three development interventions globally, reflecting its exceptional benefit-cost ratios and potential for widespread population impact. UNICEF's guidance on large-scale food fortification (LSFF) frames food vehicle selection for the fortification process around five core criteria: coverage, cost, consumption, central processing, and compatibility, alongside physiological availability and the presence of dietary inhibitors, underscoring why centrally processed staples with high and regular consumption are consistently prioritized over less standardized food items (UNICEF 2023).

Food fortification is not a recent innovation. Since the 1920s, when Switzerland and the United States first began salt iodization, fortification of staple foods and condiments has expanded systematically across high-, middle-, and low-income countries. Today, food fortification initiatives are implemented in more than 196 countries worldwide, although policy commitment, regulatory enforcement, population coverage, and implementation effectiveness vary substantially across contexts.

1.3 Global Status of Food Fortification Programs (Adoption and Implementation)

Commonly fortified staple foods include wheat flour, maize flour, rice, salt, and edible oils, selected primarily because they are widely and consistently consumed among target populations. Iodized salt is mandated in over 120 countries, making it the most widely implemented fortification intervention. The World Health Assembly adopted a resolution in 2023 to accelerate efforts to combat micronutrient deficiency through food fortification (WHA76.19). Wheat flour is fortified with iron, folic acid, and B vitamins in more than 90 countries. Edible oil, primarily in Africa and Latin America, is fortified with vitamin A in over 30 countries. Maize flour fortification is mandatory in approximately 20 countries and voluntary in several others, particularly across Africa. As of 2023, rice fortification is mandated in 8 countries, while more than 20 other countries have adopted either voluntary initiatives or pilot programs. Milk fortification, such as with vitamin D in the United States and with calcium in the European Union, is practiced in some regions but remains limited in Africa. In India, milk fortification with vitamins A and D has been scaled nationally through initiatives by the National Dairy Development Board (NDDB) and Food Safety and Standards Authority of India (FSSAI), reaching over 100 million consumers daily (GFDx n.d.).

These fortification efforts have been mandated by law or undertaken voluntarily, and they are often integrated into comprehensive national strategies to improve nutrition and strengthen food systems. This distribution highlights uneven but steady progress across commodities, with salt and wheat flour reaching the largest scale, while edible oil, maize, and rice fortification continue to grow mainly in regions with high micronutrient deficiency burdens, such as Africa, Asia, and Central America. The ability of countries to effectively regulate and expand fortification efforts varies significantly, often limited by scarce financial and technical resources, underdeveloped regulatory systems, and challenges in ensuring consistent industry compliance.

Globally, only Costa Rica, Nicaragua, Panama, the Solomon Islands, India, Papua New Guinea, and the Philippines have implemented mandatory rice fortification programs through safety-net initiatives and some open-market channels, with only six US states also requiring fortification. Brazil, Colombia, and the Dominican Republic maintain large-scale nonmandatory rice fortification initiatives (Food Fortification Initiative n.d.-a). Japan has been fortifying grains added to rice before cooking for several decades, with fortified products available since 1981.

Costa Rica mandated rice fortification in 2001, including folic acid, vitamin B1, niacin, vitamin B12, vitamin E, selenium, and zinc. Food fortification remains one of the most cost-effective and scalable strategies for addressing micronutrient deficiencies worldwide. While global policy adoption has expanded rapidly, benefiting over a billion people, the real challenge is translating mandates into equitable, sustainable impact.

Successful programs in Costa Rica and India show that lasting impact depends on strong regulations, political commitment, supply chain resilience, strategic partnerships, and integration with social safety nets. Future progress hinges on closing the implementation gap through increased regulatory investment, greater equity for vulnerable populations, strengthening domestic production capacity, and evidence-based, locally driven global partnerships. When combined with complementary interventions in diet, health, and sanitation, fortification can significantly help eliminate hidden hunger and achieve nutrition security (Global Fortification Data Exchange n.d.). Refer to Table 1.1.

Table 1.1. Global status of food fortification programs by commodity and UNICEF recommendations.

Commodity	UNICEF Recommended Fortificants	Countries with Current Practice	Micronutrients Currently Used
Salt	Iodine and, in special cases, fluoride, iron, and folic acid	120 (mandatory)	Iodine
Wheat flour	Iron, zinc, selenium, vitamins A, D, B1 (thiamine), B2 (riboflavin), B3 (niacin), B6 (pyridoxine), B9 (folate/folic acid), B12 (cobalamin)	90 (mandatory)	Iron, folic acid, and B vitamins
Edible oil	Vitamins A, D, and E	35 (voluntary/ mandatory)	Vitamin A
Maize flour	Iron, zinc, vitamins A, D, B1, B2, B3, B6, B9, B12	20 (mandatory); others voluntary	Iron, folic acid, vitamin A, and B vitamins
Rice	Iron, zinc, selenium, vitamins A, D, B1, B2, B3, B6, B9, B12	8 (mandatory); 20+ (voluntary/pilot)	Iron, folic acid, B vitamins, and vitamin A
Milk	Vitamins A, D, iron, and folic acid	Selected countries	Vitamin D (USA), calcium (EU); limited in Africa, vitamins A and D in India

Source: Food Fortification Initiative (n.d.-b), "Countries/Micronutrients Currently Used" columns; UNICEF (2023), Large-Scale Food Fortification for the Prevention of Micronutrient Deficiencies in Children, Women and Communities: Guidance Note, Annex 1, Table 2, "UNICEF Recommendation" column.

1.4 Rationale and Objectives

Although notable successes in food fortification have been achieved, such as universal salt iodization in many countries, mandatory wheat flour fortification in Central America, and large-scale rice fortification in India, opportunities remain to improve program implementation, quality control, coverage monitoring, and impact assessment. Countries demonstrate varying capacities to regulate and expand fortification efforts, supported by ongoing efforts to mobilize financial and technical resources, strengthen regulatory systems and laboratory infrastructure, improve industry compliance, particularly among small- and medium-scale producers, address supply chain efficiencies and premix affordability, and build consumer awareness and demand.

Countries have substantial potential to learn from each other, share best practices, avoid duplication, and address common implementation challenges. These areas, listed and covered in 16 high-burden countries across Africa, Asia, and Latin America, emerged as major takeaways from the Global South delegation hosted by PATH in January 2025. This learning exchange highlighted local successes, ongoing challenges, and scalable innovations in LSFF, underscoring the need for a comprehensive knowledge resource. This document serves as a single repository, gathering what has worked and what has not, success stories from pioneering programs, and global insights on policy, implementation, and partnerships, designed for any country aiming to initiate or scale up LSFF efforts effectively.

This report also systematically maps fortification initiatives across various food vehicles, placing them within their policy, institutional, and operational contexts. It seeks to deepen understanding of regional variations in policy frameworks, implementation models, and program outcomes, while highlighting common challenges and adaptable successful practices. By translating comparative insights into practical recommendations, the study promotes the development of context-responsive and sustainable fortification strategies. It also underscores the importance of knowledge exchange within the Global South to strengthen evidence-based programming, support global nutrition security, and create more resilient food systems that ensure equitable access to micronutrients for vulnerable populations.

The objective is to conduct a landscape analysis to assess current readiness and share best practices and lessons learned. These insights can help bridge the gap for countries that have either recently initiated food fortification programs or plan to initiate them.

1.5 Selection of Geographies and Stakeholder Discussion

This review analyzed 16 countries: Ethiopia, Ghana, Madagascar, Nigeria, and Senegal in Africa; Argentina, Brazil, Costa Rica, and Guatemala in Latin America; and India, Bangladesh, Indonesia, Myanmar, Nepal, Sri Lanka, and Vietnam in Asia. These countries were selected based on criteria such as the scale of fortification programs (e.g., mandatory versus voluntary for staples like rice, wheat flour, salt, and oil), geographic diversity (South Asia, Southeast Asia, and Latin America), program maturity (from pioneers like India to emerging programs like Vietnam), and high rates of micronutrient deficiencies. These deficiencies include anemia rates exceeding 45.5-68% among children and women of reproductive age (WRA), as well as widespread deficiencies of vitamin A, zinc, iron, and iodine that negatively affect human capital, productivity, and economic growth. These regions, particularly Sub-Saharan Africa and South Asia, bear the heaviest global burden of nutritional deficiencies, with countries such as Nigeria, Ethiopia, India, and Bangladesh ranking high in incidence, mortality, and disability-adjusted life years (DALYs) caused by hidden hunger.

Compounding this nutritional crisis, these countries are among the most vulnerable to climate change impacts, such as droughts, floods, cyclones, storms, and erratic rainfall, which disrupt rainfed agriculture dependent on staples such as maize, rice, teff, and wheat that dominate local diets. In Ethiopia, inconsistent rainfall exacerbates food insecurity and micronutrient gaps by reducing crop yields, degrading livestock fodder, and increasing food prices during lean seasons. Similarly, Madagascar, along with countries such as India and Bangladesh, faces increased risks, with extreme events increasing the prevalence of undernourishment by 1.5 percentage points in affected areas.

The selection thus focuses on contexts in which fortifying staples provides scalable resilience against two major threats: persistent micronutrient burdens and climate-related food system shocks that limit dietary diversity and access to nutrient-rich foods. By targeting these high-burden, climate-vulnerable countries, the analysis highlights opportunities for fortification to improve nutrition security amid global disruptions.

A mixed-methods desk review and qualitative synthesis approach was employed, combining data from global databases, interactions with global experts, donors, policymakers working in fortification and nutrition, peer-reviewed literature, policy documents, and program reports to evaluate the status, performance, and future direction of food fortification efforts worldwide.

Semi-structured interviews were conducted with key stakeholders across different countries, guided by a set of structured questions. This was complemented by a review of peer-reviewed articles, government policy documents, and program reports issued by development partners. A desk review of national nutrition surveys (e.g., Demographic and Health Surveys or DHSs and National Family Health Surveys), policy documents, regulatory frameworks, and program performance data, including coverage metrics, compliance testing results, and impact evaluations from sources such as the Food and Agriculture Organization (FAO), Nutrition International, the United Nations Children's Fund (UNICEF), the World Food Programme (WFP), the Global Alliance for Improved Nutrition (GAIN), PATH, and national ministries in the respective countries, was also performed.

The analysis employed a common framework that examined 12 dimensions per country: nutrition ecosystem, nutrition status and dietary practices, nutrition flagship programs, policy environment, industry capacity, safety net programs, reach and coverage, value chain/quality assurance, monitoring mechanisms, stakeholder partnerships, challenges and policy reforms required and opportunities and future directions. This approach enabled structured comparisons of enablers (e.g., regulatory enforcement and lab networks) and gaps (e.g., coverage inequities and data limitations), drawing on implementation of research principles for evidence-based recommendations.

2. Regional Synthesis

2.1 Africa

Across the African countries reviewed-Ethiopia, Ghana, Madagascar, Nigeria, and Senegal-anemia and micronutrient deficiencies remain widespread, particularly among children and WRA. Anemia prevalence among children ranges from 50% in Ghana to an alarming 68% in Nigeria, with similarly high rates among WRA. Vitamin A deficiency affects 30–40% of children and women in most of these countries, while zinc deficiency is common in 40–60% of children, especially in Ethiopia, Madagascar, and Nigeria.

The diet in these countries primarily consists of cereals, with staples such as maize, teff, and rice accounting for most of the daily intake. Rice, in particular, is being consumed more in both rural and urban areas, with significant imports noted in Senegal and Ghana, suggesting an opportunity for centralized fortification before distribution. These patterns strongly support the case for mandatory fortification of widely consumed staples such as rice, wheat flour, edible oil, and salt, with essential nutrients such as iron, folic acid, vitamin A, and zinc.

2.1.1 Ethiopia

2.1.1.1 Nutrition and Fortification Ecosystem

Ethiopia, the second most populous nation in Africa with over 126 million people, is navigating a complex nutritional transition. The government has prioritized nutrition as a matter of national security, recognized in the "Seqota Declaration," which aims to eliminate stunting among children under two years old by 2030. This goal is implemented through the National Food and Nutrition Strategy (FNS 2021–30), which calls for a multi-sectoral approach across health, agriculture, and industry. Currently, the country is in the "Expansion Phase" (2021–25) of the Seqota Declaration, scaling up high-impact interventions to 700 woredas (districts), with plans to expand nationwide from 2026 to 2030 (Government of Ethiopia 2016).

Economically, Ethiopia is transitioning from state-led development to a liberalized market, significantly impacting food systems. In June 2022, the government enacted a landmark mandatory fortification policy for wheat flour and edible oil, marking a clear shift from voluntary pilots to regulatory enforcement. However, this transition is occurring against a backdrop of macroeconomic challenges, including foreign exchange shortages and inflation exceeding 25%, which make it more difficult to import essential fortification inputs like premix and technology (Ali and Asfaw 2023).

2.1.1.2 Nutritional Status and Dietary Practices

Ethiopia continues to face a complex nutrition landscape marked by the persistent "triple burden" of malnutrition: undernutrition, micronutrient deficiencies, and an emerging pattern of overweight and obesity in urban areas. Despite progress in some health indicators, malnutrition remains a critical public health concern, undermining child growth, cognitive development, and national productivity. The 2019 Ethiopia Mini DHS (Demographic and Health Survey) (Ethiopian Public Health Institute and ICF 2021) reports that children under five years old are affected (37% stunted, 7% wasted, 21% underweight), with low micronutrient intake and suboptimal feeding practices.

Pregnant women show poor iron supplementation (with 40% taking none), while data on adolescents are limited to contextual guidelines without specific metrics. Disparities persist by region, residence, education, and wealth, with urban and educated groups faring better. This burden of stunting varies significantly by region, with the highest prevalence in the rural highlands of Amhara and Tigray, where dietary diversity and access to nutrient-rich foods remain particularly limited. The 2016 Ethiopia DHS indicated that anemia is a major, worsening public health problem, with prevalence among children aged 6–59 months rising to 57% and among pregnant women to 24% (Central Statistical Agency and ICF 2017).

According to the Ethiopia Mini DHS 2019, 11% of children aged 6 to 23 months meet the minimum standards for all three infant and young child feeding (IYCF) practices (breastfeeding status, number of food groups, and number of times fed during the day or night before the survey). Fourteen percent of children have an adequately diverse diet (i.e., they are given foods from the appropriate number of food groups) and 55% are fed the minimum number of times appropriate for their age. Among children aged 6 to 23 months, 39% consumed vitamin A-rich foods and 24% consumed iron-rich foods in the prior 24 hours, with vitamin A consumption improving with age (28% to 52%). Vitamin A supplement intake was observed at 45-53% for children aged 6 to 35 months, with higher rates in urban areas. Iron-rich food consumption varied significantly, ranging from 14% among those with no education to 41% among those with higher education. Breastfeeding is nearly universal at 96%, with 72% of mothers initiating breastfeeding early and 59% exclusively breastfeeding their infants under six months. However, only 11% of children achieve a minimum acceptable diet, which is characterized by 14% dietary diversity and 55% feeding frequency. Grains dominate the diet, making up 65%, while the inclusion of animal sources remains low.

Among women who gave birth in the last five years, 40% did not take any iron tablets during their most recent pregnancy, 36% took them for less than 60 days, 12% for 60-89 days, and 11% for over 90 days. Urban areas had higher usage rates (70% took any tablets) than rural areas (57%). The highest rates of women taking iron tablets for over 90 days were in Dire Dawa (22%) and Addis Ababa (19%), while the lowest rate was in the Somali region (2%). Education significantly increased uptake (with only 7% of women without education taking tablets compared to 27% of those with higher education). Among women who attended antenatal care, 74% received care from skilled providers. Of these, 71% received nutritional counseling, 88% examined for blood pressure, and 74-79% had samples taken (Ethiopian Public Health Institute and ICF 2021).

Zinc deficiency also affects roughly 49% of young children, impairing immune function and growth. The Food Consumption Survey (2021) confirmed significant dietary gaps in several essential micronutrients, including iron, folate, and vitamin A. Adolescent girls, in particular, face heightened nutritional vulnerability due to increased physiological needs and limited access to varied diets.

Dietary patterns across the country are primarily centered around cereals, which form the backbone of the Ethiopian diet. The main sources of dietary energy include teff, wheat, sorghum, and maize, reflecting both cultural preferences and agricultural production patterns. However, the dependence on staple grains, combined with one of the world's lowest levels of animal-source food consumption, limits the intake of highly bioavailable micronutrients. While teff is nutrient-dense, it presents technical challenges for fortification due to its small grain size and traditional milling and processing practices. In this context, wheat flour and edible oil have emerged as the most promising vehicles for large-scale fortification, given their wider processing infrastructure and consumption patterns (Global Nutrition Report 2024).

Ethiopia's ongoing urban transition is reshaping dietary behaviors and food markets, creating both opportunities and risks. The growing urban middle class has increased demand for wheat-based and processed foods, with wheat imports reaching approximately 1.7 million tons in 2023-24 (U.S. Department of Agriculture, Foreign Agricultural Service 2025). Rice consumption has also expanded rapidly, growing by more than 45% in early 2024. These shifts in staple consumption patterns highlight the potential to engage new fortification vehicles that can reach urban and peri-urban populations more effectively, while also calling for integrated strategies to address rising obesity and non- communicable diseases (NCDs). Together, these nutritional dynamics underscore the

urgency of multi-sectoral approaches that can respond to Ethiopia's evolving food system and its dual challenge of undernutrition and emerging overnutrition.

2.1.1.3 Nutrition-related Flagship Program

Ethiopia has shown sustained political commitment in improving nutrition outcomes through several high-profile national initiatives aligned with its broader development agenda. The Seqota Declaration (2015–30) is the country's flagship pledge to end childhood undernutrition by 2030. Launched as a government-led, multisectoral platform, the declaration has now entered its expansion phase (2021–25), scaling coverage to 700 woredas nationwide. It explicitly identifies food fortification as a priority "nutrition-specific" intervention to address micronutrient deficiencies among vulnerable populations.

Complementing this is the Productive Safety Net Program, one of Africa's largest social protection schemes, serving more than 8 million beneficiaries (European External Action Service n.d.). Traditionally designed to ensure caloric sufficiency by distributing staple grains, the fifth phase marks a significant policy shift toward nutrition-sensitive programming (Government of Ethiopia, Ministry of Agriculture 2020). Productive Safety Net Program V integrates fortified food transfers and other measures to improve diet quality, with a particular focus on pregnant and lactating women and young children. This evolution underscores Ethiopia's recognition that nutrition security extends beyond calorie intake to encompass dietary diversity and micronutrient adequacy.

These efforts are guided by the National Nutrition Program (NNP II), which provides the national framework for multisectoral coordination and accountability. NNP II mandates joint action among the ministries of health, agriculture, and industry to deliver integrated nutrition interventions, ranging from community-based health promotion and agricultural diversification to food fortification and market access. Together, these flagship initiatives reflect Ethiopia's holistic, systems-oriented approach to combating malnutrition and advancing its vision of a well-nourished, productive population.

2.1.1.4 Policy Environment for Food Fortification

Ethiopia's policy and regulatory framework for food fortification has undergone a significant transformation in recent years, shifting from a voluntary to mandatory approach. The Ministry of Industry officially launched the National Food Fortification Program in August 2024 (Fana Media Corporation 2024), following the Council of Ministers' approval in June 2022. This marked a turning point, institutionalizing large-scale fortification as a national strategy to combat micronutrient deficiencies. With this launch, fortification standards became compulsory for all domestic producers and importers of edible oil, wheat flour, and salt, the three major food vehicles selected for their wide consumption and nutritional impact.

Under the new regulatory regime, the Institute of Ethiopian Standards has established and enforced mandatory fortification standards across key commodities. For edible oil, Standard ES 6133:2021 requires fortification with vitamins A and D to address widespread deficiencies. Wheat flour is governed by ES 6132/CES 309, which mandates fortification with iron, folic acid, zinc, B1 (thiamine), B2, B3 (niacin), B6 (pyridoxine), and B12 (cobalamin) (Ethiopian Standards Agency 2022), along with prescriptive requirements for moisture content and packaging to ensure quality and safety. Meanwhile, the country continues to uphold universal salt iodization, and in January 2026 became the first country globally to launch double-fortified salt (iodine and folic acid) at national scale, aimed at reducing the high burden of neural tube defects.

Regulatory oversight has also been strengthened through new policy proposals and enforcement planning. In April 2025, the Ethiopian Food and Drug Authority released the Draft Directive for the Registration of Fortified Foods, which aims to tighten compliance and address persistent gaps in the circulation of unfortified foods. If adopted, the draft would prohibit the manufacture, import, or sale of unregistered (and thus unfortified) products in Ethiopia, thereby establishing a potential legal framework to deter noncompliance and safeguard consumer access to nutritionally improved foods.

Effective coordination remains central to the successful implementation of the National Food Fortification Program. The National Nutrition Coordinating Body, chaired by the Ministry of Health, plays a pivotal role in aligning ministerial actions with those of key ministry co-chairs (agriculture and education), harmonizing technical standards, and ensuring policy coherence across the food, health, and industry sectors. Complementing this, the Millers for Nutrition coalition, formally launched in December 2024, serves as an institutionalized platform for public-private dialogue. It brings together millers, regulators, industry associations, and development partners to identify and address operational and compliance challenges, promoting a culture of accountability and shared responsibility within Ethiopia's food fortification ecosystem.

2.1.1.5 Industry Capacity and Role of Private Players

Ethiopia's food processing industry has a distinct dual structure. It features a small number of large, capital-intensive enterprises alongside thousands of smaller, fragmented processors. This structure is especially evident in the edible oil and wheat flour sectors, which play a central role in household food security and hold significant potential for large-scale food fortification (LSFF). While industrial players have expanded installed capacity in recent years, their overall impact on national nutrition outcomes remains constrained by shortages of raw materials and foreign exchange, as well as gaps in coordination with the government, development partners, and suppliers (Food Fortification Initiative n.d.).

In recent years, the edible oil sector has experienced rapid industrialization, driven by a few mega-refineries. These facilities have a combined capacity that, if fully utilized, could meet or even exceed domestic demand. The Phibela Industrial Complex has an installed refining capacity of around 1.5–1.6 million liters/day, positioning it as one of the largest edible oil plants in the country. Similarly, W.A. Oil has a refining capacity of about 1.3 million liters/day. Along with other major players such as Shemu and Alimpex, these firms have enabled domestic refining capacity to increase from an estimated 5% of total demand to roughly 40% in just a few years. However, actual production often lags due to shortages of crude oil, oilseeds, and foreign exchange needed for imports. Consequently, large processors frequently underutilize their facilities, and the government continues to rely on imports of finished edible oil to stabilize prices and ensure availability (Food Business Middle East & Africa 2021).

The Ethiopian Edible Oil Manufacturing Industry Association (EEOMIA), representing more than 232 processors of varying scales, has emerged as a key intermediary between the industry and the government (The Reporter Ethiopia 2023). This connection is especially important for issues related to access to foreign currency and input prioritization. The association regularly engages with the Ministry of Finance and the Ministry of Trade and Regional Integration (The Reporter Ethiopia 2023; Milling Middle East & Africa Magazine n.d.). Their advocacy focuses on securing foreign-currency allocations for crude oil and premix imports, as well as seeking policy solutions to alleviate constraints on raw materials, including requests related to oilseed export restrictions (Milling Middle

East & Africa Magazine n.d.). This organized platform also serves as a conduit for discussing the fortification mandate, with the association collaborating with development partners, including Millers for Nutrition, TechnoServe and the Global Alliance for Improved Nutrition (GAIN), to support processors in meeting fortification requirements (Millers for Nutrition 2024).

The wheat flour milling industry is divided into two distinct segments: a relatively small group of medium and large mills that supply urban markets and institutional buyers, and a very large number of small village mills that serve rural households. It is estimated that there are roughly 30–50 large wheat flour mills, primarily in Addis Ababa and high-production regions such as Oromia and Amhara. These large mills dominate formal market supply and are best positioned to implement and sustain mandatory fortification. Prominent industrial players in this sector include DH Geda, Ten Day Belt, Nyala Flour Factory, Admas Tesfa, and Brothers Ah-Wan. Many of these companies operate modern roller mills and have installed dosifiers for vitamin and mineral premixes. However, they face challenges, including irregular premix availability and financing issues, which undermine consistent fortification efforts. Addressing these supply-side bottlenecks through improved forex access, pooled procurement strategies, or subsidy mechanisms could significantly enhance the potential public health impact of flour fortification, especially considering the large volumes processed by these mills (ReliefWeb 2016; Milling Middle East & Africa 2025).

At the other end of the spectrum, there are more than 1,000 small village mills that process the bulk of wheat and other cereals consumed by rural and low-income households. These mills often use small hammer or stone mills operating on a toll basis. However, these enterprises typically lack the infrastructure, quality assurance systems, and working capital required for conventional premix-based fortification. Recently, these small mills have become the focus of technology pilots that are exploring decentralized or simplified fortification solutions (Food Fortification Initiative n.d.). Examples include low-cost, manually operated dosifiers or fortified grain-blending models. The insights gained from these pilots will be critical to determining how and to what extent small mills can be integrated into a national fortification strategy. Additionally, complementary measures such as social protection, consumer awareness programs, or targeted distribution of fortified flour from larger mills are needed to reach rural populations that depend on this informal milling sector.

2.1.1.6 Integration with Social Safety Net Programs

Social protection platforms in Ethiopia play a pivotal role in ensuring the demand for staple foods and serve as strategic entry points for integrating fortified commodities into public procurement systems. These platforms purchase substantial quantities of food for vulnerable populations, creating an opportunity to leverage government spending to advance national fortification objectives and improve nutrition outcomes. Two major programs, the Productive Safety Net Program and the Home-Grown School Feeding initiative, illustrate both the potential and the challenges of incorporating fortification into social protection mechanisms.

The Productive Safety Net Program is one of Africa's largest social safety nets, providing critical assistance to over 8 million Ethiopians facing food insecurity. With the introduction of Productive Safety Net Program 5, there is a significant shift toward digital cash transfers, which currently benefit around 1.7 million households. However, in regions that are prone to drought and chronic food insecurity, in-kind food transfers remain indispensable. These food transfers offer an important opportunity to include fortified staples, such as wheat flour and edible oil. While the Productive Safety Net Program policy framework already endorses integrating fortified commodities, implementation remains uneven because of constrained domestic supply capacity, limited

coordination between implementing agencies, and variability in local market readiness to provide fortified products. To enhance progress toward consistent fortification coverage in targeted regions, it is essential to strengthen linkages among Productive Safety Net Program procurement systems, fortified food producers, and government fortification monitoring agencies (World Bank 2020).

The Home-Grown School Feeding program represents a significant opportunity to incorporate food fortification within Ethiopia's public food systems. Currently, it reaches approximately 6.9 million students across eight regions. The program's procurement model links smallholder farmers to schools, enhancing nutrition and supporting local agricultural development. According to the Global Child Nutrition Foundation 2024, school meals provided through Home-Grown School Feeding already include fortified ingredients, such as iodized salt, fortified edible oil, and wheat flour enriched with zinc and vitamin A. This demonstrates the feasibility of integrating fortification compliance into government procurement. Furthermore, the growing inclusion of rice in urban school meal menus presents an additional opportunity to pilot fortified rice. Such pilot programs could serve as scalable models for introducing fortified rice into the broader food system, enabling Ethiopia to strengthen fortification compliance without relying solely on commercial retail channels (Sustainable Financing Initiative for School Health & Nutrition 2025).

Together, the Productive Safety Net Program and Home-Grown School Feeding program position social safety nets as catalytic vehicles for advancing national fortification goals. By aligning procurement standards, strengthening supply chain coordination, and reinforcing quality assurance mechanisms, Ethiopia can transform these platforms into sustainable delivery systems for fortified staple foods. This approach aims to bridge the gap between policy intentions and improvements in nutrition at the population level.

2.1.1.7 Population Reach and Coverage Metrics

Data on the population's access to and consumption of fortified foods in Ethiopia continues to evolve but remains fragmented across various sources. Recent national and regional assessments suggest that approximately 89% of the population consumes fortifiable edible oil. This high percentage is largely due to the dominance of industrially processed or imported oil in the domestic market. In contrast, only 29% of the population consumes fortified wheat flour, as many households, particularly in rural areas, rely on grain milled locally or at small community mills. This difference underscores both the reach and the limitations of industrial food fortification in a context where traditional food systems remain strong (Samuel et al. 2024).

To complement industrial-scale fortification, Sanku's small-scale mill fortification model has gained popularity in Ethiopia, targeting underserved rural populations that are typically beyond the reach of large processors. As of late 2024, 133 Internet of Things (IoT)-enabled dosifiers have been deployed across 221 partner mills, collectively benefiting an estimated 4 million people. Sanku's approach of integrating premix dosing technology, training, and remote performance monitoring has been instrumental in extending the benefits of fortification to decentralized milling networks. However, challenges related to geographic expansion and sustainability remain ongoing concerns (Milling Middle East & Africa 2025).

Iodine salt fortification is Ethiopia's most mature and widely implemented fortification program, with over 80% of households having access to iodized salt. However, only 26% to 37% of households consume salt with adequate iodine levels (>15 ppm) (Ajmani et al. 2020; Alamneh et al. 2021). This

disparity points to persistent challenges in maintaining iodine content across the supply chain, which may be attributed to poor production practices, inadequate storage, and iodine degradation during transport. Despite these limitations, the program provides valuable insights into national fortification coordination, regulatory enforcement, and monitoring across a wide range of commodities.

Similarly, vitamin A fortification of edible oil is one of the country's mandated vehicles, but it faces compliance issues analogous to those in other markets in the region. For example, Gidey et al. (2025) highlighted that, while most brands claim to provide fortification, the actual vitamin A levels often fall below regulatory requirements. This is often due to underdosing and vitamin degradation over time, with as much as 60% of vitamin A content lost during traditional deep-frying practices or extended storage under high ambient temperatures and inadequate packaging.

2.1.1.8 Value Chain, Quality Assurance, and Regulatory Frameworks

The Ethiopian food fortification ecosystem is anchored in a centralized yet capacity-constrained regulatory system, with emerging partnerships to strengthen the value chain and domesticate key inputs such as premix. The Ethiopian Food and Drug Authority serves as the primary regulatory authority, responsible for registering fortified foods, licensing facilities, enforcing fortification directives, and inspecting production and market outlets (Federal Democratic Republic of Ethiopia 2023). However, its enforcement presence remains much stronger in Addis Ababa and major regional towns than in remote rural areas. This urban-biased reach creates a gap between de jure requirements for wheat flour and edible oil fortification and de facto compliance in more peripheral markets, where small and medium millers often operate with limited direct oversight.

Quality assurance responsibilities are shared among different parties, with the Ethiopian Standards Agency overseeing certification schemes and establishing product and process standards for fortified staples. Under these schemes, mills are expected to institutionalize internal quality assurance systems, which include basic in-house laboratories capable of performing routine checks on visual or qualitative "spot" indicators, such as iron spot tests, to verify the addition of premix. However, accurately determining the quantitative levels of micronutrients (such as iron, zinc, or vitamin A) typically requires sending samples to external laboratories. This can increase costs and turnaround times, making routine compliance monitoring more challenging, particularly for smaller private operators (Ethiopian Standards Agency n.d.).

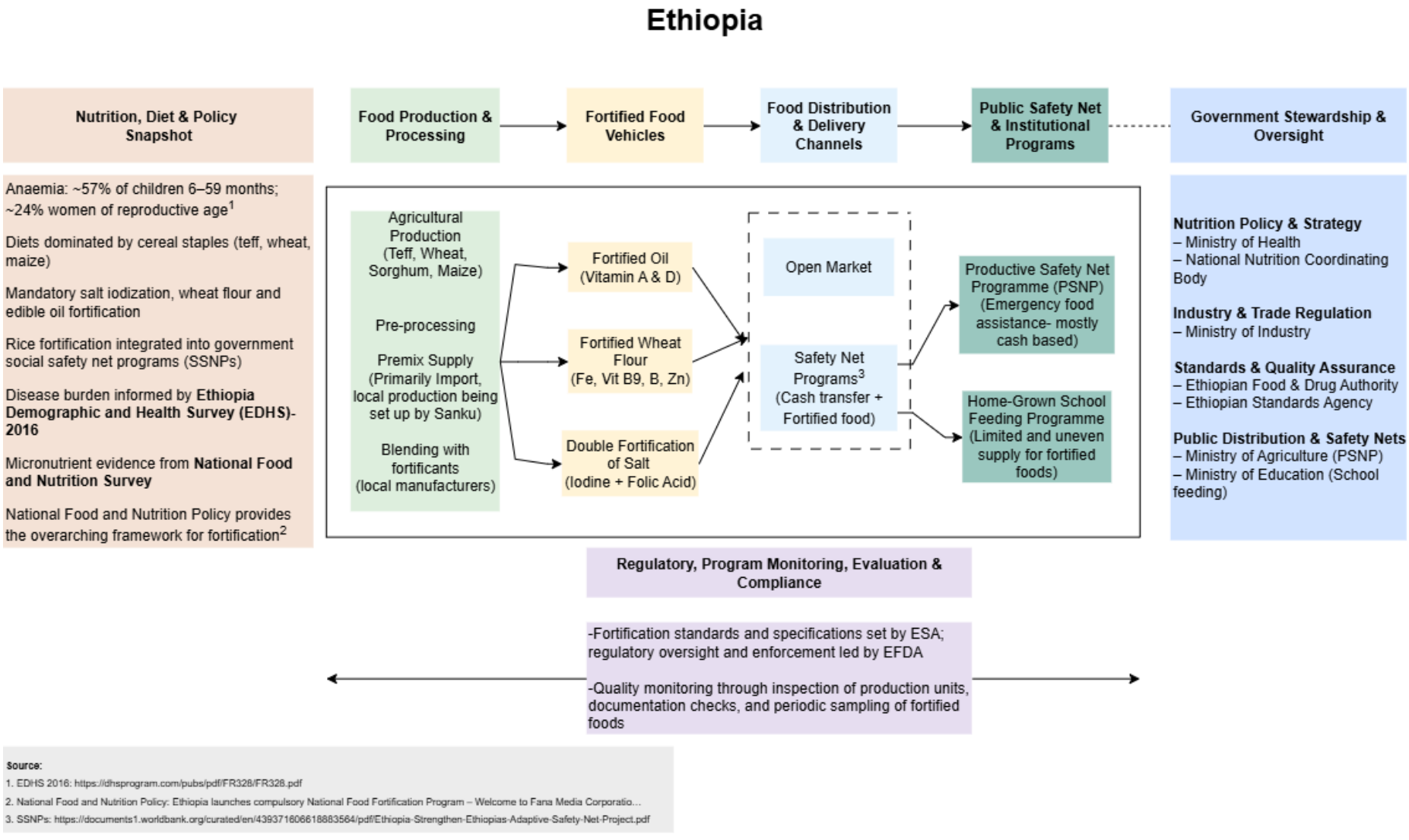
The premix supply chain is one of the most critical vulnerabilities in Ethiopia's fortification value chain, as premix is almost entirely imported. This reliance exposes millers and refiners to challenges, including foreign exchange constraints, long lead times, and price volatility. To tackle this structural issue, initiatives such as Millers for Nutrition and Sanku are partnering with government and development organizations to establish a local nutrient premix blending facility in the Kilinto Special Economic Zone in Addis Ababa. This facility is envisioned as a hub for the pharmaceutical and food industries. Once operational, the factory is expected to reduce dependence on imported blends, lower landed premix costs, and create a more predictable supply for both large industrial plants and the growing network of small and medium millers supported by Sanku's dosifier technology (Milling Middle East & Africa n.d.).

In Ethiopia, the testing infrastructure for food fortification relies on a limited number of national and regional reference laboratories. These laboratories are responsible for conducting confirmatory quantitative analyses essential for regulatory surveillance and program monitoring. However, they

often face shortages of reagents, calibration materials, and spare parts, as well as delays in equipment maintenance. These issues severely constrain their ability to provide timely, reliable testing services needed for comprehensive national coverage. While rapid, field-friendly tools such as BioAnalyt's iCheck devices offer quantitative testing closer to the point of production, their high costs for both units and consumables make them difficult for many small millers to use routinely unless subsidized through donor or government programs (Ethiopian Food and Drug Authority 2025).

Taken together, Ethiopia's value chain, quality assurance, and regulatory architecture for food fortification are evolving from a largely import-dependent, centrally regulated system toward a more integrated model that leverages private sector and development partnerships. To effectively implement new policies and directives for consistent food fortification at scale, it is crucial to strengthen the Ethiopian Food and Drug Authority's reach beyond major cities, expand Ethiopian Standards Agency-linked certification and mill-level quality assurance capacity, secure sustainable premix supply via the Kilinto facility, and invest in affordable testing options for small and medium mills (Milling Middle East & Africa Magazine. (2025). Refer to Figure 2.1.

Figure 2.1. Ethiopia's food fortification ecosystem



Source:

1. EDHS 2016: https://dhsprogram.com/pubs/pdf/FR328/FR328.pdf
2. National Food and Nutrition Policy: Ethiopia launches compulsory National Food Fortification Program – Welcome to Fana Media Corporatio...
3. SSNPs: https://documents1.worldbank.org/curated/en/439371606618883564/pdf/Ethiopia-Strengthen-Ethiopias-Adaptive-Safety-Net-Project.pdf

2.1.1.9 Monitoring and Evaluation Mechanisms

Monitoring and evaluation of food fortification programs in Ethiopia relies on a combination of national surveys, routine administrative systems, and emerging digital innovations. At the national level, large-scale surveys such as the DHS and the National Micronutrient Survey are primary tools for tracking long-term nutrition outcomes. These surveys provide valuable information on population-level indicators, such as anemia prevalence and micronutrient deficiencies, which offer insights into the overall nutritional impact of fortification efforts. However, their periodic nature, often conducted every five years, limits their utility for real-time program management and timely course correction (Ruth et al. 2018).

In parallel, administrative data systems form the foundation of routine monitoring of industry compliance and program performance. Periodic assessments evaluate adherence to fortification standards and quality assurance protocols. The National Information Platform for Nutrition, managed by the Ethiopian Public Health Institute, was established to integrate and analyze multisectoral nutrition data, including information relevant to food fortification (National Information Platform for Nutrition Ethiopia n.d.). Despite this institutional framework, the current linkage between factory-level production data and broader health and nutrition statistics remains challenging, constraining the system's ability to provide comprehensive and timely insights into program effectiveness.

To address these challenges, digital innovations are being introduced to strengthen the timeliness and accuracy of monitoring and evaluation data. One promising approach is the use of IoT-enabled dosifiers, which Sanku has piloted for real-time monitoring of flour fortification (Tronel 2022; Sheidu 2024). These devices automatically track fortification levels, production volumes, and equipment uptime, transmitting data remotely to a centralized dashboard. By sharing this digital data with government stakeholders, the initiative illustrates how technology can enhance program transparency, accountability, and responsiveness. Scaling these digital solutions could significantly improve Ethiopia's capacity for continuous monitoring, enabling faster identification of gaps and more targeted support for food processors.

2.1.1.10 Stakeholder Ecosystem and Partnerships

The food fortification ecosystem in Ethiopia is supported by a strong, collaborative network of government institutions, development partners, and the private sector, all working toward the common goal of reducing micronutrient deficiencies through large-scale and small-scale fortification initiatives. The Ministry of Health serves as the lead agency, providing overall leadership in formulating, coordinating, and monitoring of nutrition and fortification policies. The Ministry of Industry plays a supportive role by facilitating engagement with private sector stakeholders and ensuring that fortification targets align with industrial production capacities. The Ministry of Trade oversees import regulations to ensure that fortified commodities meet national standards. The Ethiopian Food and Drug Authority acts as the primary enforcement body, responsible for regulatory compliance, quality assurance, and inspection of fortified products in the market. Meanwhile, the Ethiopian Public Health Institute is responsible for research and monitoring functions, generating data on coverage, compliance, and impact to inform ongoing policy and programmatic decisions (Nutrition International 2022).

Ethiopia's development partners play a pivotal role in advancing the country's fortification agenda through technical assistance, capacity-building, supply chain strengthening, and coordination

platforms. GAIN provides strategic support to the national LSFF initiative and facilitates the "Millers for Nutrition" coalition, which mobilizes private millers and food producers to adopt fortification practices and improve product quality. Nutrition International complements these efforts by supporting salt iodization programs and providing technical assistance to develop and revise food fortification standards. WFP strengthens logistical and operational capabilities, particularly within the Productive Safety Net Program and Home-Grown School Feeding initiative, ensuring the delivery of fortified foods to vulnerable populations. Sanku, a key implementation partner, enables small- and medium-scale millers to fortify flour at the community level through innovative dosifier technology and ongoing technical support.

Private sector engagement remains a cornerstone of Ethiopia's fortification efforts. Industry associations such as the Ethiopian Millers Association and the Ethiopian Edible Oil Industries Association play a critical role in advocating for enabling policies, ensuring compliance with standards, and fostering peer learning among millers and processors. Large anchor firms, including Phibela and DH Geda, demonstrate leadership by adopting fortification technologies at scale, thereby improving the availability of fortified staples nationwide. This multi-sectoral collaboration anchored in strong government stewardship, technical expertise from development partners, and private sector commitment forms the foundation for Ethiopia's progress toward achieving universal access to fortified foods and reducing widespread micronutrient deficiencies (TechnoServe 2025).

2.1.1.11 Critical Challenges and Policy Reforms Needed

Ethiopia's national food fortification program faces several critical structural challenges that hinder effective implementation and sustainability. Chief among these is the persistent foreign exchange crisis, which has severely limited industries' ability to import vitamin and mineral premixes essential for fortification (USDA FAS 2025). Industry leaders consistently cite the foreign exchange shortage as a key bottleneck because premix procurement depends on access to hard currency. To address this, policy reform is needed to prioritize foreign exchange allocation for premix imports by categorizing them as essential medical or nutritional commodities. Establishing a dedicated "foreign exchange window" for such inputs could ensure uninterrupted production and maintain compliance with national fortification standards.

Another major challenge stems from unfair market competition. Compliant domestic industries, which bear the additional cost of fortification, are often forced to compete with cheaper, illicitly imported, unfortified food products, particularly edible oil and wheat flour. This not only undermines fair market conditions but also disincentivizes compliance with fortification mandates. Effective reform in this area would require stronger border controls and strict enforcement of the April 2025 government directive banning the import of unregistered or unfortified food products. Swift implementation of this measure would protect compliant producers while safeguarding public health.

The cost of compliance also remains a significant concern, given the price-sensitive nature of the Ethiopian consumer market. Fortification adds a marginal production cost that can erode already thin profit margins for processors. To balance public health goals with commercial viability, targeted fiscal policy measures are essential. These include granting duty-free status for the import of fortification equipment and premix policies, which are already under discussion but often delayed by bureaucratic processes. Streamlining these incentives would provide much-needed operational relief to compliant producers and strengthen program adherence.

Lastly, enforcement capacity presents a structural bottleneck. The Ethiopian Food and Drug Authority faces limited human and technical resources, which constrain its ability to consistently monitor and test fortified products. Decentralizing testing and enforcement to regional laboratories can significantly improve coverage and responsiveness. Additionally, legal recognition of rapid digital testing tools for preliminary compliance checks would allow inspectors to act swiftly against noncompliance while maintaining scientific rigor. Together, these reforms would create a more enabling environment for fortification, improve regulatory efficiency, and advance Ethiopia's efforts to combat micronutrient deficiencies at scale.

2.1.1.12 Opportunities and Future Directions

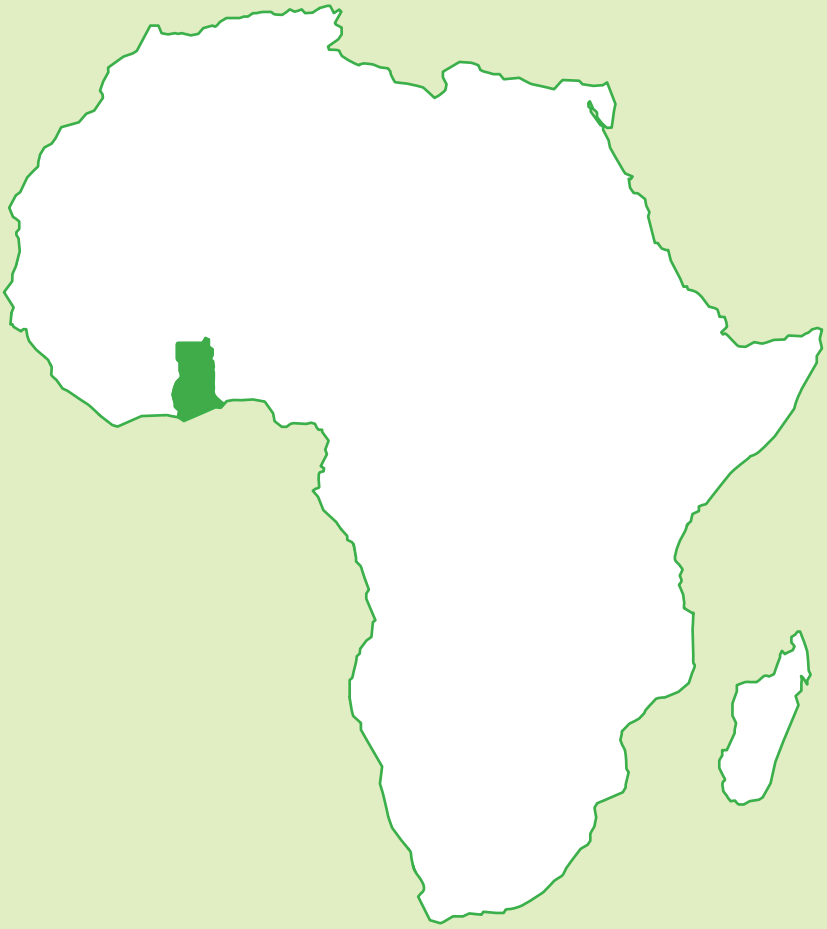
Ethiopia's food fortification landscape presents several promising opportunities and future directions that can significantly advance national nutrition outcomes while strengthening supply chain resilience. With rice imports increasing by 45% in early 2024 and urban consumption continuing to rise, there is a compelling opportunity to introduce rice fortification as a strategic intervention. The initial focus could be on instituting import mandates requiring all imported rice to be fortified, thereby ensuring immediate population-level coverage through existing trade channels. In parallel, integrating fortified rice into the Addis Ababa Urban School Feeding Program, where rice is already a staple menu item, would offer a practical and high-impact entry point to improve micronutrient intake among school-age children.

A major enabler for sustained fortification across staples will be the upcoming Sanku premix production facility in Kilinto, which positions Ethiopia to become self-reliant in premix supply. This facility could mark a transformative shift from the country's current dependence on imported premix to a regional supplier role in East Africa. Such a move would not only secure Ethiopia's domestic supply chain against global price and logistics shocks but also open new economic opportunities through regional trade in fortification inputs.

Additionally, establishing a mandatory public procurement policy that requires government-funded programs, such as the Productive Safety Net Program and School Feeding initiatives, to purchase only fortified foods would create a substantial and stable demand base. This "anchor market" would de-risk investment for private millers and food processors by guaranteeing long-term market demand, thereby catalyzing broader industry participation in large-scale fortification.

Lastly, harmonizing fortification standards with regional blocs such as the East African Community, of which Ethiopia is not currently a member but has periodically been discussed as a candidate for future accession, presents a longer-term strategic opportunity to facilitate cross-border trade and ensure the availability of fortified staples during domestic production shortfalls. Should such alignment materialize, Ethiopia could import fortified commodities, such as rice and wheat flour, from neighboring countries like Kenya and Tanzania, helping maintain a steady supply of nutrient-rich food for various population groups. Together, these initiatives establish a strong foundation for Ethiopia to develop a resilient, sustainable, and regionally integrated fortification ecosystem that provides both nutritional and economic dividends.

2.1.2 Ghana



2.1.2.1 Nutrition and Fortification Ecosystem

Ghana, a lower-middle-income nation in West Africa, has made significant progress in recent years to enhance food security and nutritional outcomes. The country's agricultural strategy is based on the Food and Agriculture Sector Development Policy (FASDEP II), which focuses on achieving import substitution and enhancing productivity. A central pillar of this strategy is the Planting for Food and Jobs (PFJ) initiative, which aims to support producers through input subsidies and extension services. Despite these advancements in agriculture, Ghana faces a "double burden" of malnutrition, characterized by persistent undernutrition (including stunting and micronutrient deficiencies) alongside rising rates of overweight and obesity. Staple food consumption is dominated by maize, yams, cassava, and an increasing amount of rice. Although rice per capita consumption has reached 40 kg/year, domestic production only meets 40% of national demand. This shortfall requires significant imports from countries such as Vietnam, India, Thailand, and Pakistan. The country's high dependence on rice imports, totaling 950,000 tons/year, presents a strategic opportunity to fortify at the point of entry, thereby complementing domestic value chain interventions (Ministry of Food and Agriculture n.d.).

2.1.2.2 Nutritional Status and Dietary Practices

The nutritional status of the Ghanaian population reflects a complex relationship between ongoing micronutrient deficiencies, limited dietary diversity, and regional disparities in nutritional outcomes. Findings from the 2021 National Food Consumption and Micronutrient Survey and recent DHSs underscore the continuing burden of "hidden hunger" across the country. Anemia continues to be a pressing public health concern, affecting nearly half (41%) of WRA and about 49% of children under five years old. The high prevalence of anemia indicates underlying deficiencies in iron, folate, and other micronutrients, further exacerbated by infections and poor dietary intake.

Child undernutrition remains a significant issue, particularly in its chronic forms. An estimated 18% of children under five years old are classified as stunted, with higher rates observed in the Northern, Upper East, and Volta regions. These areas experience greater food insecurity and have limited access to a diverse range of diets. Additionally, widespread deficiencies in essential micronutrients, particularly vitamin A and zinc, further exacerbate the situation. Zinc intake is critically low, especially among rural populations whose diets mainly consist of phytate-rich cereals and legumes that inhibit zinc absorption (Ghana Statistical Service and ICF 2024; University of Ghana et al. 2017).

Dietary patterns in Ghana are generally skewed toward energy-dense but nutrient-poor foods. Grains and tubers constitute the mainstay of most diets, while the consumption of fruits, vegetables, and animal-source foods remains inadequate. This is particularly concerning for children aged 6 to 23 months, as their diets often do not meet the minimum dietary diversity standards. To address these deeply rooted nutritional deficiencies, it is essential to implement integrated strategies that promote dietary diversification, provide micronutrient supplementation, and enhance food fortification. Additionally, broader food system interventions are necessary to improve access to and affordability of nutrient-rich foods (Opoku Agyemang et al. 2023).

2.1.2.3 Nutrition-related Flagship Program

The Government of Ghana has incorporated nutrition objectives into several of its flagship social protection and agricultural programs, ensuring a multisectoral approach to nutrition. A notable initiative is the Ghana School Feeding Programme, which provides one nutritious hot meal daily to children enrolled in public primary schools. By adopting a "home-grown" model that sources ingredients from local farmers, the Ghana School Feeding Programme not only improves the dietary intake of school children but also boosts local agricultural production and supports rural livelihoods. Importantly, the program also serves as a platform for integrating fortified staples such as rice and vegetable oil, thereby improving micronutrient intake among vulnerable school-age populations (Global Child Nutrition Foundation 2024).

Complementing these efforts, the PFJ initiative implemented its first phase from 2017 to 2022 through direct input subsidies for seeds and fertilizers, and transitioned under PFJ 2.0 to a smart agricultural input credit system, designed to eliminate barriers to credit access, stabilize food prices, and promote commercial agriculture. The five-year program is anchored on four principles: a value chain approach, private sector focus, market-driven design, and inclusivity, prioritizing 11 commodities across grains, roots and tubers, vegetables, and poultry. While PFJ primarily focuses on agricultural growth, its emphasis on increasing the availability and accessibility of essential staples such as rice and maize also indirectly bolsters household nutrition outcomes (Ministry of Food and Agriculture, Ghana, n.d.).

Meanwhile, the Livelihood Empowerment Against Poverty (LEAP 1000) program focuses on pregnant women and mothers with young children, particularly in Ghana's northern region. It combines unconditional cash transfers with social and behavior change communication interventions. This integrated design aims to improve IYCF practices, boost household food security, and reduce stunting and other forms of undernutrition. Collectively, these flagship initiatives demonstrate Ghana's commitment to leveraging social protection and agricultural platforms to advance national nutrition goals (Quinones et al. 2023).

2.1.2.4 Policy Environment for Food Fortification

Ghana's policy environment for food fortification includes a well-balanced combination of mandatory legislation and evolving voluntary initiatives to address micronutrient deficiencies nationwide. Mandatory fortification programs have been in place for several years, beginning with salt iodization, which has been compulsory since 1996 to combat iodine deficiency disorders. In February 2010, Ghana extended its regulatory framework through Gazette No. 92 to include the mandatory fortification of wheat flour and vegetable oil. According to this regulation, wheat flour must be fortified with a premix containing iron, folic acid, zinc, vitamin A, B1 (thiamine), B2, B3 (niacin), and B12 (cobalamin), while vegetable oil must be fortified with vitamin A (USDA 2010; Nyumuah et al. 2012).

Beyond these mandatory foods, Ghana has initiated voluntary and pilot fortification efforts for rice. Although national rice fortification is not yet mandated, the Ghana Standards Authority and the Ministry of Health are collaborating to develop relevant national standards. Currently, the WFP-led pilot projects are assessing the feasibility and scalability of these efforts.

Regulatory oversight in Ghana is jointly managed by two key bodies: the Food and Drugs Authority and the Ghana Standards Authority. The Food and Drugs Authority is responsible for enforcement, quality assurance, and market surveillance, while the Ghana Standards Authority formulates and maintains technical standards, such as GS 811 for fortified flour and GS 812 for fortified oil. This integrated regulatory and institutional framework positions Ghana as one of the leading countries in West Africa, promoting a structured and evidence-based approach to food fortification (SGS DigiComply n.d.).

2.1.2.5 Industry Capacity and Role of Private Players

Ghana has a strong industrial capacity for large-scale food fortification in wheat flour and vegetable oil, but this capacity is more fragmented and nascent for rice. This reality shapes the roles and potential leverage of private sector actors across various commodities.

Wheat flour milling: The wheat flour industry in Ghana is relatively consolidated, with four major milling companies accounting for an estimated installed capacity of around 1,500 tons per day. This level of consolidation, which includes firms such as Flour Mills of Ghana/Seaboard, Irani Brothers, Golden Spoons Ltd., and Takoradi Flour Mill, allows for easier engagement between regulators and development partners on both mandatory and voluntary fortification (Logistics Cluster n.d; USDA, 2023.). As a small number of large mills handle the bulk of national wheat flour output, it is efficient to install and monitor premix feeders and in-line dosifiers. This approach reduces transaction costs and increases the likelihood of maintaining consistent fortification quality across the formal market.

Vegetable oil refining: The industry is primarily dominated by a few large integrated agribusinesses, notably Wilmar Africa and Olam Agri, which control major refining and packaging operations. These companies already have the technical infrastructure, quality assurance systems, and laboratory capacity required to fortify edible oils with vitamin A at scale (BioAnalyt 2026). They have also participated in regional initiatives to fortify cooking oil with vitamin A in West Africa. As a result, the main fortification gap lies less with large refiners and more with smaller repackers and informal operators, where challenges in premix use, dosing control, and compliance monitoring lead to uneven coverage of adequately fortified oil in the market.

Rice imports and domestic milling: The rice sector presents a contrasting picture of fragmentation and emerging opportunity for fortification. On the import side, the market is relatively concentrated among a small group of large traders. About six major companies, including Olam Ghana (which holds an estimated share in the mid-teens), control a substantial portion of imported volumes and distribution channels. These importers are structurally well-positioned to implement rice fortification either at the origin or at centralized blending and packing facilities, as they already handle bulk shipments and manage branding, packaging, and quality control for national distribution. In contrast, domestic rice processing is far more dispersed, primarily comprising numerous small- and medium-sized millers who use basic equipment and have limited knowledge of fortification technologies. Nevertheless, landscape assessments report that a large majority of processors, over four-fifths, express a willingness to adopt rice fortification if they receive appropriate technical assistance, equipment support, and training. While the intent to fortify is high, a gap remains in current awareness and practical knowledge. This situation underscores the need for targeted technical support, financing mechanisms, and demonstration pilots to help translate intent into operational fortification among domestic mills (United States Department of Agriculture 2024).

Role of private sector in scale up: In Ghana, large private players play a crucial role in any strategy to expand the coverage of industrial fortification across various commodities. For wheat flour and vegetable oil, a few dominant firms provide efficient entry points for scaling and enforcing national fortification standards. They integrate premix procurement, dosing, internal quality assurance, and reporting into existing production systems. For rice, large importers can help initiate early scale by fortifying high-volume brands and supply chains. Additionally, coordinated capacity-building efforts can gradually bring domestic small-and medium-sized millers into the fortified rice market, leveraging their expressed interest to widen coverage beyond imported products (Food Fortification Initiative 2016).

2.1.2.6 Integration with Social Safety Net Programs

Integrating fortified foods into Ghana's social safety net programs offers a strategic opportunity to enhance nutritional outcomes while ensuring a sustainable market demand for fortified commodities. These programs provide a structured and predictable channel, an "institutional market" that can help mitigate the challenges of limited retail distribution and low consumer awareness often faced by producers of fortified food. By leveraging existing mechanisms such as school feeding programs, emergency assistance, and cash transfer initiatives, we can create both immediate improvements in nutrition and long-term shifts in consumer demand toward fortified products.

The Ghana School Feeding Programme is an effective platform for integrating fortified foods on a large scale. Given its nationwide reach and regular procurement cycles, the inclusion of fortified rice

in the Ghana School Feeding Programme menu could provide millions of school-aged children with consistent access to micronutrient-enriched foods. Previous pilot programs using fortified vegetable oil and fortified rice in select districts have offered valuable insights into supply chains that can be scaled up nationally (World Food Programme n.d.). By including fortified staples in the Ghana School Feeding Programme, the government can simultaneously improve child nutrition, stimulate demand for fortified products, and create stable procurement channels that encourage participation from the food industry.

In addition, emergency food assistance programs managed by the WFP and the Government of Ghana provide a valuable opportunity to institutionalize the use of fortified foods. Current relief efforts deploy fortified blends such as super cereal and iodized salt, primarily targeting vulnerable populations during crises (ReliefWeb 2023). Formalizing policies that require procuring only fortified rice and vegetable oil for these interventions would create steady, predictable demand for fortified foods. This approach would not only improve the nutritional quality of humanitarian aid but also provide a consistent market for local producers, thereby promoting the sustainability of national fortification.

Finally, the LEAP program, although primarily a social cash transfer initiative, offers indirect potential for reinforcing demand for fortified products. LEAP's integration with the National Health Insurance Scheme and its embedded nutrition education components provide a strong platform for behavior change communication on diet quality. As beneficiaries learn about dietary diversity and the importance of micronutrient-rich foods, there is an opportunity to stimulate demand for fortified staples, especially if they are made accessible and affordable in local markets. Linking LEAP's social protection objectives with national fortification goals could therefore help reinforce both livelihood and nutrition outcomes at the household level (Ministry of Gender, Children and Social Protection 2021).

2.1.2.7 Population Reach and Coverage Metrics

Achieving effective coverage, defined as the proportion of the population that consistently consumes fortified foods at adequate nutrient levels, remains a key challenge in Ghana's food fortification landscape. While fortification mandates exist for several staple commodities, variability in implementation quality and consumption patterns has limited the overall nutritional impact.

Salt iodization remains the most successfully scaled intervention under Ghana's fortification program. The country has achieved near-universal coverage of iodized salt through effective regulatory enforcement and widespread market availability in the market. In 2015, the National Iodine Survey Report Ghana indicated substantial improvements in the population's iodine status, underscoring the success of universal salt iodization as a public health measure (Ghana Statistical Service 2017).

In contrast, fortification of wheat flour and edible oil demonstrates mixed outcomes. Findings from the surveys conducted between 2013 and 2015 using the Fortification Assessment Coverage Toolkit reveal that while most households consume industrially produced wheat flour and oil, making them eligible for fortification, the actual implementation of adequate fortification is inconsistent. Earlier monitoring results showed that only about 23% of wheat flour samples met the required fortification standards, despite having a mandatory policy framework in place. This gap highlights persistent challenges in quality assurance, compliance monitoring, and enforcement throughout the production and distribution chain (Aaron et al. 2017). For rice fortification, the current reach within the population remains negligible, as the initiative is still in the pilot or voluntary implementation phase.

2.1.2.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Ghana's food fortification value chain for staples such as rice and wheat is shaped by high dependence on imports and a fragmented domestic production system. This situation creates both strategic control points and significant implementation gaps. This framework is anchored in the Public Health Act and enforced by the Food and Drugs Authority (Ministry of Health n.d.; Food and Drugs Authority n.d.). However, practical challenges related to quality assurance, premix access, and the authority to impose sanctions hinder the system's effectiveness.

Value chain structure: Ghana relies significantly on imports for key fortified staples, sourcing all its wheat and a substantial share of rice from international markets. This reliance makes port-based controls crucial for ensuring compliance with food fortification regulations. Pre-shipment inspections and border checks provide opportunities to verify fortification levels before these products enter domestic circulation. However, their effectiveness hinges on having clear standards, proper sampling protocols, and coordinated efforts between customs and standards organizations. Domestic rice production involves numerous smallholder farmers and many small- and medium-sized mills. This fragmentation complicates consistent fortification. As fortification technology and quality systems are more efficient at scale, the prevalence of small mills makes on-site fortification less practical. Additionally, it increases the transaction costs associated with monitoring, training, and ensuring compliance oversight.

Quality assurance systems: Quality assurance for fortified foods in Ghana is mainly the responsibility of the Food and Drugs Authority, which ensures the safety and quality of food products in the market. This includes product registration, inspections, and product quality monitoring. While the Food and Drugs Authority conducts market surveillance and samples fortified products, its testing capacity is limited by factors such as laboratory capacity, insufficient funding, and a lack of human resources. As a result, testing frequency and geographic coverage, especially outside major urban centers, are constrained.

A significant challenge in the fortification quality assurance system is the availability, affordability, and quality of vitamin and mineral premix needed to meet Ghana's fortification standards. Smaller millers often have difficulties accessing reliable premix supplies in appropriate pack sizes and at predictable prices. This situation can result in inconsistent dosing, under-fortification, or even complete nonuse of the premix, despite the formal fortification requirements (Food and Drugs Authority 2016).

Premix supply and compliance: Ghana has adopted specific standards for fortificant premixes and micronutrient levels in staple foods, including wheat flour and edible oils, to address widespread micronutrient deficiencies. However, ensuring that mills actually procure premixes that comply with these standards is complicated. Factors such as fragmented supply chains, foreign exchange constraints, and limited bargaining power among small producers can lead to stockouts or the use of substandard premix.

Many smaller mills view premix costs as a visible, recurring expense, leading them to perceive fortification as an added financial burden rather than a business norm, particularly in price-sensitive low-income markets. Without strong, predictable enforcement and demand-side recognition of fortified products, these financial pressures can incentivize partial compliance or avoidance of

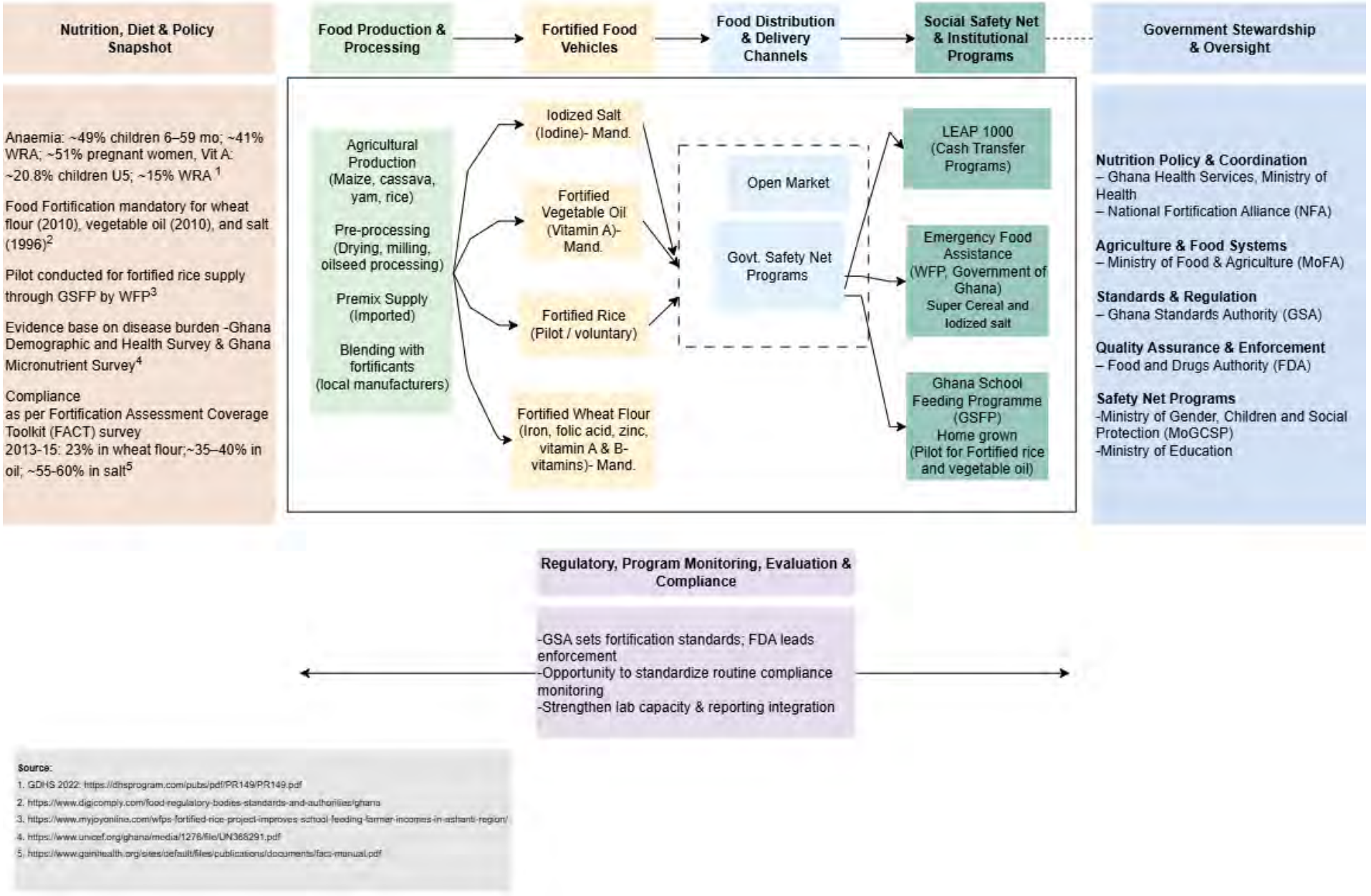
fortification requirements. This ultimately undermines the intended public health impact of the fortification program.

Regulatory and enforcement framework: The Public Health Act 2012 (Act 851) provides the legal foundation for regulating food safety and fortification in Ghana (Food and Drugs Authority n.d.; Ministry of Health n.d.). It empowers the Food and Drugs Authority to oversee the production, processing, importation, and distribution of food and ensure compliance with fortification and safety standards. Within this framework, the fortification of selected staples is encouraged, and for some products, such as wheat flour and salt, fortification is mandatory. The Food and Drugs Authority monitors and enforces these standards throughout the entire food value chain.

Despite this robust legal framework, sanctions as a deterrent remain limited in effectiveness. This is because penalties for non-compliance are often modest, inconsistently enforced, or implemented too slowly to offset the economic benefits associated with non-fortification. For small- and medium-scale industry actors, the combined costs of procuring premix and undergoing compliance testing, along with irregular and non-systematic enforcement, create conditions where the perceived cost-benefit of non-compliance can outweigh the deterrent effect of enforcement. This situation diminishes the intended deterrent effect of the framework. It underscores the need for more calibrated and proportionate penalties, simplified and cost-effective compliance processes, and enhanced risk-based inspection systems to enhance accountability and ensure consistent compliance with fortification requirements (Food and Drugs Authority n.d.). Refer to Figure 2.2.

Figure 2.2. Ghana's food fortification ecosystem

Ghana



Source:

1. GDHS 2022: https://dhsprogram.com/pubs/pdf/PR149/PR149.pdf
2. https://www.digicomply.com/food-regulatory-bodies-standards-and-authorities/ghana
3. https://www.myjoyonline.com/wfps-fortified-rice-project-improves-school-feeding-farmer-incomes-in-ashanti-region/
4. https://www.unicef.org/ghana/media/1276/file/UN365291.pdf
5. https://www.gainhealth.org/sites/default/files/publications/documents/facs-manual.pdf

2.1.2.9 Monitoring and Evaluation Mechanisms

Ghana has implemented various mechanisms to monitor and evaluate the progress of food fortification programs. This involves both national surveys and regulatory oversight systems. At the population level, impact monitoring is primarily conducted through large-scale national surveys, such as the DHS and specialized micronutrient surveys, including the National Food Consumption and Micronutrient Survey. These surveys provide valuable data on dietary patterns, micronutrient deficiencies, and fortification coverage, which together form the evidence base for refining national nutrition strategies and assessing long-term program outcomes.

Regulatory monitoring in Ghana is overseen by the Food and Drugs Authority and the Ghana Standards Authority. These agencies enforce fortification standards throughout the value chain. Their regulatory roles include conducting routine factory inspections, sampling fortified products at production sites, and performing market surveillance to ensure compliance with national fortification mandates. These efforts help maintain product quality, ensure adherence to fortification levels, and protect consumers.

Despite these established mechanisms, significant gaps remain in data consistency and timeliness. Monitoring and evaluation are largely periodic and project-driven, often linked to donor-funded initiatives rather than a comprehensive, continuous national surveillance system. This approach limits the ability to generate real-time insights into program performance and compliance trends. To address this challenge, the WFP and other development partners are collaborating with national institutions to digitize monitoring tools and strengthen data systems (World Food Programme n.d.). Their goal is to improve the efficiency, accuracy, and responsiveness of fortification program management nationwide.

2.1.2.10 Stakeholder Ecosystem and Partnerships

Ghana's food fortification initiatives are backed by a robust stakeholder ecosystem comprising government agencies, private sector actors, and development partners. However, while the overall institutional framework is strong, interagency coordination and information flow need improvement. This enhancement will help ensure cohesive implementation and sustained impact.

The Government of Ghana plays a central role through multiple ministries and agencies with complementary mandates. The Ministry of Health, particularly through its nutrition department, provides overall stewardship and policy direction for efforts to reduce micronutrient malnutrition. The Ministry of Food and Agriculture, along with its Women in Agricultural Development Directorate, integrates nutrition-sensitive agricultural strategies and supports the production and processing of fortified foods. The Food and Drugs Authority and the Ghana Standards Authority jointly provide regulatory oversight and quality assurance, developing, enforcing, and monitoring standards for food fortification. Additionally, the National Development Planning Commission ensures fortification initiatives align with national development priorities and promotes coordination across different sectors.

The private sector constitutes a crucial pillar of Ghana's fortification ecosystem. Key actors include the Association of Ghana Industries, which advocates for conducive business environments; the Wheat Flour Millers Association, responsible for large-scale production of fortified flour; and the Food and Beverage Association of Ghana, which supports compliance and raises consumer awareness among manufacturing enterprises. Enhanced engagement with these associations can

help foster industry-wide compliance, innovation, and sustainability in fortification practices.

A cornerstone of the coordination mechanism is the National Fortification Alliance, a multi-stakeholder platform typically chaired by the government, often the Ministry of Health or the Food and Drugs Authority. The National Fortification Alliance brings together representatives from the private sector, civil society, and development organizations to deliberate on regulatory updates, fortification standards, premix supply and taxation, quality compliance, and program monitoring. It has become an essential forum for policy coherence, advocacy, and problem-solving throughout the fortification value chain.

Development partners have consistently provided both technical and financial support for Ghana's fortification agenda. The WFP has successfully piloted rice fortification initiatives, demonstrating viability for broader implementation (World Food Programme n.d., 2023). GAIN contributes technical expertise and gathers evidence through initiatives such as the Fortification Assessment Coverage Toolkit surveys. UNICEF supports policy advocacy, capacity building, and raising awareness, while the United States Agency for International Development (USAID) supports both programmatic advocacy and funding. These partnerships have significantly advanced Ghana's fortification agenda; however, maintaining alignment with national leadership will be critical to achieving universal coverage and sustaining impact.

2.1.2.11 Critical Challenges and Policy Reforms Needed (Nutrition Financing)

Despite growing recognition of the importance of nutrition for human capital development, nutrition financing in Ghana remains highly fragmented and inadequately prioritized within the national budget. The 2024 budget of the Ministry of Food and Agriculture was approximately GH¢3.32 billion, of which the Government of Ghana's own contribution (through Government of Ghana, Annual Budget Funding Amount, and Internally Generated Funds sources) accounted for 82% of the total, with the remaining 18% financed by development partners (Ministry of Food and Agriculture 2024). Within this budget, the "Planting for Food and Jobs" flagship program continues to represent the dominant share of MoFA's spending, focused on general agricultural inputs such as fertilizer and seed subsidies (U.S. Department of Agriculture 2023). As a result, only a small portion of the budget is available for nutrition-sensitive or fortification-related interventions. This structural imbalance in budget allocations limits the ability to implement targeted nutrition actions across the food system, thereby missing opportunities to integrate fortification goals into mainstream agricultural value chains.

At the industry level, compliance costs pose a major challenge, especially for small- and medium-scale producers in voluntary sectors such as rice fortification. The high costs of acquiring fortification dosifiers and micronutrient premix materials, along with import duties and taxes, discourage compliance and limit private sector investment in fortification efforts. To address this issue, introducing targeted fiscal incentives such as waivers or tax exemptions on imported fortification equipment and premix would significantly reduce the financial burden on manufacturers. Implementing these measures could encourage broader industry participation and improve the availability of fortified staples in domestic markets.

Furthermore, inconsistent enforcement of existing fortification mandates, particularly for edible oil and wheat flour, undermines market fairness and erodes consumer trust. While compliant companies invest in fortification systems and quality assurance, they are at a disadvantage

compared to non-compliant producers and lower-cost imports that evade regulatory scrutiny. To create a more equitable market, it is essential to strengthen the institutional capacity of regulatory bodies, improve coordination among enforcement agencies, and apply appropriate penalties for non-compliance. Enhanced enforcement mechanisms, paired with incentives for compliance, would reinforce accountability and encourage industry-wide adherence to fortification standards, ultimately improving the nutritional quality of Ghana's food supply.

2.1.2.12 Opportunities and Future Directions

Mandating rice fortification represents one of the most impactful opportunities to enhance micronutrient coverage in Ghana. A substantial proportion of the rice consumed in the country is imported, and a small number of major traders dominate the import market. Shifting from voluntary to mandatory fortification, beginning with imported rice, would ensure widespread and equitable access to fortified staples. This approach leverages existing trade structures to achieve national nutritional goals while reducing the regulatory burden associated with a more fragmented domestic production sector.

Strengthening digital traceability systems presents a valuable opportunity to improve the quality and oversight of the national fortification program. By introducing digital quality assurance and quality control mechanisms, it would be possible to track fortified food products in real time from production or importation through to retail. These digital platforms would enhance regulatory transparency and enforcement while also fostering consumer and stakeholder confidence by providing verifiable data on product compliance and nutritional quality.

At the regional level, greater alignment with the Economic Community of West African States (ECOWAS) regarding fortification standards could significantly enhance the sustainability of Ghana's fortification efforts (Catholic Relief Services 2024). Harmonizing standards and regulations across national borders would prevent inconsistencies that could otherwise allow non-fortified foods to enter the market through regional trade. This would safeguard national investments in public health and market integrity.

Public procurement is a powerful policy tool for creating sustained market demand for fortified foods. Mandating that all rice and edible oil purchased for large-scale government programs, such as the Ghana School Feeding Programme and the supply chains of military and police barracks, be fortified can generate a guaranteed demand base. This "anchor market" would incentivize private sector compliance, reduce market risk for producers, and stimulate broader adoption of fortification practices across supply chains. Over time, these coordinated policy actions could transform Ghana's food fortification landscape, enhancing both the nutritional impact and private sector participation.

2.1.3 Madagascar

2.1.3.1 Nutrition and Fortification Ecosystem

Madagascar, the world's fourth-largest island nation with a total area of approximately 587,000 km^2, has a unique geographical and demographic profile that shapes the context for food fortification interventions. As of 2024, the population is estimated at approximately 31.965 million, with a high annual growth rate of around 2.7%, making it one of Africa's fastest-growing populations (World Bank 2024). The demographic structure is distinctly youthful, with more than 60% of the population under 25 years old, placing significant demands on food systems and nutrition services to support healthy development during critical formative years.

Approximately 80% of Madagascar's population lives in rural areas, where livelihoods depend primarily on subsistence agriculture and limited cash crop production (International Fund for Agricultural Development n.d.). This heavy reliance on agriculture leaves the population particularly vulnerable to climate shocks, seasonal fluctuations, and market volatility. The combination of rapid population growth, youthful demographics, predominantly rural settlement patterns, and agricultural dependence creates significant nutrition challenges and substantial opportunities to expand reach through agricultural-linked interventions, such as food fortification integrated with staple food systems.

Economically, Madagascar ranks among the world's poorest nations, with over 75% of the population living below the poverty line (International Fund for Agricultural Development n.d.). This

widespread poverty fundamentally constrains household access to food and dietary diversity, limiting the population's ability to purchase diverse, nutrient-rich foods. Consequently, nutrition interventions must be calibrated to low purchasing power and limited access, delivered through subsidized or free distribution channels. They must focus on staple foods that are already widely consumed regardless of economic status (International Fund for Agricultural Development n.d.).

2.1.3.2 Nutritional Status and Dietary Practices

Madagascar's nutritional landscape reflects a complex burden of both acute and chronic malnutrition, marked by widespread micronutrient deficiencies that substantially undermine human capital development and economic productivity. Understanding the precise dimensions of this burden is essential for designing appropriately targeted food fortification interventions.

Madagascar faces a severe burden of child malnutrition, with 40% of children under five years old stunted, according to the INSTAT/EDSMD (Enquête Démographique et de Santé de Madagasca or Madagascar Demographic and Health Survey)-V (2021) DHS, which shows little progress toward the government's 38% target. Stunting remains driven by poor dietary diversity, inadequate IYCF practices, limited access to health care, inadequate water, sanitation, and hygiene (WASH) infrastructure, and widespread poverty that restricts access to nutritious foods. Acute malnutrition affects 7.7% of children nationally, surpassing the Eastern Africa average, and reaches crisis levels in the drought-affected Grand Sud and Grand Sud-Est regions, where rates have exceeded 30% and crossed famine thresholds. Particularly alarming is the Atsimo-Andrefana region, where severe acute malnutrition has affected over 40% of children with tuberculosis. Additionally, 17.1% of infants are born with low birth weight, reflecting maternal undernutrition and poor prenatal care. Altogether, these trends highlight deep-rooted nutritional deficiencies that undermine the health and development of Madagascar's children.

Madagascar faces widespread "hidden hunger," with zinc deficiency affecting over 30% of the population and an alarming riboflavin (vitamin B2) deficiency affecting 75% to 90% of the population (UNICEF 2024). UNICEF (2024) shows that in regions such as the Grand Ouest (Melaky and Boeny), over 40% of adolescent girls and women are folate-deficient, posing a high risk of neural tube defects (NTDs) in newborns. Additionally, UNICEF (2024) has observed a dramatic decline in vitamin A deficiency, which has dropped to 12% among children aged 6 to 59 months (down from 42% in the early 2000s) and is almost non-existent among adolescent girls and women (around 2%).

High levels of iron, iodine, and vitamin A deficiencies harm cognition, immunity, productivity, and survival, even when they do not always cause visible undernutrition. UNICEF (2024) reports anemia rates: 42.1% among children and 30.4% among women. However, it clarifies that only about one-third of these cases of anemia are linked to iron deficiency. Factors such as malaria (which has an 11% infection rate among adolescents) and inflammation (affecting 45% of children) play a massive role in this issue. Therefore, iron fortification alone will not address anemia. Anemia, driven by low dietary iron, infections, poor dietary diversity, and inadequate sanitation, contributes to poor maternal health and adverse pregnancy and child outcomes. According to UNICEF (2024), there has been a notable improvement: 45.0% of households now have access to adequately iodized salt (≥ 15 ppm), and 79.5% use salt that contains some iodine.

More importantly, urinary analysis indicates that the iodine status of the Malagasy population is currently adequate globally (median level of 147 μg/liter for women). However, median levels of

iodine in salt (10 mg/kg) fall below the World Health Organization's (WHO) 15 mg/kg standard. Additionally, women's median urinary iodine concentration is just 46 μg/liter, which undermines children's cognitive development, especially in inland, low-iodine areas. Vitamin A deficiency is also a concern, with only 26% of children aged 6–59 months receiving the recommended two high-dose vitamin A supplements annually. This leaves many at risk of infections due to weakened immunity. Given these persistent gaps and the limited reach of supplementation programs, LSFF appears to be a cost-effective, sustainable, and equitable strategy to reduce micronutrient deficiencies and address their long-term human and economic consequences (Global Nutrition Report n.d.).

Madagascar's food consumption patterns reveal heavy reliance on a few staple foods and very limited dietary diversity, driven by widespread poverty and geographic isolation. Rice dominates the national diet and is eaten daily by nearly all households, often at every meal. With per capita consumption estimated at 143–157 kg annually, rice accounts for over half of the country's total calorie intake and is the most effective vehicle for fortified micronutrients. Although Madagascar produces rice domestically, output remains insufficient, leading to consistent imports mainly from Thailand, Vietnam, India, and Pakistan, which present both opportunities to introduce fortified rice and challenges related to trade policy and supply chain oversight (Satake Corporation 2020).

Cassava and sweet potatoes are important secondary staples, particularly in the southern and rural regions, where they play a critical role in ensuring food security during droughts or lean seasons. Maize is widely cultivated across the highlands, while other tubers, such as taro and yams, are locally significant but available only seasonally. Despite this variety, dietary diversity remains minimal. Most households, regardless of income level, tend to eat repetitive meals dominated by rice or cassava, with limited inclusion of legumes, vegetables, or animal-source foods such as meat, eggs, or dairy. This lack of dietary diversity contributes to widespread micronutrient deficiencies and hidden hunger (Golden et al. 2019).

Regional variations in food diversity exist, with the northern and eastern regions experiencing somewhat greater food diversity due to favorable rainfall and agricultural conditions. However, poverty and limited market access continue to limit this variety even in those areas. In contrast, the arid southern and southwestern regions struggle with chronic droughts, recurrent food shortages, and frequent dependence on government or humanitarian aid. Overall, Madagascar's strong dependence on staple foods, combined with limited dietary diversity and persistent poverty, underscores the critical potential of LSFF, particularly rice, as a sustainable strategy to combat micronutrient malnutrition. This approach aligns with existing consumption habits and affordability constraints.

2.1.3.3 Nutrition-related Flagship Program

Madagascar's National Nutrition Policy (2022–30) outlines the country's multisectoral vision to reduce all forms of malnutrition by strengthening linkages among health, agriculture, education, WASH, and social protection. The National Nutrition Council oversees this initiative, while the Office of Nutrition implements it in collaboration with ministries, civil society, and other partners. The National Multisectoral Action Plan for Nutrition (Plan National d'Action Multisectorielle pour la Nutrition, 2022–26) translates this policy into concrete actions. It focuses on scaling up proven interventions, strengthening systems, and improving coordination. Among its key strategies, the National Multisectoral Action Plan for Nutrition prioritizes food fortification to tackle micronutrient deficiencies (Resnick 2024).

Direct nutrition and maternal-child health programs: Essential nutrition services in Madagascar focus on promoting breastfeeding, improving complementary feeding, and supporting maternal nutrition through the health system. However, the coverage of these services remains limited. Micronutrient supplementation is inadequate, with low levels of iron and zinc coverage among children. While treatment for acute malnutrition is available through health facilities that use ready-to-use therapeutic and supplementary foods, the capacity and local production remain inadequate, particularly in drought- or crisis-affected areas.

School feeding programs: They serve as a vital platform for delivering nutrition interventions and fortified foods. The Ministry of National Education implements programs that provide regular in-school meals, often rice-based and locally sourced. The Mianatra Project, under the McGovern-Dole program, supports 130 schools in the Androy region by integrating daily nutritious meals with objectives to improve literacy and attendance. Regional programs in Atsimo-Atsinanana and Androy further extend coverage, while less vulnerable areas implement seasonal, limited-frequency meal programs aligned with local food resources. Typically, these programs provide in-school meals five times per week during the school year, while some nutrition-focused pilot programs provide daily meals. The meals are typically rice-based with seasonal vegetables, reflecting local production and procurement practices. To extend program benefits in vulnerable regions, take-home rations are distributed outside of the school year (World Food Programme 2025).

In addition, Madagascar is expanding its Home-Grown School Feeding approach, supported by national efforts and the Food Systems Resilience Program, which is funded by the World Bank and implemented by the WFP. The Home-Grown School Feeding model currently covers nine regions, reaching approximately 240,000 schoolchildren across around 800 schools, and links procurement systems to nearly 20,000 smallholder producers. By connecting school meals with local agricultural production and structured markets, the model creates concrete opportunities to integrate fortified or enriched staple foods into regular public procurement systems. This approach strengthens both nutrition outcomes and local economic resilience, representing a promising platform for scaling LSFF within structured national programs.

Other school feeding initiatives are being implemented across different regions of Madagascar through partnerships that involve the private sector, non-governmental organizations, faith-based institutions, and local authorities. These initiatives vary in scale, funding mechanisms, and operational models. Although more fragmented, they play a valuable role in expanding access to school meals. Additionally, they may offer additional entry points for integrating fortified foods, as long as standards and quality assurance mechanisms are aligned.

Social protection and emergency assistance: Under its Country Strategic Plan (2024–28), WFP supports Madagascar through various initiatives, including food assistance, specialized nutrition commodities, and capacity-building in social protection and emergency preparedness. During lean seasons and droughts, humanitarian agencies deliver lifesaving food aid in the Grand Sud and Grand Sud-Est. While this aid addresses acute needs, it also underscores the need for sustainable solutions such as food fortification to prevent recurring crises.

Nutrition programming operates within Plan National d'Action pour la Nutrition IV's coordinated monitoring and evaluation system, led by the National Nutrition Council and ONN. Core data sources include the 2021 Enquête Démographique et de Santé de Madagasca (Madagascar Demographic and Health Survey), IPC (Integrated Food Security Phase Classification) analyses, and new surveys

such as UNICEF's 2024 micronutrient and consumption survey, which will help guide targeting efforts and track fortification outcomes.

2.1.3.4 Policy Environment for Food Fortification

Legislative and policy framework: Madagascar's food fortification journey began in 1995 with Decree No. 95,587. It mandated universal salt iodization in accordance with the WHO's recommendations. However, the implementation lagged behind policy intent. Following a period of political instability from 2009 to 2013, the government renewed its commitment through Decree No. 2014-1771, which mandated double fortification of salt with potassium iodate (50 ppm) and potassium fluoride (250 ppm) to address iodine and fluoride deficiencies. However, Resnick (2024) notes that this policy was completely ignored, as producers found it financially infeasible to add fluoride and donors (including USAID and UNICEF) refused to fund the program, deeming it a non-priority. UNICEF (2024) highlights a concerning reality: nearly half of Malagasy women (up to 53%) are already at risk of excess fluoride intake due to naturally high levels in groundwater (highlights a concerning reality). Consequently, enforcing the 2014 fluoride mandate could pose significant health risks, making it potentially toxic and dangerous for public health. The recommendation is no longer to "enforce" this decree, but to urgently abolish the fluoride requirement (Resnick 2024).

The National Nutrition Policy (2017), updated for 2022–30, identified food fortification as a core nutrition strategy, elevating it from a narrow focus on salt iodization to a multisectoral national priority. Building on this, the National Strategy for Food Fortification (2021) outlines a structured plan with four priorities: strengthening institutional and regulatory frameworks, identifying feasible food vehicles and supporting industry, improving quality control and monitoring, and advancing advocacy and communication. The priority food vehicles for fortification include gari (cassava), breadfruit flour, and rice, which are chosen for their dietary relevance. Wheat flour and edible oil are considered secondary options because of their lower consumption. The strategy also highlights the importance of linking technology identification, population acceptability, and private sector engagement, underscoring the importance of rice fortification despite existing technical barriers (Randremanana et al. 2019).

Institutional architecture and governance: The Office National de Nutrition, established in 2004 under the Prime Minister's Office, coordinates Madagascar's multisectoral nutrition agenda, policy implementation, and monitoring. It operates through regional branches in all 23 regions. Despite decentralization, regional capacity and resources remain limited. The National Nutrition Council, a multisectoral governance body comprising ministries, civil society, the private sector, and donors, provides oversight and ensures alignment of national nutrition actions. The National Food Fortification Alliance, created in 2008, serves as the technical and coordination platform specifically for food fortification, linking government, industry, academia, and partners. While designed to guide strategy and advocacy, the National Food Fortification Alliance's impact has been hindered by staff turnover, inadequate funding, and dependence on donor funding.

Key regulatory authorities include the Ministry of Public Health and its nutrition service (SNUT), responsible for nutrition policy and program coordination, and the quality control agency (ACSQDA or Authority for the Control of Quality and Safety of Food), which oversees testing and certification but lacks adequate capacity and equipment for micronutrient testing beyond iodine. The Madagascar Standards Bureau develops fortification standards, mandated or voluntary, but has faced delays due to lengthy cross-ministerial approval processes. The Ministry of Industrialization,

Commerce, and Consumption monitors enforcement at markets; it issues commercialization certificates, but it lacks laboratory capacity to verify micronutrient content, leaving major compliance gaps. Overall, coordination challenges, limited funding, and constrained capacity across institutions constrain enforcement and program scale-up (Nutrition International 2023).

Standards and regulations: Currently, two food products are covered under mandatory fortification: salt fortified with potassium iodate and fluoride (Decree 2014, 1771) and infant flour fortified under Malagasy Standard NMG 103, 5 (2019). Voluntary standards for cereal bars, muesli, and therapeutic foods (ready-to-use therapeutic food/ready-to-use supplementary food) are based on international guidelines. However, these guidelines have no enforcement mechanism. The narrow scope of mandatory standards contrasts with the national strategy's vision for diversified staple fortification, meaning a wide gap between policy ambition and regulatory action.

Integration with international frameworks: Madagascar aligns with Southern African Development Community minimum fortification standards, harmonizing micronutrient levels for regional trade and consistent quality benchmarks. It has also been participating in global nutrition initiatives, including the Scaling Up Nutrition (SUN) movement since 2012, which enhanced multisectoral coordination, and Nutrition for Growth, under which Madagascar committed to increasing nutrition budget allocations. Despite strong alignment with international norms and advocacy platforms, local implementation remains limited due to dependence on external support and insufficient domestic funding for sustainability (Southern African Development Community 2022).

2.1.3.5 Industry Capacity and Role of Private Players

Food manufacturing and processing capacity (milling industry - rice): Madagascar's rice milling industry is highly fragmented, dominated by hundreds of small, artisanal mills with minimal mechanization and little quality control. Only a few larger mills can process more than 5 MT/h. This fragmentation makes nationwide rice fortification nearly impossible because small mills lack the technical capacity, consistent operations, and economic incentives. Although Madagascar imports sizable volumes of rice from countries like Thailand, Vietnam, India, and Pakistan, many of which fortify rice domestically, local consumer preference for Malagasy rice and trade restrictions limits the share of fortified imports in the local market (Resnick 2025).

Wheat and maize flour milling: Industrial wheat flour mills in Madagascar process over 20 MT/day. These mills primarily serve urban markets and use simpler, cheaper fortification methods than those used for rice fortification. Wheat flour consumption is widespread, and not limited to urban niches. Nearly 6 out of 10 Malagasy households (59.8%) consume products made from wheat flour. UNICEF (2024) uncovered a massive, previously undocumented public health crisis: over 90% of the Malagasy population has an inadequate daily calcium intake. Because the wheat milling industry is highly centralized (dominated by the large LMOI mill, which facilitates quality control), the ENCM explicitly recommends wheat flour as the primary vehicle for mass fortification. Fortifying wheat flour with calcium (alongside iron, zinc, B2, B9, and B12 is the most viable strategy to address this severe national calcium deficit, which currently poses high risks for preeclampsia in pregnant women and stunts adolescent bone growth.

Salt production: One large producer in northern Madagascar supplies 40–50% of the country's salt, with well-established iodization and quality-control processes. Around eight medium-scale producers account for 30–35% of the country's salt but exhibit inconsistent fortification due to

variable technical capacity. Over 100 small southern producers contribute 20–25% of the supply and largely lack the capacity to consistently iodize, resulting in significant variability in household salt iodine levels (Resnick 2024).

Specialized food processing: Local bouillon and condiment producers are expanding into fortification, with support from development partners. Notably, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), through its ProSAR project, is funding a pilot initiative implemented in partnership with Helen Keller International. Working with the local Mirary cooperative, this project aims to produce fortified bouillon cubes using natural, locally sourced spices as a healthier alternative to industrial bouillons that are high in monosodium glutamate and sodium. Infant food producers such as GRET's Nutri'zaza and Agrikoba's Koba Fenosoa make fortified complementary foods under the "Tovonantsoa" brand, but their scale is limited by high premix taxes and low market penetration. Tanjaka Foods, in collaboration with Nutriset, produces ready-to-use therapeutic food and ready-to-use supplementary food but faces high costs of international testing and imported inputs, which constrain local expansion (Helen Keller International 2025).

Private sector coordination and networks: SUN Business Network, coordinated by WFP, connects around 30 nutrition-related businesses to promote fortification and collaboration. However, without dedicated funding, an executive secretariat, or clear mandates, the network has been struggling to maintain momentum or deliver measurable results.

Import taxes on fortification premixes: High import taxes on vitamin and mineral premixes, levied by the Ministry of Finance, significantly raise production costs. This deters private investment and inflates prices for fortified foods. While mandatory fortification (e.g., salt) passes costs to consumers, voluntary fortification (e.g., infant flour and bouillon) becomes economically unviable. Efforts to secure tax exemptions are still underway; continued engagement with relevant authorities that highlights fortification's cost-effectiveness could help accelerate progress.

USAID AFFORD Program support: Since 2024, AFFORD has provided technical, financial, and policy support to strengthen private sector engagement in fortification. Prioritizing cooking oil and bouillon cubes, the program seeks to remove policy barriers, such as premix taxes, and enhance local business capacity for sustainable fortification.

Collaborations such as Tanjaka Foods' partnership with Nutriset demonstrate how international technical support can drive local production of fortified foods. With improved policy and lab infrastructure, similar partnerships could expand the diversity of fortified products and their availability in local markets. Cooperative models, exemplified by Helen Keller International's partnership with the Mirary cooperative for fortified bouillon, show promise for aggregating small producers under shared quality and scale systems. Expanding such cooperative approaches could help overcome fragmentation challenges in sectors such as rice milling.

Beyond industrial LSFF, Madagascar is also exploring locally based food enrichment approaches. Through the MIKASA platform, researchers are developing nutrient-enhanced traditional foods for vulnerable groups using locally available ingredients. These initiatives complement large-scale fortification, particularly in settings with limited industrial capacity.

2.1.3.6 Integration with Social Safety Net Programs

Madagascar's social protection architecture, while growing, presents both opportunities and challenges for integrating fortification. The WFP, a primary social protection actor in Madagascar, explicitly integrates fortified foods into its assistance programs. The WFP's Country Strategic Plan (2024, 28) identifies fortified foods for humanitarian assistance and social protection as a priority intervention. WFP provides both general food assistance and specialized nutritious foods (including fortified foods) to populations affected by food insecurity. During acute crises such as the 2021, 22 drought in the south, WFP provided fortified foods (ready-to-use therapeutic food/ready-to-use supplementary food) to prevent and treat acute malnutrition, with explicit emphasis on pregnant and breastfeeding women and young children (World Food Programme 2022).

School feeding programs as fortification vehicles: Madagascar's home-grown school feeding programs provide daily meals to enrolled students during the school year. These programs represent a critical channel for reaching children during a nutritionally critical period and for delivering fortified staple foods at scale. The feasibility of integrating fortified rice or fortified flour into existing school meal programs may be a priority consideration, particularly in the following cases (Global Child Nutrition Foundation 2024):

- Programs already have established logistics and procurement systems for delivering meals to schools.
- Meals are consumed by a captive population (enrolled students) with high frequency (daily to five times weekly).
- School feeding programs are recognized as delivering both educational and nutritional benefits.
- Programs already operate at substantial scale (thousands of schools, hundreds of thousands of students nationally).
- School-based feeding provides a platform for integrating nutrition and health education.

The WFP's pilot fortified rice initiative (Tambatra Project) for school students showed that fortified rice could be successfully integrated into school meals with good acceptance and effective distribution logistics. Scaling this model across the national school feeding program could systematically reach a large, nutritionally vulnerable population.

Vulnerability-based targeting within safety nets: Both WFP's general food assistance programs and government social protection programs employ geographic and demographic targeting to identify and reach vulnerable populations. In the Grand Sud and Grand Sud-Est regions, where acute food insecurity and malnutrition are concentrated, ensuring that all assistance foods are fortified would provide a reliable channel for reaching the most acutely vulnerable populations. This is particularly important for populations in crisis (IPC Phase 3) or emergency (IPC Phase 4), where food access is severely constrained and fortified foods contribute meaningfully to micronutrient intake.

Challenges in social safety net integration (sustainability beyond donor funding): Madagascar's social safety net programs, including school feeding, are substantially dependent on donor funding. Government budget allocation for school feeding is limited, and programs often operate at suboptimal frequency due to resource constraints (Mazraani 2023). Integrating fortified foods requires not merely adding fortified products to existing procurement, but also maintaining supply chains and quality control systems, all of which demand adequate funding. Sustaining fortification

within social safety nets requires that the government meaningfully commit to adequate budgeting for nutrition-focused social protection.

Coordination between implementing agencies: Multiple agencies implement social safety net programs, including the Ministry of Education (school feeding), WFP (food assistance), health facilities (therapeutic feeding), and local government entities. Coordinating fortification standards and quality assurance across these fragmented systems requires inter-agency cooperation and shared technical standards, which are not yet fully established.

Supply chain reliability: Effective integration of fortified foods into social safety nets requires reliable supply chains that deliver appropriate quantities on schedule. Given Madagascar's supply chain fragmentation and limited logistics infrastructure, ensuring the consistent availability of fortified foods for these programs requires substantial investment in supply chain strengthening and warehousing.

2.1.3.7 Population Reach and Coverage Metrics

Assessing the current and potential reach of food fortification means understanding both the population benefiting from existing fortified products and the population that could be reached through expanded fortification. Coverage metrics are constrained by data gaps but are critical for estimating impact.

Salt fortification coverage: According to 2009 DHS data (the most recent comprehensive national estimate), only 68% of households nationwide consume iodized salt. However, this overstates effective fortification coverage because the survey measured only consumption of salt labeled as iodized, not adequately iodized salt. The 2014 iodine survey found that only 26.2% of households with WRA consumed adequately iodized salt (≥15 mg/kg), indicating that true effective coverage is less than one-quarter, which is far below the 90%+ targets necessary for adequate population iodine intake.

Fortified infant flours (Koba Aina, Koba Fenosoa) reach a small proportion of the child population, primarily in urban areas where these products are marketed and among program participants in targeted nutrition projects. Production of fortified infant flours remains limited, and market penetration among the broader child population is also minimal.

Therapeutic and supplementary foods: Ready-to-use therapeutic food and ready-to-use supplementary food are provided through the health system's acute malnutrition treatment programs and humanitarian assistance during food crises. Coverage is limited by supply constraints and gaps in early case identification and referral. The 2021 DHS reported that only 11% of children with diarrhea in the preceding two weeks received zinc treatment, suggesting that micronutrient therapy through the health system reaches only a small proportion of children in need (ICF and National Institute of Statistics 2022).

Potential reach through expanded fortification: If large-scale rice fortification were implemented (either through domestic industrial mills, imported fortified rice, or blending models), the potential reach would be extraordinary. In the country, approximately 95%+ of the population consumes rice daily, and rice contributes >50% of dietary calories. Fortifying rice with iron, folic acid, B1 (thiamine), B3 (niacin), B6 (pyridoxine), and B12 (cobalamin) could meaningfully address micronutrient

deficiencies across the entire population. The constraint is not population reach potential but rather the feasibility of implementing the supply chain (Helgi Library n.d.).

Wheat flour fortification reach: Wheat flour consumption is substantially lower than rice consumption. Wheat flour consumption is estimated at 10-15 kg per capita annually, compared with 143-157 kg for rice. Fortification of wheat flour would, therefore, reach a smaller population and contribute less to the overall micronutrient intake. However, wheat flour is consumed regularly among urban populations and in some rural areas, and fortification could provide additional micronutrient benefits for urban consumers.

Cooking oil fortification reach: Cooking oil is consumed by a broad spectrum of the population, though consumption varies by income level. Fortifying cooking oil with vitamin A and D (or vitamin A alone) could reach a large population. USAID AFFORD identifies cooking oil as a priority vehicle, suggesting that technical feasibility and supply chain concentration (fewer, larger oil producers) may be more favorable than for rice. Refined vegetable oil has an extraordinarily high penetration rate, with 93.3% of households consuming it across all socioeconomic levels and regions (Resnick 2024). While vitamin A deficiency has decreased significantly nationally, maintaining adequate vitamin A status relies heavily on expensive, donor-funded biannual vitamin A capsule distribution campaigns for children. To transition away from donor dependency and sustainably stabilize vitamin A intake for the entire population, it is strongly recommended to fortify refined cooking oil with vitamin A (as well as vitamins D and E). As industrial oil refining in Madagascar is highly concentrated among a small number of players, this concentration is administratively and economically one of the lowest-hanging fruits for LSFF in Madagascar, though it also underscores the importance of independent quality oversight given the market's limited competitive structure.

Bouillon cube fortification reach: Bouillon is consumed across income levels and in both urban and rural areas, making it a promising vehicle for broad population reach. However, consumption frequency may be lower than for rice, thereby limiting the per capita micronutrient contribution relative to rice fortification.

School feeding fortified foods reach: Madagascar's primary school enrollment is approximately 90% of school-age children nationally, with lower enrollment in some regions. Fortified school meals would, thus, reach approximately 90% of children during the school months, representing enormous reach for a critical age group (5 to 12 years old) during a period of rapid growth and learning.

Geographic variation in access: The potential impact of fortification varies substantially by region. In the Grand Sud and Grand Sud-Est regions, where food insecurity is acute and dietary diversity most severely constrained, fortified staples represent a critical opportunity to improve nutritional outcomes among the most vulnerable populations. Conversely, in regions with higher agricultural productivity and economic development (the central highlands and urban areas), dietary diversity is somewhat higher, reducing (though not eliminating) dependence on fortified staples. Equitable implementation of fortification requires particular attention to ensuring fortified foods reach rural and remote populations that are often the least served by commercial markets.

2.1.3.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Madagascar's rice value chain is highly fragmented, comprising thousands of small producers, hundreds of mostly artisanal mills, difficult aggregation, and dispersed retail. Production occurs nationwide, mainly in the central highlands through small-plot subsistence farming with limited use of improved varieties or good agronomic practices. Rice fortification is technically challenging and can sometimes alter organoleptic properties, deterring consumers. This is important in Madagascar, where appearance and texture play a major role in consumer preferences. Because of this high consumption of diverse, locally milled varieties, UNICEF (2024) concludes that only 12.5% of the rice consumed in Madagascar is currently considered "fortifiable".

Post-harvest losses are high due to poor storage and traditional drying and threshing methods. Milling is dominated by small operators without fortification capacity, while a few large mills are geographically concentrated. This fragmentation makes rice fortification difficult, requiring either complex engagement of many small mills, costly consolidation around large mills, or reliance on fortified rice imports, which face policy and consumer barriers. The distribution system involves multiple intermediaries with little quality control, enabling adulteration and making fortified rice hard for consumers to identify. While all households consume rice and traditional cooking preserves fortificant nutrients, the current domestic milling structure cannot sustain large-scale fortification at an effective cost. In the near term, importing fortified rice or blending fortified kernels with locally milled rice may be more viable (Food and Agriculture Organization 2016).

The salt sector is more structured than the rice sector, comprising a few large and medium-sized producers and numerous small producers. One industrial-scale producer and about eight medium enterprises have partial fortification capacity, while smaller producers face technical and material constraints. Salt fortification occurs during production by adding iodine or fluoride premixes, but small producers often lack reliable access to premixes and accurate dosing knowledge. The distribution system relies on wholesalers and retailers with little oversight, and poor storage conditions, especially humidity, reduce nutrient stability. Despite the theoretically manageable structure, implementation and quality assurance remain challenging.

Madagascar's industrial cooking oil supply chain is highly concentrated, offering one of the most viable pathways for mass fortification. Rather than being dispersed among several processors, the market is dominated by a small number of players that command national distribution coverage. According to UNICEF (2024), refined vegetable oil is consumed by 93.3% of Malagasy households across all income levels and regions. This near-universal reach, combined with the extreme consolidation of industrial production, makes oil an ideal and practical vehicle for near-term fortification implementation. Regulating and monitoring a single dominant player significantly reduces bureaucratic hurdles. Furthermore, experts recommend using this vehicle to fortify not only with vitamin A but also with vitamins D and E to maximize public health impacts.

Madagascar has a unified food safety and fortification framework, supported by regional offices that enable coordination across levels. However, the implementation of quality assurance is severely hampered by gaps in technical, financial, and institutional capacity. ACSQDA, under the Ministry of Public Health, operates with severe resource deficits, employing only about ten agents to oversee food safety nationwide. Currently, the agency can only reliably test for iodine domestically; testing for iron and other vitamins must be done abroad at high cost. Consequently, the state's regulatory bodies frequently issue certificates of commercialization without actually verifying the presence of claimed micronutrients.

testing for iron and other vitamins must be done abroad at high cost. Consequently, the state's regulatory bodies frequently issue certificates of commercialization without actually verifying the presence of claimed micronutrients.

Expanding accredited micronutrient testing laboratories is a key national priority, with GIZ acting as the primary donor investing in the physical infrastructure and accreditation processes required for local food fortification testing. Meanwhile, other partners focus on strengthening the regulatory and operational environment. Notably, the USAID AFFORD program provides critical systemic support by driving the operationalization and costing of the National Strategy for Food Fortification.

AFFORD is also spearheading the update of the national iodized salt control manual, revising the legal texts governing the National Food Fortification Alliance, and developing the strict specifications (cahier des charges) required for companies to legally utilize the national "Tovonantsoa" fortification logo.

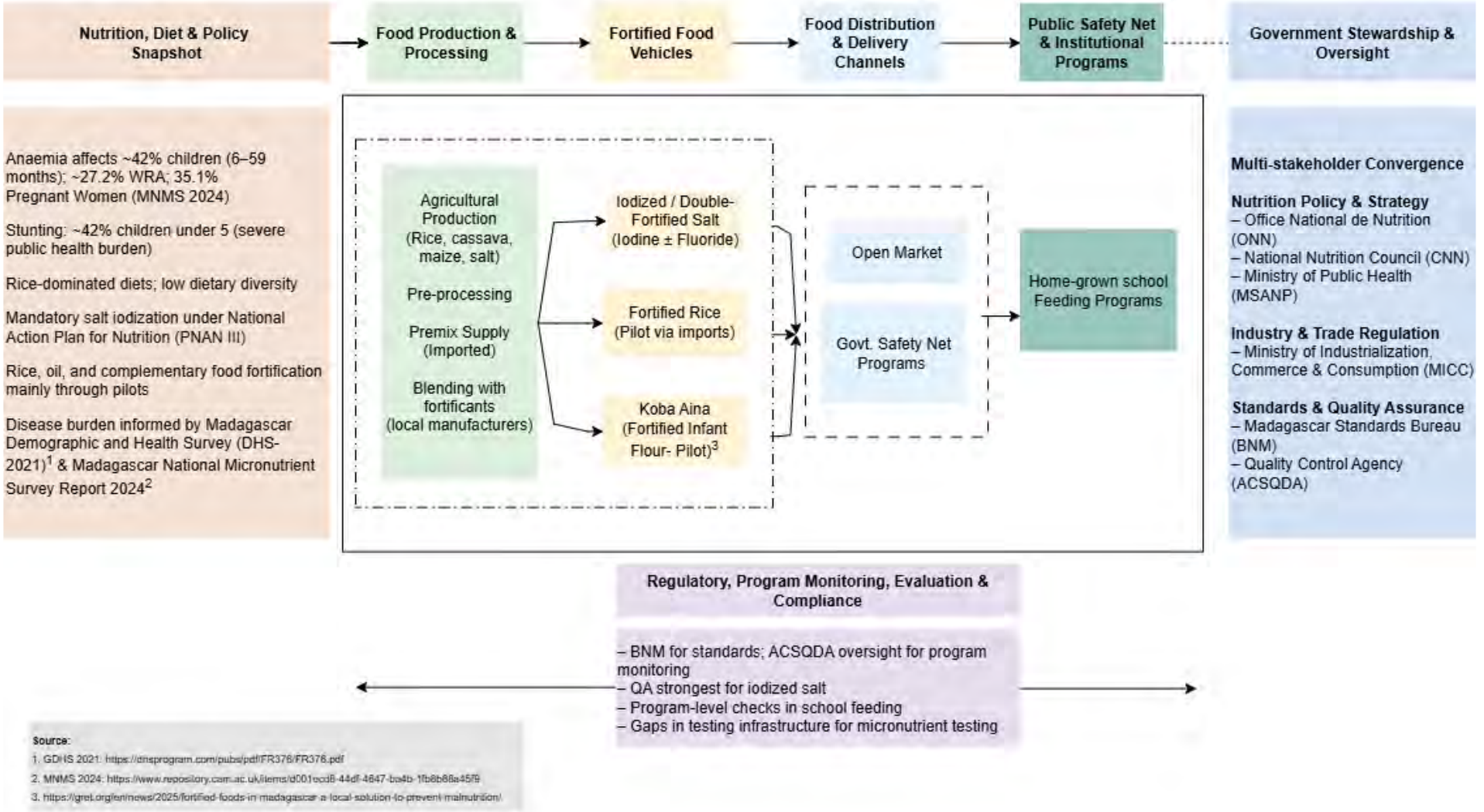
At the production level, manufacturers are expected to ensure internal quality control, but many small producers lack the means to do so, and external inspection is challenging. At the market level, the Ministry of Industrialization, Commerce and Consumption leads monitoring, which largely depends on label checks since nutrient testing is unavailable. At the household level, systematic monitoring is lacking, with occasional surveys such as the 2014 iodine study, revealing large gaps between fortification standards and actual intake.

Although fortification laws define penalties for non-compliance, enforcement is inconsistent, especially in southern regions with low capacity. Product recalls are not systematic, and counterfeit fortified salt bearing official logos remains common, indicating challenging market control.

Madagascar imports all fortification premixes, as none are produced locally. This dependency drives-up costs through import taxes, discourages manufacturers, and complicates quality verification. The risk of counterfeit premixes and delays in customs or supply chains poses frequent operational disruptions, as seen during the 2009–13 political crisis.

Regional standards and harmonization: Madagascar's fortification standards align with the Southern African Development Community's minimum standards for key food vehicles, supporting trade and technical consistency. However, despite formal adoption, practical implementation and compliance remain challenging. Innovative "iodine teams" of trained community members monitor salt iodine content locally, aiming to improve oversight through community engagement, though long-term sustainability depends on ongoing training and integration into formal systems. Digital traceability tools are also being piloted for monitoring and product tracking but are not yet institutionalized (European Commission 2024). Refer to Figure 2.3.

Madagascar



Source:

1. GDHS 2021: https://dhsprogram.com/pubs/pdf/FR376/FR376.pdf
2. MNMS 2024: https://www.repository.cam.ac.uk/items/d001ecd8-44df-4647-ba4b-1fb8b88a45f9
3. https://gret.org/en/news/2025/fortified-foods-in-madagascar-a-local-solution-to-prevent-malnutrition/

Figure 2.3. Madagascar's food fortification ecosystem

2.1.3.9 Monitoring and Evaluation Mechanisms

The Plan National d'Action pour la Nutrition (National Nutrition Action Plan IV) includes a structured monitoring and evaluation framework that tracks both process indicators (implementation, coverage, compliance) and outcome indicators (micronutrient status) through annual, mid-term, and final evaluations. The National Nutrition Council oversees this process and ensures data quality. However, the national nutrition dashboard managed by the Office National de Nutrition is underutilized due to challenges in data collection and inconsistent reporting from implementing agencies (World Bank 2020).

Population-level nutritional status monitoring: The EDSMD (Demographic and Health Survey of Madagascar) V (2021) provides nationally representative data on maternal and child nutrition and intervention coverage and serves as the main reference for tracking progress. Yet, its five-year frequency limits timely program adjustments. A nationwide micronutrient deficiency and consumption survey, initiated in 2024 with UNICEF support, aims to generate comprehensive data on deficiencies and food consumption by 2025–26. Meanwhile, iodine monitoring data are outdated: the last national survey in 2014 showed moderate deficiency, and the next round is overdue, highlighting a major monitoring gap.

Fortification program monitoring: Compliance testing of fortified foods by ACSQDA is irregular and constrained by limited laboratory capacity and inconsistent sampling, making the true extent of micronutrient compliance uncertain. Market surveillance checks product presence but rarely analyzes actual nutrient content, and response mechanisms for noncompliance are challenging. Data on household consumption of fortified foods are sporadically available from DHS or specific program surveys, and there is no systematic, routine collection to determine whether vulnerable populations consume sufficient quantities of fortified foods.

Data gaps and limitations: Madagascar's monitoring and evaluation system faces several critical gaps. These include limited routine testing of fortified foods due to laboratory constraints, challenging sub-national and vulnerable-group data, and insufficient short-term measures of fortification impact. Monitoring largely relies on national averages rather than detailed, localized, or population-specific data, hindering responsive programming and impact attribution (MQSUN+ 2021).

Monitoring system-strengthening initiatives: Efforts to address these challenges include the 2024–25 nationwide micronutrient survey, which will establish baseline data for planning and refine fortification priorities. Capacity-building initiatives, supported by USAID AFFORD and partners, aim to improve micronutrient testing through accredited labs. Concurrently, pilot initiatives to report digital nutrition data seek to strengthen sub-national data quality and timeliness.

2.1.3.10 Stakeholder Ecosystem and Partnerships

Food fortification in Madagascar is guided by a network of government institutions led by the Office National de Nutrition under the Prime Minister's Office, which coordinates national nutrition policy and programming. The Ministry of Public Health oversees the implementation of nutrition policies, food safety regulations, and service delivery, while MICC ensures compliance with standards developed by the Madagascar Standards Bureau. The Ministry of Education implements fortified school feeding programs, the Ministry of Agriculture leads nutrition-sensitive agriculture efforts, and regional and district health offices manage local-level implementation and monitoring. Coordination occurs mainly through the National Nutrition Council for multisectoral oversight, the National Food

Fortification Alliance for fortification-specific collaboration, and participation in SUN Movement platforms that link government, civil society, and private sector actors.

International development partners: Madagascar's food fortification initiatives draw significant support from bilateral, multilateral, and philanthropic partners. USAID supports fortification via the AFFORD and McGovern-Dole (Mianatra) programs, while GIZ aids institutional capacity building, and the World Bank provides financing to strengthen nutrition-sensitive health and social protection systems. Among the UN agencies, WFP leads food assistance, humanitarian response, and school feeding operations; UNICEF supports child nutrition, surveys, and advocacy; FAO promotes nutrition-sensitive agriculture, and WHO provides technical standards. Philanthropic entities such as the Gates Foundation and Power of Nutrition Initiative contribute to research, innovation, and program financing (ReliefWeb 2018).

The private sector includes producers across key fortified commodities such as salt, wheat and maize flour, cooking oil, bouillon cubes, and complementary foods. Both large- and small-scale salt producers have fortification capacity, while social enterprises such as Nutri'zaza, Koba products, and Tanjaka Foods (ready-to-use therapeutic food/ready-to-use supplementary food producer) supply fortified foods for vulnerable populations. The Mirary cooperative produces fortified bouillon with support from Helen Keller International, and the SUN Business Network links around 30 companies for nutrition-focused business engagement and coordination.

Madagascar's civil society plays a strong role through the Harmonized Initiative for Nutrition Action (HINA), which encompasses roughly 600 organizations engaged in advocacy, education, and local program implementation. The SUN Academic Network (MIKASA) brings together researchers from national universities to generate evidence on nutrition, food fortification, and food systems, and to contribute technical expertise to policy dialogue and program development. International non-governmental organizations, including Helen Keller International (quality control labs and bouillon fortification), GRET (locally fortified complementary foods via Nutri'zaza), Nutrition International, Global Communities, Catholic Relief Services, and FHI 360, provide technical and financial assistance across policy development, fortification, and nutrition service delivery. Local advocacy coalitions complement these efforts through policy engagement and community mobilization.

Academic institutions, particularly the University of Antananarivo and other national universities, contribute to fortification research and training, while MIKASA members and international research bodies such as the International Food Policy Research Institute and Consultative Group on International Agricultural Research centers conduct assessments of enabling environments, supply chains, and program effectiveness to inform evidence-based interventions.

The National Food Fortification Alliance, established in 2008, serves as the primary multi-stakeholder coordination mechanism for fortification strategy, technical assistance, and policy advocacy. Despite its broad mandate, the National Food Fortification Alliance's operations are constrained by challenging financing and capacity. Madagascar is also an active participant in the SUN Movement, yet coordination among government, civil society, and private sector networks remains inconsistent. The Nutrition Cluster, activated in 2018 and jointly led by ONN and UNICEF, manages emergency nutrition responses and integrates humanitarian and development actors.

Support for the national food fortification strategy (SNFA): ProSAR provides technical and institutional assistance to the National Alliance for Food Fortification to operationalize the SNFA, adopted in 2021. This includes strengthening the capacity of key stakeholders and developing communication strategies to promote healthy diets, including foods enriched with essential micronutrients.

ProSAR supports two concrete initiatives in partnership with Helen Keller International: The production of fortified bouillon cubes through the Mirary cooperative, which uses natural, locally sourced ingredients as an alternative to industrial bouillons high in monosodium glutamate and support to the MIKASA research platform in establishing a national laboratory for quality control of fortified foods, to ensure the safety, efficacy, and regulatory compliance of fortified products distributed across the country.

Although Madagascar's nutrition architecture features formal government leadership through the Office National de Nutrition and the Conseil National de Nutrition, implementation remains heavily donor-dependent and often reflects external priorities more than domestic commitments. Coordination remains fragmented, with overlapping interventions such as school feeding, WFP food assistance, and health system nutrition programs lacking clear integration or harmonized standards. Partnership sustainability is challenged by reliance on donor funding, which can weaken structures such as Agence Nationale de Fortification Alimentaire once funding cycles end. Civil society involvement, though institutionalized through platforms like HINA and MIKASA, varies in depth; concerns persist that fortification is approached as a technical solution without adequately engaging communities or advancing complementary strategies such as dietary diversification and nutrition-sensitive agriculture (ReliefWeb 2017).

2.1.3.11 Critical Challenges and Policy Reforms Needed (Nutrition Financing)

Governance and political economy barriers: There is a meaningful opportunity to further strengthen fortification's standing within Madagascar's broader national policy and budget conversations, building on its existing inclusion in national frameworks. Clearer articulation of fortification's long-term health and economic returns could help it compete more effectively for resources alongside other pressing development priorities. Reviewing how customs revenue considerations from premix import taxes interact with public health goals may also open pathways for more supportive fiscal treatment over time. Strengthening continuity across ministerial transitions, through institutional knowledge sharing and onboarding for incoming officials, could help sustain momentum in fortification initiatives. Similarly, deepening coordination among ministries (health, commerce, finance, agriculture, and education) and expanding private-sector engagement would build on the coordination role already played by the Agence Nationale de Fortification Alimentaire.

Financial and economic barriers: High import taxes on fortification premixes, which increase costs by 30–50%, severely discourage private sector participation and make fortified foods less affordable (Resnick 2024). These taxes significantly inflate production costs and discourage private sector compliance across oil, bouillon, flour, and rice fortification. These taxes persist due to reluctance to forgo customs revenue and the complex inter-ministerial coordination required to secure exemptions. Government nutrition budgets are insufficient and declining despite prior commitments under the Nutrition for Growth initiative. As a result, fortification programs depend heavily on donors, and interruptions in donor funding, such as during the 2009–13 crisis, have previously led to program collapse.

Supply chain fragmentation and technical barriers: Madagascar's fragmented food-processing systems, especially for rice and salt, constrain large-scale fortification. Thousands of small rice mills make fortification logistically infeasible and economically unviable because of high production costs and a lack of demand coordination. Salt production, though less fragmented, still involves over 100 small producers with varying capacities, leading to uneven standards. Compounding these issues, Madagascar lacks accredited domestic laboratory capacity for micronutrient testing beyond iodine, preventing systematic quality assurance and compliance monitoring.

Regulatory and enforcement barriers: Although legal frameworks for fortification exist, such as the salt fortification decree, implementation is challenging due to limited enforcement capacity, insufficient inspection resources, and low political attention. Fraudulent fortified products remain on the market. The multi-agency process for approving fortification standards is slow and bureaucratic, leading to long delays in establishing or updating them. Private sector actors face limited transparency and participation in policy development, which reduces their trust and engagement with the system. The regulatory framework must ensure "no one is left behind," including locally produced and imported foods. Given Madagascar's reliance on both fragmented local production (e.g., small rice and salt producers) and significant imports (e.g., rice from Thailand, Vietnam, India), harmonized standards and enforcement are needed across all products entering the market, regardless of origin. Clear, enforceable regulations that apply equally to domestic producers and importers are essential to guarantee equitable access to safe, adequately fortified foods.

Knowledge and capacity gaps: Strengthening the evidence base on fortification's public health and economic returns could help build stronger and more sustained political commitment over time. . Technical skills at the sub-national level are also limited, leaving regional and district officers without the capacity or resources to support fortification activities or compliance checks. Strengthening decentralized capacity and laboratory infrastructure is essential for sustainability (Resnick 2024). This includes establishing an International Laboratory Accreditation Cooperation (ILAC) aligned micronutrient testing lab and adopting rapid testing tools to ensure that fortified foods consistently meet standards.

Implementation challenges from prior programs: Three decades of salt iodization experience show that legislation and donor-driven programs alone are insufficient. Sustained political engagement, dedicated enforcement resources, robust quality control systems, and resilience to donor withdrawal are critical. The 2009–13 crisis demonstrated how fragile gains are when donor support lapses.

Consumer awareness remains a major gap: Limited awareness of fortified foods, particularly in rural areas, constrains demand and contributes to challenges such as the circulation of counterfeit iodized salt. Strengthened social and behavior change communication and consumer education must be emphasized as a core pillar of scale up.

Recommendations for policy reform: Reform efforts may prioritize eliminating or reducing premix import taxes through sustained advocacy to finance authorities, demonstrating the economic returns of fortification, and exploring mechanisms such as domestic premix production or subsidization. Domestic financing must be strengthened via dedicated budgets for quality control, regulatory monitoring, laboratory establishment, and the Agence Nationale de Fortification Alimentaire's functioning. Investment in accredited local laboratory capacity is key for quality assurance and combating counterfeit products. Organizing small producers into cooperatives or

clusters can also enhance supply chain efficiency, drawing lessons from other African contexts. Finally, policy and regulatory processes may become more transparent and inclusive, and sub-national authorities may receive training and resources to ensure effective decentralized enforcement and program continuity.

2.1.3.12 Opportunities and Future Directions

Madagascar's National Nutrition Policy (2022–30) and Plan National d'Action pour la Nutrition (2022–26) explicitly prioritize food fortification, reinforced by commitments through the SUN movement and Nutrition for Growth platform. This provides a sound policy foundation, though operationalization requires adequate budgets and institutional capacity. Alignment with the Southern African Development Community Minimum Standards will ensure harmonized, evidence-based technical standards, enabling regional trade and comparability. Continued engagement with Southern African Development Community processes can strengthen Madagascar's regulatory and policy frameworks for fortification.

Implementation and scale-up opportunities: Key development partners are actively pursuing the expansion of large-scale fortification with priority given to vehicles beyond salt. The German development agency, GIZ (through its ProSAR program), is offering crucial support in this area. GIZ is currently leading the technical exploration of fortifying cooking oil with major industrial players and is the primary funder of a pilot project with Helen Keller International to develop a fortified, locally produced bouillon cube. While the USAID AFFORD program (which concluded in January 2025) was instrumental in identifying these vehicles and strengthening the overarching policy and regulatory frameworks, GIZ is currently driving the direct implementation and scale-up efforts for these specific food vehicles.

School feeding programs such as the national Home-Grown School Feeding and WFP's Mianatra can deliver fortified foods to most school-age children by integrating fortified rice or flour into meal procurement, with minimal added cost if supply chains align. Humanitarian actors, particularly WFP, can mainstream fortified commodities in assistance to crisis-affected southern regions, improving micronutrient intake among vulnerable populations. Emerging private sector interest in bouillon and complementary foods could grow substantially if premix taxes are lifted and technical assistance continues. Rice fortification, though constrained by fragmented milling, can progress through a blending model that mixes fortified kernels with local rice, supported by school feeding demand, public awareness, and partnerships between importers and millers.

Research, evidence, and capacity-building opportunities: The forthcoming 2024–25 micronutrient and consumption survey will generate essential baseline data to refine fortification strategies, vehicle prioritization, and nutrient levels, provided the results are effectively communicated to policymakers. USAID-backed development of domestic, accredited laboratory capacity will improve compliance testing, reduce industry costs, detect non-compliance quickly, and empower regulators. Research on organizing small producers, coupled with private sector training in technology and quality control, can strengthen implementation capacity. Tailored social and behavior change communication campaigns may build consumer awareness and demand, motivating uptake and market sustainability. Continued research on acceptability, sensory perception, and health impacts, along with documentation of successful interventions like fortified bouillon or school meals, can strengthen advocacy and guide program scale-up.

Financing and sustainability opportunities: Madagascar can expand financing by creating budget lines for fortification within the health and education ministries, using innovative instruments such as nutrition bonds or public-private partnerships, and integrating fortification into existing budgets for feeding and humanitarian programs. Removing premix import taxes can stimulate private investment, while commercially viable fortification models and public-private partnerships for laboratory and distribution services can lessen public fiscal burdens. Beyond traditional donors, newer financing avenues from global health initiatives, impact investors, and blended finance could be tapped if cost-effectiveness and impact are demonstrated.

Institutional strengthening opportunities: Revitalizing the National Food Fortification Alliance is essential for coordination and advocacy. This entails securing a sustainable secretariat, defining stakeholder roles, enhancing transparency, and establishing accountability frameworks for implementation. At sub-national levels, capacity development, resource allocation, and inclusion of fortification in local nutrition plans can enable stronger decentralized delivery. Leveraging Madagascar's participation in the SUN movement provides a platform for multi-sectoral coordination that brings together government, the private sector, civil society, and partners to advance fortification progress.

Evidence-based strategic priorities (next three to five years): Immediate priorities include securing tax relief for premixes, completing and accrediting national lab capacity, revitalizing salt fortification enforcement, and expanding cooking oil and bouillon fortification through AFFORD and private sector collaboration. Complementary strategies include integrating fortified staples into school feeding, piloting rice fortification through blending, organizing small producers into cooperatives, and translating micronutrient survey findings into targeted policy actions. Collectively, these actions balance foundational reforms, consolidation of existing programs, near-term vehicle expansion, and longer-term fortification system development to achieve sustained nutrition gains.

2.1.4 Nigeria

2.1.4.1 Nutrition and Fortification Ecosystem

Nigeria, a lower-middle-income country in West Africa, is home to more than 237.5 million people (UNFPA 2025). It faces a "triple burden" of malnutrition: undernutrition, micronutrient deficiencies, and a growing prevalence of overweight, obesity, and related NCDs. The underlying causes of malnutrition in Nigeria are multifaceted, encompassing poverty, regional disparities, ongoing conflicts, and food insecurity. These challenges are particularly acute in the northeast and northwest regions, where frequent humanitarian crises and disruptions to food systems have worsened poor nutritional outcomes.

Despite Nigeria's economic potential and abundant agricultural and natural resources, persistent development challenges, including high poverty incidence, unemployment, inadequate infrastructure, and insecurity, continue to limit progress toward improved nutrition outcomes. Rice plays a central role in the national diet, with an annual per capita consumption estimated at 104 kg, making Nigeria not only the largest consumer but also one of Africa's leading rice importers. The dominance of rice as a staple food underscores its potential to deliver essential micronutrients through fortification initiatives (Ajanaku 2025).

Recognizing the far-reaching social and economic impacts of malnutrition, the Government of Nigeria has articulated its commitment to improving nutrition across sectors through robust policy frameworks. The National Multi-Sectoral Plan of Action for Food and Nutrition 2021–2025 outlines strategic priorities to reduce stunting, wasting, and micronutrient deficiencies by strengthening the integration of nutrition into health, agriculture, education, and social protection interventions. Complementing these measures, Nigeria has also established one of Africa's most extensive LSFF programs. Mandatory fortification of salt with iodine commenced in 1993, while mandatory fortification of wheat and maize flour, edible oil, and sugar with vitamin A has been in place since the early 2000s, providing a foundational platform for addressing micronutrient deficiencies at the population scale (National Agency for Food and Drug Administration and Control 2021). These initiatives collectively position the country as a regional leader in leveraging policy, innovation, and private-sector engagement to advance nutritional well-being (Federal Republic of Nigeria 2020).

2.1.4.2 Nutritional Status and Dietary Practices

Findings from the 2021 National Food Consumption and Micronutrient Survey underscore the scale of nutritional challenges in the country. According to the Nigeria Demographic and Health Survey (NDHS) 2024, approximately 40% of Nigerian children under five years old are stunted, 27% are underweight, and 8% are wasted, reflecting chronic and acute undernutrition. Among WRA, nearly 28% are overweight or obese, illustrating the nutrition transition taking place in urban and peri-urban populations. At the same time, anemia remains widespread, affecting more than half of WRA and children between 6 and 59 months. Consumption of essential micronutrients such as iron, zinc, folate, and vitamin A consistently falls below recommended levels, especially among low-income and rural households that depend heavily on monotonous, cereal-based diets (Federal Ministry of Agriculture and Food Security 2024).

The National Food Consumption and Micronutrient Survey 2021 documents severe inadequacies: Ninety-five percent of non-pregnant, non-lactating WRA and 92% of lactating WRA do not receive sufficient calcium (defined as 466-502 mg to meet their needs). Additionally, iron inadequacy affects 45% of non-pregnant and 82% of pregnant women. Zinc inadequacy ranges from 26% to 46%, while vitamin A inadequacy affects 26% to 58% of the population. Folate inadequacy is over 90%, and 54% of non-pregnant, non-lactating individuals lack sufficient vitamin B12. Regional disparities also exist, such as an average iron intake of 13.7 mg in the North-East and 10.9 mg of zinc in the South-South. Furthermore, among children aged 24 to 59 months, 92% have calcium inadequacy, and 18% have inadequate iron. Animal protein consumption is very low, averaging just 14 g/day in WRA and accounting for approximately 3% of their total energy intake.

Nigeria's diets remain dominated by starchy staples such as rice, maize, and cassava, which provide about 54% of total energy from carbohydrates. This reliance on energy-dense but nutrient-poor foods reflects limited dietary diversity, compounded by a heavy dependence on palm oil, which accounts for 33% of total fat intake and offers few nutrients beyond vitamin A (National Food Consumption and Micronutrient Survey 2021). The result is largely monotonous and unbalanced diets, especially among children aged 6 to 23 months, with only 58% achieving minimum dietary diversity and just 41.4% consuming an acceptable diet.

Food insecurity persists nationwide, with roughly an average of 41.5% of households experiencing some form of food shortage. Many people resort to common coping strategies such as reducing portion sizes, skipping meals, or switching to cheaper, less nutritious foods. While these tactics may

temporarily help manage scarcity, they can also worsen nutrient deficiencies and increase the risk of malnutrition. The adoption of biofortified crops remains low, with less than 14% of households participating nationally. Among these, orange maize has the highest uptake (13.5%), particularly in the northeast region, although its overall nutritional impact remains modest (National Food Consumption and Micronutrient Survey 2021).

Children's diets further highlight micronutrient deficiencies: Seventeen percent of children aged 6 to 23 months do not consume any fruits or vegetables, limiting dietary diversity and potentially contributing to inadequate vitamin and mineral intake (National Food Consumption and Micronutrient Survey 2021). Anemia remains a significant public health concern in Nigeria and is multifactorial, resulting from inadequate dietary iron intake, infections, inflammation, malaria, and other nutritional deficiencies (WHO 2023).

Urban–rural disparities are stark: According to the Nigeria Demographic and Health Survey 2024, Stunting affects 48% of children in rural areas compared to 28% in urban areas, reflecting deeper poverty and food insecurity present in rural regions. Meanwhile, urban populations are increasingly struggling with overweight and obesity, illustrating Nigeria's growing double burden of malnutrition amid dietary transition (John et al. 2024).

According to the National Food Consumption and Micronutrient Survey (NFCMS) 2021, tackling these challenges requires systemic food and nutrition strategies. Priority actions include improving access to nutrient-rich foods, encouraging consumption of animal-source proteins, and expanding both fortification and biofortification initiatives. Together, these interventions are critical to bridging persistent micronutrient gaps, reducing anemia, and advancing the country's overall nutritional well-being (United Nations Children's Fund 2022).

2.1.4.3 Nutrition-related Flagship Program

Nigeria National Multi-Sectoral Plan of Action for Food and Nutrition (NMPFAN) 2021-25 has operationalized the National Policy on Food and Nutrition 2021-2025 (currently being revised) through six priority areas (food security, caregiving, health services, insecurity response, awareness, resource allocation), targeting a 50% reduction in malnutrition through 18 interventions costing 295 billion over five years (88% prevention-focused).

The National Home-Grown School Feeding Program (under Renewed Hope/the National Social Investment Programme Agency) provides rice-inclusive meals from local sources to 10-24 million primary pupils daily. This initiative helps increase enrollment (81% in urban areas and 44% in rural areas), improve nutrition, and support agriculture; however, the integration of fortification has not progressed as expected. Additionally, the National Social Safety Nets Program supports 1.5 million poor households via cash transfers, complementing maternal newborn child health weeks, vitamin A supplementation, and community management of acute malnutrition, with the National Multi-sectoral Platform for Food and Nutrition focusing on the critical first 1,000 days of life, addressing emergencies, and tackling NCDs amid low intervention coverage (e.g., Maternal, Infant and Young Child Nutrition counseling, promotion of consumption of nutrient dense meals like Tombrown, dietary diversification and backyard garden).

2.1.4.4 Policy Environment for Food Fortification

Nigeria's food fortification framework is governed primarily by the National Agency for Food and Drug Administration and Control (NAFDAC) Food Fortification Regulations of 2021, which mandate fortification for all applicable food categories. These regulations require that all wheat and maize flour be fortified with iron, zinc, folic acid, and vitamins B1, B2, and B3; that vegetable oil and sugar be fortified with vitamin A; and that salt be iodized, a mandate in effect since 1993. The regulations emphasize compliance with good manufacturing and packaging practices, hygienic handling, and the exclusive use of approved fortificants and premixes. Fortified products must also adhere to specified labeling standards, ensuring consumers are adequately informed about nutrient content and compliance with fortification norms.

The National Fortification Alliance, a multi-stakeholder platform comprising government agencies, industry representatives, and development partners, facilitates oversight and coordination. The Standards Organisation of Nigeria (SON) plays a crucial role in formulating and aligning fortification standards, ensuring consistency across regulatory instruments and harmonization within the ECOWAS framework. NAFDAC and SON conduct routine laboratory analyses to monitor and ensure quality, assessing micronutrient adequacy and product safety. Non-compliant manufacturers face penalties, ranging from product recalls to administrative sanctions, thereby reinforcing regulatory enforcement (National Agency for Food and Drug Administration and Control 2021).

Food fortification is deeply embedded within Nigeria's nutrition policy architecture, notably the National Policy on Food and Nutrition, recently succeeded by the new 10-year National Policy on Food and Nutrition (NPFN, 2026 35), adopted by the National Council on Nutrition in April 2026 (Federal Ministry of Information and National Orientation 2026), National Policy on Food and Nutrition, the National Strategic Plan of Action for Nutrition (NSPAN II), and the National Guidelines for the Prevention and Control of Micronutrient Deficiencies in Nigeria. These policy instruments collectively position fortification as a core strategy for addressing widespread micronutrient deficiencies. Mandatory fortification of salt has been enforced since 1993; mandatory fortification of flour, sugar, and edible oil has been enforced since 2002, while fortification of rice presently remains voluntary, supported through advocacy and pilot initiatives spearheaded by the Promoting Rice Fortification in Nigeria (PRiFN) platform. Stakeholders continue to engage policymakers to elevate rice fortification to mandatory status, contingent upon the SON's development and adoption of corresponding national standards. Discussions are ongoing on regulated voluntary fortification of bouillon cubes.

The regulatory environment also includes fiscal and trade facilitation incentives, such as duty waivers for approved micronutrient premixes, to encourage industry compliance and reduce production costs. This incentive structure reflects Nigeria's pragmatic approach to sustaining participation from food producers, particularly small- and medium-sized enterprises. The NAFDAC prohibits both overaged and underaged to ensure that fortified foods provide safe, efficacious nutrient levels without exceeding recommended limits. This aligns Nigeria's efforts with global quality fortification benchmarks. Collectively, these measures underscore Nigeria's commitment to fortification as a cost-effective public health intervention integral to its broader nutrition security agenda.

2.1.4.5 Industry Capacity and Role of Private Players

Nigeria's rice fortification landscape comprises over 1,200 rice mills, with 20-30 large industrial players, such as Flour Mills of Nigeria, WACOT Rice, and Dangote Group, dominating processing capacity. While these mills handle significant volumes, such as WACOT's 120,000 MT annual capacity in Kebbi State (TheCable 2022), small-scale fragmentation across thousands of artisanal operations hinders uniform blending and quality control for fortified rice kernels (FRK). This structure limits scalability, as smaller mills often lack the infrastructure to integrate micronutrients consistently.

The Promoting Rice Fortification in Nigeria project, led by GAIN, WFP, and TechnoServe, has enabled six millers to produce over 12,000 MT of fortified rice in 2023 using imported and local FRK blends. The project provided technical support, equipment, and training to mills, particularly in Kano State. The initiative aimed to enhance school feeding programs, reach 200,000 children, and strengthen stakeholders' capacity. Recent expansions, such as the inauguration of fortified rice in Kebbi State in December 2025, signal a growing momentum (TechnoServe n.d.).

Private sector leadership has been driving LSFF through GAIN's Premix Fund, which subsidizes import-reliant premixes, as well as through market engagement and digital quality tools. The National Multi-Sectoral Plan of Action for Food and Nutrition mobilizes organized private sector alliances, contributing 7.5% of funding to value-chain investments, such as premix production and mill upgrades. These efforts foster partnerships covering 80% of flour milling and significant rice processing markets.

2.1.4.6 Integration with Social Safety Net Programs

Nigeria's social safety net programs offer strong platforms for integrating food fortification, particularly fortified rice, to combat micronutrient malnutrition among vulnerable populations. The National Home-Grown School Feeding Programme, launched in 2016, provides rice-heavy meals to over 10 million primary school children daily and sources 90% of food locally. However, it lacks specific guidelines for fortified rice mandates, despite pilot programs demonstrating feasibility (TechnoServe n.d.).

The National Home-Grown School Feeding Programme emphasizes locally procured staples to boost school enrollment and nutrition, making it well suited to scaling fortified rice. PRiFN pilots in over 500 schools in Kebbi State have successfully introduced fortified rice into school meals, testing its acceptability among children and teachers with plans for statewide integration and national expansion to 10 million beneficiaries (WACOT Rice n.d.).

National Social Safety Net Programme cash-transfer synergies: The National Social Safety Net Project provides monthly cash transfers to 1.5 million poor households, thereby improving food security and dietary diversity without directly procuring food. Integrating fortified rice subsidies or vouchers could leverage this reach, as studies show that cash transfers paired with nutrition guidance increase purchases of staple foods and reduce micronutrient gaps (National Social Safety Nets Coordinating Office n.d.).

Humanitarian and policy alignments: WFP deploys fortified rice in internally displaced persons camps in Borno. The rice is blended locally through PRiFN partnerships to address emergency needs,

aligning with the National Multi-Sectoral Plan of Action for Food and Nutrition's focus on safety nets for vulnerable groups. State and local governments fund this effort, contributing 51% of the resources. The National Guidelines for the Prevention and Control of Micronutrient Deficiencies in Nigeria advocate multi-sectoral fortification strategies, positioning the National Home-Grown School Feeding Programme and National Social Safety Net Programme as priority channels for implementing mandatory standards.

2.1.4.7 Population Reach and Coverage Metrics

Nigeria has made significant progress in fortifying widely consumed staples, though coverage and compliance remain uneven across products and regions. Nearly universal coverage has been achieved for salt (99%) and edible oil (90%), reflecting the maturity of these fortification programs and the robustness of their regulatory enforcement. However, coverage for fortified wheat flour and maize flour is estimated at 28% and 57%, respectively, highlighting major implementation gaps, particularly given that these cereals are staples for large rural and low-income populations. The 2023 compliance figures further underscore persistent quality and monitoring challenges: only 54% of sampled wheat flour, 40% of maize flour, and 31% of oil samples have met national fortification standards (Global Alliance for Improved Nutrition 2024).

According to data from the National Food Consumption and Micronutrient Survey 2021, household penetration of fortified oil, sugar, salt, and bouillon cubes exceeds 90%, confirming the strong market reach of industry-driven, commercially packaged foods. In contrast, coverage of fortified flour remains below 57%, constrained by informal milling, fragmented supply chains, and limited consumer demand in semi-urban and rural areas. These disparities contribute to uneven nutrient intake across population segments, especially among poorer and food-insecure households, which account for 41.5% of the population nationally.

On the safety net front, large-scale programs like the National Home-Grown School Feeding Programme, serving over 10 million pupils, and the National Social Safety Net Programme, reaching roughly 1.5 million poor households, provide structured channels to improve access to fortified foods. However, integration of fortified staples within their procurement and menu design frameworks remains partial. Complementary innovations, such as fortified rice pilots (currently around 12,000 tons) and biofortified crop dissemination (still under 14% population reach), show emerging potential, though scale-up remains limited.

Urban areas report around 35% awareness of fortification benefits, but rural awareness and access to products remain minimal, thereby widening nutrition disparities between regions. Strengthening fortification compliance systems, expanding rural distribution networks, and embedding fortified staples into existing safety nets can substantially increase equitable micronutrient coverage across Nigeria’s population.

2.1.4.8 Value chain, Quality Assurance and Regulatory Frameworks

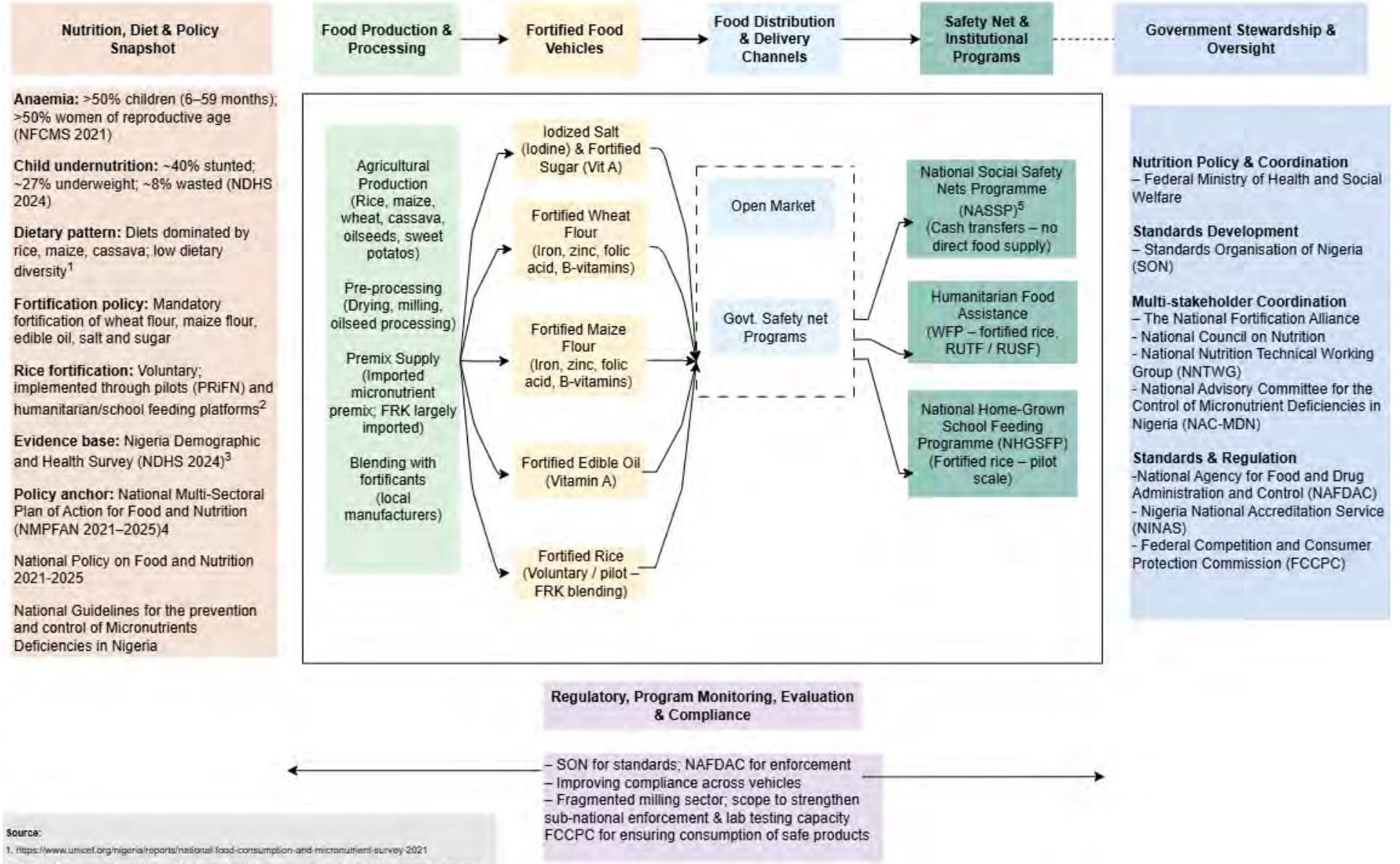
Nigeria's fortified staples value chain relies heavily on imports of key premix micronutrients, supporting around 1,200 mills that process wheat flour, maize flour, sugar, and vegetable oil, while local FRK blenders remain underdeveloped. The Standards Organization of Nigeria and NAFDAC jointly oversee standards and enforcement, with mandatory fortification of salt since 1993 and mandatory fortification of sugar and other selected staples since 2002. The process has evolved through revisions, such as the 2015 Nigerian industrial standards for premixes. Premix pooling mechanisms help mitigate high costs through bulk procurement by multi-stakeholder alliances, thereby addressing foreign exchange volatility and the 5-10% import duty on fortificants (TechnoServe 2019).

Regulatory frameworks: The 2021 Food Fortification Regulations mandate specific nutrient levels, such as at least 5% of the nutrient reference value per serving for vitamins and minerals in fortified foods, alongside quality assurance and quality control protocols, including labeling and Good Manufacturing Practices compliance. The SON sets Nigerian industrial standards, including NIS 212:2015 for wheat flour premixes (e.g., 48.9-53.79 g/kg vitamin A), 15% reference value for iron, zinc, folic acid and vitamin B12 according to the National Code of Practice of bouillon and the National Industrial Standard for bouillon by SON, NAFDAC enforces them through inspections, product registration, and border controls, while the Federal Competition and Consumer Protection Commission (FCCPC) ensures consumers are provided with safe fortified products according to the regulatory specification. These frameworks apply to all manufactured, imported, or distributed fortified staples, with recent stakeholders calling for stricter enforcement amid compliance gaps of 40-60% in some vehicles (National Agency for Food and Drug Administration and Control 2021).

Value chain dynamics: Premixes for flour (600 g/MT) are mostly imported from global players such as DSM, BASF, and Muhlenchemie and blended locally by firms such as Biochemical Derivatives Ltd. (TechnoServe 2019). However, local capacity lags due to technical limitations and quality inconsistencies. For oil and sugar, vitamin A palmitate (13.5-23 g/MT) dominates imports from China, Europe, and the US, with a theoretical annual demand of 33-55 MT for oil alone, amid a projected US$42 million premix market at full scale (TechnoServe 2022). FRK production for rice remains nascent and constrained by infrastructure limitations, while safety nets such as the public distribution system integrate fortified staples through programs targeting micronutrient deficiencies.

Quality assurance and labs: NAFDAC accredits labs through mentorship with bodies such as the Nigeria National Accreditation Service, training inspectors on quality assurance and quality checks, internal verification, and audits; recent UNICEF-NAFDAC sessions have bolstered monitoring for vitamin A in staples. SON and NAFDAC conduct premix testing at entry points and mills, but stakeholders urge expanded capacity for affordable, reliable analysis to close compliance gaps. The FCCPC tests fortified products at the household level to confirm the availability of specified nutrient levels at the point of consumption and adherence to regulatory standards. Multi-stakeholder alliances, including TechnoServe and Food Fortification Initiative (FFI), promote self-regulation via industry associations and codes of practice (Global Alliance for Improved Nutrition 2022). Refer to Figure 2.4.

Nigeria



Source:

1. https://www.unicef.org/nigeria/reports/national-food-consumption-and-micronutrient-survey-2021
2. PRiFN: https://www.technoserve.org/fight-poverty/projects/promoting-rice-fortification-in-nigeria-prifn-project/
3. NDHS 2024: https://dhsprogram.com/pubs/pdf/FR395/FR395.pdf
4. NMPFAN: https://faolex.fao.org/docs/pdf/nig212106.pdf
5. NASSP: https://nassp.gov.ng/what-we-do/national-cash-transfer-programme

Figure 2.4. Nigeria's food fortification ecosystem

2.1.4.9 Monitoring and Evaluation Mechanisms

At the policy and coordination level, the National Fortification Alliance plays a central role in convening stakeholders and overseeing implementation progress. It conducts quarterly compliance reviews that draw on inspection data, program reports, and partner feedback to assess whether the industry is adhering to LSFF standards. In addition, the National Fortification Alliance compiles annual fortification progress reports that synthesize key findings on coverage, quality, and bottlenecks, and feed into national nutrition coordination platforms and policy dialogue.

NAFDAC, SON, and FCCPC primarily manage regulatory oversight and independent verification of fortification compliance. These agencies undertake routine inspections and third-party monitoring of fortified staples. This includes plant-level inspections, market surveillance, and laboratory testing of product samples to ensure they meet approved standards, as well as household-level testing to verify that product safety and nutrient levels meet regulatory and fortification specifications for consumers. This regulatory monitoring helps ensure that fortified foods supplied through commercial channels and safety net schemes meet minimum quality and micronutrient content requirements. It also provides a basis for corrective actions, such as enforcement measures, technical assistance to millers, or revisions to guidelines where needed (School Drillers 2024).

To understand outcomes and impact beyond compliance, Nigeria draws on the National Food Consumption and Micronutrient Survey 2021 and related research as part of its broader monitoring and evaluation framework. The National Food Consumption and Micronutrient Survey and similar surveys generate baseline and follow-up data on dietary patterns, consumption of fortified foods, and micronutrient status across population groups, including WRA and young children. These data help the government and partners assess whether fortified staples distributed through social safety nets and the general market translate into improved intake of priority micronutrients and reduced deficiency prevalence over time (eHealth Africa n.d.).

The National Fortification Alliance of Nigeria has articulated a MEAL (monitoring, evaluation, accountability, and learning) framework that links routine information systems with periodic evaluations. Routine monitoring draws heavily on the National Health Management Information System and other sectoral data platforms to track coverage indicators, such as the reach of fortified foods through health and social protection programs, and, where feasible, selected outcome indicators. Mid-term and end-line evaluations are planned as part of major program cycles to assess effectiveness, cost-efficiency, and equitable access, using mixed methods and triangulating across multiple data sources (Federal Republic of Nigeria 2020).

Accountability and learning are further reinforced through national coordination bodies such as the National Committee on Food and Nutrition and the National Council on Nutrition. These bodies receive regular updates from the NFA, the NAFDAC, the SON, the FCCPC, and implementing ministries' coordination bodies such as the NNTWG of the Health Sector. They provide a forum to review progress, address policy and implementation gaps, and align fortification efforts with broader nutrition and food systems strategies. Through this structure, Nigeria's monitoring and evaluation mechanisms not only monitor regulatory compliance and program coverage but also institutionalize continuous learning and accountability for results across fortified staples and safety-net programs.

2.1.4.10 Stakeholder Ecosystem and Partnerships

Anchored by strong government leadership and active partnerships with development, private sector, and civil society actors, regulatory oversight is jointly led by NAFDAC, SON, FCCPC, and the Federal Ministry of Health and Social Welfare. These agencies collectively provide the policy framework, regulatory enforcement, and quality assurance mechanisms that govern the fortification of staple foods and condiments, such as flour, rice, oil, salt, and sugar, and include ongoing discussions on bouillon cube fortification. Their collaboration ensures that fortification standards are harmonized across products and that compliance monitoring is systematically implemented through periodic inspections, laboratory testing, and market surveillance.

Complementing government leadership, the private sector plays a central role in driving large-scale fortification implementation. Key industry players such as the Flour Millers Association of Nigeria and major food conglomerates like the Dangote Group lead production and distribution of fortified food commodities, often in partnership with international technical partners. GAIN supports these efforts through its premix facility and quality-control assistance, ensuring that high-quality micronutrient premixes are accessible to local producers. These collaborations have catalyzed improvements in fortification coverage and compliance levels, while also strengthening supply chain efficiency.

Several development and technical partners, including WFP, TechnoServe, UNICEF, and FFI, support both upstream (policy and systems strengthening) and downstream (industry and consumer-level) components of the fortification ecosystem. Many of these organizations engage under platforms such as the PRiFN and the National Fortification Alliance, which facilitate coordination, evidence generation, and advocacy across public and private stakeholders.

The National Multi-Sectoral Plan of Action for Food and Nutrition in Nigeria further extends its engagement to subnational levels, mobilizing ministries, departments, and agencies, civil society organizations, and representatives of the organized private sector. The Scaling Up Nutrition business network and related private sector networks foster business engagement and innovation, linking fortification with broader nutrition and food system agendas. This integrated approach combining regulation, private sector delivery, and multi-stakeholder partnerships positions Nigeria as one of Africa's leading examples of a coordinated national fortification program.

2.1.4.11 Critical Challenges and Policy Reforms Needed

Nigeria's food fortification program continues to face significant systemic and financing bottlenecks, limiting its national impact despite strong policy intent. A primary issue is low industry compliance, particularly in staple commodities such as rice and maize, where enforcement remains challenging and regulatory coverage is fragmented across states. The absence of a national rice fortification mandate leaves a major consumption channel outside the fortification ecosystem, constraining population-level micronutrient reach. In addition, the promotion of a reduction in salt consumption, in line with the WHO-recommended daily intake, poses a significant cohesion challenge for bouillon cube fortification. Similarly, frequent shortages of FRK and micronutrient premixes driven by import dependence, foreign exchange volatility, and customs delays disrupt production continuity and add cost pressures on small- and medium-sized millers.

The economic viability of fortification remains a persistent concern. Current implementation costs for prioritized nutrition interventions to curb malnutrition are estimated at around ₦295 billion, with

only ₦35 billion projected to be funded from federal resources under the Nigeria Multi-Sectoral Plan of Action for Food and Nutrition. The remaining financing gap is widening as millers struggle with rising input costs, energy prices, and logistics inefficiencies. Small- and medium-sized enterprises, which dominate Nigeria's milling sector, often lack the working capital and technical expertise to adopt fortification technologies, making them dependent on external subsidies or pooled procurement models.

Another critical barrier is limited public awareness and demand for fortified foods. Inadequate social and behavior change communication limits consumers' awareness of the benefits of fortified foods, reducing market demand and incentives for industry compliance. In addition, differences in implementation capacity across states contribute to uneven program coverage and monitoring, particularly in northern regions where coverage of fortified staple foods remains comparatively low.

Policy reform and financing priorities: Targeted policy reforms are essential to sustain fortification financing and drive compliance. Nigeria needs to prioritize import waivers or tax exemptions for FRK and premix materials to reduce production costs for compliant industries, and to provide procurement subsidies or revolving funds to help millers purchase inputs and equipment. Establishing local FRK production capacity would be a critical medium-term reform, reducing supply dependency and stabilizing costs through backward integration.

A robust financing framework must also be established to diversify funding sources beyond federal allocations. Currently, nutrition financing for fortification is skewed toward external partners (approximately 29%) and state governments (51%), neither of which is sustainable or equitable. A dedicated national fortification financing window, either under the Ministry of Finance or Central Bank-supported schemes, could help mobilize blended capital from development partners, state budgets, and private sector investments.

Additionally, scaling up social and behavior change communication investments to increase awareness of fortified foods and behavior change is vital. National and sub-national campaigns may be institutionalized within existing health and education systems to drive demand generation. Finally, improved monitoring and enforcement mechanisms, including digital quality assurance systems and sub-national accountability frameworks, will be key to translating financing reforms into measurable nutrition outcomes.

2.1.4.12 Opportunities and Future Directions

Nigeria's fortification landscape stands at a pivotal juncture, offering opportunities to advance national nutrition outcomes through a more integrated and sustainable approach. While staple fortification of wheat flour, sugar, salt, and oil has been mandatory for years, the rice sector and bouillon cubes remain largely voluntary. Introducing a mandatory rice and bouillon cubes fortification standard through SON, enforcing it through NAFDAC, and ensuring consumers have access to fortified products with nutrient levels in line with regulated specifications through FCCPC could serve as a major policy lever. As rice consumption continues to rise across both rural and urban populations, institutionalizing fortification at the milling and blending stages for rice, and at the blending stage for bouillon cubes can significantly increase micronutrient coverage among vulnerable groups.

Public-sector feeding programs, such as the National Home-Grown School Feeding Programme and the National Social Safety Nets Project, offer immediate avenues to amplify impact and build demand. By subsidizing fortified rice or fortified staples through these safety-net platforms, the government can ensure regular consumption among low-income households and school children, while creating predictable market volumes that incentivize millers and FRK producers to invest in fortification technology and quality assurance systems.

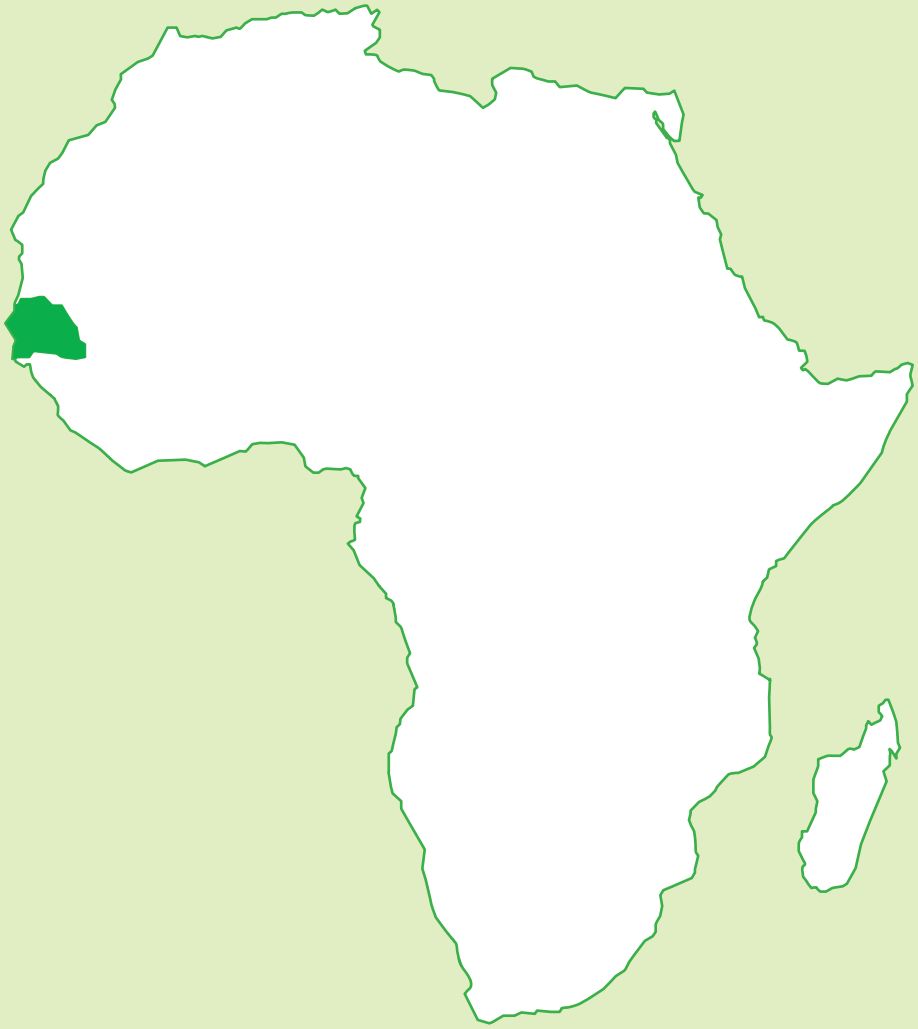
The ongoing moves to fortify bouillon cubes with iron, zinc, vitamin B9, and vitamin B12 through a phased implementation approach accompanied by fiscal incentives, technical assistance, strengthened enforcement, and support for local manufacturers may help mitigate the economic burden envisaged for manufacturers.

Localization will be the key to long-term program success. Strengthening local FRK production capacity can reduce dependence on imported premix or blended kernels and foster domestic industry participation. Parallel investments in social and behavior change communication tailored to local languages, culinary practices, and gender roles can build community ownership and enhance adoption. Linking these efforts through the National Fortification Alliance of Nigeria will ensure that policy coherence, technical guidance, and private sector participation remain aligned with broader regional frameworks, such as ECOWAS standards.

Nigeria also stands to benefit from emerging market trends and innovations. Urban consumers increasingly seek healthier, convenience-driven products, creating scope for branded fortified food vehicles in retail markets. Leveraging digital tools for quality assurance, from traceability applications to supply chain dashboards, can modernize compliance monitoring and enhance consumer trust. Moreover, combining industrial fortification with biofortification initiatives embedded in smallholder agriculture programs can create a continuum of micronutrient access. This dual approach will strengthen dietary diversity and ensure that both urban and rural populations benefit equitably from fortification interventions.

Collectively, these opportunities signal a maturing fortification ecosystem in Nigeria, one that balances regulatory enforcement, market incentives, domestic capacity, and behavioral enablers to drive sustained nutrition outcomes across the country.

2.1.5 Senegal



2.1.5.1 Nutrition and Fortification Ecosystem

Senegal, a lower-middle-income nation in West Africa, with a population of more than 19.37 million (World Population Review 2026), has established itself as a regional leader in development planning and food policy reform despite persistent challenges of poverty and food insecurity. The country has benefited from a stable political environment and an enabling governance structure, creating momentum for nutrition-focused policy development over the past two decades. In 2023, Senegal ranked 66th out of 125 countries on the Global Hunger Index, with a score of 16.8, indicating a moderate level of hunger. Yet climate shocks, food price volatility, and undernutrition remain persistent vulnerabilities that threaten human development outcomes for vulnerable populations in the country.

Agriculture remains a cornerstone of Senegal's economy, contributing approximately 15% to gross domestic product and employing over 70% of the rural population. The primary food crops cultivated include millet (281,000 hectares, producing 900,000–1,000,000 tons annually, with production increasing since 2013), sorghum (41,000 hectares), maize (91,000 hectares), and rainfed rice (71,000 hectares) (Government of Senegal and ICF 2024). Millet historically served as the dominant staple, but in recent times rice has emerged as the most frequently consumed cereal in daily diets, particularly among urban populations and key vulnerable groups, including adolescent girls and WRA.

With an average per capita consumption of 198 g/day, rice consumption is nearly twice that of wheat flour and more than triple that of maize, positioning it as the nation's foremost staple food. Despite significant increases in domestic rice production, from 300,000 tons of paddy rice in 2009 to 885,000 tons in 2016 (approximately 612,000 tons of milled rice), Senegal remains heavily dependent on rice imports. Approximately 60–70% of the country's total rice consumption is met through imports, primarily from India (60%), Thailand (20%), and Brazil (10%). This import dependency reflects the gap between domestic production capacity, which accounted for only 35% of total consumption in 2016, and the rising national demand, driven by urbanization and dietary transitions (Resnick and Diatta 2025).

Recognizing the multifaceted nature of malnutrition affecting its population, the Senegalese government has demonstrated a strong political commitment to nutrition-focused interventions. This commitment is exemplified by the establishment of the National Nutrition Development Council (CNDN), anchored at the Secretariat General of the Government following the institutional reorganization in September 2020.

The PNDN (Plan National de Développement de la Nutrition) 2021–25, complemented by the Multisectoral Strategic Plan for Nutrition (PSMN) 2018–22 and its successor 2024–28, provides the overarching strategic framework for coordinated multisectoral action to reduce micronutrient deficiencies through an integrated approach encompassing fortification, supplementation, dietary diversification, behavior change communication, and institutional capacity strengthening. Between 2018 and 2022, the Senegalese government mobilized CFA 247 billion (approximately US$420–440 million) to implement PSMN, with annual expenditure increasing from CFA 32 billion in 2018 to CFA 66 billion in 2022, representing an average annual growth rate of 23%. This upward trend underscores the state's substantive resource commitment to nutrition, although notable funding gaps persist in micronutrient-specific interventions (Government of Senegal 2024).

Senegal's fortification landscape positions it as a pioneering nation in West Africa. It initiated mandatory fortification of both wheat flour with iron and folic acid and edible oil with vitamin A through Decree 2009-872 of September 2009, with the broader Food Fortification Program implementation beginning in 2010. Decree 2000-1154 of December 2000 mandated salt iodization (U.S. Department of Agriculture Foreign Agricultural Service n.d.; Faye et al. 2025; Diagne et al. 2018). These policies were developed following rigorous fortification rapid assessment tool surveys conducted by GAIN and the FFI, which identified foods with household penetration exceeding 80% and stable consumption patterns across diverse socioeconomic and geographic subgroups.

National fortification standards were subsequently aligned with ECOWAS and UEMOA standards to facilitate harmonization of regional trade, positioning Senegal as a catalyst for fortification standardization across West Africa. Despite a decade of mandatory fortification of wheat flour and oil, micronutrient deficiencies persist at endemic levels, prompting renewed strategic focus on both strengthening existing fortification programs and scaling new vehicles, particularly rice, to close the remaining nutrient gaps. The confluence of high rice consumption, import dependence, and fragmented domestic milling infrastructure underscores the need for rice self-sufficiency through the National Rice Self-Sufficiency Program (launched in 2014). Favorable policy momentum creates an unprecedented opportunity for rice fortification as a complementary intervention to amplify the impact of micronutrients across the population.

2.1.5.2 Nutritional Status and Dietary Practices

Senegal exhibits a complex dual burden of malnutrition, characterized by persistent undernutrition alongside emerging overweight and obesity, particularly in urban centers and among WRA. This epidemiological transition reflects broader dietary shifts associated with urbanization, market integration, and economic development, as populations increasingly transition from traditional plant-based diets toward processed, energy-dense, nutrient-poor foods.

Prevalence and geographic distribution of undernutrition: Among children under five years, stunting (chronic malnutrition) affects 17–18.8% of the population, with longitudinal data showing a concerning upward trend from 16.0% in 2005 to 18.8% in 2018. This suggests insufficient progress despite multisectoral interventions. Acute malnutrition (wasting), measured as weight-for-height deficiency, presents a national average of 7.8%. However, there are significant regional disparities. In the Saint-Louis and Matam regions, global acute malnutrition rates exceed 15%, and severe acute malnutrition rates exceed 2%. These figures indicate conditions of an acute crisis that warrant an immediate humanitarian response in these districts. Underweight (weight-for-age deficiency) affects approximately 14.5% of children under five years old nationally. These anthropometric indicators reveal concentrated vulnerability in arid central and northern regions where rainfed agriculture predominates, pastoral livelihoods are affected by climate variability, and market integration remains limited (National Agency of Statistics and Demography and ICF 2018).

Micronutrient deficiencies: Micronutrient deficiencies constitute the predominant form of malnutrition in Senegal and represent the primary target of the national fortification strategy. Anemia, caused predominantly by iron deficiency but also by insufficiencies of folate, vitamin B12, and vitamin A, remains hyperendemic: 58–71% of children aged 6 to 59 months are anemic, with the highest prevalence documented in 2024 surveys. Among WRA, anemia prevalence ranges from 50–54%, with the rates being particularly elevated among adolescent girls aged 15–19 years, reflecting heightened iron demands during menstruation and growth. Iron deficiency alone has beenestimated at 36.9% among women, with dietary iron intake analysis revealing that 100% of Senegalese school-age children have insufficient calcium intake, 100% have insufficient folic acid intake, 79% have inadequate vitamin A intake, and 69% have insufficient zinc intake.

Vitamin A deficiency affects 12.8–40% of children under five years of age, depending on the survey methodology used and the year of the study. Recent national biomarker data (2010) indicate that 12.8% of children aged 12–59 months were vitamin A deficient. Among WRA, vitamin A deficiency (plasma retinol <0.70 μmol/L) was observed in 2.4% of cases. Additionally, 14.2% of WRA have low vitamin A reserves, indicating a marginal status that makes them susceptible to deficiency during periods of increased physiological demand, such as pregnancy and lactation. Vitamin A supplementation coverage has exceeded 85% nationally, though uptake and compliance vary significantly by district, with rural uptake lagging behind that in urban centers.

Zinc deficiency is a particularly widespread problem. It affects 58% of women and 42.8–50% of children under five years old, with regional variation from 44% in the Ziguinchor region to 82% in the Saint-Louis region. Zinc is essential for immune function, growth, wound healing, and cognitive development; its deficiency is associated with increased susceptibility to infectious disease, stunting, and developmental delays. Iodine deficiency disorders (IDD) affect 28.3% of WRA and 30.9% of pregnant women, with the situation particularly critical in salt-producing regions, where iodized salt consumption reaches only 11% compared with a national average of 37.7%, well below the government-established target of 90% (GroundWork et al. 2018).

Dietary diversity and dietary practices: An analysis of dietary consumption patterns reveals substantial nutrition-related vulnerability. Less than 50% of children aged 6–23 months meet the minimum dietary diversity threshold (which requires consuming foods from four or more food groups), indicating a predominant reliance on monotonous, energy-dense, micronutrient-poor foods, typically refined staple grains with minimal contributions from vegetables, fruits, legumes, or animal-source foods (Adams et al. 2024). Exclusive breastfeeding rates remain suboptimal, ranging from 26–52% across six monitored regions, with the lowest in Tambacounda (26%). This is well below the WHO recommendation of six months of exclusive breastfeeding.

Rice consumption patterns, while quantitatively substantial, remain nutritionally unbalanced: milled rice, the typical form consumed, provides energy but is a poor source of micronutrients as the nutrient-rich bran and germ are removed during milling. The predominance of white, refined rice in both imported and domestically produced supplies exacerbates this deficiency, as traditional parboiling methods that partially retain nutrients are increasingly displaced by modern, fully refined milling techniques aimed at meeting consumers' aesthetic preference for "whiteness" (Ka and Manus 2023).

Overweight, obesity, and NCD risk: Senegal has shown limited progress towards achieving the diet-related NCD targets. Obesity affects 15.1% of adult women (aged 18 years and over) and 4.8% of adult men. Senegal's obesity prevalence is lower than the regional average of 20.8% for women and 9.2% for men. At the same time, diabetes is estimated to affect 8.3% of adult women and 8.7% of adult men (Global Nutrition Report n.d.). These dual burdens often coexist within the same household and geographic area, reflecting complex dietary transitions in which processed, fortified grains provide calories yet remain nutritionally imbalanced, lacking dietary fiber, whole grains, and micronutrient density.

2.1.5.3 Nutrition-related Flagship Program

Senegal has established a comprehensive suite of evidence-informed, nationally owned nutrition programs spanning health, education, social protection, and agriculture sectors. These programs form the delivery infrastructure through which fortified foods and micronutrient interventions reach target populations.

School feeding program: The National School Feeding Program, coordinated by the Directorate of School Canteens under the Ministry of National Education and supported by the WFP, is one of Africa's largest school-feeding initiatives in terms of coverage. In 2022–23, the program reached approximately 2.34 million primary school students out of 2.86 million enrolled (63% coverage), 1.29 million secondary school students out of 2.74 million enrolled (47% coverage), and 316,433 preschool children out of 1.61 million (20% coverage), totaling approximately 3.9 million beneficiaries across all school levels. The program operates through both state-funded mechanisms (coordinated by the state with 93,961 beneficiaries receiving meals twice per week) and WFP-supported schemes (reaching 119,864 beneficiaries five times per week). The program targeting employs vulnerability indices, gross enrollment rates, school access indicators, school completion rates, and nutritional status indicators to prioritize resource allocation toward marginalized and food-insecure regions (World Food Programme 2024).

Food rations typically include whole grains, legumes, liquid oils (fortified with vitamin A), iodized salt, and increasingly fortified foods. The average ration provides approximately 150 grams of rice per

child per day in rice-consuming regions, constituting 37–50% of daily caloric intake and representing a critical window for nutrition interventions for school-age children (Learning Generation Initiative 2024). The state-level budget allocations for school feeding have progressively increased from CFA 500 million in prior years to CFA 1.4 billion in 2024, demonstrating a commitment to program sustainability, though funding gaps persist. WFP reported that school meal programs were funded at only 17% of requirements in 2024, resulting in a US$5.4 million shortfall.

A landmark initiative launched in October 2024 represents a strategic policy shift: the Government of Senegal, in partnership with WFP and financial support from dsm-firmenich (a Swiss-Dutch nutrition company), initiated distribution of fortified rice in 236 primary schools, targeting 61,000 students across Matam and other high-burden regions. This pilot distributed over 30 tons of fortified rice during the 2024–25 school year, serving as proof of concept for the broader integration of fortified rice into national school feeding infrastructure (World Food Programme 2024).

National cash transfer program: The Program National des Bourses de Sécurité Familiale (PNBSF), implemented since 2013, represents Senegal's flagship social safety net targeting extremely poor and vulnerable households. As of 2024, the program benefits approximately 300,000 households (originally 280,000) across all 14 administrative regions, identified through a national poverty targeting registry and vulnerability assessment. The program provides quarterly cash transfers of approximately US$50 per household, combined with soft conditionalities regarding health and education service utilization, designed to stimulate investments in human capital, including nutrition. The program serves as a platform for shock-responsive expansion during climate-induced crises, enabling rapid scaling of assistance through adaptive mechanisms. Evaluation evidence indicates positive impacts on household dietary diversity, women's dietary intake, and child anthropometric outcomes, though micronutrient-specific outcomes require strengthened monitoring (World Bank 2021).

Community-based nutrition services and micronutrient interventions: The Ministry of Health and Social Action, through the Cellule de Lutte Contre la Malnutrition (CLM, now integrated within CNDN), implements the Paquet d'Activités Intégrées de Nutrition (PAIN, Integrated Nutrition Activities Package), which combines community-based detection and management of acute malnutrition, antenatal micronutrient supplementation (iron and folic acid), postnatal supplementation, IYCF counseling, and screening through Integrated Management of Childhood Illness protocols. Community nutrition workers, trained and supervised at the district level, conduct routine home visits to identify and refer malnourished children for treatment and provide behavior change communication on optimal feeding practices.

The vitamin A supplementation program provides high-dose vitamin A supplements biannually to children aged 6 to 59 months, achieving national coverage above 85%, but with substantial subnational variation. Antenatal iron and folic acid supplementation programs target pregnant women, though compliance and adherence data suggest suboptimal utilization rates. The Ministry of Agriculture integrates nutrition objectives through home-garden initiatives, nutrient-dense crop production (pulses, vegetables, and fortified grains), and agricultural extension on crop diversification.

PSMN implementation framework: The PSMN 2024–28 serves as the coordinating framework and has organized interventions across six intervention axes: (i) prevention and management of chronic and acute malnutrition; (ii) prevention and management of obesity and diet-related NCDs;

(iii) micronutrient deficiency reduction through fortification, supplementation, dietary diversification, and nutrition education; (iv) availability of diversified, healthy foods; (v) training, research, and innovation; and (vi) governance strengthening. Sectoral ministries (Health, Agriculture, Education, Water and Sanitation, and Social Development) have developed aligned sector action plans with specific targets, budgets, and monitoring indicators. The CNDN provides strategic coordination, harmonizes sectoral approaches, facilitates multisectoral dialogue, and monitors progress toward national nutrition targets (Government of Senegal 2024).

2.1.5.4 Policy Environment for Food Fortification

Senegal's policy framework for food fortification represents one of West Africa's most advanced and institutionalized systems, grounded in a sustained government commitment over two decades, the generation of technical evidence, and iterative policy refinement.

Strategic policy documents and institutional architecture: The PNDN 2021–25 provides the overarching policy direction, establishing nutrition as a cross-cutting development priority integrated into the broader development agenda. The PSMN operationalizes the PNDN through sector-specific action plans, targets, and resource allocations (Results for Development 2023). Complementing these is the Fortification Strategic Plan (PSF) 2025–29, launched in mid-2025. It provides sector-specific strategic direction to scale and optimize fortification as a cornerstone micronutrient intervention. The Plan Sénégal Émergent (2014) and its successor, the National Transformation Agenda Senegal 2050, with its 2025–29 implementation plan, have identified nutrition security and food autonomy as strategic development pillars, thus creating enabling political space for nutrition investment across government (Government of Senegal 2024).

Mandatory fortification standards and compliance framework: Currently, Senegal mandates fortification of three primary food vehicles: wheat flour (fortified with iron and folic acid since 2009), refined vegetable oil (vitamin A since 2009), and salt (iodized since 1994 and formalized through a 2000 decree). National standards for these vehicles were revised in 2014 to align with ECOWAS regional standards, facilitating intra-regional trade while establishing common quality benchmarks. The Senegalese Association for Normalization (ASN), the official standards-setting body, develops and manages fortification standards in consultation with the Senegalese Committee for the Fortification of Foods in Micronutrients (COSFAM), a multisectoral alliance including the Ministry of Health and Social Action, the Ministry of Industry and Trade, food manufacturers, civil society, and research institutions.

However, compliance assessments reveal substantial gaps. Recent market surveillance conducted in the Dakar and Thiès regions (2025) found that 51.4% of wheat flour samples were fortified below the standard minimum for iron and folic acid, 44.6% of edible oil samples were not fortified with vitamin A, and 23.6% of salt samples were not fortified with iodine. However, among fortified samples, the median iodine content (33.3 mg/kg) exceeded the minimum standard. These compliance gaps reflect multiple systemic challenges: limited factory-level quality assurance infrastructure, inadequate regulatory enforcement, inconsistent monitoring and testing, cost-driven incentives to minimize fortification costs, and insufficient coordination between manufacturers and regulatory authorities. Disparities by origin of production (domestic versus imported) and by food vehicle type underscore the need to strengthen quality assurance mechanisms, third-party verification, and regulatory enforcement (World Food Programme and Nutrition International 2019).

Rice fortification policy status and strategic direction: Despite rice being the most consumed staple (198 g/person/day), rice fortification remains nonmandatory in Senegal, though policy momentum is accelerating toward integration into the national nutrition strategy. The 2019 Landscape Analysis conducted jointly by WFP and Nutrition International, building on prior GAIN/FFI (Food Fortification Initiative) analysis from 2015, provided comprehensive evidence on rice fortification feasibility, demonstrating that fortified rice could contribute one-third of the daily iron recommended nutrient intake across all age groups, addressing a critical gap in current intervention coverage (Global Alliance for Improved Nutrition 2023).

Government institutions, including the Ministry of Health and Social Action and the CNDN, have begun incorporating rice fortification into policy discussions, with the October 2024 school feeding pilot representing the first operationalized deployment of fortified rice through a government program. The PSMN 2024–28 and PSF 2025–29 explicitly include rice fortification as a priority scaling intervention, with targets for voluntary adoption of fortification among large mills and exploratory analysis of mandatory fortification pathways for imported rice. Regional harmonization efforts through UEMOA have commenced, with initial discussions to establish a unified rice fortification standard across member states, though these remain in their early stages.

Institutional coordination and governance: The CNDN, established in 2020 and anchored at the Secretariat General of the Government, coordinates multisectoral nutrition action and serves as the government's primary policy coordination mechanism for fortification. It comprises representatives from relevant ministries, local elected representatives, nongovernmental organizations, civil society organizations, academia, development partners, and the private sector, ensuring inclusive stakeholder engagement. Sectoral working groups, coordinated by lead ministries (health, agriculture, and education), develop action plans and coordinate implementation within sectors. Technical working groups on specific interventions (including a fortification working group) provide evidence-informed guidance on standards, quality assurance, and scaling strategies.

The COSFAM functions as the primary technical platform for fortification policy development, standard-setting, and industry engagement. It brings together Ministry of Health and Social Action representatives, ASN, food manufacturers, industry associations, research institutions (particularly the Food Technology Institute, ITA), international development partners (WFP, GAIN, and Helen Keller International), and civil society, facilitating consensus-based decision-making on fortification standards, implementation modalities, and quality assurance protocols (World Food Programme and Nutrition International 2019).

Regional harmonization and trade considerations: Senegal is a member of both UEMOA (the West African Economic and Monetary Union, comprising eight francophone and lusophone countries) and ECOWAS (comprising 12 members). UEMOA established its own common external tariff (CET) in 2000, with a four-tiered system (0% for essential social goods, 5%, 10%, and 20%) (Union Économique et Monétaire Ouest-Africaine, n.d.). ECOWAS subsequently adopted its own CET, effective January 2015, which builds on the UEMOA structure but adds a fifth tier of 35% for specific goods targeted for economic development, creating trade policy frameworks that influence fortification economics (Economic Community of West African States, 2013). Regional harmonization of fortification standards through UEMOA aims to reduce transaction costs for manufacturers serving multiple markets, enhance mutual recognition of fortified products, and facilitate economies of scale in premix procurement and quality assurance infrastructure.

UEMOA standards currently specify common requirements for the fortification of edible oil (with vitamin A), wheat flour (with iron and folic acid), and iodization of salt. These standards were established through collaborative processes and are aligned with Codex Alimentarius standards and WHO guidelines. However, implementation remains uneven across member states, with compliance varying from near-universal to highly fragmented depending on national enforcement capacity and political commitment. Broader ECOWAS harmonization efforts, initiated through the ECOWAS Health Organization (WAHO) and the Joint Technical Secretariat, seek to extend common standards beyond UEMOA member states. However, member states outside UEMOA face challenges in adopting it due to differing governance structures, enforcement mechanisms, and fiscal frameworks.

Specifically for rice fortification, regional dialogue has commenced within UEMOA to establish harmonized standards. This would facilitate trade in fortified rice and enable the sharing of technical expertise and quality assurance mechanisms. This would also create sufficient market demand to incentivize regional production or procurement of fortified kernels. However, as of 2025, no unified UEMOA rice fortification mandate exists, with implementation approaches varying from pilots (Senegal and Mali) to exploratory planning (other member states) (World Food Programme and Nutrition International 2019).

2.1.5.5 Industry Capacity and Role of Private Players

Senegal's food manufacturing and distribution sectors play instrumental roles in fortification implementation, with capacity constraints, market dynamics, and business models significantly shaping the feasibility and sustainability of fortification scaling.

Wheat flour milling industry: The wheat flour manufacturing sector comprises both industrial-scale modern mills and small-scale artisanal units. Approximately 12–15 registered industrial mills operate nationally, primarily concentrated in Dakar and other urban centers, with a total milling capacity sufficient to support domestic production of fortified flour. Since the implementation of the 2009 policy, industry compliance with mandatory fortification standards has improved substantially. However, market surveillance (2025) reveals that 51.4% of wheat flour samples fall below the standard minimum, with disparities between domestic and imported products. Industrial mills, particularly those with export aspirations, generally maintain higher compliance standards, while smaller, artisanal mills face cost barriers and lack technical capacity for consistent fortification.

Edible oil refining and fortification: The edible oil sector comprises both large industrial refineries and smaller processing units. Edible oil fortification with vitamin A, mandatory since 2009, has achieved relatively high market coverage (55–68% of poor WRA consume sufficient quantities to meet ≥10% of the recommended vitamin A intake). However, current market surveillance (2025) found 44.6% of samples not fortified. The sector benefits from technical expertise regarding fortification (decades of implementation experience), established supply chains for micronutrient premixes, and economies of scale in fortification equipment and testing. But challenges persist, including cost pressures, limited enforcement of standards in informal retail channels, and inadequate quality-assurance infrastructure in smaller mills.

Rice milling infrastructure and fortification readiness: The rice milling sector presents the most critical opportunities and challenges for fortification scale-up. Senegal's rice milling industry remains highly fragmented: approximately 582 rice processing units operate nationally, of which only 63 are

classified as industrial-scale mills with basic mechanization. Only 8 mills possess capacity exceeding 5 ton/h, predominantly located in the Senegal River Valley region and associated with state-run or state-supported enterprises, including the Société d'Aménagement et d'Exploitation du Delta, the primary state rice development agency. These eight large mills represent a total theoretical capacity of 144,000 ton/year at full operation, sufficient to reach nearly 2 million beneficiaries (12% of the population) if fully engaged in fortification (World Food Programme 2019).

The remaining mills, approximately 513 small-scale hullers and semi-mechanized units, process rice using limited, labor-intensive techniques, lack quality assurance infrastructure, and rely on inconsistent input supplies from smallholder farmers. This fragmentation reflects structural features of the rice sector: limited access to credit for mill modernization, high capital requirements for mechanized equipment, seasonal variability in paddy supply, and competitive pressures from cheaper imported rice. Only about 13% of domestically milled rice meets quality standards comparable to imported rice, limiting market competitiveness and the profitability margins available for fortification investment (World Food Programme 2019).

Fortification readiness among large mills varies considerably. Some mills, particularly those engaged with government programs or export markets, have expressed interest and the technical capacity to implement fortification using imported FRK, typically at a 0.5–2% blending ratio by weight, which can be procured from established suppliers (primarily India and Thailand) (Global Alliance for Improved Nutrition 2023).

Pilot implementations with WFP support have successfully demonstrated feasibility: the SFA (Société Sénégalaise des Filières Alimentaires) installed fortification equipment with WFP technical support and obtained marketing authorization (FRA) from the Ministry of Industry and Trade (World Food Programme 2024), representing a first-mover advantage in domestic fortified rice production. However, the broader mill sector faces barriers: the cost of imported FRK (a price premium of approximately 5–10% on final rice), limited access to technical expertise on fortification protocols, uncertain demand from consumers and institutional buyers, and limited regulatory clarity regarding mandatory versus voluntary pathways.

Import and distribution sector: The rice import sector is more concentrated than domestic milling: approximately 13 large trading houses handle imports, with the top four responsible for 66% of total import volume (approximately 1.1 MT of broken rice annually, with 60% from India, 20% from Thailand, and 10% from Brazil) (U.S. Department of Agriculture Foreign Agricultural Service n.d.). These importing companies sell bulk quantities to wholesalers concentrated in Dakar, who then distribute to semi-wholesalers and retailers through established channels. The final retail system comprises approximately 15,000 small boutiques, kiosks, and traditional open-air markets selling 95% of retail rice volume, with 1,000–1,500 modern retailers (supermarkets and convenience stores) selling the remainder.

This import-distribution system presents both opportunities and constraints for rice fortification. Rice from India and Thailand, Senegal's primary suppliers, is already fortified in their countries of origin to meet their countries' mandatory fortification requirements, creating a potential opportunity to leverage pre-fortified imports without additional domestic processing. However, fortification specifications in the countries of origin may differ from Senegalese/UEMOA standards, requiring harmonization negotiations and import verification protocols. The concentration of importers enables relatively straightforward policy engagement for mandatory import fortification. In contrast,

the highly dispersed retail system (15,000+ points) poses challenges for consumer awareness, product authentication, and prevention of mislabeling.

Private sector engagement and partnerships: International development partners, including WFP, Nutrition International, GAIN, and Helen Keller International, actively engage private sector actors through technical assistance, knowledge-sharing, equipment support, and market development initiatives (World Food Programme 2024; Helen Keller International 2024; Food Fortification Initiative n.d.; NYAS Publications 2025). These partnerships have facilitated technology transfer, trained mill operators and manufacturers on fortification protocols and quality assurance, provided financing or cost-sharing for fortification equipment installation, and supported market development through consumer awareness campaigns and retailer training.

International nutrition companies have also engaged: dsm-firmenich provided financial support for the 2024 fortified rice school feeding initiative, representing strategic corporate investment in nutrition-focused business development. Such partnerships reflect growing recognition within the private sector of nutrition as a business opportunity, market differentiator, and driver of brand reputation and consumer loyalty (World Food Programme and Nutrition International 2019).

2.1.5.6 Integration with Social Safety Net Programs

Senegal's social safety net architecture, encompassing cash transfers, food-based assistance, and contingency mechanisms, serves as a critical platform for delivering fortified foods and nutrition interventions, particularly for the most vulnerable populations.

School feeding integration pathway: The school feeding program represents the most mature integration point for fortified foods. WFP-supported school feeding reaches 2.3–3.9 million students, depending on the counting methodology, with consistent rice provision (an average of 150 g/child/day). The October 2024 initiative, piloting fortified rice in 236 schools serving 61,000 students, provides proof of concept for scale-up, with the government expressing a commitment to expanding fortified rice across all school feeding programs. This integration offers several advantages: (i) regular, controlled food distribution enabling assured reach and consumption; (ii) vulnerable age group (school-age children aged 6–15) with demonstrated nutritional benefit from fortification; (iii) institutional buy-in from education and health ministries; (iv) feasibility of curriculum-based nutrition education reinforcing fortification messaging; and (v) demonstrable impacts on school attendance, cognitive function, and academic achievement, strengthening political support (World Food Programme 2024).

Cash transfer program integration: The PNBSF reaches 300,000 households through quarterly cash transfers (World Bank n.d.). Integration of fortification objectives occurs indirectly by encouraging beneficiaries to purchase fortified foods (when available and affordable) and through complementary behavior change communication. However, market access barriers persist: despite fortification mandates, market availability of fortified foods in rural areas and informal retail settings remains limited, and consumer awareness of fortified products and their benefits remains low.

Food assistance programs: WFP operates complementary food assistance programs, including food-for-assets, which provides food or cash-for-work for asset creation during lean seasons; targeted food assistance, providing direct food assistance to vulnerable households during crises; and emergency response mechanisms activated during climate shocks or conflict. These programs

distribute food baskets including fortified wheat flour, fortified oil, and iodized salt, though rice, currently unfortified, remains the dominant cereal component. Integration of fortified rice into these baskets presents a direct opportunity to enhance micronutrient delivery to vulnerable populations while maintaining acceptable commodity volumes and caloric content.

Community health and nutrition service delivery: Community-based nutrition services, delivered through health posts and community health workers in collaboration with local government structures, provide complementary points of integration to promote consumption of fortified foods. Community nutrition workers conduct household nutrition counseling, screen for malnutrition, provide counseling on optimal infant and young child feeding practices (including fortified complementary foods), and deliver micronutrient supplements (World Bank 2021).

2.1.5.7 Population Reach and Coverage Metrics

Quantifying the potential population reach of fortification interventions requires analysis of consumption patterns, coverage of delivery platforms, and the regional distribution of vulnerable populations.

Cereal consumption and rice market reach: Senegal's rice consumption is near-universal, with 93% of the population consuming rice daily (World Food Programme and Nutrition International 2019). With an average per capita consumption of 198 g/day (approximately 72 kg/capita/year), rice reaches significantly broader population coverage than wheat flour (102 g/capita/day) or maize (71 g/capita/day) (World Food Programme and Nutrition International 2019). Consumption is consistent across age groups, with particular relevance for WRA and adolescent girls, high-priority groups for iron and zinc interventions.

Domestic production contributes approximately 35% of the total rice supply (approximately 600,000 tons milled rice annually), while imports constitute 65% (approximately 1.1 MT broken rice annually, on a net basis) (U.S. Department of Agriculture Foreign Agricultural Service 2024). Fortifying the entire domestic production (through mandatory or voluntary mechanisms, with eight large mills) could, in theory, reach approximately 12 million people (70% of the population) at current consumption rates, assuming full compliance and achievement of target fortification levels. Fortifying a proportion of imports could enable even broader reach: fortifying all imported rice (834,837 tons net in 2016) could, in theory, reach over 11.5 million people (70% of the population) (World Food Programme and Nutrition International 2019).

School feeding coverage and nutritional reach: School feeding programs in Senegal reached approximately 369,053 students during the 2022–2023 school year, representing roughly 5% of the 7.21 million school age population, or about 9% of the 3.94 million enrolled students. Coverage varied across education levels, with primary school students receiving the largest share (331,884 students, or approximately 14% of the 2.34 million enrolled primary students), while preschool (23,889) and secondary (13,280) levels showed markedly lower school-feeding reach (Global Child Nutrition Foundation 2024). Coverage gaps affect dropouts, out-of-school children, and children in regions with lower school enrollment, underscoring the importance of complementary interventions (such as social cash transfers and community-based nutrition services) that reach non-school-attending populations.

Regional variation in school feeding coverage reflects underlying patterns of school access and food insecurity: the central and northern arid regions (Saint-Louis, Matam, Tambacounda) and southern regions (Kolda, Sédhiou) experience the highest malnutrition burden and greatest potential nutritional benefit from fortified rice in school meals. The October 2024 initiative targeting Matam and other high-burden regions represents strategic geographic prioritization (World Food Programme 2024), with potential to benefit vulnerable populations in regions with Global Hunger Index scores indicating crisis-level food security.

Vulnerable population distribution: Micronutrient deficiencies are concentrated among children under five years old, pregnant and lactating women, and WRA groups, which have heightened micronutrient requirements and are at heightened risk of deficiency-related health consequences. Geographically, central regions (Saint-Louis, Matam, Tambacounda) and southern regions (Kolda, Sédhiou) reported relatively higher levels of child undernutrition and anemia than the national average. These regional disparities underscore the need for geographically targeted nutrition interventions (ANSD & ICF, 2024).

The PNBSF reaches 300,000 households (approximately 1.5–2 million individuals, assuming a household size of 5–7), representing approximately 9–12% of the population. However, targeting mechanisms based on vulnerability indices mean that beneficiary households are concentrated among the poorest households in each region, aligning well with the regions with the highest micronutrient deficiency burden. School feeding reaches 54% of school-age children, with geographic concentration in marginalized areas. Together, social protection programs reach 10–20% of the population directly, with potential for significant micronutrient impact through strategic integration of fortification (Kampman et al. 2017).

2.1.5.8 Value Chain, Quality Assurance, and Regulatory Frameworks

The sustainability of Senegal's food fortification efforts rests on three interlinked pillars: efficient value chains that deliver fortified foods to consumers, robust quality assurance systems that ensure compliance with standards, and regulatory frameworks that enforce adherence and penalize non-compliance.

The WFP-supported pilot with the SFA represents a promising integrated model. It sources local rice from farmers, blends it with imported FRK at the mill, and distributes it through institutional channels such as school feeding programs. This approach achieves multiple objectives: generating local employment and farmers' incomes through domestic rice procurement, establishing mill-level quality control through standardized blending protocols, simplifying distribution through institutional delivery, and supporting national goals of rice self-sufficiency alongside improved micronutrient nutrition.

Wheat flour and edible oil value chains: Wheat, which is entirely imported due to a lack of domestic production, is processed in approximately 12–15 industrial mills across the country. Fortification with iron and folic acid is mandatory, but compliance remains a challenge; recent assessments found around 51.4% of flour samples below standard thresholds. While mill-level testing is common, enforcement limitations and technical capacity gaps hinder consistent compliance. Urban markets have near-universal access to fortified wheat flour, but rural coverage is limited. Similarly, edible oil fortification relies on imported oilseeds and domestically refined crude oil, with vitamin A added during processing. Given the widespread consumption of oil among both urban and rural

populations, fortified oil reaches broad market coverage, though gaps in quality consistency still exist (World Food Programme and Nutrition International 2019).

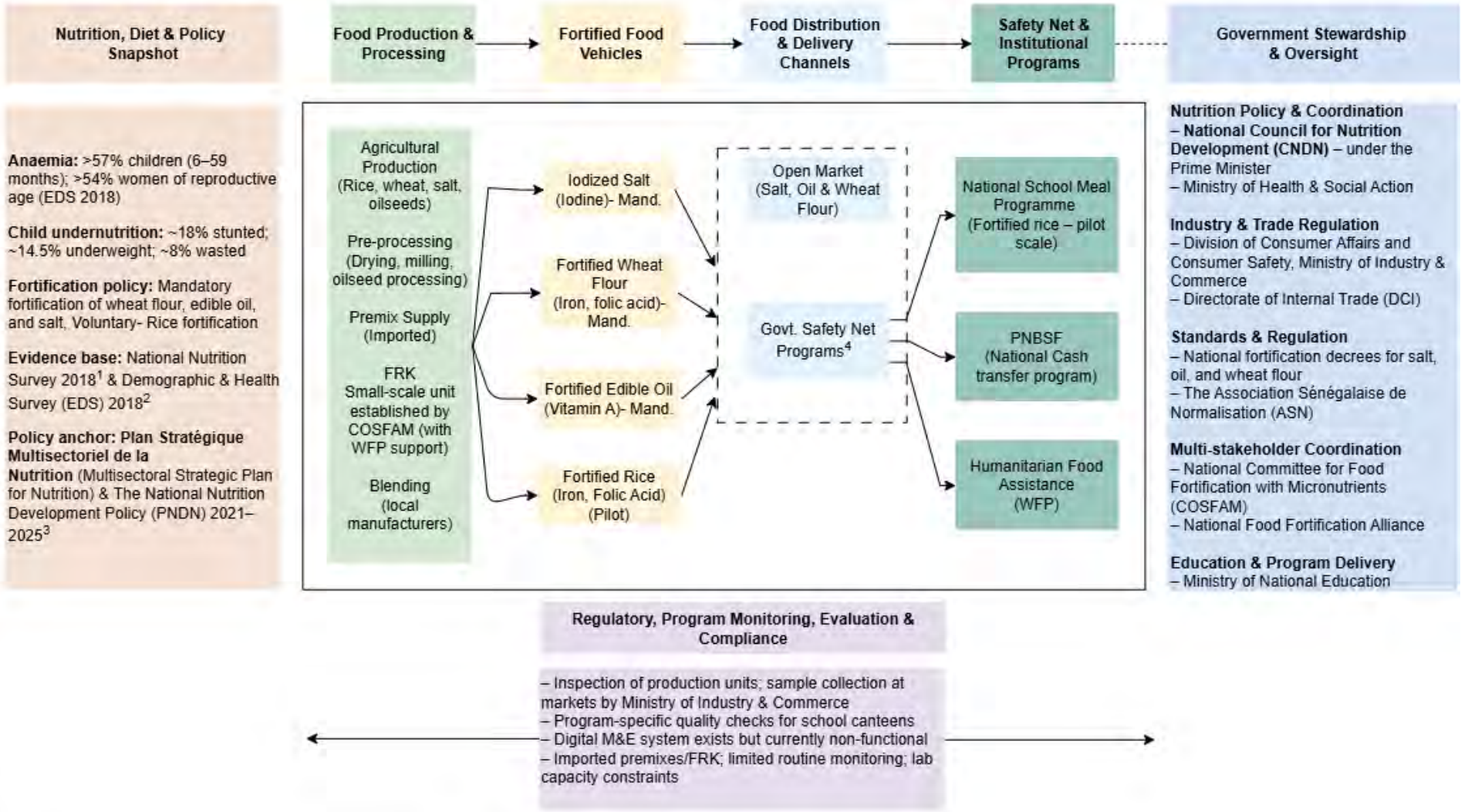
Quality assurance mechanisms and testing infrastructure: Senegal's quality assurance system includes factory-level testing, government laboratory analysis, and regulatory inspection, though capacity and coverage remain uneven. Industrial mills and refineries conduct in-house quality testing with varying levels of sophistication. Large facilities are better equipped, while smaller ones often lack trained technicians or laboratory infrastructure. Government oversight is coordinated by the Directorate of Domestic Trade, which operates a central laboratory to test imported food products and conduct market surveillance. However, resource limitations restrict the frequency and geographic reach of inspections. Independent laboratory capacity remains limited, and most testing continues to rely on government or manufacturer facilities. Infrequent inspections and limited sanctioning mechanisms constrain enforcement by the Ministry of Industry and Trade (Food Fortification Initiative and Global Alliance for Improved Nutrition 2025).

The ASN is the national standards body responsible for developing and managing fortification standards. As ASN lacks enforcement authority, responsibility for monitoring compliance rests with sectoral regulators, such as the Ministry of Health and Social Action and the Ministry of Industry and Trade. This division of roles causes coordination and enforcement gaps: while standards are developed through multi-stakeholder consultation under COSFAM, their implementation and compliance monitoring are fragmented.

Market surveillance in 2025 revealed significant non-compliance: 51.4% of wheat flour, 44.6% of edible oil, and 23.6% of salt were found to be below the required fortification levels. The main drivers include limited technical capacity among smaller producers, cost pressures leading to under-fortification, inconsistent enforcement, insufficient laboratory infrastructure, incomplete market monitoring, and low consumer awareness that fails to reward compliant products.

Regional and international standards harmonization: Senegal's fortification standards align with ECOWAS and UEMOA specifications, supporting intra-regional trade and shared quality-assurance mechanisms while enabling economies of scale in premix procurement. Nonetheless, implementation levels differ across member countries, affecting regional consistency. For rice fortification, a unified UEMOA standard is still under discussion within the Joint Technical Secretariat, with harmonization anticipated in the near term. National standards also draw on global benchmarks established by Codex Alimentarius and WHO guidelines, which provide evidence-based reference points for micronutrient levels, bioavailability, and safety. These international frameworks inform COSFAM's standard-setting processes and ensure alignment with global best practices (Food Fortification Initiative and Global Alliance for Improved Nutrition 2025). Refer to Figure 2.5.

Senegal



Source:

1. NNS: https://groundworkhealth.org/wp-content/uploads/2023/03/ENGLISH_Senegal-Micronutrient-Survey-2018_Report_230307_FINAL.pdf
2. DHS: https://dhsprogram.com/pubs/pdf/FR367/FR367.pdf
3. https://staging.r4d.org/wp-content/uploads/FINAL_PSMN_2018_2022_Expenditure_Assessment_EN.pdf
4. World Bank (2021). Senegal Adaptive Safety Net Project. Social Protection and Resilience. World Bank

Figure 2.5. Senegal's food fortification ecosystem

2.1.5.9 Monitoring and Evaluation Mechanisms

Senegal has established institutional frameworks and developed mechanisms to monitor nutrition interventions and the implementation of fortification programs, though significant capacity gaps persist.

Institutional monitoring architecture: The CNDN, established in 2020, serves as the primary coordination body for nutrition monitoring and evaluation. The CNDN houses technical working groups on specific interventions (including fortification) responsible for developing monitoring frameworks, collecting and analyzing data, and reporting progress toward national nutrition targets. Sector-specific monitoring systems within ministries of health, education, agriculture, and others generate complementary data on intervention coverage and outputs.

For school feeding specifically, the national monitoring system, the School Feeding Monitoring System in Senegal, tracks enrollment, attendance, meals served, and nutritional composition of rations, enabling assessment of program reach and nutritional impact. The system provides regular feedback to the Directorate of School Canteens and WFP for program management and course correction (World Food Programme and Nutrition International 2019).

Nutrition status monitoring: Large-scale nutrition surveys, including the Demographic and Health Survey (DHS), are conducted periodically (most recent in 2023), and specialized micronutrient surveys generate population-level prevalence estimates of stunting, wasting, anemia, and specific micronutrient deficiencies. The DHS 2023 provides current baseline data on stunting (17%), anemia (58–71% children, 54% WRA), vitamin A deficiency, and zinc deficiency. The ITA/COSFAM endline survey on micronutrient status (conducted in 2018 with approximately 5,000 blood samples) provides biomarker data on the prevalence of anemia, vitamin A deficiency, and folate deficiency, enabling assessment of changes since baseline (conducted in 2010). The pending results will inform the assessment of the current fortification program's effectiveness and provide an evidence base for future standard-setting and scaling decisions (National Agency of Statistics and Demography and ICF 2018).

Fortification coverage monitoring: Market surveillance surveys, conducted periodically (most recent in 2025), assess the prevalence of fortified foods in the market and compliance with fortification standards through sampling and laboratory analysis. These surveys provide critical data on: (i) market availability of fortified foods; (ii) compliance with micronutrient content standards; (iii) coverage disparities (urban versus rural, formal versus informal retail); (iv) disparities by product origin; and (v) disparities by manufacturer. However, survey frequency and geographic coverage remain limited due to resource constraints. Surveys conducted by the government, development partners, and research institutions, sometimes with overlapping sampling frames, suggest inefficiencies in survey coordination (Global Alliance for Improved Nutrition 2023).

Household-level consumption monitoring: Household consumption surveys, incorporated into DHS and complementary studies, measure household dietary diversity, per capita food consumption, and specific food consumption frequencies. These data enable estimation of the reach of fortified foods to households and target populations. However, household-level data on fortified food consumption, specifically distinguishing between fortified and non-fortified products, relies on market availability data and household food purchase patterns rather than direct consumption tracking.

2.1.5.10 Stakeholder Ecosystem and Partnerships

Senegal's nutrition and food fortification landscape is characterized by rich multisectoral collaboration that supports policy development and implementation. This extensive engagement among government, development partners, academia, civil society, and the private sector has created an enabling environment for coordinated action. However, it also poses ongoing challenges for alignment and communication among actors.

Government stakeholders: The Ministry of Health and Social Action provides overall leadership on nutrition, houses the CNDN, and guides the national nutrition strategy. The Ministry of Education, through its Directorate of School Canteens, plays a key role in integrating fortified foods into school meal programs. The Ministry of Agriculture, particularly through the Directorate of Rural Development and Agricultural Entrepreneurship, supports the production of fortifiable crops and promotes nutrition-sensitive agriculture. The Ministry of Industry and Trade oversees food safety regulations, import controls, and mill operations, ensuring that fortification aligns with industrial compliance. The Ministry of Social Development implements social protection programs, such as the PNBSF, which integrates nutrition objectives into household support. The ASN, in close collaboration with COSFAM, develops fortification standards and ensures alignment with national regulations.

International development partners: Senegal benefits from strong engagement with international development agencies. The WFP is a key partner through its school feeding and social protection initiatives, as well as its role in piloting rice fortification. Nutrition International provides technical expertise on policy and standard development and has conducted major feasibility studies on rice fortification. GAIN contributes to developing and assessing fortification standards and regulatory compliance. Helen Keller International has long supported advocacy for vitamin A supplementation and fortification. UNICEF provides policy guidance and technical assistance for program monitoring and evaluation. Other actors, including the World Bank, International Fund for Agricultural Development, and bilateral donors from the United States, France, Canada, and Germany, as well as regional organizations such as UEMOA (WAEMU), offer financial and technical support for nutrition and agriculture programs.

Civil society and academic institutions: Civil society organizations, both national and international, advocate for improved nutrition policies, implement community-based interventions, and mobilize public support for fortification. Academic and research institutions provide critical technical expertise. The Université Cheikh Anta Diop (Dakar) and ITA contribute research and evidence to guide fortification policymaking. At the same time, the Senegalese Institute of Agricultural Research supports work on nutrition-sensitive agriculture and on the development of fortifiable crops.

Private sector: It plays a central role in implementing fortification. Key actors include wheat flour mills, edible oil refineries, salt producers, and a growing number of rice mills. Industry associations such as the Senegalese Chamber of Commerce represent the private sector's collective interests and engage in policy dialogue. Global nutrition-focused companies, including dsm-firmenich, contribute technical know-how and investment, underscoring the increasing recognition of nutrition as a shared business and public health priority.

The Senegalese Committee for the Fortification of Foods with Micronutrients: COSFAM serves as Senegal's primary multisectoral coordination platform for food fortification. It convenes representatives from the Ministry of Health and Social Action, ASN, food industries, research

institutions, and development partners. The committee functions through plenary meetings and specialized technical working groups focused on individual vehicles (e.g., wheat flour, oil, rice, salt, bouillon) and crosscutting areas such as quality assurance and consumer awareness. COSFAM facilitates evidence-based dialogue, consensus building, and policy harmonization. However, meeting frequency and participation vary depending on resource availability and institutional priorities (Government of Senegal 2024).

International and regional networks: Senegal actively participates in global and regional nutrition initiatives, including the Scaling Up Nutrition movement, which it joined in 2012. This platform strengthens multisectoral collaboration among government, civil society, the private sector, and partners. Regional institutions such as UEMOA and ECOWAS further support harmonization of fortification standards and foster policy dialogue across West Africa.

2.1.5.11 Critical Challenges and Policy Reforms Needed

Compliance and quality assurance gaps: Despite Senegal's strong policy framework, compliance with quality standards remains challenging. Market surveillance (2025) found 51.4% of wheat flour, 44.6% of oil, and 23.6% of salt samples failed to meet national standards, highlighting discrepancies between policy objectives and their implementation. Key factors include limited technical capacity among small producers, high production costs, inconsistent enforcement and sanctions, inadequate laboratories, infrequent market monitoring, low consumer awareness, and poor regulatory coordination.

Improving compliance requires enhanced laboratory and surveillance capacity, third-party certification, consistent enforcement with transparent sanctions, targeted technical support for small manufacturers, consumer education to strengthen demand for fortified foods, and digital data systems to improve traceability and accountability.

Nutrition financing gaps and budgetary constraints: Although nutrition expenditure grew by 23% between 2018 and 2022, total allocations remain inadequate. Government spending under PSMN (CFA 247 billion over five years, approximately US$ 84–88 million annually) is modest for a population exceeding 19.37 million with widespread micronutrient deficiencies. Most funding goes to WASH and health, while agriculture and micronutrient interventions receive limited support. Community nutrition and school feeding programs are underfunded; only 17% of needs were met in 2024, leaving a US$5.4 million gap.

Closing financing gaps calls for stronger nutrition integration into sectoral budgets, dedicated budget lines, nutrition-sensitive tax measures (e.g., tariff relief for fortified goods and premixes), and innovative financing instruments such as results-based funding and private sector partnerships (Results for Development Institute 2020).

Implementation bottlenecks and coordination deficits: Fragmentation across health, agriculture, education, and industry agencies poses challenges to program execution. Overlapping mandates and unclear accountability reduce efficiency. The rice sector lacks an integrated governance model covering the full value chain, hampering efforts to align rice fortification and self-sufficiency goals. Standards developed by ASN, in coordination with COSFAM, face challenging enforcement, and data systems across surveillance, consumption, and monitoring remain disconnected. Private sector engagement in policymaking is also limited.

Critical reforms include establishing a cross-sectoral rice policy platform, clarifying enforcement mandates through regular performance reviews, integrating nutrition and market data systems, and institutionalizing private sector participation in policy dialogue.

Consumer awareness, acceptance, and behavior change: While awareness of fortified foods is growing, understanding of their benefits remains low, especially in rural areas. Encouraging consumer adoption may require nationwide social and behavior change communication campaigns, retailer education, school-based nutrition curricula, and community mobilization through local influencers. Reducing costs along the value chain can also improve affordability for low-income consumers.

Supply chain fragmentation and value chain modernization: A fragmented milling sector constrains Senegal's rice fortification scale-up. Approximately 87% of production comes from small hullers that lack the technical and financial capacity for fortification. Irregular paddy supply, low production quality, and limited competitiveness against imports worsen the challenge.

Modernizing the value chain requires consolidating mills through cooperatives or contract models, providing technical and financial support for equipment upgrades, improving farmer organization and paddy collection, monitoring quality standards, and strengthening market linkages with institutional and commercial buyers (Global Alliance for Improved Nutrition 2023).

Climate vulnerability and food system resilience: Senegal's food security remains vulnerable to climate shocks, droughts, and floods, which reduce yields, distort markets, and increase household vulnerability. Rural livelihoods suffer from income loss, migration pressures, and asset depletion.

Building resilience requires integrating nutrition within climate adaptation programs, promoting drought-tolerant crops and water-efficient farming, scaling shock-responsive social protection, strengthening local value chains to reduce import dependency, and ensuring nutrition-sensitive climate strategies.

Regional harmonization and trade considerations: Regional standardization efforts through UEMOA and ECOWAS aim to unify fortification norms, but implementation remains uneven due to varying capacities and political commitments. Gaps in trade policy alignment and a lack of mutual recognition mechanisms further hinder progress.

Priority actions include harmonizing standards through inclusive processes, building regulatory enforcement capacity, aligning trade rules with fortification objectives, and establishing regional accreditation and certification systems.

Nutrition financing strategic priorities: To close financing deficits, Senegal may strengthen domestic resource mobilization through sectoral budgets, develop innovative financing tools (e.g., nutrition bonds, blended finance, and results-based contracting), foster private sector investment, enhance coordination among development partners, and enact fiscal reforms such as tariff exemptions and simplified regulations to reduce fortification costs and enhance private sector participation.

2.1.5.12 Opportunities and Future Directions

Despite challenges, Senegal's fortification landscape offers strong potential for scale-up, supported by an enabling policy environment, proven technical feasibility, and alignment with national development priorities.

Rice fortification - a high-impact opportunity: Rice, which is consumed daily by approximately 93% of Senegal's population (on average 198 g per person per day) (WFP 2019), serves as a strategic vehicle for nationwide micronutrient delivery. Evidence confirms its potential as a high-impact intervention, given the high burden of iron and zinc deficiencies, demonstrated technical feasibility from pilots, strong consumer acceptance (88% interest, 63% willing to pay a premium), and clear integration points with school feeding, social safety nets, and imported rice supply chains. Scaling options include:

- **Phased mandatory fortification:** Begin with imported rice and large mills for rapid impact, expanding as capacity grows.
- **Voluntary incentives:** Use tariff reductions and preferential procurement to engage industry.
- **Integration with social safety nets:** Embed fortified rice in school meals, cash transfers, and emergency food programs.
- **Regional harmonization:** Pursue UEMOA/ECOWAS fortification standards to achieve economies of scale in fortified kernel supply.

Universal rice fortification could meet one-third of daily iron needs and 15–20% of zinc requirements, potentially lowering anemia prevalence by 10–15 percentage points within a decade.

Strengthening existing fortification programs: Long-standing wheat flour and oil fortification programs (operational for over 15 years) require revitalization to enhance their effectiveness and maximize public health impact. Key priorities include enhancing compliance (addressing non-compliance in flour and oil), updating standards to incorporate zinc and B12, expanding coverage in rural areas, and ensuring alignment with rice fortification efforts that comprehensively address multiple micronutrient gaps.

Leveraging social safety nets: Institutional platforms such as school feeding programs (3.9 million children) and PNBSF (1.5–2 million individuals) offer effective channels for distributing fortified food. Opportunities include expanding fortified rice pilots nationwide, linking PNBSF with fortification promotion through cash transfer points, integrating fortified food into emergency assistance, and using these programs to test delivery and behavior change strategies.

Value chain modernization and private sector growth: Modernizing Senegal's rice value chain strengthens the foundation for fortification. Priorities include mill consolidation and cooperative models to enable investment; building domestic milling capacity through equipment and training; enhancing farmer productivity to ensure a steady supply; partnering with global nutrition companies for financing and technical support; and offering fiscal incentives such as reduced tariffs on fortified kernels and tax breaks to enhance economic viability.

Institutional strengthening and coordination: Sustained progress requires strong institutional mechanisms. Actions include establishing an inter-ministerial body to coordinate rice and nutrition policies, building regulatory capacity for monitoring and enforcement, developing integrated data systems for coverage and impact tracking, formalizing private sector participation within COSFAM, and advancing regional collaboration on harmonized standards and enforcement.

Community engagement and behavior change: Awareness and behavior change are critical to the success of fortification. Opportunities include launching a national communication campaign on fortified foods and their micronutrient health benefits, training small retailers as information agents, integrating fortification messages into community health counseling, embedding nutrition education in schools, and ensuring inclusive outreach to rural populations with high malnutrition and low awareness.

Evidence generation and research: Ongoing research is essential to refine strategies and prove impact. Priorities include consumer acceptance studies to address sensory and trust concerns, evaluations of nutritional impact, economic and value chain analyses to identify cost efficiencies, cost-effectiveness comparisons with other interventions, and behavioral studies to identify approaches for encouraging consumer adoption.

Political economy and sustainability: Long-term sustainability depends on political will, domestic financing, and stakeholder commitment. Opportunities include strengthening accountability for PSMN targets, integrating nutrition across sectoral plans, increasing government investment through budget alignment and innovative financing, incentivizing private sector participation through market and fiscal measures, and ensuring civil society involvement in advocacy and monitoring.

Alignment with Senegal 2050 Development Agenda: These directions align with Senegal's Vision 2050 goals of human capital development, food sovereignty, and economic transformation. By improving micronutrient nutrition, rice fortification enhances cognitive and physical development, supports agricultural productivity, and strengthens food systems. Synergy with the National Rice Self-Sufficiency Program and value chain modernization fosters both nutritional and economic resilience.

2.2 Asia

The Asian context, represented by Bangladesh, India, Indonesia, Myanmar, Sri Lanka, and Vietnam, reveals widespread micronutrient deficiencies affecting large segments of the population. India and Bangladesh show extremely high anemia rates among children (67% and 64%, respectively) and significant deficiencies in iron, folate, vitamin A, and zinc. Rice is the predominant staple across all countries, with complementary consumption of wheat, edible oils, and milk in some areas.

Indonesia faces a “triple burden” of malnutrition, coexisting undernutrition, micronutrient deficiencies, and rising overweight and obesity, highlighting the need for both fortification and broader food system reforms. Myanmar’s nutrition indicators are compounded by conflict-related food insecurity, low dietary diversity, and supply chain disruptions, underscoring the need for resilient, accessible fortification initiatives.

While most countries in South and Southeast Asia have fortification policies in place, enforcement, industry incentives, and monitoring infrastructure vary. For instance, India has introduced standards for fortifying rice, wheat, oil, and milk, yet enforcement and coverage differ across states. Bangladesh and Indonesia have established mandatory fortification of edible oil and wheat flour, supported by active regulatory oversight and institutionalized compliance mechanisms. Sri Lanka mandates the fortification of salt and wheat flour and has introduced voluntary rice fortification alongside established standards for both salt and rice; however, enforcement is effective only for

salt, while implementation of rice fortification remains in progress. The Ministry of Health in Sri Lanka strictly regulates fortification of other grain-based food products. In contrast, Myanmar continues to rely largely on voluntary fortification initiatives with limited coverage and scale, resulting in uneven population-level impact.

Socioeconomic and demographic divides also influence the impact of fortification. Urban and wealthier populations often consume packaged or branded staples, increasing their exposure to fortified foods, while rural and lower-income groups depend on locally milled, unfortified products. This disparity necessitates targeted policies to enhance equity and reach.
The dominance of rice, wheat flour, and edible oils across the region remains a critical entry point for fortification. However, designing effective interventions must consider country-specific dietary patterns, reliance on imports, policy maturity, and socio-political factors.

2.2.1 Bangladesh

2.2.1.1 Nutrition and Fortification Ecosystem

Bangladesh presents a unique socioeconomic and demographic context that fundamentally shapes its food fortification strategy and the landscape of nutrition security. As the eighth-most populous country globally, Bangladesh houses approximately 170 million people within a compact area of 148,460 km2, resulting in one of the world's highest population densities at 1,350 people/km2 (Bangladesh Bureau of Statistics 2023). This demographic concentration creates both significant opportunities and substantial challenges for implementing large-scale nutrition interventions that can effectively reach vulnerable populations.

The country has undergone a dramatic demographic transition, with the total fertility rate declining substantially from approximately 7.0 in the 1970s to 1.93 in 2022 (National Institute of Population Research and Training, Mitra and Associates, and ICF 2023). The median age is approximately 26-28 years, with 26% of the population under 14 years old and only 6% over 65 years old. This relatively young population structure creates an urgent need to address childhood and maternal nutrition outcomes, as these early-life periods establish trajectories for lifelong health and development. The ethnic composition shows that Bengali people comprise 98-99% of the population, with religious representation including 91.04% Muslims, 7.95% Hindus, 0.61% Buddhists, and 0.30% Christians (Bangladesh Bureau of Statistics 2023). This demographic homogeneity has simplified certain aspects of nutrition programming, as dietary patterns and cultural food preferences tend to be

relatively consistent across the population, thus facilitating the selection of appropriate fortification vehicles and dietary messaging strategies.

Geographically, Bangladesh shows a significant rural-urban divide, with 42.6% of the population residing in urban areas, while the majority live in rural regions (World Bank 2024). This distribution has profound implications for implementing food fortification strategies, as rural populations may have different access patterns to fortified foods and may rely more on locally produced staples than on centrally manufactured products. The Chittagong Hill Tracts, Sylhet, Mymensingh, Barisal, and North Bengal regions host diverse tribal populations with potentially distinct nutritional needs and food consumption patterns that require targeted intervention design.

Bangladesh faces significant development challenges related to nutrition security, including persistent poverty that affects a large portion of the population and susceptibility to climate-related shocks. The country has faced increased cyclones, droughts, and floods that disrupt food production and distribution systems. The dual challenges of rising flood levels and more intense heat days further complicate agricultural difficulties (Bangladesh Meteorological Department 2023). These environmental pressures reduce crop yields, strain livestock health, and alter pest and disease distribution patterns. The dual crises created by climate change impacts and global conflict have led to significant surges in staple food, fuel, and fertilizer prices that profoundly affect both fortification program costs and household purchasing power. These economic pressures particularly impact rural and economically disadvantaged populations, who are priority targets for fortification interventions.

Despite these challenges, Bangladesh has demonstrated a growing commitment to addressing malnutrition through evidence-based programming. The country has established a robust policy framework, including the National Food and Nutrition Security Policy and various fortification regulations, and has implemented large-scale programs fortifying rice, wheat flour, and edible oil through social safety net programs that reach a cumulative total of around 15 million beneficiaries (World Food Programme 2024). This progressive policy environment, combined with demonstrated implementation capacity and growing technical expertise, has helped Bangladesh continue to expand and optimize its food fortification initiatives to address persistent micronutrient deficiency challenges.

2.2.1.2 Nutritional Status and Dietary Practices

The nutritional landscape in Bangladesh reflects a complex pattern of progress alongside persistent and severe challenges, particularly affecting children aged 6 to 23 months and WRA. Bangladesh faces severe micronutrient deficiencies that significantly affect the population's health outcomes. The National Strategy for Anaemia Prevention and Control recognizes anemia as a severe public health problem, according to international classification criteria. It affects 46% of pregnant women, 64% of children aged 6 to 23 months, 42% of children aged 24 to 59 months, 30% of adolescent girls, and 33% of nonpregnant women (Ministry of Health and Family Welfare 2020). Different national surveys report varying anemia prevalence estimates depending on age group, geographic coverage, and methodology. More broadly, the prevalence of anemia among children under five years old is 21.1%, highlighting a significant burden that requires urgent intervention (National Institute of Population Research and Training 2022).

The National Micronutrient Survey conducted in 2019-20 revealed additional concerning patterns of deficiency across the population. Among preschool children, 21% were deficient in vitamin A, 11% in iron, and 45% in zinc, prevalence rates that substantially exceed acceptable public health thresholds (National Nutrition Service and OPHS 2020). Among women, the survey found that 5% were deficient in vitamin A, 7% in iron, and 57% in zinc. Furthermore, 9% of women were deficient in folate and 6% in vitamin B12, indicating widespread micronutrient inadequacies across multiple nutrients, which can be effectively addressed through systematic food fortification (National Nutrition Service and OPHS 2020). The distribution of these deficiencies varies significantly by geography. Urban preschool children have a higher anemia prevalence than their rural counterparts, while pregnant women exhibit the opposite trend. Within urban areas, slum populations experience higher rates of anemia compared to those in non-slum areas. Additionally, the Chittagong Hill Tracts region shows particularly elevated anemia rates compared to other rural areas, underscoring the need for targeted interventions in specific geographic regions.

Childhood malnutrition remains a significant public health concern in the country despite notable improvements over the past decade. According to the Global Nutrition Report, 28.0% of children under five years old are affected by stunting. This is more than Asia's average of 21.8%, indicating that Bangladesh lags behind its regional peers in achieving optimal linear growth outcomes. The prevalence of wasting among children under five years old is 9.8%, which is higher than the regional average of 8.9%. Additionally, 27.8% of infants are born with low birth weight, indicating prenatal nutritional deficiencies that continue to impact child development trajectories from the earliest stages of life (Development Initiatives 2023).

Rahman et al. (2025), using selected Bangladesh Demographic and Health Survey (BDHS) 2022 cohorts, have reported lower prevalence estimates than earlier national surveys. These figures demonstrate that while some progress has been made compared to earlier surveys, malnutrition remains a critical challenge requiring sustained intervention through fortification and complementary nutrition-specific programs. Particularly concerning are the age-specific patterns of malnutrition, with children aged 6 to 23 months being the most vulnerable. This critical development window coincides with the introduction of complementary foods and represents a period when micronutrient needs are exceptionally high relative to body size. The high malnutrition rates during this period emphasize the importance of ensuring that staple foods consumed by these children and their caregivers are adequately fortified with essential micronutrients.

Dietary practices and food consumption patterns: Current dietary practices among target populations reveal patterns that both support and challenge fortification strategies. Rice consumption is exceptionally high, constant, and widespread across Bangladesh, making it the most promising vehicle for population-wide fortification. The predominant dietary pattern shows that 70% of the diet consists of cereals, with inadequate protein and micronutrient intake. This significant dependence on cereals, particularly rice, presents an excellent opportunity for fortification interventions, as this staple food vehicle is consumed daily by nearly the entire population. However, the limited dietary diversity also makes fortification even more critical for addressing micronutrient gaps that cannot be met through natural food variety, as dietary diversification remains constrained by both economic factors and dietary preferences. Similarly, edible oil is widely consumed across socioeconomic groups, supporting its suitability as a fortification vehicle (Suthakaran and Islam 2016).

This consistency in consumption across socioeconomic strata means oil fortification can achieve relatively equitable reach across the population. Breastfeeding practices show some positive trends, with 62.6% of infants aged 0 to 5 months exclusively breastfed, representing progress toward achieving nutrition targets. However, complementary feeding practices during the critical period of 6 to 23 months require improvement. This is an important time when fortified foods can significantly help prevent micronutrient deficiencies that can lead to stunting and other forms of malnutrition. The dietary patterns also show significant gender disparities in nutrition outcomes associated with maternal education. In urban areas, 69% of children with illiterate mothers suffer from anemia, while only 37% of children whose mothers have secondary education or higher experience the same condition. This suggests that fortification programs may have varying effects based on household socioeconomic characteristics, which food-based interventions alone do not directly address (National Institute of Population Research and Training, Mitra and Associates, and ICF 2023).

2.2.1.3 Nutrition-related Flagship Program

The central health-sector platform is the Health, Population and Nutrition Sector Development Program. This program integrates nutrition into a comprehensive framework instead of treating it as a stand-alone project. The Ministry of Health and Family Welfare employs a single program implementation plan to organize "operational plans" for different thematic areas, ensuring that nutrition is incorporated into service delivery through both the Directorate General of Health Services and the Directorate General of Family Planning. A key strategic shift in the sector program involves moving away from earlier geographically targeted vertical projects, such as the Bangladesh Integrated Nutrition Programme, towards nationwide community-based and facility-based nutrition services within the routine primary health care system.

Within this sector-wide platform, the flagship nutrition-specific initiative is the National Nutrition Services (NNS), launched in 2011 to anchor government nutrition programming and integrate it into existing health and family planning programs. NNS focuses on maternal, infant, and young child nutrition. This includes counseling on breastfeeding, complementary feeding, micronutrient supplementation, and growth monitoring and promotion. These services are primarily delivered through community clinics and frontline workers, such as community health care providers, family welfare assistants, and health assistants. Over time, NNS has prioritized strengthening last-mile delivery by building community health workers' capacity, investing in social and behavior change communication, and integrating growth monitoring and promotion with the expanded program on immunization and maternal health contacts. This approach aims to increase coverage and ensure continuity of services (Rahman et al. 2025).

Bangladesh's flagship nutrition response encompasses a comprehensive set of national policies and crosscutting investment plans that guide and shape programmatic action, even though they are not "programs" in the narrow project sense. The National Plan of Action for Nutrition (NPAN2) 2016-25 and the National Strategy on Prevention and Control of Micronutrient Deficiencies (2015–24) articulate multisector actions across health, food, agriculture, education, and social protection, while the Bangladesh Essential Health Service Package defines the core nutrition interventions that may be available at the primary care level. Complementing these efforts, the Nutrition-Sensitive Food Systems (2016–20): Programming framework sets out priority nutrition-sensitive interventions "from production to plate," signaling a deliberate shift to leverage agriculture, markets, and value chains to improve diets and address hidden hunger.

Beyond the health sector, several major social protection and food-based schemes serve as nutrition-sensitive flagships by providing food or cash with explicit nutrition objectives or a strong potential to improve diets. Evaluations of the joint government–UNICEF nutrition program highlight that Bangladesh has a "plethora of food- or cash-based social safety net programs." These programs are part of efforts under NPAN2 and related strategies aimed at expanding coverage and improving targeting for nutritionally vulnerable groups, such as adolescents, pregnant and lactating women, and households in urban slums. International reviews of nutrition-sensitive social protection highlight Bangladesh's engagement with research on transfer modalities and school feeding type initiatives. This is part of a broader effort to make social protection more nutrition- and gender sensitive, even when individual schemes may have different names and implementing agencies (UNICEF n.d.).

2.2.1.4 Policy Environment for Food Fortification

Bangladesh has established a comprehensive policy framework for food fortification. The framework encompasses coordination across multiple levels of government, strategic planning, and integration with broader nutrition and food security objectives. The National Food and Nutrition Security Policy, approved in August 2020, provides the overarching framework for Bangladesh's fortification efforts. This represents the first integrated food and nutrition security policy formulated by the Government of Bangladesh and establishes five key objectives that directly support and align with fortification initiatives: ensuring availability of safe and nutritious food for healthy diets, improving access to affordable nutritious food, enhancing consumption and utilization of healthy diversified diets, increasing access to nutrition-sensitive social protection, and strengthening cross-sectoral governance and coordination.

The Plan of Action accompanying the National Food and Nutrition Security Policy spans 2020 to 2030, and aligns with both the Eighth Five-Year Plan (2020-25) and the Ninth Five-Year Plan (2025-30). This alignment provides stability for fortification investments and allows for the systematic scaling up of interventions (Ministry of Food 2020). This long-term planning horizon represents a significant commitment to sustainable nutrition programming, highlighting the need for continuous, coordinated investment to achieve meaningful improvements in micronutrient status over extended periods. The policy framework builds on established foundations, including the National Food Policy 2006 and the National Nutrition Policy 2015, and aligns with the Sustainable Development Goals framework and the evolving understanding of nutrition challenges. This evolutionary approach ensures that the policy framework benefits from accumulated experience and emerging evidence regarding effective nutrition interventions.

2.2.1.5 Regulatory Framework and Technical Standards

The Bangladesh Food Safety Authority is the primary regulatory body that oversees food fortification standards, compliance, and enforcement. The Draft Food Fortification Regulation 2023 proposes comprehensive guidelines, covering mandatory and voluntary fortification requirements, technological specifications, packaging and labeling standards, micronutrient compliance parameters, and registration procedures for fortified foods. This regulatory framework provides essential legal backing for fortification programs and ensures consumer protection and product quality through consistent application of science-based standards.

The regulatory approach distinguishes between mandatory and voluntary fortification, recognizing that different policy mechanisms may suit different food vehicles and market contexts. Schedule I

specifies mandatory micronutrient levels for designated food vehicles, ensuring that essential micronutrient fortification reaches all consumers. Schedule II outlines voluntary fortification standards, allowing food manufacturers to enhance their products beyond minimum standards as a market-driven strategy to meet consumer preferences and competitive positioning. This tiered approach allows both population-wide intervention through mandatory requirements and market-driven innovation through voluntary enhancement beyond minimum standards (Bangladesh Food Safety Authority 2023).

An established laboratory infrastructure coordinated by the Bangladesh Food Safety Authority supports quality standards and testing requirements. The accredited laboratory network includes 18 facilities capable of conducting food and micronutrient testing, distributed across the country to provide accessible testing services. Key government facilities include the National Food Safety Laboratory at the Institute of Public Health, the Institute of Food Science and Technology at the Bangladesh Council of Scientific and Industrial Research, and specialized laboratories within major food companies such as ACI Foods Limited and the PRAN Quality Control Laboratory. University-based facilities, such as the Central Laboratory at Hajee Mohammad Danesh Science and Technology University in Dinajpur, offer both testing services and research capabilities to support program innovation and improvement. In addition, international standard laboratories, including SGS Bangladesh Ltd., Bureau Veritas Bangladesh, and TÜV SÜD Bangladesh, provide additional testing capacity and global certification services. This ensures that Bangladesh's fortified products can meet international quality standards and support potential export opportunities (Bangladesh Food Safety Authority 2024).

2.2.1.6 Multi-ministerial Coordination and Institutional Roles

The Ministry of Health and Family Welfare plays a vital role in coordinating through the National Institute of Population Research and Training (NIPORT), which coordinates national demographic and health surveys in collaboration with international technical partners. These surveys help guide program adjustments based on emerging evidence. The ministry's program management and monitoring unit works closely with technical partners to ensure programming and systematic evaluation of fortification impacts. The Ministry of Food oversees the distribution of fortified rice through social safety net programs. District-level controllers manage local implementation and ensure that distribution targets are met effectively. Additionally, the Ministry of Women and Child Development coordinates programs targeting vulnerable women and children. This ensures that fortification efforts align with broader social protection strategies and gender-specific nutrition needs.

While this multi-ministerial approach necessitates sophisticated coordination mechanisms, it enables comprehensive coverage across different population segments and service delivery channels. The involvement of multiple government entities acknowledges that nutrition security is inherently multisectoral and requires coordination across health, food security, education, and gender equality. Technical working groups facilitate coordination among government agencies, research institutions, and international partners to ensure coherent program implementation and identify synergies among different nutrition interventions and service delivery platforms.

2.2.1.7 Industry Capacity and Role of Private Players

Bangladesh has developed a foundational capacity to produce fortified foods across multiple staple crops, though challenges remain in scaling production to meet national coverage targets and maintaining consistent quality standards across distributed manufacturing facilities. The fortification program has expanded beyond rice and includes wheat flour and edible oil as additional vehicles for micronutrient delivery. Recently, the Millers for Nutrition coalition was launched during the BAPA Food Pro Expo 2025. This coalition supports millers in fortifying wheat flour, edible oil, and rice with vital micronutrients. It represents a significant step toward strengthening the technical capacity of food manufacturers and ensuring consistent fortification standards across different food vehicles. The coalition serves as a platform for knowledge sharing, technical support, and collaborative learning among manufacturers. It creates positive peer pressure to adopt fortification practices and helps smaller producers meet technical and regulatory requirements (Milling Middle East & Africa n.d.). Additionally, industry recognition programs have emerged to incentivize excellence in fortification practices and drive quality improvements within the manufacturing sector. Champion Millers receive recognition for their progress in fortifying food products, with awards such as Industry Ambassador of Food Fortification, Voice of Fortification Excellence, and Woman Leader in Food Fortification (World Grain 2025).

Despite progress in establishing fortification capacity, local production of fortification premix and fortificants remains limited. This creates a dependency on imported materials, which affects both program sustainability and cost-effectiveness. While Bangladesh has developed domestic capacity for FRK production and blending, it often imports the underlying vitamin and mineral premixes. This reliance creates potential supply chain vulnerabilities and foreign exchange costs that affect program economics. Producing FRKs through extrusion and maintaining consistent micronutrient levels during blending with regular rice requires sophisticated technical expertise and equipment maintenance. Variations in manufacturing practices across facilities can lead to inconsistent product quality and micronutrient content, thereby reducing the program's effectiveness. Blending efficiency and quality control across distributed manufacturing facilities poses ongoing challenges that require continuous technical support and monitoring.

Storage and transportation infrastructure limitations affect the maintenance of fortified product quality from production to consumption. Bangladesh's tropical climate and high humidity require careful attention to packaging and storage protocols to prevent micronutrient degradation, particularly of vitamin A and other sensitive compounds. Inadequate cold-chain facilities and extended distribution networks can compromise product quality, especially in rural areas where infrastructure limitations are most pronounced. These infrastructure constraints create a conflict between the goal of providing wide geographic coverage and ensuring product quality throughout the supply chain.

Developing the market for voluntarily fortified products in Bangladesh faces challenges due to limited consumer awareness and a lack of willingness to pay higher prices for enhanced products. While mandatory fortification through social safety nets ensures access for vulnerable populations, achieving broader market penetration requires improved consumer education and economic incentives that are still not fully developed in Bangladesh. Limited consumer awareness of the benefits of fortified foods leads to hesitation to purchase higher-cost products, even when those additional costs reflect genuine quality improvements through micronutrient addition.

2.2.1.8 Integration with Social Safety Net Programs

Bangladesh has strategically leveraged its social protection system as the primary mechanism for delivering fortified foods to vulnerable populations most at risk of micronutrient deficiencies. Distribution occurs primarily through established social safety net programs, including the Vulnerable Women Benefit Program and the Food Friendly Program. These programs provide subsidized fortified rice to approx. 5 million beneficiaries during lean seasons. This approach utilizes existing government infrastructure, including registration systems, community-based targeting mechanisms, and payment distribution systems. At the same time, it ensures that fortified foods reach populations most at risk of micronutrient deficiencies. The integration of fortification with existing social protection mechanisms represents a strategic advantage for Bangladesh, as it enables efficient delivery while building on proven implementation capacity developed over years of social protection program implementation (World Food Programme 2024).

Integrating fortification with the NNS planned nationwide expansion represents a strategic opportunity to achieve comprehensive coverage. The program includes behavior change communication, growth monitoring and promotion, supplementary feeding, and micronutrient supplementation targeting children under two years old, pregnant/lactating mothers, and adolescent girls. Plans for a nationwide scale-up indicate the government's commitment to expanding coverage by setting timelines and resource requirements, which remain important considerations for realistic planning and resource mobilization. As the NNS scales from its current coverage to a national geographic scope, fortification interventions can be systematically integrated into service delivery platforms, behavior change communication strategies, and monitoring systems, creating synergies with other nutrition interventions while building comprehensive community-level nutrition support systems.

This approach of integrating fortification with social protection systems creates significant implementation advantages but also defines important coverage boundaries. By linking access to fortified food to social protection eligibility, the program ensures that vulnerable populations receive priority access to fortified foods, but access remains contingent on participation in social protection programs. This creates coverage gaps for vulnerable populations who may not qualify for existing programs or who fall through administrative cracks in targeting and enrollment systems. Dependence on social protection mechanisms also makes fortification coverage vulnerable to changes in social protection policy, funding allocations, or program administration as government priorities shift over time.

The sustainability advantages of integrating fortification with social protection may also be recognized. The Bangladesh government has demonstrated sustained political commitment to social protection programs, and integrating fortification into these programs provides greater assurance of continued support than standalone nutrition programs, which may face more unstable funding environments. The established delivery and accountability mechanisms within social protection systems also provide infrastructure to monitor fortification coverage and assess program performance against defined targets.

2.2.1.9 Population Reach and Coverage Metrics

The rice fortification program in Bangladesh, launched by the government in 2013, initially reached approximately 30,000 beneficiaries and has since expanded substantially through social safety-net platforms (World Food Programme 2023). As of recent estimates (2023–2024), the program directly reaches around 15 million beneficiaries, equivalent to roughly 8.7% of the total population, primarily through targeted schemes for vulnerable groups (World Food Programme 2023). In contrast, broader estimates of 7–15 million people reflect indirect or potential reach, including individuals accessing fortified rice through expanded program phases or market-based distribution channels. Despite this growth, population-level coverage remains limited, with the majority of Bangladesh's population still relying on non-fortified staples purchased through open markets. Market-based initiatives, including efforts by the Millers for Nutrition Coalition, aim to expand voluntary fortification and increase indirect reach among urban and middle-income populations. This distinction between direct (social protection-based) and indirect (market-based or potential) coverage is critical for accurately interpreting program scale and identifying persistent gaps in equitable access.

2.2.1.10 Value Chain, Quality Assurance, and Regulatory Frameworks

Bangladesh's rice fortification value chain starts with farmers supplying paddy to local brokers or directly to rice mills, where broken rice, a byproduct of milling, is used as the base for fortification, helping reduce waste. Premixes containing iron, zinc, folic acid, vitamin A, vitamin B1, and vitamin B12 are mostly imported or sourced locally, though supply vulnerabilities persist due to limited domestic production.

Rice mills, especially large and medium automated ones (processing 28% of national rice), produce FRK via extrusion to match local parboiled varieties like miniket in taste and appearance. These FRK are blended with regular milled rice at ratios to ensure adequate micronutrient delivery, in accordance with voluntary standards set by Bangladesh Standards (Bangladesh Standards and Testing Institution 2015).

Rice millers are the central actors, supported by the Millers for Nutrition coalition, government bodies such as the Ministry of Food, and partners including Nutrition International, the WFP, and GAIN. Millers' associations influence pricing and procurement, while international groups provide technical support for quality control (Food Fortification Initiative 2025).

Fortified rice flows through social safety nets, including vulnerable group feeding, vulnerable group development, and food-friendly programs, reaching around 7 million people through government procurement and WFP logistics. Market-based channels use commercial networks, including wholesalers, retailers, and supermarkets, driven by voluntary efforts by millers (DSM 2021).

Quality assurance framework and laboratory infrastructure: Bangladesh has established a multi-layered quality assurance system encompassing government regulatory oversight, industry quality control mechanisms, and third-party testing facilities for independent verification of fortification compliance. The Bangladesh Food Safety Authority oversees fortification standards and monitors compliance through facility inspections and product testing. It operates a network of 18 accredited laboratories that provide testing services to verify micronutrient content, food safety parameters, and adherence to fortification standards. The presence of both government and private laboratories creates competitive pressure, ensuring high-quality service and giving manufacturers a range of testing options (Bangladesh Food Safety Authority 2023).

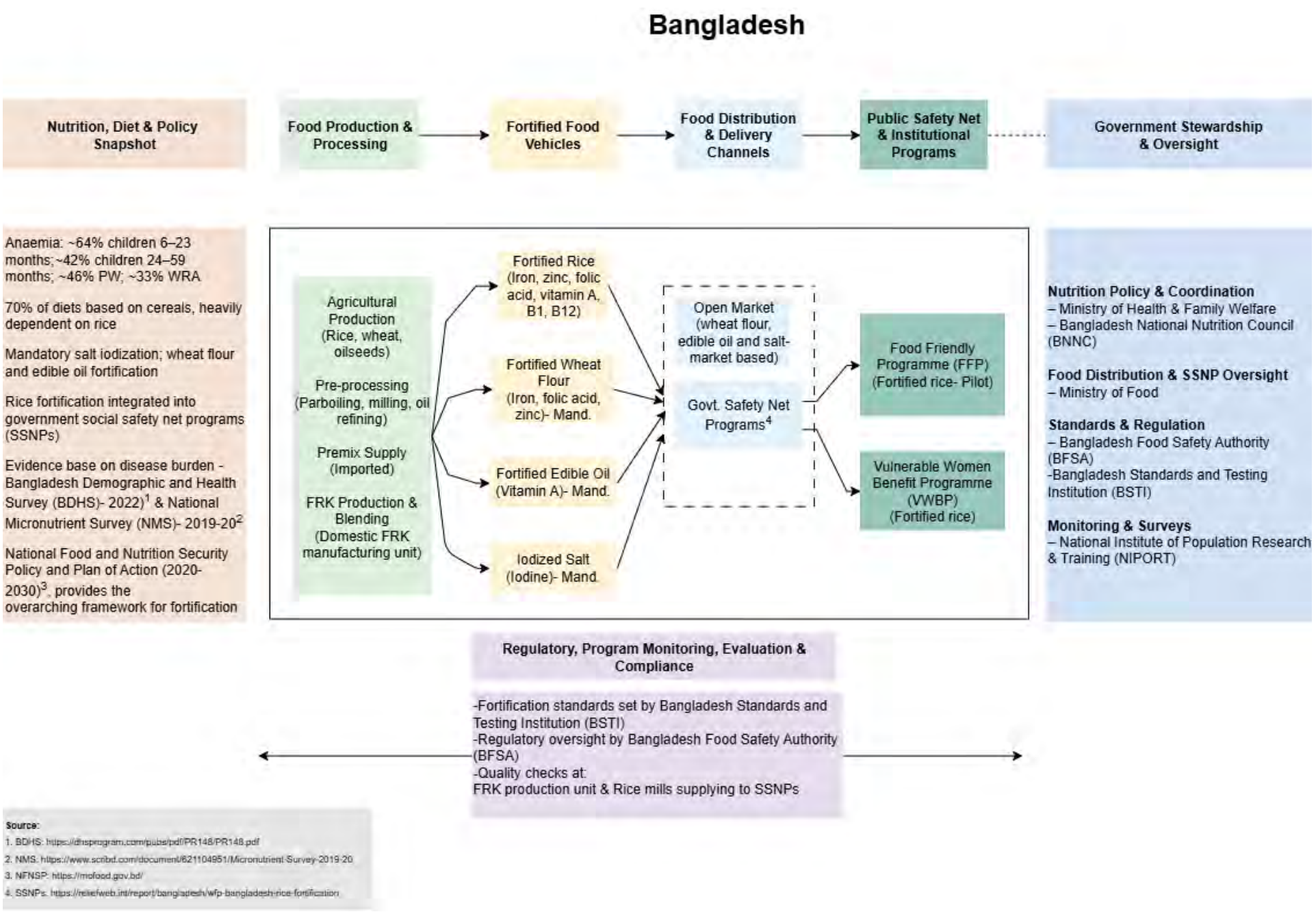
Quality control in manufacturing involves multiple checkpoints to ensure product quality, from receiving raw materials to packaging finished products. Testing moisture levels and verifying micronutrient composition during production stages are essential for identifying quality problems before products reach consumers. Nutrition International provides continuous technical support to both government and industry partners to address emerging quality challenges. This includes on-the-ground assistance for factories, training programs for quality control personnel, and systematic processes to identify and resolve problems. These efforts help to maintain consistent product quality across different manufacturing facilities (Bangladesh Food Safety Authority 2024).

Integrating fortification monitoring with monitoring of existing social safety net programs offers opportunities for systematically tracking the effectiveness of distribution and the reach of beneficiaries. However, comprehensive digital systems that ensure end-to-end traceability from production through consumption are still under development and represent an important area for future investment.

Regulatory enforcement and compliance monitoring: Regulatory enforcement capacity remains limited, particularly in ensuring compliance with fortification standards across distributed manufacturing facilities and retail outlets. While Bangladesh has established comprehensive regulations through the Bangladesh Food Safety Authority, the practical capacity to monitor compliance and enforce standards throughout the diverse food manufacturing sector requires continued investment in regulatory infrastructure and personnel (DigiComply 2024).

The challenges of inspecting manufacturing facilities and testing products for compliance are compounded by the widespread nature of manufacturing, the geographic dispersion of production sites, and the limited resources available for comprehensive regulatory oversight. These enforcement challenges are particularly acute for smaller and medium-scale producers who may lack the technical expertise or financial resources to consistently meet fortification standards as illustrated in the edible oil sector, where only 7% of bulk oil (versus 69% of bottled oil) meets minimum fortification standards, largely due to the economic pressures facing the more than 50 unregistered oil packers operating in the market (Aaron et al. 2021). Refer to Figure 2.6.

Figure 2.6. Bangladesh's food fortification ecosystem



2.2.1.11 Monitoring and Evaluation Mechanisms

Bangladesh has developed a strong network of accredited laboratories that provide food and micronutrient testing to ensure fortification quality. The network has been established through strategic investment in laboratory infrastructure, training for technical staff, and quality assurance systems. The strategically located laboratories enable decentralized testing, helping reduce logistical barriers for manufacturers seeking quality verification. Key facilities in this network include the National Food Safety Laboratory at the Institute of Public Health in Dhaka, the Institute of Food Science and Technology at Bangladesh Council of Scientific and Industrial Research, specialized laboratories within major food companies such as ACI Foods Limited and PRAN Quality Control Laboratory, and university-based facilities that offer both testing services and research capacity (Bangladesh Food Safety Authority 2024).

Evaluation and impact assessment through population surveys: The systematic evaluation of the impacts of fortification programs depends largely on national demographic and health surveys conducted by the NIPORT in collaboration with international partners. The Bangladesh Demographic and Health Survey regularly monitors key nutrition indicators, including the prevalence of anemia, child malnutrition rates, and the micronutrient status of target populations. These surveys serve as the primary source of population-level impact data for assessing the effectiveness of fortification programs and identifying emerging nutrition challenges that may require program adjustments. The 2022 Bangladesh Demographic and Health Survey represents the most recent comprehensive assessment of nutrition outcomes, providing baseline data for evaluating the impact of subsequent programs (Rahman et al. 2025). The survey methodology includes collecting and analyzing biomarkers, enabling objective measurement of micronutrient status beyond dietary intake assessments. This rigorous technical approach enables stakeholders and researchers to associate nutrition outcomes with specific interventions. However, the complexity of nutrition makes it difficult to definitively link changes in micronutrient status solely to fortification, especially when multiple interventions are occurring simultaneously. Future surveys will enable assessment of trends in micronutrient deficiency prevalence and malnutrition rates attributable to fortification interventions over time. This will enable evidence-based program adjustment and optimization.

Monitoring and accountability systems: Integrating fortification monitoring with broader nutrition program oversight creates accountability mechanisms to track program performance and ensure beneficiaries receive the intended micronutrient fortification in delivered foods. Government district-level controllers overseeing social safety-net distribution can report procurement and distribution volumes of fortified products, providing aggregate-level data on the program's scale and reach. However, the systematic monitoring of fortification quality and micronutrient content in the distributed products remains underdeveloped. There is a significant opportunity to strengthen monitoring systems to detect quality issues and facilitate rapid corrective actions.

2.2.1.12 Stakeholder Ecosystem and Partnerships

Bangladesh's food fortification system involves a multisectoral network of government agencies. The Ministry of Health and Family Welfare leads nutrition programming and surveys through the NIPORT. The Ministry of Food manages fortified rice distribution through social safety nets and coordinates with participating millers. Ministry of Women and Children Affairs implements fortified rice distribution through social protection programs targeting women and children, such as the Vulnerable Women Benefit program. The Bangladesh Food Safety Authority regulates standards and oversees compliance. Technical working groups link ministries with research and development

partners, facilitating alignment, information exchange, and problem-solving (Bangladesh Food Safety Authority 2023). While coordination is stronger at the national level and in major cities, it poses challenges at the district and upazila levels due to limited local capacity.

Food manufacturers play a key role in fortification, controlling production and managing supply chains. The Millers for Nutrition coalition unites companies and associations to promote best practices, peer learning, and self-regulation. Champion Miller initiatives reward quality performance. Larger firms engage more actively because of their capacity and links to government procurement, while smaller and informal producers face financial and technical constraints limiting their participation.

Research bodies such as the Bangladesh Council of Scientific and Industrial Research's Institute of Food Science and Technology and university labs support research and development on fortification, quality testing, and innovation. Collaborations with international institutions such as PATH and Nutrition International, as well as with global universities, enhance technical expertise and evidence generation, which contribute to policy development and global learning.

Development partners, including USAID, WFP, UNICEF, GAIN, Nutrition International, and others, provide financial and technical assistance and implementation support. They strengthen program design, monitoring, and quality assurance. However, overlapping initiatives can cause fragmentation, highlighting the need for strong coordination mechanisms.

2.2.1.13 Critical Challenges and Policy Reforms Needed

Technical and infrastructure constraints: Bangladesh's fortification programs face significant challenges due to limited domestic capacity to produce premix and fortificants, forcing reliance on imports that increase costs, expose programs to currency fluctuations, and create supply chain vulnerabilities. Developing local production capacity could improve sustainability and generate skilled employment, but it requires substantial investment and technical expertise. Maintaining consistent micronutrient content in fortified rice is challenging because blending efficiency, equipment quality, and staff skills vary across facilities. To ensure uniform standards, continuous training, equipment upgrades, and strict quality control systems are essential. Additionally, poor storage and transportation infrastructure, along with high humidity and tropical heat, contribute to micronutrient degradation, especially vitamin A. Inefficient cold chain systems and prolonged distribution times further threaten product quality, particularly in rural areas.

Economic and market barriers: Rising costs of food, fuel, and fertilizer are straining both program budgets and household purchasing power. As a result, low-income families may opt for cheaper, non-fortified staples, thereby limiting the program's reach. Currently, fortification has reached only about 8.7% of the population through safety net schemes, limiting economies of scale. Expanding coverage could improve cost-effectiveness, but it would require significant investment in production and distribution capacity. Additionally, voluntary fortification faces challenges in meeting consumer demand due to low awareness and reluctance to pay higher prices. To build a viable market, it is essential to implement behavior change communication, public education, and supportive policy measures.

Climate change and environmental pressures: Frequent floods, cyclones, and droughts disrupt food supply chains, fortification logistics, and manufacturing in Bangladesh, increasing the risk of malnutrition. Reduced crop yields and soil degradation affect the cost and availability of staple

foods needed for fortification. To adapt fortification systems to climate-related stresses, it is essential to develop resilient storage solutions, diversify food vehicles, and integrate these efforts with broader climate adaptation programs.

Institutional and coordination challenges: Several ministries, including those responsible for food, health, and women and children's affairs, oversee different fortification components, often leading to overlapping roles and coordination challenges. To prevent duplication of efforts, it is essential to establish clear mandates, regular coordination platforms, and accountability mechanisms. The Bangladesh Food Safety Authority's enforcement capacity is limited, especially for smaller producers. Strengthening inspection systems, laboratory infrastructure, and technical assistance would improve compliance and quality assurance. The dependence on rice as the primary staple food increases vulnerability to economic or technical disruptions. Expanding fortification efforts beyond wheat, oil, and salt would enhance dietary coverage and increase program resilience.

Geographic and population-specific challenges: Nutritional needs and fortification coverage vary across regions. The Chittagong Hill Tracts require tailored interventions due to severe malnutrition and limited access to resources. Bangladesh's dense population increases production and distribution demands, straining infrastructure. Despite declining fertility rates, the absolute number of vulnerable children continues to rise, necessitating the scaling up of programs. Gender inequality and low maternal education reduce program impact, with child anemia significantly higher among children of illiterate mothers. Integrating women's empowerment and education initiatives can enhance outcomes.

Data gaps and monitoring limitations: Current market-level surveillance of fortified food quality is inadequate, leading to uncertainty about actual micronutrient levels in consumer products. To enhance program accountability, it is crucial to strengthen regular quality audits and laboratory testing. Limited evidence on consumer perceptions constrains strategies for promoting voluntary fortification. More research on consumer awareness, taste preferences, and pricing sensitivity is needed to design effective market approaches.

2.2.1.14 Opportunities and Future Directions

Scale-up and coverage expansion: Expanding fortified rice distribution from 15 million beneficiaries to nationwide coverage offers Bangladesh a major nutrition opportunity. Leveraging existing social safety nets, such as Vulnerable Group Development, Open Market Sales, and the Food-Friendly Program, fortification can gradually be extended to school meals and open markets, ensuring that both vulnerable and middle-income consumers have access to fortified rice. Achieving this goal requires coordinated investment in mill capacity, supply chain systems, and laboratory-based quality assurance, guided by established institutional frameworks and technical expertise. Integrating fortification into the National Nutrition Program's nationwide rollout would enable joint delivery through community health workers, growth-monitoring platforms, and behavior change communication. This alignment can strengthen local nutrition service delivery and reinforce complementary interventions such as micronutrient supplementation and IYCF counseling.

Creating domestic market pathways for fortified rice can help make it a mainstream product by increasing consumer awareness, improving labeling, and offering industry incentives. Targeted campaigns, regulatory frameworks, and fiscal incentives can help promote affordability and boost demand. The Millers for Nutrition coalition can engage the private sector to scale the market for fortified rice across regions.

Technological innovation and industry development: Improving the production of local premix and FRK is crucial for sustainability and cost efficiency. By investing in technology transfer, domestic production facilities, and skilled workforce development, Bangladesh can position itself as a South Asian hub for fortification technology and supply chains. Public–private partnerships can reduce investment risks and build industry capability.

Implementing digital systems such as blockchain-based traceability and mobile quality reporting can improve monitoring, ensure product authenticity, and support transparent oversight. Developing data dashboards for real-time tracking will enhance regulatory capabilities and accountability. Collaborating with universities and international institutions can advance research and development in fortification technologies and precision nutrition analytics, including AI-based tools to identify high-risk populations.

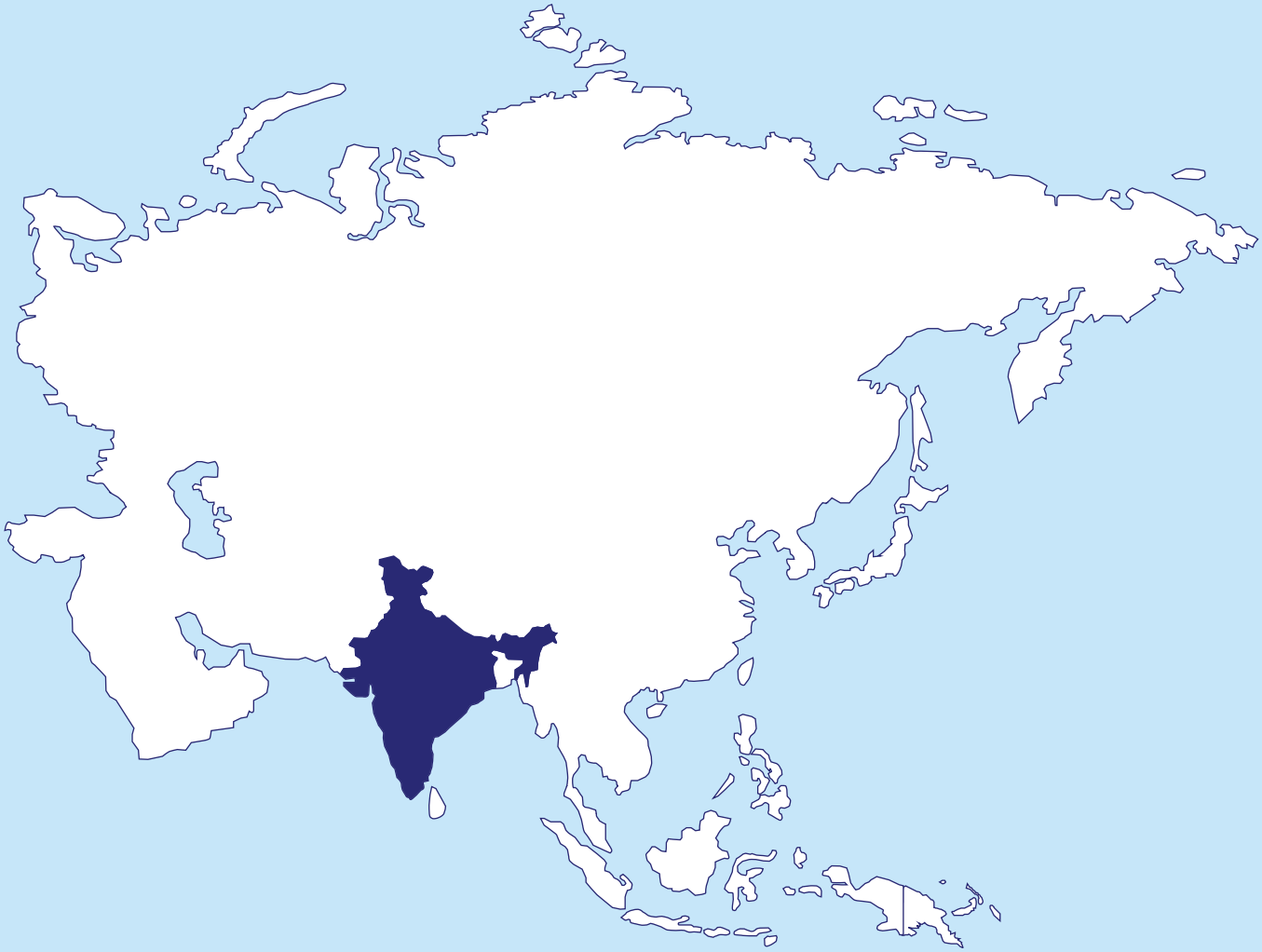
Policy integration and institutional strengthening: Embedding fortification into climate adaptation and food security policies will strengthen Bangladesh's resilience to climate-driven disruptions in food supply. Linking fortification to sustainable agriculture and nutrition outcomes can help attract climate financing. Additionally, regional collaboration through South-South networks and the Millers for Nutrition coalition can enable knowledge exchange, shared procurement, and harmonized standards. Aligning national regulations with Codex and regional norms will enhance product quality while opening export opportunities for fortified foods and technology.

Financing and partnership development: Blended finance models that combine donor support, government funding, and private capital can scale fortification infrastructure while sharing risks. Impact investors and development finance institutions offer opportunities to sustainably finance fortification of value chains. Additionally, corporate engagement through corporate social responsibility and shared-value initiatives can enhance industry involvement in fortification and consumer education. Establishing clear public-private partnership frameworks can help align commercial and social outcomes. Furthermore, integrating fortification within broader Sustainable Development Goal-linked initiatives spanning nutrition, health, education, and climate resilience will help mobilize multi-sectoral funding and policy commitments.

Community-level implementation and consumer engagement: Community actors, including health workers, teachers, and local leaders, can play a vital role in promoting awareness, acceptance, and sustained adherence to fortified food initiatives. Tailored behavior changes communication strategies that emphasize the contribution of fortified foods to child growth and maternal health can further increase regular consumption.

Introducing fortified rice through school feeding schemes can effectively reach children during crucial developmental stages while also integrating nutrition education into the curriculum. Utilizing school platforms can enhance both dietary diversification and long-term consumer acceptance of fortified foods.

2.2.2 India



2.2.2.1 Nutrition and Fortification Ecosystem

India's nutrition landscape reflects a paradoxical challenge. Despite being the world's second-largest producer of food grains, the country continues to face a substantial burden of micronutrient malnutrition affecting multiple demographic groups in both urban and rural settings. This apparent contradiction highlights the critical distinction between food security, defined as reliable access to sufficient caloric intake, and nutritional security, which requires a diverse, safe, and nutrient-dense food supply necessary for optimal health and development. The fortification ecosystem in India emerged as a strategic policy response to address this gap, evolving from fragmented initiatives into a comprehensive, multi-sectoral approach over the past seven decades.

India's fortification journey began in the 1950s with the fortification of vanaspati with vitamin A (Duggal et al., 2022), following recommendations from the Ghee Adulteration Committee. This established the foundational principle that staple foods could serve as vehicles for micronutrient delivery. This early recognition of fortification's potential set the stage for subsequent regulatory frameworks and public health interventions. In 1952, the Nutrition Advisory Committee of the Indian Council of Medical Research issued similar fortification recommendations, which led to mandatory fortification of vanaspati in the early 1950s. This initiative marked India's early pioneering role in food fortification, demonstrating the government's commitment to addressing nutritional deficiencies through food-based interventions decades before many other nations adopted similar strategies.

The 1962 launch of the National Goiter Control Programme, following pivotal research by Professor V. Ramalingaswami on endemic goiter in Himalayan regions, marked India's first large-scale, evidence-based fortification initiative to address a specific public health crisis (Ramalingaswami 1953). The program's transformation from a limited public sector operation to an inclusive model incorporating private-sector participation by 1984 demonstrated adaptive governance and institutional learning that would later characterize broader fortification strategies. By 2005, India had established 807 iodization units across the country, capable of producing 116 lakh tons annually, with 48.9 lakh tons of iodized salt produced and 46.4 lakh tons distributed, meeting the needs of 80-85% of the population and transforming salt iodization into a public health success story (Institute for Competitiveness 2023).

India's enactment of the National Food Security Act (NFSA) on July 5, 2013, and its enforcement from July 20, 2013, represented a transformative shift by elevating food security from a welfare provision to a legal entitlement for approximately 800 million beneficiaries (75% of the rural population and 50% of the urban population). The NFSA's institutional architecture was built upon existing social safety-net programs, the targeted public distribution system (TPDS), PM POSHAN (Pradhan Mantri Poshan Shakti Nirman) (formerly known as Mid-Day Meal Scheme), and Mission Poshan 2.0 (formerly known as Integrated Child Development Services, ICDS), by converting them into legal obligations rather than discretionary welfare provisions. This legal scaffolding created the foundational infrastructure for systematically delivering food fortification at scale, establishing fortification not merely as a nutritional intervention but also as a component of citizens' fundamental rights (Department of Food and Public Distribution, Government of India n.d.).

The contemporary fortification ecosystem comprises five primary food vehicles: salt, wheat flour, rice, edible oil, and milk. Each vehicle has distinct positions within consumption patterns, industrial structures, and implementation pathways. Rice holds particular strategic importance, as it is consumed by over 65% of India’s population and provides approximately 50% of total energy intake. Globally, rice production exceeds 480 MT annually, with the grain being processed through industrial milling (Muthayya et al. 2014). Yet fortification has been adopted in less than 1% of global rice production. This indicates that, despite technological feasibility, its adoption remains limited globally.

Salt fortification achieved near-universal mandatory status following regulatory reinforcement in 1997 and reinstatement in 2005, establishing a public health success story that serves as a reference model for subsequent fortification initiatives (Institute for Competitiveness 2023). In contrast, rice and wheat flour fortification, which are strategically important to over 65% and 45% of India's population, respectively, remain fragmented, with mandatory provision through social safety nets and voluntary uptake in commercial channels. Edible oil, consumed by nearly 99% of Indian households, and milk, which is produced in both formal and informal sectors, present distinct implementation challenges and opportunities that reflect India's broader agricultural and industrial heterogeneity (World Food Programme n.d.).

Multiple government entities share the responsibility for the fortification ecosystem in India, reflecting the country’s federal structure and sectoral complexity. The Ministry of Health and Family Welfare assumes primary responsibility for nutrition policy and health-related interventions, while the Ministry of Women and Child Development oversees supplementary nutrition programs, including the Mission Poshan 2.0. The Ministry of Education implements the PM POSHAN scheme, delivering nutritionally planned meals through government and government-aided schools

nationwide. The Ministry of Consumer Affairs, Food and Public Distribution implements the TPDS and distributes fortified rice. The Food Safety and Standards Authority of India (FSSAI), established under the Ministry of Health and Family Welfare, functions as the primary regulatory agency. It sets fortification standards, guides quality assurance mechanisms, and promotes stakeholder coordination. The Ministry of Food Processing Industries (MoFPI) facilitates food fortification and industrial scaling through the National Institute of Food Technology Entrepreneurship and Management Centre of Excellence, while providing credit-linked subsidies and production incentives for manufacturers (Ministry of Food Processing Industries 2022, 2026). This institutional fragmentation, while reflecting India's constitutional distribution of powers, necessitates continuous inter-ministerial coordination to ensure effective policy implementation and prevent contradictory directives (Nutrition Connect n.d.).

2.2.2.2 Nutritional Status and Dietary Practices

India faces a significant and complex challenge of micronutrient malnutrition, with anemia being the most common and noticeable form. The National Family Health Survey (NFHS) 5, conducted from 2019 to 2021, documented alarming prevalence rates: 67% of children under five years old, 57% of non-pregnant women, and 52% of pregnant women suffered from anemia. These figures indicate stagnation or even deterioration compared with the previous survey period, despite multiple government interventions aimed at anemia reduction. This suggests that existing approaches have failed to achieve the requisite scale and intensity. Regional heterogeneity in anemia prevalence indicates an unequal distribution of the burden across regions. States in north and northeastern India, such as Ladakh, Assam, Chhattisgarh, Tripura, and Mizoram, have seen increases of 10-15% between survey cycles. This may signal gaps in either program implementation or the emergence of new risk factors in these regions (International Institute for Population Sciences and ICF 2021).

The Comprehensive National Nutrition Survey conducted during 2016-18 revealed endemic deficiencies across multiple micronutrients critical for cognitive development, immune function, and growth. Vitamin A deficiency, affecting 18% of pre-school children, 22% of school-age children, and 16% of adolescents, indicates insufficient dietary intake of foods rich in provitamin A carotenoids, despite India's production of vitamin A-rich fruits and vegetables. The prevalence of vitamin D deficiency, at 14% in pre-school children, 18% in school-age children, and 24% in adolescents reflects multiple contributing factors, including inadequate sunlight exposure (particularly in urban and polluted areas), low consumption of fortified dairy products, and limited dietary sources of natural vitamin D. Folate deficiency is a serious concern given its role in NTD prevention and cognitive development, affecting 23% of pre-school children, 28% of school-age children, and 37% of adolescents, with prevalence increasing with age, suggesting cumulative dietary insufficiency during critical developmental windows (MoHFW, UNICEF, and Population Council 2019).

Zinc deficiency is a significant issue, affecting 19% of preschool children and 32% of adolescents, according to data from the Comprehensive National Nutrition Survey. This often-overlooked micronutrient crisis has profound implications for growth, immune function, and reproductive health. Vitamin B12 deficiency, typically associated with dietary insufficiency in predominantly vegetarian populations or low consumption of fortified foods, along with folate deficiency, forms a nutritional triad that affects cognitive development and hematologic health, particularly among children and adolescents. The consequences of these deficiencies extend beyond immediate health outcomes; epidemiological evidence links micronutrient deficiencies during critical developmental periods to reduced educational achievement, decreased earning potential, and a cycle of intergenerational poverty and malnutrition (Venkatesh et al. 2021).

Geographic and socioeconomic variation in nutritional status reveals alarming disparities. According to the Social Progress Index 2022, over 690 districts have fewer than 30% of children receiving an adequate diet. In 17 districts, more than 50% of children are stunted, and in 12 districts, more than 50% of children are underweight.

An analysis of 112 aspirational districts reveals a nutrition crisis: only 12.32% of children aged 6 to 23 months receive an adequate diet, the poorest nutritional outcome among high-need district classifications. Average anemia prevalence in these districts is 61.2% among women and 69.65% among children, with prevalence among women varying from 26.9% to 81.5% across districts, indicating extreme geographic variation. Of the 112 aspirational districts, 93 have over 50% of women suffering from anemia, and 67 districts (over 50% of the total) have less than 12% of children receiving an adequate diet. Furthermore, 82 of these 112 districts have more than 30% of children under five years old classified as underweight (Institute for Competitiveness 2023).

India's dietary patterns, shaped by socioeconomic status, geographic location, cultural preferences, and agricultural production systems, constitute the fundamental determinant of micronutrient availability at the household level. Data from the National Sample Survey Office and the National Nutrition Monitoring Bureau reveal persistent reliance on cereals across all income groups, with cereals providing 60-80% of dietary energy. This reflects both cultural preferences and economic accessibility. Consumption of protective foods rich in micronutrients, such as vegetables, fruits, animal products, and pulses remains remarkably low in both urban and rural populations. Pulse consumption, critical for providing protein and micronutrients, has decreased from approximately 6-7 kg/capita annually to below 5 kg in recent periods. This decline is driven by rising costs and a shift toward alternative protein sources among higher-income groups. While higher-income households have increased milk and animal product consumption, vast segments of the population, particularly in rural areas and among lower-income groups, consume milk and animal foods only occasionally, relying on plant-based protein sources with lower micronutrient density (NFI 2022).

Additional dietary assessment data reveal persistent under-consumption of micronutrient-rich foods despite India's agricultural capacity. Between NFHS 4 (2015-16) and NFHS 5 (2019-21), anemia prevalence increased across all demographic segments children, pregnant women, non-pregnant women, and men indicating that dietary and supplementation interventions have failed to achieve adequate coverage or effectiveness. The average daily calorie consumption in India falls below the recommended 2,503 kilocalories per capita per day, and protein intake remains inadequate, with only 6-8% of calories derived from protein. Whole grains contribute disproportionately to calorie intake while fruits, vegetables, legumes, meat, fish, and eggs are consumed in lower quantities, further cementing the micronutrient deficiency epidemic. A preference for processed foods over fresh fruits and excessive cereal consumption compounds nutritional insufficiency.

Beyond child nutrition, adult dietary practices reveal persistent nutritional gaps. The NFHS 5 (2019-21) revealed that 49% of women consume food groups sporadically (not regularly), indicating that nearly half of women achieve inadequate dietary diversity. Furthermore, only 11% of children aged 6 to 23 months receive a diet that meets minimum acceptability criteria for food group diversity and meal frequency, suggesting that the critical developmental window of 6 to 23 months is characterized by severe dietary inadequacy for the vast majority of Indian children (Institute for Competitiveness 2023).

2.2.2.3 Nutrition-related Flagship Program

India's nutrition intervention architecture comprises multiple interconnected flagship programs, each addressing specific life stages and populations, integrated within the legal framework of the National Food Security Act, 2013.

Mission Saksham Anganwadi and Poshan 2.0 (Mission POSHAN 2.0) is a flagship program of the Government of India launched by the Ministry of Women and Child Development in 2021-22, bringing together the ICDS (launched in 1975), Scheme for Adolescent Girls (SAG), and Prime Minister's Overarching Scheme for Holistic Nutrition (POSHAN) Abhiyaan under one umbrella. It covers children under six years old, pregnant women and lactating mothers, adolescent girls (14–18 years), early childhood care and education (3-6 years), and Anganwadi infrastructure, including modern, upgraded Saksham Anganwadi, Poshan Abhiyaan, and Scheme for Adolescent Girls (Ministry of Women and Child Development 2021). The mission emphasizes a lifecycle approach to nutrition, focusing on the critical 1,000-day window from conception to a child's second birthday, which is vital for preventing malnutrition and ensuring optimal growth and development (Ministry of Women and Child Development 2021), with a budget outlay of INR 21,960 crore in FY 2025-26 and a reach of nearly 9 crore beneficiaries through a network of 14 lakh Anganwadi Centres across all States and Union Territories (Press Information Bureau 2026a, 2026b).

The Mission POSHAN 2.0 provides six services in an integrated manner to eligible beneficiaries: (i) supplementary nutrition through hot cooked meals and take-home rations (THR), (ii) preschool nonformal education; (iii) nutrition and health education; (iv) immunization; (v) health check-ups; and (vi) referral services. Three of the six services- immunization, health check-ups, and referral services-are related to health and are provided through the National Health Mission and public health infrastructure. Supplementary nutrition is provided to children aged 6 months to 6 years, pregnant women, lactating mothers, and adolescent girls in accordance with the nutrition norms contained in Schedule II of the National Food Security Act, 2013. These norms have been revised in January 2023. The revised norms are more comprehensive and balanced in both the quantity and the quality of supplementary nutrition. They are based on the principles of diet diversity and provide quality protein, healthy fats, and micronutrients (calcium, zinc, iron, dietary folate, vitamin A, vitamin B6, and vitamin B12). Children with severe acute malnutrition receive additional supplementary nutrition (Press Information Bureau 2026c). The mission also promotes community participation through Jan Andolan, Poshan Maah, Poshan Pakhwada, and mandatory bi-monthly Community based events. The status of nutrition among children (aged 6 years) in all states and union territories, as well as progress reported, is available on the Poshan Tracker public dashboard at the given link: https://www.poshantracker.in/statistics.

PM POSHAN: Originally established as the Mid-Day Meal Scheme in 1995, the program was renamed PM POSHAN in September 2021. This centrally sponsored scheme, launched by the Ministry of Education, is the world's largest school feeding program, providing nutritionally planned meals to approximately 120 million children across 1.27 million government and government-aided schools. The scheme received a total financial outlay of ₹1,30,794.90 crore for the period 2021-22 to 2025-26 (Press Information Bureau 2025). The program targets children in Bal Vatika (pre-primary) through Class VIII, with food norms specifying cereals, pulses, vegetables, fortified food commodities, and micronutrient-rich ingredients. The dual objectives of addressing hunger and improving educational outcomes through enhanced attendance and classroom concentration reflect evidence linking nutritional status to learning ability and school participation.

PM POSHAN is a federally mandated entitlement under the NFSA that obligates state governments to provide meals that meet specified nutritional standards and food safety requirements. The scheme incorporates fortified foods as mandatory components: fortified rice, fortified wheat flour, and double-fortified salt are systematically integrated into meal planning, thereby positioning PM POSHAN as an important mechanism for delivering fortified foods to school-age children. The program budget for 2022-26 demonstrates a substantial commitment to both meal provision and nutritional enhancement, though state-level expenditure variations affect meal quality and the implementation of fortification (MoE n.d.).

Anaemia Mukt Bharat: Launched in 2018 by the Ministry of Health and Family Welfare in collaboration with UNICEF, the Anaemia Mukt Bharat initiative represents a comprehensive, life-cycle approach to anemia prevention and treatment across children (6-59 months), adolescents (10-19 years), and women (15-49 years). The program operates through six institutional mechanisms: inter-ministerial coordination, convergence with allied departments, provision of technical assistance, capacity-building, quality assurance, and community engagement. Specific interventions include prophylactic iron-folic acid supplementation across all target age groups, deworming for children and adolescents, behavior change communication campaigns emphasizing dietary sources of iron and supportive practices (such as vitamin C co-consumption to enhance bioavailability), and identification and management of severe anemia cases through health facilities.

Fiscal allocation to Anaemia Mukt Bharat demonstrates fluctuating commitment: In 2019-20, the allocation increased from ₹851 crore to ₹940 crore in 2020-21, distributed among states based on burden assessment and programmatic requirements. The program's integration with fortification initiatives, particularly the incorporation of fortified foods into social safety net program distributions and supplementary nutrition programs, positions anemia reduction as a multi-pronged intervention that combines food fortification, micronutrient supplementation, and health service strengthening (MoHFW n.d.).

2.2.2.4 Policy Environment for Food Fortification

India's policy environment for food fortification reflects a gradual evolution from voluntary promotion to mandatory regulatory frameworks, with varying levels of regulation across food commodities and implementation contexts.

Regulatory frameworks and standards: The FSSAI, established under the Ministry of Health and Family Welfare through the Food Safety and Standards Act, 2006, maintains primary regulatory authority over food fortification. Following national summits and multi-stakeholder consultations between October 2016 and October 2017, FSSAI operationalized the Food Safety and Standards (Fortification of Foods) Regulations, 2018, establishing comprehensive standards for five staple food vehicles. These regulations prescribe mandatory micronutrient levels for fortified foods: salt fortified with iodine or an iodine-iron combination; wheat flour, rice, and processed flour fortified with iron, folic acid, and vitamin B12 (with optional additions of B vitamins and zinc); edible oil fortified with vitamins A and D; and milk fortified with vitamins A and D (FSSAI 2021).

The regulatory framework explicitly designates fortification as voluntary unless the government mandates specific products for mandatory fortification based on scientific evidence of public health need and severity of micronutrient deficiency. This distinction is critical: while fortification remains optional for private-sector manufacturers, government-funded social safety net programs

increasingly mandate fortified foods through TPDS, Mission Poshan 2.0, and PM POSHAN, creating a dual market: mandatory in public procurement and voluntary in commercial channels.

FSSAI established mandatory labeling requirements for fortified foods, requiring the "+F" logo with specified color codes and size requirements, to be printed in English or Hindi, to help consumers identify them. The regulations further specify that fortified food packages must provide transparent nutritional information and comply with all applicable labeling and packaging requirements under broader food safety regulations.

Mandatory versus voluntary implementation: Salt iodization represents India's most stringent fortification mandate, with government directives requiring all edible salt for human consumption to be iodized, enforced through legislative mechanisms under the Food Safety and Standards (Prohibition and Restriction on Sales) Regulations, 2018. This mandatory provision emerged from the 1997 policy decision, briefly reversed between 2000 and 2004, and permanently reinstated in 2005, reflecting shifts in political commitment that ultimately stabilized due to public health evidence and international advocacy (FSSAI n.d.-a).

Rice and wheat flour fortification policies vary across geographic regions and implementation contexts. Fortification is mandatory in social safety net programs, TPDS, Mission Poshan 2.0, and PM POSHAN in numerous states, but remains voluntary in open-market commercial channels. This bifurcated approach reflects political economy considerations: mandatory commercial fortification faces resistance from industry groups concerned about production costs and consumer acceptance, while social safety net mandates leverage government purchasing power and institutional infrastructure to achieve scale without disrupting market dynamics (Dalberg Advisors n.d.).

Double fortified salt, containing both iron and iodine, maintains voluntary status in open market distribution but has been mandated or heavily promoted in specific social safety net programs in states like Tamil Nadu (since 2004), Madhya Pradesh, and Gujarat, where double fortified salt reaches over 12 million people at subsidized rates of ₹1/kg. The staggered, location-specific approach to double-fortified salt adoption reflects continued evaluation of its acceptability and effectiveness across diverse socioeconomic and geographic contexts (Nutrition International n.d.).

Government initiatives and inter-ministerial coordination: The Ministry of Consumer Affairs, Food and Public Distribution launched a centrally sponsored pilot scheme in 2019-20 for rice fortification distribution through TPDS, with a total budget allocation of ₹174.64 crore over three years, covering 15 districts across 15 states. This pilot was followed by a national-scale-up planned for 2024, which was subsequently extended to December 2028. This phased implementation approach, comprising Phase I, covering Mission Poshan 2.0 and PM POSHAN (2021-22); Phase II expanding to aspirational districts (2022-23); and Phase III extending to all districts under TPDS nationwide (2023-24), reflects deliberate programmatic learning from earlier rice fortification pilots in states like Odisha and Andhra Pradesh (MoHFW 2023).

Following successful pilot outcomes, the Government of India made a pivotal commitment in 2021 to comprehensive scale-up, pledging that all rice disbursed through TPDS, PM POSHAN, and Mission Poshan 2.0 would be fortified by 2024, with a national program cost of ₹2,700 crore per annum to be borne by the central government until completion in June 2024. This announcement, made on India's 75th Independence Day, substantially accelerated efforts to strengthen the fortification ecosystem.

The national government's commitment to mandatory rice fortification across all social safety nets by 2024 represented a dramatic policy escalation from earlier voluntary and limited regional initiatives.

Wheat fortification initiatives gained momentum during the POSHAN Abhiyan, with 12 states implementing programs that targeted vulnerable populations as of 2018. However, state-level adoption varies substantially: some states have integrated fortified wheat flour into TPDS and Mission Poshan 2.0, while others remain at the pilot or planning stage (Institute for Competitiveness 2023).

The Eat Right India campaign, launched by FSSAI as part of the broader alignment with the National Nutrition Policy 2017, functions as a demand-creation initiative through consumer awareness campaigns, behavior change communication emphasizing the benefits of fortified foods, and collaboration among government bodies, the food industry, civil society, and health experts. This communication-focused complement to regulatory initiatives addresses the critical barrier posed by consumer demand, recognizing that regulatory mandates have limited impact without consumer knowledge and acceptance (FSSAI n.d.-c).

2.2.2.5 Industry Capacity and Role of Private Players

India's food industry shows varying capacity for participation in fortification, reflecting significant differences in scale, technological sophistication, and organizational structure across food commodity value chains.

Industry consolidation and fortification adoption: The edible oil and salt industries are highly consolidated, with large-scale producers accounting for 40-90% of total production, enabling coordinated fortification implementation through direct engagement with a limited number of primary manufacturers. In the oil sector, 341 brands have adopted fortification with vitamins A and D, demonstrating substantial voluntary uptake driven by competitive differentiation, perceived consumer demand for health-enhancing products, and relatively modest incremental production costs. Similarly, double-fortified salt has attracted approximately 10 brands to the market, primarily through major manufacturers such as Tata Salt, leveraging their brand reputation and distribution networks to capture premium market segments.

The milk sector, increasingly dominated by organized dairy cooperatives and processing enterprises (approximately 30% of production is in the private sector, and the remainder is informal), has seen adoption by major dairies, including National Dairy Development Board member cooperatives, with 40 brands now offering fortified milk products primarily in urban markets. Cargill India's "Nourishing India" campaign exemplifies private sector brand positioning around nutritional benefits, integrating consumer education with product marketing to create demand differentiation in fortified oil categories.

Conversely, the wheat flour and rice milling industries remain highly fragmented, with many small-scale mills (both formal roller mills and informal chakki units) and limited participation in fortification initiatives. Recent assessments indicate that only 3% of wheat flour and 0.1-0.2% of rice production are fortified, suggesting that despite regulatory promulgation, voluntary adoption by private mills remains minimal. This fragmentation creates substantial coordination challenges: capacity-building, technology transfer, quality assurance mechanisms, and enforcement activities

require engagement with thousands of dispersed small producers that often lack access to information and face capital constraints for equipment investment (Dalberg Advisors n.d.).

Supply chain infrastructure development: Government investment in fortification infrastructure has expanded substantially in recent years. As of 2025, India has approximately 925 active FRK manufacturers with a collective annual production capacity of over 111 lakh tons, 232 specialized premix manufacturers, and approximately 21,000 rice mills equipped with blending facilities for integrating FRKs (Singh, Sood, and Khanduja 2025). This infrastructure expansion shows strong momentum: cumulative annual FRK manufacturing capacity increased more than 18-fold from 0.9 lakh tons in August 2021 to 17 lakh tons by 2022. More than 400 FRK manufacturers have been established, with standardization and quality-control measures in place to ensure the intervention's effectiveness. Additionally, rice mills with blending infrastructure expanded from 2,690 in August 2021 to 18,227 by March 2023, significantly increasing monthly production capacity (Institute for Competitiveness 2023).

This infrastructure development, concentrated particularly in rice fortification, represents tangible evidence of systemic capacity-building, though distribution remains concentrated in states with active government procurement programs. The FSSAI brings together government ministries, state authorities, industry leaders, food producers, and manufacturers of fortification inputs to align policies, solve technical problems, and coordinate stakeholders. These efforts have included developing comprehensive technical toolkits, including manufacturing handbooks, quality assurance/quality control manuals, and good manufacturing practice guidelines, reducing information asymmetries that historically hindered industry adoption, particularly among small producers.

Testing and quality assurance infrastructure has similarly expanded: As of February 2025, 57 FSSAI-empaneled National Accreditation Board for Testing and Calibration Laboratories (NABL)-accredited laboratories test fortified rice, 32 test FRKs, and 13 on premixes, providing a distributed quality-verification capacity essential for regional-scale compliance monitoring. This laboratory network development contrasts sharply with the limited quality assurance capacity that existed a decade ago, reflecting deliberate institutional investment in regulatory capacity (FSSAI n.d.-c.).

Private sector's constraints and market incentives: Despite expanded capacity, the private sector's adoption of fortification in fragmented industries remains constrained by multiple factors. High capital costs of blending machinery, estimated at ₹15-20 lakh for basic equipment, combined with limited access to affordable financing for small mill operators, impede technology adoption. An increase in operating costs (approximately 2-5% of production costs for premix, packaging modifications, and quality assurance procedures) disproportionately affects small-scale mills operating on thin margins, with limited ability to pass these costs on to consumers in competitive markets dominated by price-sensitive purchasing. The absence of policy incentives represents another critical constraint: unlike early industrial development in countries such as Costa Rica (which provided tax credits) or Bangladesh (which offered enhanced access to government procurement), India has not implemented sustained financial incentives, subsidies, concessional financing, tax exemptions, or preferential government purchasing to offset the private-sector costs of fortification adoption. Privatizing costs while socializing benefits (through improved public health outcomes) creates insufficient economic motivation for private manufacturers without captive institutional markets.

Consumer awareness limitations further constrain market expansion. Low household understanding of fortification benefits and skepticism regarding food safety persist, particularly in rural and low-income communities, limiting the demand for fortified products. The "+F" logo, while facilitating identification, has not catalyzed substantial shifts in consumer preference in open-market channels without complementary awareness and behavior change campaigns.

2.2.2.6 Integration with Social Safety Net Programs

Food fortification in India achieves substantial population reach through systematic integration into three foundational social safety net programs: TPDS, Mission Poshan 2.0, and PM POSHAN, which collectively serve over 300 million individuals.

TPDS and fortified rice: TPDS, which covers 75% of rural and 50% of urban populations under NFSA legal entitlements, has been systematically transitioned toward fortified food provision as a government procurement policy priority. Fortified rice distribution through TPDS represents the most ambitious food fortification scale-up initiative, with the government mandating that all states transition rice procurement toward fortified varieties. The public distribution system, reaching up to 800 million beneficiaries with ration cards redeemable at approximately 5.13 lakh fair price shops across the country, provides the infrastructure foundation for this unprecedented nutrition intervention scale-up.

The implementation proceeded through deliberate phases: Phase I (2021-22) focused on Mission Poshan 2.0 and PM POSHAN, with states and union territories lifting approximately 17.51 lakh tons of fortified rice. Phase II (2022-23) expanded significantly to include all ICDS, PM POSHAN centers, and TPDS across 291 aspirational and high-burden stunting districts, resulting in 106.25 lakh tons lifted through TPDS and 29.58 lakh tons for Mission Poshan 2.0/PM POSHAN. The successful completion of Phase II ahead of schedule demonstrated the feasibility of procurement and distribution at unprecedented scale, with 134 lakh tons of fortified rice procured in 2022-23 alone. Phase III (2023-24) completed the national rollout, with cumulative fortified rice distribution of 322.27 lakh tons, ensuring nationwide nutritional coverage for all TPDS, Mission Poshan 2.0, and PM POSHAN beneficiaries (Press Information Bureau 2025c).

This systematic approach leveraged existing grain procurement infrastructure, food security allocation budgets, and distribution networks (comprising approximately 5.13 lakh fair price shops serving beneficiaries), eliminating the need for parallel distribution systems and enabling cost-efficient integration into established institutional mechanisms. The Food Corporation of India (FCI) and state government procurement agencies coordinate FRK acquisition, in-mill blending at designated facilities, and transport through godowns to retail distribution points, maintaining quality-control protocols and quality verification at transition points.

Mission Poshan 2.0 supplementary nutrition integration: The Mission Poshan 2.0 program serves approximately 110 million people, including pregnant and lactating women, children aged 6 to 36 months, and children aged 3 to 6 years, who receive either take-home rations or hot, cooked meals at mother-child health and nutrition centers. This program serves as an important mechanism for delivering fortified food (NITI Aayog 2022b).

Telangana's Bal Amrutham, a fortified complementary food provided as take-home rations through ICDS, has achieved high coverage among target populations (93.7% caregiver awareness, 86.8%

product receipt), with 57.2% of children reporting regular consumption despite barriers including irregular supply and intra-household sharing. This case study demonstrates that ICDS infrastructure can deliver fortified foods at scale with reasonable coverage, though supply chain optimization remains essential (Fiedler et al. 2016).

PM POSHAN school meal fortification: PM POSHAN serves approximately 118 million school-age children in Grades 1-8, with beneficiaries receiving hot midday meals from government and government-aided schools. Meal planning mandates the inclusion of fortified food components: fortified wheat flour or rice serves as cereal components, double-fortified salt replaces standard salt in meal preparation, and fortified oil is used in cooking.

2.2.2.7 Population Reach and Coverage Metrics

Salt fortification coverage: Iodized salt achieved near-universal household coverage by 2019: the NFHS-5 indicated that 90.4% of household salt samples contained iodine according to the 2009 Coverage Evaluation Survey, though these figures reflect household availability and use rather than individual consumption. By 2019-21, iodized salt coverage was sufficiently widespread to be documented in routine national surveys, indicating the program's foundational success in reaching populations. However, significant disparities persist: low-income and rural households demonstrate lower levels of adequate iodized salt consumption, with the former state of Andhra Pradesh reporting coverage of adequately iodized salt (containing ≥15 ppm iodine) at only 63.6%, below national averages. Double-fortified salt reach remains limited to specific geographic regions where the government explicitly mandated integration into the social safety net program provision. Tamil Nadu, Madhya Pradesh, and Gujarat provide double-fortified salt through public distribution to over 12 million beneficiaries at subsidized rates, but double-fortified salt penetration in open-market channels remains minimal, reflecting low commercial demand and limited consumer awareness of the benefits of dual fortification relative to standard iodized salt (Tsai et al. 2025).

Rice and wheat fortification coverage: Fortified rice distribution through government programs has expanded rapidly: the cumulative 322.27 lakh tons distributed through TPDS, Mission Poshan 2.0, and PM POSHAN by the end of Phase III (2023-24) theoretically reaches more than 800 million potential beneficiaries enrolled in these programs, though actual consumption remains unmeasured. The national program's acceptance and perceived value are evident from the rapid procurement trajectory: 134 lakh tons procured in 2022-23 alone, demonstrating both government commitment and potential market viability. Household consumption data on fortified rice through private commercial channels remain negligible, with estimates suggesting only 0.1-0.2% of total rice consumption incorporates fortification in open markets.

Wheat flour fortification in commercial channels similarly demonstrates minimal private sector adoption (approximately 3% of wheat flour production). However, state-level mandatory adoption in TPDS and ICDS in states such as Gujarat, Haryana, and Rajasthan extends the reach of fortified wheat flour to millions of beneficiaries. Gujarat's experience, detailed in comprehensive case studies, demonstrated that the state's introduction of fortified wheat flour into TPDS, Mission Poshan 2.0, and mid-day meal beneficiary populations achieved coverage that expanded from pilot phases to near-universal coverage among social safety net program beneficiaries within five to seven years, driven by a deliberate state policy commitment and engagement with the milling industry (Bhattacharjee and Bhole 1984).

Edible oil and milk fortification coverage: Edible oil fortification has made significant strides, with 341 brands currently fortified with vitamins A and D. This initiative has achieved substantial market presence in organized retail and urban markets, with coverage estimates of 40-60% in organized sectors. However, its presence in traditional/informal retail channels, serving lower-income populations, remains limited. Similarly, milk fortification is primarily concentrated within organized dairy sectors (with 40 fortified brands available). Its reach in informal milk markets is limited, which is important to note since these markets largely serve rural and low-income households that consume the majority of their milk from informal sources (FSSAI 2021).

Overall fortified food consumption among vulnerable populations: Rigorous assessment of fortified food consumption among the most vulnerable population segments (lowest income quintiles, Scheduled Castes and Scheduled Tribes, rural populations) remains limited. This means that fortification programs, while achieving substantial scale, have not yet achieved equitable distribution aligned with the intensity of need. This equity gap reflects multiple factors: supply chain leakage disproportionately affecting remote and rural areas with limited infrastructure; low consumer awareness and acceptance in segments with limited health literacy; and commercial distribution concentration in urban and peri-urban areas with higher population density and purchasing power.

2.2.2.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Fortified rice in India moves through a well-defined value chain from premix procurement to last-mile distribution, with the Department of Food and Public Distribution (DFPD)/FCI managing procurement and movement for social safety net schemes and FSSAI providing standards, digital traceability (fortified rice traceability, or FoRTrace/fortified rice quality management system, or FRQMS), and regulatory oversight, including sample testing by food safety officers and notified laboratories. The numerical figures cited for the ecosystem (925 FRK manufacturers, 232 premix suppliers, approximately 21,000 blending-equipped mills, and 57 laboratories) are drawn from government records and FSSAI documents on the rice-fortification ecosystem. Rice fortification through FRK follows a structured stepwise supply chain integrated with the standard paddy-to-rice flow. The stages below assume government schemes (public distribution scheme/Mission Poshan 2.0/PM POSHAN) but are broadly applicable to open-market fortified rice.

Premix and FRK production: Premix manufacturers produce micronutrient premix (iron, folic acid, vitamin B12, and optional micronutrients) using approved compounds such as micronized ferric pyrophosphate, within ranges notified in the Food Safety and Standards (Fortification of Foods) Regulations, 2018. FRK manufacturers procure premix and raw rice, then use extrusion to produce rice-shaped kernels containing about 28–42.5 mg/kg iron, 75–125 µg/kg folic acid, and 0.75–1.25 µg/kg vitamin B12, aligned with FSSAI standards to ensure that typical consumption provides approximately 30–50% of the adult recommended dietary allowance per day.

Paddy procurement and milling: DFPD and state food departments oversee paddy procurement from farmers through FCI and state agencies under the minimum support price and decentralized procurement systems. Approved rice mills receive paddy, undertake standard operations (drying, dehusking, polishing, grading), and must hold a valid milling license as well as an FSSAI license for processing fortified rice under the relevant food category before blending (Department of Food and Public Distribution 2023).

Blending at rice mills: Rice millers procure FRK only from FSSAI-licensed/registered FRK manufacturers and must obtain a certificate of analysis from an FSSAI-notified NABL-accredited lab for each FRK lot. Fortified rice is produced by blending FRK with non-fortified rice at a 1:100 ratio (1 kg FRK to 100 kg raw rice), as specified in DFPD operational guidelines and procurement tenders (Department of Food and Public Distribution n.d.).

Warehousing, transportation, and distribution: Once accepted by FCI/state agencies, fortified rice is stored in central and state godowns; warehousing operations must maintain segregation, proper labeling (with the +F logo), and records for each fortified lot. Fortified rice is then transported to fair price shops and program delivery points (ICDS centers, schools) under DFPD/FCI movement plans, with documentation linking consignments back to specific lots and mills for traceability and quality audit.

2.2.2.9 Roles of DFPD and FCI

The DFPD sets policy and issues operational guidelines for "Fortification of Rice and its Distribution" under public distribution scheme and other schemes, including eligibility conditions for mills, blending ratio, and quality parameters. Through its storage and research division, it monitors self-certification and records of FRK producers and mills. It directs FCI and state agencies to conduct regular sampling and testing of fortified rice. The FCI and state procuring agencies procure fortified rice that meets blending and quality specifications, including a certificate of analysis for FRK and fortified rice, and ensure all bags carry the blue "+F" logo and appropriate labeling.

FSSAI's fortification regulations specify mandatory addition of iron, folic acid, and vitamin B12 to rice (and atta/maida) using permitted compounds such as ferric pyrophosphate, with fortification levels designed so that usual consumption contributes about 30–50% of the recommended dietary allowance, recognizing fortified staples as one component of total micronutrient intake. Standards also require manufacturers to maintain records of raw material procurement, premix/FRK use,

blending procedures, and internal quality checks, and to use the +F logo and mandatory labeling declarations (including warnings for conditions such as thalassemia where relevant). For rice fortification, standards specify that when consumed at usual portions (150-200 g cooked rice equivalent), fortified rice provides 30-50% of the recommended dietary allowance for iron and folate. This approach reflects a careful dosing philosophy aimed at avoiding excessive micronutrient provision while recognizing that fortified staples constitute only one component of overall micronutrient dietary intake.

FSSAI aims to promote and support LSFF to reduce micronutrient deficiencies. Working in collaboration with nutrition-focused partners, it provides technical guidance, capacity-building, and implementation support to states, union territories, and food businesses to adopt fortification in line with the Food Safety and Standards (Fortification of Foods) Regulations, 2018. It also facilitates policy dialogue, develops standards-compliant practices, and promotes the use of the "+F" logo to identify fortified foods in the Indian market (Food Safety and Standards Authority of India n.d.-d).

FoRTrace and FRQMS: A digital quality assurance/quality check and traceability system, named the FoRTrace application within the Food Safety Compliance System portal of FSSAI, to create end-to-end digital traceability of fortified rice, covering premix, FRK manufacturers, millers, warehouses, and distributors. Within FoRTrace/FRQMS-type modules, millers and warehouses record FRK lot receipt, batch creation, blending details, dispatches, and lab tests, enabling regulators to track each fortified lot's movement, monitor production volumes and quality parameters, and quickly investigate any non-compliance or adulteration.

2.2.2.10 Laboratory Network and Sampling Intensity

FSSAI notifies NABL-accredited laboratories specifically authorized to test fortified rice, FRK, and vitamin–mineral premix (Food Safety and Standards Authority of India 2026); these lists are updated periodically and currently include many labs capable of analyzing iron, folate, vitamin B12, and physical parameters. Operational guidelines advise FRK manufacturers to maintain self-testing records and that FCI/state procurement agencies send a minimum share (e.g., about 10%) of monthly fortified rice samples to FSSAI-approved NABL labs (Department of Food and Public Distribution n.d.-b). However, full coverage of all mills remains constrained by capacity and geography.

2.2.2.11 Wheat Flour Fortification Processes

Wheat flour fortification employs simpler technology: direct addition of a premix containing iron, folic acid, and vitamin B12 to flour during milling, enabling adoption across diverse mill scales from large roller mills to small organized chakkis. This simplicity paradoxically creates quality assurance challenges: smaller mills lack the capacity for consistent premix blending, equipment maintenance, and record-keeping essential for compliance verification. Successful wheat fortification in states like Gujarat required sustained government engagement with milling associations, technical training on fortification procedures, and monitoring protocols to ensure consistent implementation (Nutrition Connect 2017; Radhika et al. 2011). Refer to Figure 2.7.

Figure 2.7. India's food fortification ecosystem

India

Nutrition, Diet & Policy Snapshot

Anaemia: ~67% children (6–59 months); ~57% women of reproductive age

Child undernutrition: ~35.5% stunted; ~19.3% wasted; ~32% underweight

Micronutrient gaps: Iron, folate, vitamin A, vitamin B12 deficiencies widespread

Dietary pattern: Rice- and wheat-based diets

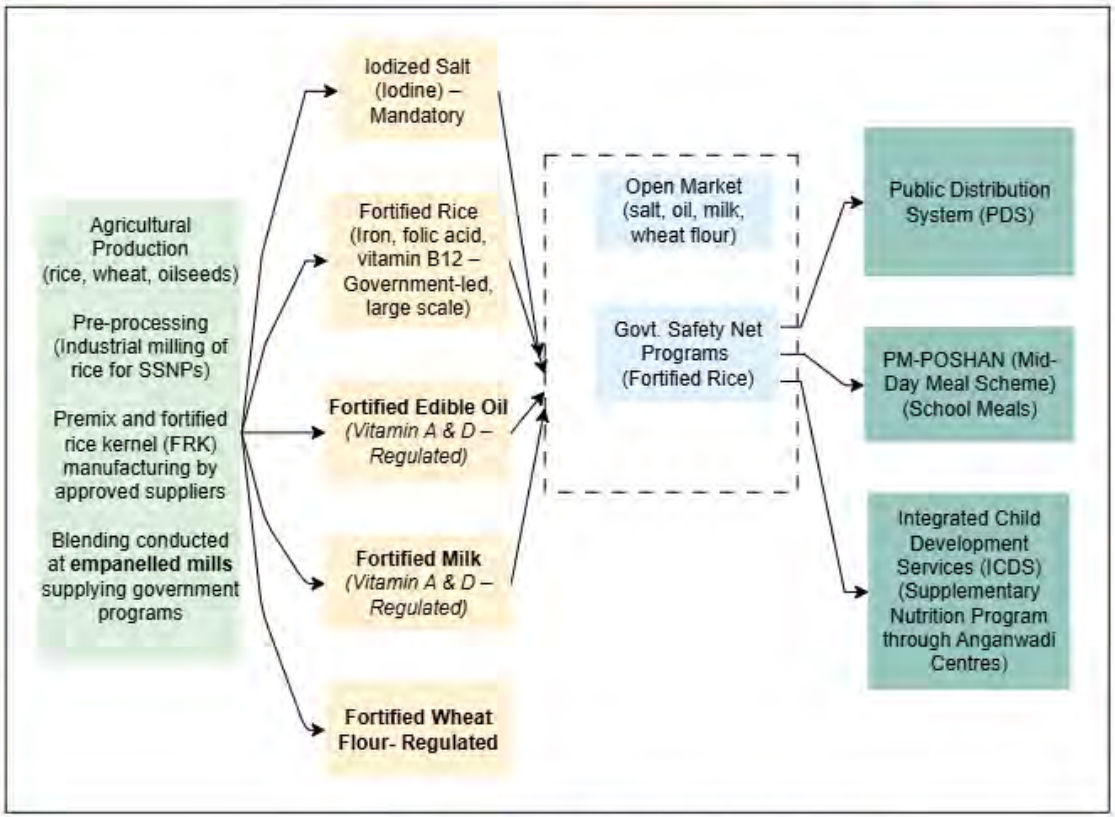
Mandatory vehicles: Iodized salt (universal); fortified oil & milk (regulated); rice (government-led)

Rice fortification: Implemented at scale through government social safety nets programs

Delivery platforms: Public Distribution System (PDS), PM-POSHAN (school meals), ICDS

Evidence base: National Family Health Survey (NFHS-5); CNNS 2016–18

Policy anchor: National Nutrition Mission (POSHAN Abhiyaan); Food Safety & Standards Act



Nutrition Policy & Coordination
– Ministry of Women & Child Development (POSHAN Abhiyaan)
– Ministry of Consumer Affairs, Food & Public Distribution
– Ministry of Education (School Meal)

Standards & Regulation
–Food Safety and Standards Authority of India (FSSAI)

Health & Monitoring
– Ministry of Health & Family Welfare
– National Centre for Disease Control / surveys (NFHS, CNNS)

State Level Implementation
– State Food & Civil Supplies Departments
- State Food Safety Department

Regulatory, Program Monitoring, Evaluation & Compliance

–FSSAI fortification regulations & +F logo
– Food Safety Officer inspections; lab testing (NABL-accredited & FSSAI approved labs)
– Digital system for QA/QC & Traceability- FoRTrace for monitoring entire supply chain for fortified rice

Source:
1. National Family Health Survey (NFHS-5), 2019-21: https://www.dhsprogram.com/pubs/pdf/FR375/FR375.pdf.

2.2.2.12 Monitoring and Evaluation Mechanisms

Government programs have developed standardized monitoring approaches that vary in sophistication. For rice fortification distributed through TPDS, the DFPD tracks fortified rice procurement, storage, and distribution through state-level reporting systems linked to fair price shop point-of-sale transactions, which are increasingly recorded through ePoS (electronic point-of-sale) devices. As of 2023, approximately 99.6% of fair price shops use ePoS systems, enabling digital documentation of fortified rice distribution and, in theory, creating comprehensive beneficiary-level transaction records (Press Information Bureau 2024).

Mission Poshan 2.0 monitoring operates through integrated management information systems that track supplementary nutrition provision at the Anganwadi center level, with state-level consolidation providing monthly reports on beneficiaries served and food items distributed. However, data quality varies substantially by state, with some states maintaining detailed individual beneficiary records while others report only aggregate center-level summaries.

Household coverage surveys and effectiveness studies: The NFHS, conducted periodically with representative national samples, has included only a limited number of questions on fortification coverage in recent rounds. NFHS 5 (2019-21) included queries on household salt consumption and iodine testing, providing national- and state-level data on iodized salt availability but not on individual consumption. These data indicated that while household iodized salt coverage was substantial, regional variations persisted, and the survey did not systematically assess coverage of household fortified rice, wheat flour, or other vehicles.

Specialized fortification coverage assessments employing GAIN's Fortification Assessment Coverage Tool have been conducted in select districts and states, measuring household awareness of fortified foods, purchasing/receipt patterns, and consumption frequencies, providing more granular coverage data than national surveys. The Telangana Bal Amrutham coverage assessment found high product awareness (93.7%) and receipt (86.8%) among target households, with consumption among 57.2% of target beneficiaries (Leyvraz et al. 2016). However, these specialized surveys remain geographically limited and cannot provide comprehensive national coverage estimates.

Quality assurance monitoring: Food safety laboratory monitoring of fortified foods involves periodic market surveillance, sampling, and testing of fortified products procured through routine market channels or government procurement. FSSAI and state food safety departments conduct surveillance sampling and testing of products to ensure compliance with specified micronutrient standards. Surveillance data, when systematically compiled, provide indicators of supply-side compliance but do not capture household-level consumption patterns.

Field-level enforcement and sample testing (food safety officers and state authorities): State food safety commissioners and food safety officers implement FSSAI regulations on the ground, including licensing of mills and FRK manufacturers, conducting facility inspections, verifying fortification records, and collecting samples from markets and supply chain points. Food safety officers are required to collect at least 10% of fortified rice samples from mills monthly and send composite samples to FSSAI-empaneled NABL labs to verify micronutrient content and blending consistency before distribution. Food safety officers can also seize noncompliant products, issue improvement notices, and initiate prosecution under the Food Safety and Standards Act where fortified foods do not meet declared standards or make misleading claims.

2.2.2.13 Stakeholder Ecosystem and Partnerships

India's fortification ecosystem comprises diverse stakeholders, including government agencies, international development organizations, civil society groups, private sector entities, and research institutions, each with varying mandates, resources, and institutional interests that require deliberate coordination.

Government institutional framework: At the central level, FSSAI serves as the primary regulatory authority and policy coordination hub. The Ministry of Women and Child Development and the Ministry of Health and Family Welfare coordinate programmatic implementation through Mission Poshan 2.0 and health-related interventions, while the DFPD manages TPDS procurement and distribution of fortified commodities. State governments, through departments that mirror their central counterparts, assume responsibility for implementing Mission Poshan 2.0, TPDS, and PM POSHAN, with substantial variation in capacity, political commitment, and coordination mechanisms across states.

State-level coordination structures vary: some states (such as Gujarat and Haryana) have established dedicated committees that bring together department secretaries, district administrators, civil supply officials, food business operators, and industry representatives for systematic problem-solving and progress reviews. Other states maintain minimal coordination, resulting in fragmented, department-level initiatives without a comprehensive fortification strategy.

Between October 2016 and October 2017, a series of high-level consultations and strategic meetings were convened to advance the prioritization of rice fortification in India. These national summits and stakeholder consultations brought together senior government officials, including the Honorable Union Minister of Consumer Affairs, Food and Public Distribution, and the Union Minister of State. During these deliberations, strong emphasis was placed on developing and implementing comprehensive regulatory frameworks to support LSFF initiatives. The Ministry of Women and Child Development and FSSAI jointly organized five zonal consultations across different regions to support the implementation of LSFF. State-level meetings discussed including fortified staples in public distribution schemes and government social safety net programs across West Bengal, Delhi, Assam, Karnataka, Punjab, Rajasthan, Haryana, and Madhya Pradesh. Technical consultations strengthened technical capacity, including premix supply and quality, conducted in collaboration with development partners and the Indian Institute of Health Management Research.

International development organizations: GAIN has maintained continuous engagement in India's food fortification sector for over 15 years, providing technical assistance, financial resources, and institutional support for the LSFF program, which has been scaled up since 2003, working collaboratively with government, industry, and civil society partners. GAIN's contributions include promoting fortification technology, building industry capacity, strengthening the supply chain, and policy advocacy, with a particular focus on wheat flour and oil fortification across multiple states.

The WFP runs programmatic initiatives to support the integration of fortified foods into social safety net programs, with notable success in Gajapati, Odisha, where the introduction of fortified rice through the midday meal program improved children's nutritional intake and reduced anemia prevalence. A strategic initiative involved a WFP pilot in Varanasi that garnered heightened government attention to the merits of fortified rice, contributing significantly to government momentum for fortification. WFP's recent South-South cooperation initiative with Nepal, supported by the Indian government, extends India's fortification model to regional partners, positioning India as a provider of technical expertise.

The food fortification initiative works in 18 Indian states to strengthen wheat flour and rice fortification programs through supply chain analysis, industry engagement, and policy support, with demonstrated success in Haryana, where state-level fortification implementation benefits 12.6 million people (Food Fortification Initiative n.d.).

PATH's role as the technical partner to the DFPD from 2020–21 to 2025 has been instrumental in advancing the Government of India's rice fortification agenda across 12 states. It provided end-to-end technical assistance to state nodal departments, facilitating planning, capacity-building, supply chain integration, and quality assurance to ensure smooth implementation through social safety net programs such as the public distribution scheme, Mission Poshan 2.0, and PM POSHAN. PATH's technical experts worked closely with state governments to adapt national guidelines to local contexts, resolve implementation challenges, and build institutional ownership. A key sustainability measure was the establishment of state-level technical support units, supported through Gates Foundation funding, which strengthened in-state capacities for monitoring, coordination, and scale-up beyond the project period.

Civil society and private sector coordination: FSSAI worked to convene and facilitate stakeholder coordination on fortification policy and implementation, and to provide ongoing support for state-level program strengthening and industry engagement. The Tata-Cornell Institute, in collaboration with Tata Trusts, released a comprehensive 2020 report revealing that approximately 194 million people in India were still grappling with undernourishment during 2016-18, representing only a modest 8% decrease from 210 million undernourished individuals documented in 1990 92. This evidence underscored the imperative to rapidly scale up fortification interventions to address persistent hidden hunger at the national level.

Industry associations such as the Confederation of Indian Industry, the Wheat Flour Millers Federation, the Rice Millers Association, dairy cooperatives, and salt producer associations participate in government consultations, technical working groups, and capacity-building initiatives. However, coordination effectiveness varies by association strength and member engagement.

Private sector players range from multinational food companies (such as Cargill India, which runs awareness campaigns on the benefits of fortified oil) to thousands of small-scale mills and producers that require targeted capacity-building and financial support to adopt fortification. The heterogeneous private sector requires differentiated engagement strategies: large, consolidated industries (oil, salt) respond to market incentives and brand positioning, while fragmented sectors (wheat, rice) need government-supported infrastructure, technical assistance, and perhaps direct subsidization to make fortification adoption affordable.

Research and academic institutions: Nutrition research institutions, including the National Institute of Nutrition, the Indian Council of Medical Research, and university departments, contribute evidence-based research through dietary survey analysis, impact evaluations, and technology development research, informing policy decisions and standard setting. These institutions' engagement in FSSAI's regulatory working groups and technical committees ensures that standards reflect current scientific evidence on micronutrient requirements, bioavailability, and efficacy. Prashanth Thankachan, a professor in the Division of Nutrition at St John's Research Institute, has emphasized that "in a country with a lack of diversity in food consumption, supplying iron-fortified rice is a low-cost, safe and effective means of addressing malnutrition," underscoring the evidence-based consensus supporting fortification approaches.

2.2.2.14 Critical Challenges and Policy Reforms Needed

While India has established comprehensive fortification policies, infrastructure, and programmatic integration into social safety net programs, implementation and impact are constrained by multiple systemic challenges requiring policy reform and increased resource mobilization.

Financing inadequacy: The fundamental constraint affecting all nutrition interventions, including fortification, remains insufficient funding. The total annual cost of delivering core direct nutrition interventions across India was calculated at ₹48,440 crore in 2022-23, representing a gap of ₹9,869 crore above actual allocations as of that fiscal year. This financing gap reflects both absolute under-investment and unequal distribution across states, with poorer states facing a greater burden but receiving proportionally smaller allocations. Within the overall nutrition budget, fortification constitutes a relatively modest expenditure component primarily reflecting procurement cost differentials between fortified and unfortified staples in government procurement (estimated at a 2 5% additional cost), plus regulatory and capacity-building support. However, fortification's insufficient financing reflects broader inadequacy in nutrition program budgets rather than fortification-specific underfunding (Kapur et al. 2023).

Supply chain leakage and efficiency loss: The public distribution scheme, through which fortified rice reaches the largest population, experiences substantial leakage: approximately 28% of allocated food grains do not reach intended beneficiaries (approximately 20 million tons annually), representing an annual fiscal loss of ₹69,108 crore as of 2022-23 (International Food Policy Research Institute & Indian Council for Research on International Economic Relations 2024). This leakage, though reduced from 46% in 2011-12 through ePoS implementation and digitization, remains at levels that substantially undermine the fortification program's impact. Addressing these efficiency losses requires substantial infrastructure investment in modern silos, cold storage facilities, and automated handling systems, thereby competing with other nutrition priorities within constrained state budgets.

Supply- and demand-side barriers in implementation: On the supply side, the fragmented private sector structure in rice and wheat milling creates coordination challenges and reduces incentives for fortification adoption without a government mandate. Small mill operators face capital barriers (equipment costs of ₹15 20 lakh), technical knowledge gaps, and perceived quality-control difficulties that deter voluntary fortification adoption. Government mandates in social safety net procurement overcome these barriers through institutional purchasing power and scale, but extending mandates to open-market channels would require sustained enforcement capacity and economic incentives not yet operationalized.

On the demand side, low consumer awareness and persistent skepticism regarding fortified foods, particularly in rural and low-income communities, constrain market expansion and voluntary consumption. Behavior change communication campaigns, while expanded through FSSAI's Eat Right India initiative, remain insufficient in reach and intensity to fundamentally shift preferences. Community-level education addressing misconceptions, highlighting the nutritional benefits of fortified foods, and demonstrating acceptability has been episodic rather than sustained. The social and behavior change communication strategies used during pilot phases proved highly effective, particularly when targeting school cooks through campaigns and conducting cooking and tasting demonstrations that showcased that fortified rice maintained the same taste and aroma as unfortified rice.

Inter-governmental coordination and implementation variance: Despite national FSSAI policy frameworks, implementation varies substantially across states. States with strong institutional coordination mechanisms, political commitment to nutrition, and adequate implementation capacity (Gujarat, Haryana, Tamil Nadu, Madhya Pradesh) have substantially integrated fortified foods into social safety net programs. In contrast, other states lag in policy adoption, capacity building, and compliance monitoring. This variance reflects a broader reality of Indian governance: federal policies require state implementation within constitutional frameworks, providing state governments substantial policy space and implementation discretion (Bhatnagar and Kanoria 2020).

Resolving state-level variance requires mechanisms beyond policy issuance: inter-ministerial coordination committees at the state level, technical assistance and capacity-building support from central agencies, monitoring and feedback systems that provide regular progress assessment, and perhaps performance incentives (tied funding allocation, recognition mechanisms) rewarding superior implementation. Several states have been slow to appoint fortification nodal officers despite central government directives, indicating that institutional change requires more than administrative issuance.

Quality assurance and enforcement limitations: Enforcement of fortification standards remains inconsistent due to limited regulatory capacity. District food safety departments vary substantially in staffing, laboratory access, and technical knowledge regarding fortification quality assessment. This capacity variance means compliance monitoring remains incomplete, and manufacturers in capacity-constrained districts face minimal enforcement incentives.

Building sustainable quality assurance requires a paradigm shift from exclusive reliance on external government oversight toward industry self-regulation supported by third-party verification: certified laboratories serving specific regions, routine internal quality procedures within manufacturing units, industry peer oversight mechanisms, and independent auditing. This transition remains nascent in India's fortification sector and requires substantial investment in capacity building and institutional change beyond current regulatory approaches (Singh, Sood, and Khanduja 2025).

2.2.2.15 Opportunities and Future Directions

Despite substantial challenges, India's fortification ecosystem has significant untapped potential to expand its nutritional impact and implement innovative approaches.

Open-market fortification expansion: The existing infrastructure for fortified food production - 1,000 FRK manufacturers, 21,000 equipped rice mills, 232 premix manufacturers, and extensive laboratory testing capacity (Ministry of Consumer Affairs, Food and Public Distribution 2025) was developed primarily to serve government institutional procurement (TPDS, Mission Poshan 2.0, and PM POSHAN). This infrastructure has substantial excess capacity to produce and distribute open-market fortified products. Transitioning from government-exclusive supply to dual-track supply chains (institutional plus commercial) would better leverage existing capacity while extending fortification reach beyond government beneficiary populations to broader consumer segments that can purchase fortified products in commercial markets.

Private sector-led expansion would require policy-enabling mechanisms: Regulatory certainty through maintained/expanded mandatory fortification standards, consumer demand creation through sustained awareness campaigns, potential financial incentives (tax benefits, preferential financing) offsetting private sector fortification costs, and market development initiatives facilitating the expansion of retail distribution channels in rural and underserved urban areas.

Global context and international fortification leadership: India's rice fortification experience has positioned the country as a potential global leader. India's pilot-to-scale approach, which uses large-scale pilot projects to demonstrate feasibility, build evidence, and inform national implementation, may serve as a valuable blueprint for nations where government endorsement of fortification is not yet fully realized. The pilot-to-scale framework incorporated four extensive pilot projects in disparate regions: three within school meal programs and one within Mission Poshan 2.0, assessing implementation efficacy, demonstrating operational effectiveness, and iteratively refining programs. In contexts where government advocacy has been established, sharing cross-national experiences and advocacy efforts may expedite widespread implementation.

Dietary diversification and nutrition-sensitive agriculture: While fortification addresses micronutrient deficiencies within existing dietary patterns dominated by white rice and refined wheat, genuine nutritional security requires dietary diversification toward protective foods, vegetables, fruits, pulses, and animal products in quantities and at a frequency currently unattainable for lower-income populations. Longer-term policy integration would position agriculture policy and food security programs to support diversified production, reduce the unit costs of nutritious foods, and strengthen agricultural extension to promote home gardening, nutrition education, and dietary behavior change, alongside expanding food availability.

Public distribution system evolution toward a “nutrition-sensitive public distribution system” that provides diversified food baskets, including biofortified staples, pulses, vegetables, and fortified products, rather than the rice-and-wheat monotony, represents structural innovation requiring policy redesign, supply chain development, and consumer acceptance management (Jose, Gulati, and Khurana n.d.).

Technological innovation and digital integration: Advanced technologies offer opportunities for improved supply chain efficiency, quality verification, and monitoring. Blockchain-based distribution tracking could reduce leakage by providing transparent, immutable records of fortified food movement from procurement through beneficiary distribution. Point-of-sale systems with real-time reporting enable instantaneous assessment of demand, supply adjustment, and leakage detection. Artificial intelligence and data analytics can identify spoilage patterns, optimize storage conditions, and forecast demand, enabling improved inventory management.

Quality assurance could incorporate rapid testing technologies (portable spectrophotometry, mobile laboratory platforms) to enable on-site fortification verification, reduce reliance on centralized laboratory capacity, and accelerate compliance feedback to manufacturers. Digital literacy programs could enhance consumer awareness through mobile-based nutrition education, QR code-linked product information, and community health worker-enabled messaging.

Regional and South-South cooperation: India's success in fortification infrastructure development and supply chain integration creates an opportunity for regional leadership and technology transfer supporting nutrition improvements in neighboring countries and the Global South more broadly. Delegations from South Asian countries, including Sri Lanka, Bhutan, and Bangladesh, have visited India to learn from fortification experience. The recent India-UN collaboration with Nepal on rice fortification supply chain management, leveraging India's public distribution system experience and technologies, demonstrates this emerging role (United Nations Development Programme n.d.). Formalizing India as a technical resource center for fortification policy, technology, and implementation could advance South-South cooperation in achieving the Sustainable Development Goals while creating commercial opportunities for the Indian fortification industry in regional markets.

2.2.3 Indonesia

2.2.3.1 Nutrition and Fortification Ecosystem

Indonesia's food fortification landscape reflects a complex intersection of demographic challenges, nutritional needs, and policy implementation across the world's largest archipelagic country. As the fourth most populous country, with over 270 million inhabitants, Indonesia faces a significant triple burden of malnutrition characterized by persistent stunting affecting 19.8% of children under five years old, widespread anemia among WRA (31.2%) (WHO n.d.), and emerging overweight and obesity concerns (Ministry of Health, Indonesia 2024; Development Initiatives 2024). The country has established mandatory fortification programs for salt, wheat flour, and palm cooking oil while piloting rice fortification through social safety net programs, yet implementation remains challenged by the archipelago's geographic diversity, fragmented regulatory framework, and variable monitoring capacity (UNICEF 2024). The archipelago comprises more than 17,000 islands and spans approximately 1.9 million km2, with approximately 55.9% of the population residing on Java Island alone (Statistics Indonesia 2023). This concentration creates stark contrasts between densely populated urban centers and remote rural communities, presenting distinct logistical challenges for food distribution and supply chain management.

The demographic profile reveals a relatively young population, with a median age of 30.2 years: 23.33% are aged 0-14 years and 70.72% are in the productive age group of 15-64 years. This demographic structure presents both opportunities and challenges for targeted nutrition interventions, particularly for the large young population requiring maternal and child nutrition programs.

Indonesia's ethnic and linguistic diversity, with over 600 ethnic groups speaking more than 700 languages, including Javanese, which comprises 40.2% of the population, and Sundanese, which comprises 15.5%, necessitates culturally sensitive approaches to nutrition education and program implementation, particularly in regions where traditional dietary practices may influence acceptance of fortified foods.

2.2.3.2 Nutritional Status and Dietary Practices

Indonesia continues to grapple with significant childhood malnutrition. The 2024 Indonesian Nutritional Status Survey (SSGI) data indicate that stunting prevalence decreased to 21.5% in 2023 and further to 19.8% in 2024, below the regional average for Asia (21.8%). Wasting affects 10.2% of children under five years old, exceeding the Asian regional average of 8.9%, while 8% of children under five years old are overweight, indicating the triple burden of malnutrition associated with Indonesia's nutrition transition.

Anemia represents one of Indonesia's most persistent nutritional challenges. Among WRA (15-49 years), 31.2% are anemic with no progress toward achieving international reduction targets, while the prevalence reaches 27.7% among pregnant women and 15.5% among teenagers aged 15 to 24. Among children aged 6 to 59 months, an estimated 38% were anemic in 2019, positioning Indonesia as a significant contributor to the global child anemia burden.

The etiology of anemia in Indonesia is complex, with research indicating that more than 50% of cases are microcytic hypochromic, 35% indicate iron deficiency, and 13% suggest thalassemia. This genetic component adds complexity to anemia mitigation strategies, requiring programs to incorporate screening and risk stratification for appropriate interventions.

2.2.3.3 Maternal and Infant Nutrition Indicators

Indonesia demonstrates mixed progress on maternal and infant nutrition targets. The country is "on course" to meet exclusive breastfeeding targets, with 50.7% of infants aged 0 to 5 months exclusively breastfed, reflecting improved implementation of infant feeding recommendations. Low birth weight affects 10.0% of infants, though dietary diversity remains suboptimal, with typical diets being largely rice-based and lacking adequate micronutrient diversity (Global Nutrition Report n.d.). This highlights the complementary role of food fortification alongside promoting dietary diversity.

2.2.3.4 Nutrition-related Flagship Program

Indonesia's nutrition landscape features several flagship programs aimed at reducing stunting, malnutrition, and micronutrient deficiencies. It is coordinated under national strategies such as the National Strategy to Accelerate Stunting Prevention (Stranas Stunting). These initiatives emphasize multisectoral action, with the Free Nutritious Meals (Makan Bergizi Gratis or MBG) program emerging as the top priority under President Prabowo Subianto's administration since early 2025.

MBG/free nutritious meals: Launched on January 6, 2025, this presidential priority provides free, locally sourced nutritious meals to over 60 million schoolchildren, pregnant women, and vulnerable groups, absorbing Rp71 trillion (US$4.3 billion) in the 2025 budget to combat stunting and malnutrition. Operated by 17,555 Nutrition Fulfillment Service Units (SPPG), it targets 82.9 million beneficiaries by 2029, with UN support to scale up (Tempo 2024).

National strategy to accelerate stunting prevention (Stranas Stunting): Launched in 2018, this strategy coordinates over 17 ministries to reduce stunting from 30.8% (2018) to 19.8% (2024 SSGI), focusing on

the first 1,000 days through family companion teams, posyandu (community-based health service posts) services, and interventions like supplementation and fortification. This includes district-level commitments from 358/360 prioritized areas.

Better Investment for Stunting Alleviation (BISA): A 2019-24 project with Nutrition International and Save the Children, this initiative aims to improve nutrition for adolescent girls, pregnant/lactating women, and children under two years old through evidence-based interventions in prioritized districts.

2.2.3.5 Supporting mechanisms

National Nutrition Agency (BGN): Established in 2024, the National Nutrition Agency leads MBG implementation, manages SPPG kitchens (targeting 19,000 by the end of 2025, including 8,200 in remote areas), and oversees budgeting and real-time tracking via the LISA dashboard.

National Action Plan on Food and Nutrition (RAN-PG) 2021-24: This action plan guides provincial and district plans for nutrition-specific (IYCF, supplementation, and fortification) and nutrition-sensitive interventions, integrated into Rencana Pembangunan Jangka Menengah Nasional with key performance indicators for stunting and wasting reduction.

Some social and behavior change communication programs, such as GERMAS (Community Movement for Healthy Life), aim to promote a culture of healthy living and help people abandon unhealthy habits and behaviors. This GERMAS action also promoted clean and healthy living behaviors and supported community-based infrastructure programs (Ministry of Health, Indonesia n.d.-a). Similarly, AKSI BERGIZI, the national nutrition action movement, is an initiative aimed at increasing students' awareness of consuming TTD (iron supplement tablets), eating a balanced nutritional menu, and engaging in physical activity (Ministry of Health, Indonesia n.d.-b).

The activity, which was carried out nationally in junior high schools/Islamic junior high schools, senior high schools/Islamic senior high schools, vocational high schools, Islamic boarding schools, and equivalent schools, had the key message: **“Healthy Living from Now on for Today's Youth”.**

Rembug stunting and GENTING movement: Local coordination forums have been established to prevent stunting, expand supplementary feeding, improve sanitation, and identify early risks in high-burden areas like Lamongan (6.9% stunting). The programs align with Rencana Pembangunan Jangka Panjang Nasional (RPJPN) 2005-25 and Scaling Up Nutrition commitments, leveraging fortification (salt, wheat flour, rice via safety nets) and digital tools for monitoring. As a result, stunting has dropped to 19.8% nationally, according to SSGI 2024, though challenges persist in remote regions (Ministry of Health, Indonesia 2024).

2.2.3.6 Policy Environment for Food Fortification

Indonesia's approach to food fortification is embedded within broader national nutrition strategies, reflecting institutional recognition that food fortification is one component of comprehensive nutrition governance. The country formally joined the Scaling Up Nutrition movement in 2011 through Presidential Announcement Number 42/2013, establishing a political framework for multisectoral nutrition action. The National Medium-Term Development Plan (RPJMN) 2025-29 includes specific targets for fortification coverage, notably the goal of ensuring 100% of social safety net beneficiaries receive fortified rice, with a government target of reducing national stunting to 14.2% by 2029.

Current implementation falls substantially short of policy targets, requiring systems strengthening and better resource allocation. Meanwhile, food fortification has also been identified as a critical priority in both the National Long-Term Development Plan (RPJPN) 2025–45 and the new Rencana Pembangunan Jangka Menengah Nasional 2025–29.

2.2.3.7 Regulatory Framework for Mandatory Fortification

Indonesia has established mandatory fortification requirements for three primary food vehicles: salt, wheat flour, and palm cooking oil, though regulatory frameworks vary significantly in complexity and effectiveness.

Salt iodization: Mandatory since 1994 (SNI 3556-2024), Indonesia has been an early adopter of this essential intervention. However, the regulatory framework is widely described as "complicated and confusing," with multiple overlapping regulations from different ministries, which creates ambiguity for producers and enforcement challenges for regulators. Recent presidential regulations encouraging the production of geographical indication salt have created additional complexity.

Wheat flour fortification: Since 2001 (SNI 3751-2018), Indonesia has mandated wheat flour fortification under the national standard (SNI), establishing a clear legislative framework for its fortification programs. This requirement, specified in SNI (Indonesian National Standard) 3751, was briefly suspended during the COVID-19 pandemic (March 2020) but was reinstated in early 2021. The standard was updated to SNI 3751:2018 and reinforced by Ministry of Trade regulations (e.g., No. 61/2024). The 2018 updates align with WHO recommendations for selecting iron compounds and require fortifying wheat flour with iron, folic acid, and vitamins. Currently, all wheat flour available in the market is fortified with these five nutrients, demonstrating successful implementation despite initial resistance (Bagriansky et al. 2023).

Palm cooking oil fortification: Mandatory fortification with vitamin A, as outlined in SNI 7709-2019, requires that all packaged oil contain at least 45 IU of vitamin A per gram. While this requirement was originally scheduled for implementation in 2019, it was ultimately put into full effect on February 1, 2023, after some delays. However, unbranded bulk oil often remains nonfortified, and many small producers continue to struggle to meet national standards (Food and Hotel Asia 2025).

Rice fortification: The government launched the rice fortification initiative in 2015 through pilot projects conducted by BAPPENAS, the Ministry of Agriculture, and BULOG, with funding from the Asian Development Bank (Soekirman, Martianto, and Indonesian Fortification Initiative 2017). The program was officially launched in mid-2023 as part of the Bantuan Pangan Beras (Rice Food Aid) program, which currently reaches 21.353 million beneficiary families.

2.2.3.8 Industry Capacity and Role of Private Players

The fortification landscape reveals significant disparities in industry capacity across different food commodities. The wheat flour milling sector represents Indonesia's most consolidated food production sector, with approximately six companies controlling 70-80% of the domestic market. This concentration significantly aids coordination of fortification implementation. The wheat millers' association (Asosiasi Produsen Tepung Terigu Indonesia or APTINDO) has played a crucial role in supporting industry compliance (UNICEF Indonesia n.d.). However, periodic government suspensions, including those in 2008 and 2020, reportedly due to price concerns and premix procurement, highlight the difficulties fortification programs face under external pressures (Food Fortification Initiative n.d.; Nutrition International 2021).

The salt production sector is highly fragmented, with thousands of small-scale producers employing traditional methods that bypass formal iodization processes and lack the technical capacity for consistent quality control. This fragmentation complicates government monitoring and enforcement across numerous dispersed producers with limited resources. Palm oil production demonstrates intermediate consolidation, with several major producers committed to fortification, but the regulatory environment and government enforcement mechanisms remain underdeveloped compared to those for wheat flour.

2.2.3.9 Integration with Social Safety Net Programs

Rice fortification through the Bantuan Pangan Beras program is Indonesia's latest and most ambitious fortification initiative, launched in mid-2023 by the National Food Agency (UNICEF Indonesia n.d.). The program aims to support 21.353 million beneficiary families, representing 23.8% of those registered in social safety net programs. Currently, it covers 2-4% of the country's rice requirements, with plans for future expansion. The program realistically recognizes the challenges of universal rice fortification, particularly because numerous small mills throughout the archipelago lack fortification capacity.

This targeted approach provides several strategic advantages: social safety net programs include population registration systems that enable the identification of the groups most in need. They involve regular distribution cycles that facilitate monitoring and ensure that interventions focus on populations most vulnerable to micronutrient deficiencies. BULOG serves as the primary distribution mechanism (UNICEF Indonesia n.d.), effectively leveraging existing infrastructure rather than requiring the development of entirely new supply chains.

However, this approach has potential limitations. Safety nets may not reach all vulnerable populations, potentially excluding informal workers and seasonal laborers. Coverage rates are unlikely to achieve universal reach, so market-based fortification remains necessary to complement targeted programs (ANTARA News n.d.).

For example, the DKI Jakarta Provincial Government's subsidized food program has reached 1,024,189 beneficiaries from various groups as of October 2025. These beneficiaries include KJP+, KLJ, KPDJ, KAJ holders, PKK cadres, KPJ, apartment residents, honorary teachers, education personnel, and participants in the PJLP (Learning and Internship Program). By 2025, more than 16 million subsidized commodities, including rice, eggs, chicken, beef, mackerel, milk, and fortified rice, will have been distributed. This distribution is a crucial component in improving the nutritional intake of low-income families, and it will continue in 2026.

2.2.3.10 Population Reach and Coverage Metrics

Despite being Indonesia's longest-standing fortification program since the 1990s, salt iodization has achieved disappointing coverage. Currently, only 37.2% of households have access to adequately iodized salt (≥15 ppm), significantly below the international target of 90% (UNICEF 2024). This coverage gap reflects fundamental challenges in the implementation model and monitoring systems rather than technological barriers. The primary challenges stem from the highly fragmented nature of salt production, which involves thousands of small-scale producers employing traditional methods. These producers often lack both the technical knowledge and the financial capacity necessary for iodization. Additionally, the geographic dispersion of remote islands further complicates monitoring and enforcement.

Wheat flour fortification has shown higher implementation success, benefiting from the consolidated milling industry that facilitates coordination and compliance monitoring (UNICEF Indonesia n.d.-b). However, having specific data on household consumption, particularly the proportion of wheat flour that consumers receive through fortified channels compared to other sources, would help better understand the true reach within the population.

As for rice fortification, which began in mid-2023 through social safety net programs, it currently reaches 21.353 million beneficiary families (23.8% of registered families), approximately 2-4% of the nation's total rice consumption (UNICEF Indonesia 2024). The program's planned 2026 expansion has not yet been confirmed.

Analysis reveals critical gaps in population reach. Geographic inequities are evident, with remote islands and rural areas typically showing lower access to fortified foods than urban centers. Socioeconomic inequities persist, with lower-income populations consuming fewer fortified foods. Age and gender inequities are relevant, as vulnerable groups with heightened micronutrient requirements may have limited access to fortified foods.

2.2.3.11 Value Chain, Quality Assurance, and Regulatory Frameworks

Salt value chain: The salt value chain remains highly fragmented, with thousands of small-scale producers using traditional methods, limited intermediate processing, and distribution through both formal retail and informal community-based sales. Supply chain losses occur through improper storage, which allows iodine leaching, and inadequate packaging that fails to protect salt from environmental moisture. Informal distribution networks, particularly in remote areas, make value chain monitoring extremely challenging.

Wheat flour value chain: Substantially more structured than salt, the wheat flour value chain features a concentrated milling industry that buys wheat through organized procurement channels, fortifies at central facilities with verified premix additions, and distributes through retail and institutional channels. Supply chain losses are minimal given flour's relatively stable nature (UNICEF 2024).

Palm oil value chain: This value chain exhibits an intermediate structure, with major producers engaging in centralized fortification followed by distribution through wholesale and retail channels. Supply chain losses can occur through improper storage conditions that affect vitamin A stability, and informal markets may bypass fortification systems when prices compete.

Rice value chain: This is a highly complex and fragmented value chain, with over 5,000 small mills distributed across the archipelago. Current social safety net programs bypass this fragmented market, relying on centralized procurement and BULOG distribution, thereby creating a separate value chain for fortified rice.

Quality assurance for fortified foods requires systematic monitoring at multiple points in the value chain: at production facilities to verify the correct premix addition, during storage and transportation to detect any loss of stability, and at the point of consumption to verify the presence of micronutrients. Indonesia's quality assurance systems remain underdeveloped compared with international best practices, and capacity constraints remain significant. The National Agency for Drug and Food Control (BPOM) serves as the primary enforcement body for food safety and fortification compliance. However, it faces substantial resource constraints relative to Indonesia's

geographic scope and production complexity. Most fortification verification relies on batch testing at production facilities rather than systematic market surveillance.

Laboratory infrastructure remains geographically concentrated, with limited facilities outside major urban centers. Nutrition International's innovation of village-level semi-quantitative testing for salt iodine content using portable mini-labs represents an important approach to extending monitoring capacity into remote areas. This approach has catalyzed government investment in expanding mini-labs to 175 villages in Central Java and additional villages in East Java and West Nusa Tenggara, though semi-quantitative testing cannot replace comprehensive laboratory analysis for systematic quality verification. Refer to Figure 2.8.

Figure 2.8. Indonesia's food fortification ecosystem

Indonesia

Nutrition, Diet & Policy Snapshot

Anaemia: ~3.5% children (6–59 months); ~31% women of reproductive age; 27.7% of PW,15.5% among teenagers aged 15-24 - SKI 2023

Stunting: ~19,8% children under 5 (persistent public health burden) - SSGI 2024

Double burden: Undernutrition alongside rising overweight and NCD risk

Mandatory salt iodization; mandatory wheat flour fortification; vitamin A fortification of palm cooking oil

Fortified rice: Targeted delivery through social safety net programs

Indonesian Nutrition Status Survey; national anemia and stunting estimates for evidence on disease burden

Policy anchor: National Medium-Term Development Plan (RPJMN), National Long-Term Development Plan (RPJPN) and SUN Movement commitments

Food Production & Processing → **Fortified Food Vehicles** → **Food Distribution & Delivery Channels** → **Public Safety Net & Institutional Programs** ---- **Government Stewardship & Oversight**

Agricultural Production (Rice, wheat, oilseeds)

Pre-processing (Milling, fluffy white rice or steamed rice, oil refining)

Premix Supply (Imported)

FRK Production & Blending (Domestic FRK manufacturing unit)

Iodized Salt (Iodine) – Mandatory

Fortified Wheat Flour (Iron, folic acid, zinc, B-vitamins) – Mandatory

Fortified Palm Cooking Oil (Vitamin A) – Mandatory / scaling

Fortified Rice (Voluntary / targeted – safety nets)

Open Market

Govt. Safety Net Programs

Pilot-Bantuan Pangan Beras (Rice Food Aid) (Fortified rice via National Food Agency / BULOG)

SEMBAKO (Sembilan Bahan Pokok) Programme

Program Keluarga Harapan (PKH)

Nutrition Policy & Coordination
– Ministry of Health
– National Development Planning Agency (Bappenas)

Standards & Industry Regulation
– Ministry of Industry

Food Safety & Enforcement
– Badan Pengawas Obat dan Makanan (BPOM)

Food Logistics & Distribution
– National Food Agency (NFA)
– BULOG

Regulatory, Program Monitoring, Evaluation & Compliance

– SNI for standards; BPOM for enforcement
– **Village-level salt testing (mini-labs)** supports last-mile iodization monitoring
– Diverse salt production landscape with ongoing efforts to strengthen sub-national enforcement and expand laboratory coverage across islandsds

Source -
1. SSGI (2024). https://www.badankebijakan.kemkes.go.id/en/ssgi-2024-prevalensi-stunting-nasional-turun-menjadi-198/

2.2.3.12 Monitoring and Evaluation Mechanisms

Laboratory infrastructure and testing capacity: Laboratory capacity for micronutrient testing remains geographically concentrated and insufficient for systematic monitoring across Indonesia's vast archipelago. While accredited laboratories exist in major urban centers, geographic distribution is highly uneven. Many facilities lack sophisticated equipment for the simultaneous analysis of multiple micronutrients, which complicates the assessment of complex fortification formulations. Nutrition International's village-level semi-quantitative testing using portable mini-labs to assess salt iodine content represents an innovative approach to extending the monitoring capacity. These mini-labs enable community-level workers at Posyandu and village kiosks to conduct rapid assessments of salt iodine content and identify non-iodized salt at distribution points.

Digital systems and real-time monitoring: Current systems for monitoring and evaluating fortification programs appear to rely primarily on traditional survey methods and periodic assessments rather than integrated digital platforms for real-time tracking and program management. The absence of comprehensive digital monitoring systems significantly limits program responsiveness and adaptive management, particularly given Indonesia's growing digital infrastructure capabilities. Real-time monitoring systems could potentially address several current challenges: supply chain monitoring could track fortified food production and movement through distribution networks; industry compliance monitoring could systematically track factory production records and quality control data; population coverage surveillance could map geographic distribution of fortified food availability and consumption.

2.2.3.13 Stakeholder Ecosystem and Partnerships

2.2.3.13.1 Government coordination and institutional roles

Multiple government ministries and agencies are involved in Indonesia's fortification programs. The Ministry of Health provides technical guidance and develops standards, establishing the nutritional science basis for fortification levels. The Ministry of Industry oversees production standards and industry compliance. BPOM serves as the primary enforcement body for food safety and fortification compliance.

The National Development Planning Agency (Bappenas) plays a coordinating role by leading the National Fortification Alliance. This alliance includes representatives from relevant ministries, BPOM, BSN (National Standardization Agency of Indonesia), industry associations, civil society organizations, and development partners. This multi-stakeholder platform serves as a mechanism for coordination and policy dialogue, though its effectiveness varies among different fortification programs. The roles of regional and local governments in implementing fortification are as clearly defined as those of central government agencies, presenting an opportunity to strengthen governance. The success of village-level salt monitoring initiatives suggests that empowering local authorities and communities can enhance program effectiveness. To achieve this, it is essential to clearly define roles, provide adequate training, and coordinate with central government quality assurance systems.

Private sector engagement varies substantially by food commodity. The wheat milling industry demonstrates the most sophisticated engagement, with APTINDO coordinating industry-wide compliance efforts and facilitating the implementation of standards. Major millers have invested in fortification equipment and quality control systems, enabling economies of scale in premix

procurement, thereby reducing per-unit costs. The salt production sector lacks effective industry coordination mechanisms. Thousands of small-scale producers lack economic incentives or resources to implement iodization, and the absence of powerful industry associations limits collective action.

Palm oil producers, particularly major companies like Wilmar and Musim Mas, have demonstrated commitment to fortification in principle and invested in pilot implementations. However, the regulatory environment is still insufficiently developed to mandate broad-scale compliance.

Civil society organizations, including nutrition and public health non-governmental organizations, play advocacy roles in promoting the adoption of fortification policies and raising consumer awareness. Community-based organizations are actively involved in village-level monitoring of salt iodization, providing critical human resources for implementing mini-lab testing and providing feedback to producers and government agencies.

2.2.3.13.2 Development partner engagement

International development partners have played substantial roles in supporting Indonesia's fortification initiatives through both technical and financial support. Major organizations engaged include the Asian Development Bank, GAIN, Nutrition International, German Development Agency (GIZ), BASF, and UNICEF. UNICEF has been particularly active in conducting landscape analyses and capacity-building efforts. Nutrition International's sustained engagement in salt iodization monitoring represents valuable technical assistance to address implementation challenges.

2.2.3.14 Critical Challenges and Policy Reforms Needed

2.2.3.14.1 Geographic and logistical complexities

Indonesia's archipelagic geography, comprising over 17,000 islands, presents unique challenges that go beyond those faced by continental countries. Distribution of fortified foods across 17,000+ islands requires sophisticated logistics networks and quality maintenance systems to ensure product integrity during extended transportation times. Remote islands face particular challenges in accessing fortified foods, often experiencing delayed distribution or higher costs compared to urban centers.

Furthermore, geographic concentration of production facilities perpetuates disparities in fortification coverage. While Java benefits from proximity to large-scale food-processing facilities with sophisticated technical capacity, outer islands depend on smaller, less sophisticated production units with limited fortification capabilities. This geographic concentration of technical capacity perpetuates disparities between urban and rural populations, exacerbating existing health inequities.

2.2.3.14.2 Regulatory complexity and enforcement challenges

The regulatory framework for food fortification is complex and fragmented across different food vehicles. While wheat flour benefits from a streamlined legislative approach with clear standards and enforcement mechanisms, salt iodization operates under a complicated regulatory environment with multiple overlapping authorities and unclear enforcement responsibilities (UNICEF Indonesia 2024). This regulatory complexity creates uncertainty among producers, inconsistent enforcement patterns, and opportunities for regulatory arbitrage.

Fragmented regulatory authority across multiple government agencies creates coordination challenges and potential enforcement gaps. Clarifying and streamlining the regulatory framework would reduce producer confusion, establish consistent enforcement expectations, and streamline government oversight.

Furthermore, enforcement capacity remains significantly constrained by limited resources for monitoring compliance among the thousands of small-scale producers scattered across the archipelago. Limited transportation resources constrain inspection frequency, and modest laboratory capacity restricts systematic sampling and analysis for compliance verification.

2.2.3.14.3 Industry capacity and technical constraints

The fortification landscape shows significant disparities in industry capacity. While the wheat flour industry benefits from market consolidation and technical sophistication, salt production remains highly fragmented, with many small-scale producers lacking the technical capacity to ensure consistent iodization. The fragmented salt sector faces challenges: thousands of small producers lack capital for equipment investment, most lack technical knowledge regarding iodization processes and quality control, and many producers have limited economic incentive to invest in fortification because non-iodized salt sells at a lower price.

Access to fortificants and premix is a constraint for small producers, particularly in remote areas. Domestic production capacity for fortificants is limited, forcing a reliance on imported premixes, which can increase costs and create supply chain vulnerabilities. The 2020 suspension of wheat flour fortification, allegedly due to premix procurement difficulties during COVID-19, highlights this vulnerability to supply chain disruptions (Nutrition International 2021).

2.2.3.14.4 Financial and economic barriers

The cost of implementing fortification poses multifaceted financial challenges for producers, governments, and consumers. For individual producers, particularly small-scale operations, the investment required for fortification equipment ranges from significant to prohibitive relative to available capital. Moreover, government enforcement and monitoring systems require sustained financing for laboratory infrastructure, equipment maintenance, and routine surveillance activities, costs that compete with other health priorities for limited budgets.

Consumer acceptance of potentially higher prices for fortified foods is another economic consideration, particularly among low-income populations, who are often the primary targets of fortification programs. The 2008 suspension of wheat flour fortification following complaints about price increases demonstrates the political sensitivity of fortification costs (Asian Development Bank 2013).

2.2.3.14.5 Fragmentation of government coordination

While the national fortification alliance provides a multi-stakeholder coordination mechanism, its effectiveness in resolving inter-ministerial conflicts and coordinating implementation appears limited. The repeated suspensions of wheat flour fortification suggest that sustaining health-sector priorities may require stronger safeguards against economic and industry pressures. This highlights the need for stronger coordination mechanisms to protect program continuity.

2.2.3.15 Opportunities and Future Directions

Leveraging digital innovation and technology: Indonesia's growing digital infrastructure and technological capabilities present significant opportunities to enhance the implementation and monitoring of fortification programs. Developing integrated digital platforms could enable real-time tracking of fortified food production, its movement through distribution networks, and consumption patterns. Supply chain management systems can help identify transportation bottlenecks and optimize inventory management. Digital platforms designed for producers could automate fortification record-keeping and quality-control documentation, thereby reducing administrative burdens and improving data reliability. Digital literacy initiatives could support consumer awareness campaigns, helping populations understand the benefits of fortified food and make informed purchasing decisions.

Expanding social safety net integration: The rice fortification program, implemented through social safety nets, demonstrates a pragmatic approach to achieving targeted coverage while building implementation experience. This model could be expanded by increasing fortified rice distribution from the current 2-4% of annual consumption to higher coverage as implementation capacity improves. Additionally, it could integrate fortification into expanded social safety net programs and incorporate additional food vehicles into safety net distribution.

In times of emergency, the regulation mandating the provision of 400 g of rice per person per day for disaster victims is stipulated in the Regulation of the Head of the National Disaster Management Agency (BNPB) Number 7 of 2008, which sets out procedures for providing assistance to fulfill basic needs. It would be prudent to integrate fortified foods, especially rice, into this policy.

Integrating Indonesia's existing social protection programs could expand the reach and impact of the fortification. The Family Hope Program and other conditional cash transfer mechanisms could require fortified foods. School feeding programs should prioritize fortified foods in meal planning and procurement processes, leveraging institutional demand to support market development. Additionally, maternal health services, such as antenatal care, could incorporate fortified food recommendations and distribution of fortified foods as part of comprehensive maternal nutrition support.

Regulatory simplification and harmonization: Regulatory simplification presents an important opportunity to reduce industry compliance costs and facilitate improved enforcement. Consolidating fragmented salt iodization regulations into a single, clear regulatory instrument would eliminate ambiguity and enable consistent enforcement. Additionally, establishing clear standards, timelines, and enforcement mechanisms for palm oil and rice fortification would accelerate implementation by reducing regulatory uncertainty.

Developing differentiated enforcement approaches suited to different industry contexts could improve effectiveness. Implementing simplified compliance pathways for small-scale producers, such as third-party or group certification managed by producer associations, can enhance efficiency while reducing compliance costs.

Strengthening quality assurance infrastructure: Investing in quality assurance infrastructure is critical to ensuring that fortified foods actually deliver the intended micronutrient content. Expanding laboratory capacity, including both central accredited laboratories and community-based testing through mini-labs, would enable more systematic monitoring and verification. Investments in

laboratory equipment and training would improve analytical capabilities. Additionally, establishing regional laboratory networks could decentralize testing capacity and reduce transport costs and time. Developing standards for quality assurance methods suited to Indonesia's specific context would improve consistency and reliability of monitoring efforts.

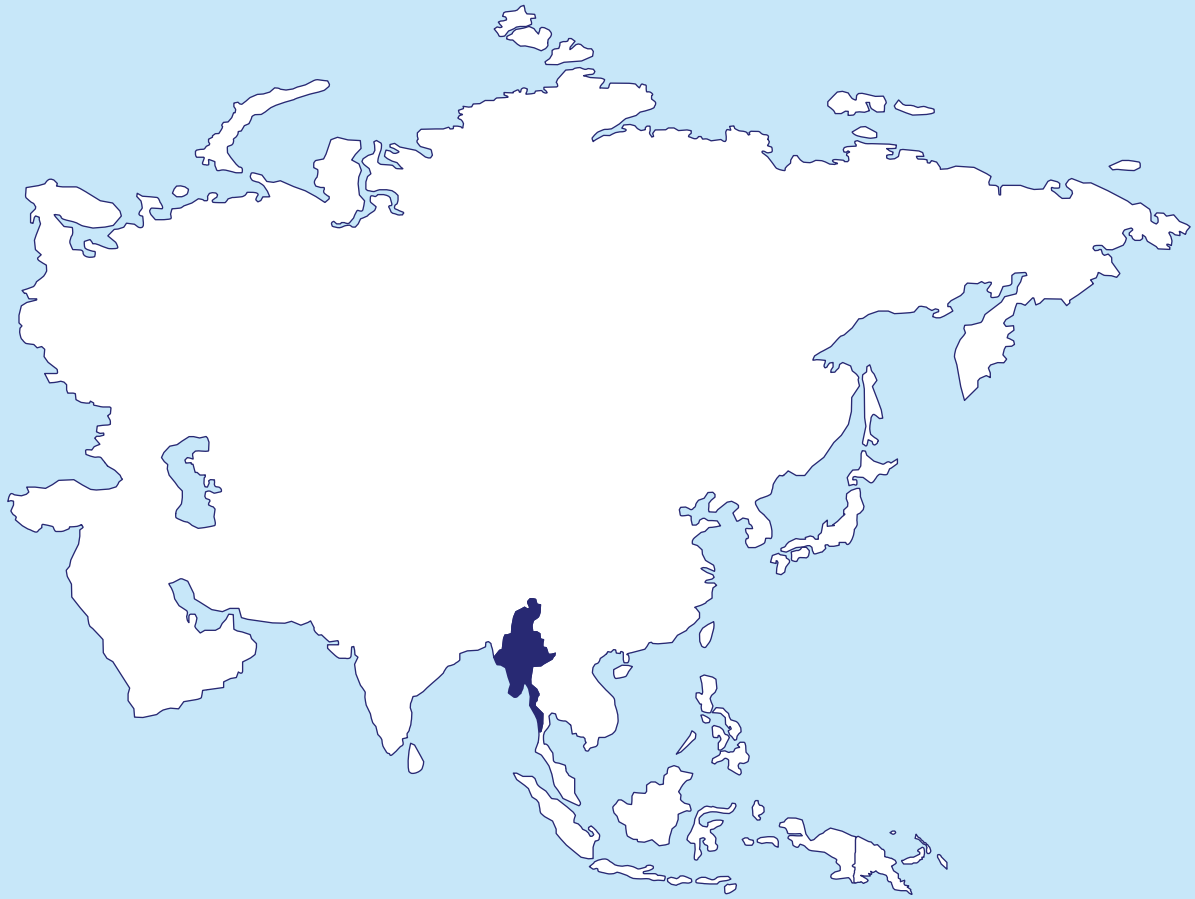
Addressing industry capacity gaps: Providing strategic support for capacity-building among small producers can help overcome technical barriers to fortification adoption. Technical training programs could build knowledge regarding fortification processes and quality control methods. Additionally, offering equipment subsidies or equipment leasing mechanisms could reduce capital barriers to implementation for small producers. Moreover, developing the premix supply chain and reducing costs will improve the accessibility and affordability of fortificants.

Enhanced multi-stakeholder coordination: Strengthening the national fortification alliance and other coordination mechanisms would improve cross-sectoral alignment and conflict resolution. Regular high-level coordination meetings among relevant ministries could help address inter-ministerial conflicts and ensure program continuity. Establishing clear agreements regarding roles, responsibilities, and decision-making authority would reduce ambiguity and improve operational efficiency. Creating regional fortification alliances that replicate national-level structures could facilitate knowledge exchange and coordinate monitoring and enforcement activities. Industry representation in multi-stakeholder processes could improve policy acceptance and implementation feasibility.

Strengthening monitoring and evaluation systems: Developing comprehensive monitoring and evaluation frameworks would improve accountability and evidence-based program management. Population-based surveys assessing micronutrient status and fortified food consumption patterns would track the program's impact on population health outcomes. Integrating data from multiple monitoring sources into unified information systems would facilitate holistic program assessment. Establishing clear program targets and regular progress reports would strengthen accountability. Additionally, public reporting on fortification overage, quality verification results, and population nutritional status trends would enable civil society oversight and build political support for sustained program investment.

Sustainable financing mechanisms: To enhance the long-term viability of programs, it is crucial to develop financing models that go beyond short-term donor support. Exploring innovative financing mechanisms, including catalytic finance from development banks, public-private partnerships for fortification infrastructure, and dedicated government budget allocations, could ensure sustained financing that is independent of donor cycles.

2.2.4 Myanmar



2.2.4.1 Nutrition and Fortification Ecosystem

Myanmar, located in Southeast Asia, has a complex geopolitical and socioeconomic landscape shaping its food fortification efforts. As of 2024, the country has an estimated population of 51.3 million, with females accounting for 53.1% of the total population. Administratively, Myanmar comprises seven states, seven regions, and one union territory, with a diverse ethnic composition that includes Bamar, Shan, Kayin, Rakhine, Mon, Kachin, Kayah, and Chin communities, each influencing dietary patterns and food preferences. Myanmar's agro-ecological zones, the central dry zone, coastal, delta, mountainous regions, and Shan Plateau support distinct agricultural systems and crop production patterns. Rice remains the universal staple food across the country, with regional variations in consumption (Ministry of Planning and Finance 2018).

Food security and nutritional outcomes are profoundly shaped by multifaceted challenges intensified in recent years. The country has experienced ongoing armed conflicts and political instability, compounded by the 2021 political changes, severely limiting access to health and food services and disrupting food supply chains at all levels. Conflict-affected areas face major accessibility challenges due to checkpoints and clashes that disrupt transportation and logistical systems. The newly announced conscription law further exacerbates the humanitarian situation. Additionally, climate-induced disasters, such as the 2024 flooding and 2025 earthquake, compound existing vulnerabilities in the food system and livelihoods.

These crises have generated significant internally displaced populations and widespread food insecurity, with 15 million people expected to face hunger in 2025, up from 13.3 million in 2024,

reflecting a steep and concerning trajectory. These factors severely impact the accessibility and affordability of nutritious food and dietary diversity for local communities and vulnerable populations, particularly in conflict-affected areas (SUN Movement 2019).

Despite these challenges, cultural acceptance of fortified foods is relatively high in Myanmar, with only minor exceptions (PATH 2019). The primary bottlenecks to food fortification implementation remain logistical rather than cultural, driven by conflict-induced disruptions and road inaccessibility, which prevent the timely distribution of fortified foods to vulnerable populations.

2.2.4.2 Nutritional Status and Dietary Practices

Myanmar is experiencing a severe and complex nutritional crisis that affects vulnerable populations across different age groups and regions. The latest comprehensive nationwide nutrition data comes from the 2015–16 Demographic and Health Survey (DHS) and the Myanmar Micronutrient and Food Consumption Survey conducted between 2017 and 2018. More recent data from the Myanmar Household Welfare Survey (2021–24) provide updated insights into worsening food security and declining dietary quality.

Dietary diversity and food consumption patterns: Dietary diversity and adequacy among young children remain significantly suboptimal across Myanmar. Data from the International Food Policy Research Institute 2023 survey show that 34.5% of children aged 6 to 23 months had inadequate dietary diversity, with a higher prevalence among girls (40.6%) compared to boys (29.1%). Only 16.8% of breastfed infants met the minimum acceptable diet standard, with exclusive breastfeeding practiced by just over half of infants, falling short of WHO recommendations.

Children's diets reveal a concerning pattern of monotony and micronutrient inadequacy. While nearly all children (99%) consume grains as their primary staple, consumption of micronutrient-dense food groups has declined substantially. The International Food Policy Research Institute survey documented that only 51.2% of children consumed legumes and nuts, 35.9% consumed milk and dairy products, 49.8% consumed eggs, 57.1% consumed vitamin A-rich fruits and vegetables, and 59.3% consumed other fruits and vegetables. Meat and fish consumption, though more prevalent at 66.1%, remains insufficient for optimal child development. These patterns reflect a predominantly cereal-based diet and lack adequate micronutrient diversity.

Among WRA, malnutrition is characterized by a dual burden of both undernutrition and emerging overweight and obesity. According to the 2015–16 Demographic and Health Survey, nearly 28.1% of women in this age group are overweight, and 13.1% are obese, highlighting nutrition transition and diet-related NCD challenges (Tauseef, Linn, and Oo 2025).

Recent food security and dietary quality trends: Data from the Myanmar Household Welfare Survey (2021–24) document a disturbing deterioration in food security and dietary quality across all regions. Over 3% of households experienced moderate to severe hunger in the latest survey, with severe geographic disparities: rates exceeded 14% in Chin State, 8% in Rakhine State, and 5% in Kayah State.

Longitudinal data demonstrate declining dietary diversity among adults, increasing from 20.6% to 25% between late 2021 and mid-2024, with women experiencing a faster decline than men. Among children aged 6 to 23 months, 29.5% had inadequate diet quality, and among children aged 6 to 59 months, 20.9% were similarly affected (Tauseef, Linn, and Oo 2025).

Micronutrient deficiency burden: Myanmar carries one of the highest burdens of micronutrient deficiencies in the Asia-Pacific region (Gayer and Smith 2015). Stunting affects one in three children, with approximately 7% experiencing acute malnutrition (wasting) (Codling et al. 2017). The prevalence of stunting among children under five years old is estimated at 29.2% based on the 2015–16 DHS data, with substantially higher rates in conflict-affected and remote areas. Wasting reaches an alarming 14% in Rakhine State, reflecting severe food insecurity in this conflict-affected region.

Anemia represents the most prevalent micronutrient deficiency, affecting 57% of children aged 6 to 59 months and 46.5% of WRA according to the 2017–18 Myanmar Micronutrient and Food Consumption Survey. More recent estimates indicate that over 60% of children aged 6 to 23 months and 47% of women aged 15 to 49 are affected by micronutrient deficiencies. Iron deficiency anemia is the primary micronutrient deficiency burden, though zinc, vitamin A, and iodine deficiencies coexist in the population.

Regional disparities are stark and reflect underlying structural vulnerabilities. The prevalence of stunting and wasting is particularly high in the Rakhine, Chin, and Kayah states, regions characterized by high poverty, limited infrastructure, conflict, and recurrent natural disasters. These cumulative micronutrient deficiencies reflect what public health practitioners term “hidden hunger”, which involves severe vitamin and mineral deficiencies despite adequate caloric intake. This situation poses serious lifelong consequences for health, growth, cognitive development, and productive capacity (Win 2015).

2.2.4.3 Nutrition-related Flagship Program

Myanmar's government operated several nutrition-related flagship programs under the Multi-Sectoral National Plan of Action on Nutrition (MS-NPAN) from 2018/19 to 2022/23. These programs coordinate efforts across the health, social welfare, education, and agriculture sectors to reduce malnutrition among mothers, children, and adolescent girls. A key component of the National Social Protection Strategic Plan is the Maternal and Child Cash Transfer program, which provides cash allowances to pregnant women and children up to age 5, aiming to improve nutritional outcomes. It was projected to benefit 2.25 million beneficiaries pre-pandemic. Additionally, school feeding initiatives, in partnership with the Ministry of Education and WFP, deliver fortified biscuits to 430,000 pre-primary and primary students across 11 states. These biscuits incorporate micronutrient supplements to help meet nutritional goals (Republic of the Union of Myanmar 2018).

The MS-NPAN emphasizes converging interventions during the first 1,000 days of a child's life, prioritizing evidence-based actions such as promoting exclusive breastfeeding (targeting 50% coverage), reducing anemia among women by 50%, and reducing stunting among children under five years old by 40%. Sector-specific allocations include MMK 285 billion for health and MMK 196 billion for education (Republic of the Union of Myanmar 2018). Institutional feeding programs under the Department of Social Welfare use fortified rice in schools for vulnerable groups like disabled children, youth, and toddlers, while the Ministry of Health integrates it into hospital meals. These programs align with Scaling Up Nutrition commitments and the Essential Package of Health Services, though implementation is challenged by conflict and funding gaps.

2.2.4.4 Policy Environment for Food Fortification

Myanmar has demonstrated increasing policy commitment to addressing micronutrient malnutrition through comprehensive national nutrition strategies. Prior to 2018, the Myanmar National Plan of Action for Food and Nutrition (2011–16) identified inadequate nutrient intake as an immediate cause

of malnutrition. This was succeeded by the MS-NPAN (2018/19–2022/23), the most recent strategic framework for nutrition interventions, which translates scientific evidence on the causes and solutions of malnutrition into operationalizable actions and prioritizes large-scale interventions, with food fortification recognized as a key strategy. The National Nutrition Centre of Myanmar served as the custodian for this plan, ensuring technical rigor and institutional ownership.
The MS-NPAN's implementation period concluded in 2022/23, and publicly available sources had not identified a formally issued successor national nutrition strategy at the time of this review. During this period, nutrition coordination in Myanmar has continued to be supported through complementary mechanisms, including the Myanmar Nutrition Cluster Strategic Plan (2022–25), coordinated by the UN Nutrition Cluster and UNICEF, and WFP's Interim Country Strategic Plan (2024–25) (World Food Programme 2024; Global Nutrition Cluster n.d.). These humanitarian coordination frameworks complement, rather than replace, a national government-led nutrition strategy, and their continuation reflects the evolving operating environment in the country. Updating and re-issuing a national nutrition strategy would strengthen the policy foundation for future food fortification scale-up efforts.

Institutional coordination mechanisms: In January 2017, the Government of Myanmar convened the first Inter-ministerial Coordination Meeting on Nutrition in Pakokku, signaling government commitment to positioning nutrition as a national priority. Subsequently, the government created a Nutrition Sector Coordination Group under the Development Assistance Coordination Unit, chaired by the Union Minister for Health and Sports. The National Nutrition Centre established the Nutrition Promotion Steering Committee, formally established by Presidential decree on June 22, 2018, formalizing multisectoral collaboration on nutrition policy (Republic of the Union of Myanmar 2018).

Food fortification as a policy priority: Food fortification has been recognized as a key intervention within Myanmar's national nutrition policy frameworks. The Ministry of Health and Sports issued technical guidance on rice fortification in 2019, indicating the government's recognition of the intervention's importance (FAO 1995). However, Myanmar currently has no national mandatory regulation for food fortification beyond salt iodization (UNICEF 2015), which significantly constrains the scaling up of fortification efforts.

Food safety and regulatory framework: The Department of Food and Drug Administration under the Ministry of Health administers the country's regulatory framework for food fortification. It implements measures related to food safety, quality, and standards for food products, including fortified foods. The regulatory framework includes provisions for fortified foods under specific commodity code classifications, aiming to enable the consumption of genuine, safe, quality food while preventing dangerous or injurious products (FDA Myanmar 2024).

Regional and international policy alignment: Myanmar has aligned its nutrition policies with regional and international frameworks, joining the Scaling up Nutrition movement. The country, along with Indonesia and Vietnam, is a member of the Scaling up Nutrition network and has incorporated food fortification into national nutrition plans for cost-effectiveness and implementation feasibility.

2.2.4.5 Industry Capacity and Role of Private Players

Food fortification in Myanmar is implemented through a combination of public-sector initiatives, private-sector food producers, and civil society organizations. The private sector plays a crucial role in producing and distributing fortified food, particularly in rice fortification.

For rice fortification, PATH worked directly with local private-sector companies that have invested in equipment and capacity to produce fortified rice using its fortified rice technology. These partners produce FRK, which is blended with regular rice to create fortified rice suitable for retail and institutional distribution (PATH 2018). Private producers have demonstrated commitment to quality standards and obtained approval from Myanmar's Food and Drug Administration (PATH 2016). Distribution occurs through private retail channels, including supermarket shelves and small retailers nationwide. Growing demand and expanding commercial channels indicate market acceptance and viability.

Technical capacity and production infrastructure: In Myanmar, fortified rice is produced using PATH's Fortified Rice® technology, employing hot extrusion to combine rice flour with a micronutrient premix that includes iron, zinc, vitamin A, and thiamin. While FRK was produced locally, the required premix was imported, creating supply chain vulnerabilities and increasing costs. A critical gap is insufficient data to assess blending efficiency at scale across different production contexts (PATH 2019).

Challenges and support needs: Supporting small-scale food producers in meeting fortification requirements remains a challenge. While larger companies have invested in equipment and training, small-scale millers and food processors often lack the technical capacity, financial resources, and knowledge to implement fortification standards. PATH has provided technical assistance to grain producers, blender-fabricators, rice millers, and distributors across the value chain, though the scope remains limited relative to need, particularly for small-scale operators in rural areas.

Opportunities for private sector engagement: The successful establishment of public-private partnerships in rice fortification demonstrates the viability and sustainability of private sector engagement. Companies such as Mya Fortified Rice, Nu Ayer, and Gold Power are driven by profit margins and consumer demand, which in turn drive efficiency and innovation (LIFT n.d.). However, realizing this potential requires supportive government policy, adequate regulatory oversight, and incentive structures that make fortification financially attractive. The current lack of mandatory fortification regulations constrains private-sector investment in this area.

2.2.4.6 Integration with Social Safety Net Programs

Social safety nets in Myanmar can serve as critical channels for reaching large populations with fortified foods. The WFP provides fortified biscuits to 430,000 children across 11 states through the school feeding programs. In 2025, WFP distributed approximately 305 tons of rice fortified with 15% broken kernels (Rice Fortified Broken 15%) to vulnerable populations as part of its nutrition assistance programs for individuals affected by HIV/tuberculosis in the Hpa-An and Yangon areas (World Food Programme n.d.).

The Department of Social Welfare in the Ministry of Social Welfare, Relief and Resettlement uses fortified rice in school lunch programs and institutional feeding for various schools serving people living with disabilities, youth, women, and toddlers. The Ministry of Health and Sports has incorporated fortified rice into hospital and training institute meals, demonstrating public-sector acceptance of fortified rice (MoHS n.d.).

Despite positive initiatives, social safety net coverage through fortified foods remains limited relative to the scale of food insecurity and nutritional needs. The 430,000 children receiving fortified biscuits represent coverage of only a small fraction of the estimated millions of food-insecure

children. Coverage is significantly constrained by funding shortages and logistical barriers in conflict-affected zones.

Integration of fortified rice into broader social safety-net programs remains limited and has not been mandated as a policy requirement. Regional experiences, particularly from India's PDS and the Philippines' school feeding programs, demonstrate that mandatory integration of fortified rice can achieve population-level scale and impact

Recommendations for strengthening integration: To maximize the public health impact of food fortification, prioritizing the integration of fortified foods into social safety net programs is a key scaling strategy. This requires policy mandates requiring the use of fortified rice in school feeding, PDSs, and institutional feeding programs. Subsidized fortified rice or incentive-based arrangements with producers could enhance economic attractiveness for social safety-net implementers.

2.2.4.7 Population Reach and Coverage Metrics

Rice fortification forms the cornerstone of Myanmar's reach strategy, given that rice is consumed by 90% of the population. This universal consumption provides an exceptional opportunity to reach the entire population with essential micronutrients through a single food vehicle, without requiring changes in dietary behavior or modifications to food preparation practices. Widespread consumption across regions, ethnic groups, socioeconomic levels, and age groups makes rice fortification a uniquely powerful population-level intervention.

Current distribution and market penetration: Fortified rice is currently available through multiple distribution channels, though market penetration remains concentrated in urban and semi-urban areas with well-developed commercial retail. Supermarket shelves in major cities now stock fortified rice products, and small retailers are increasingly doing so, indicating expanding market acceptance and consumer demand.

However, geographic coverage remains uneven. Rural and remote populations, often facing the highest food insecurity and micronutrient deficiency burden, have more limited access to fortified rice through retail channels. This coverage gap underscores the critical importance of integrating fortified rice into social safety net programs that reach rural and remote areas more effectively than commercial retail distribution.

Institutional program coverage: Coverage through institutional programs is documented but remains limited in scope. School meal programs, hospital feeding, and institutional support are using fortified rice, but the total population reached through these institutional channels is far below the estimated need. The 430,000 children reached through WFP fortified biscuit programs remain far below the estimated need.

Logistical barriers, particularly those related to conflict and road inaccessibility, pose the most significant obstacles to reaching rural and remote populations. In conflict-affected areas, transportation challenges, security concerns, and disrupted supply chains make it difficult to maintain a consistent supply of fortified foods. Many regions with the highest food insecurity and greatest nutritional needs, such as Rakhine, Chin, and Kayah states, have the poorest logistical access. Economic factors also affect accessibility. While the price of commercial fortified rice is competitive with non-fortified rice in urban markets, affordability remains a barrier for poor rural

populations. Price subsidies or inclusion in social protection programs could help ensure that disadvantaged populations can access fortified foods.

2.2.4.8 Value Chain, Quality Assurance, and Regulatory Frameworks

The value chain for fortified rice encompasses multiple actors, starting from premix suppliers to the final consumer. The first crucial step in this chain is the international supply of fortification premix, which is currently imported, creating supply chain vulnerabilities, adding import costs, and posing potential supply disruptions. Following premix supply, the value chain involves blending premix with rice flour to produce FRK at manufacturing facilities using Fortified Rice® technology. FRK is then blended with regular rice at appropriate ratios. Distribution occurs through commercial retail, including supermarkets and small retailers, primarily serving urban and semi-urban consumers. Additionally, institutional distribution occurs through schools, hospitals, and social welfare programs, and humanitarian distribution through other humanitarian organizations. Final consumption involves household preparation of fortified rice, requiring no special practices compared to non-fortified rice.

Quality assurance and quality control challenges: A critical gap is Myanmar's inadequate quality-assurance and quality-control infrastructure. The country currently has no ILAC-accredited (International Laboratory Accreditation Cooperation) facilities capable of testing micronutrient fortification levels in food products. This leaves supply chains vulnerable to quality inconsistencies and potential non-compliance with fortification standards.

Premix analysis and testing capacity remains limited. The Myanmar Accreditation Body, in partnership with Singapore's Singapore Accreditation Council, has initiated joint assessments for food testing laboratories, but progress has been slow due to funding constraints (World Bank Group 2016). Digital systems for traceability and real-time quality control are entirely absent from the fortified rice supply chain, leaving supply chains vulnerable to counterfeiting and adulteration. The absence of a centralized database for nutrition indicators further constrains impact monitoring and evaluation.

Regulatory framework for food fortification: Myanmar's regulatory framework is administered by multiple government agencies with overlapping responsibilities. The Department of Food and Drug Administration under the Ministry of Health implements measures related to food safety, quality, and standards. For fortified wheat flour, for example, Myanmar requires import licenses, adherence to food safety standards, proper labeling of the fortification content, and compliance with quality requirements.

Mandatory salt iodization as a regulatory model: Myanmar's salt iodization approach provides insight into regulatory capacity and its experience with mandatory fortification. Under the Salt Enterprise Law framework, Myanmar has mandated iodine fortification of salt. Legislation requires that only iodized salt be produced when raw salt is refined for human consumption, and that producers obtain specific licenses depending on product type. This regulatory model demonstrates the government's capacity to implement and enforce mandatory fortification requirements through licensing mechanisms, providing a precedent adaptable to other food vehicles such as rice and oil.

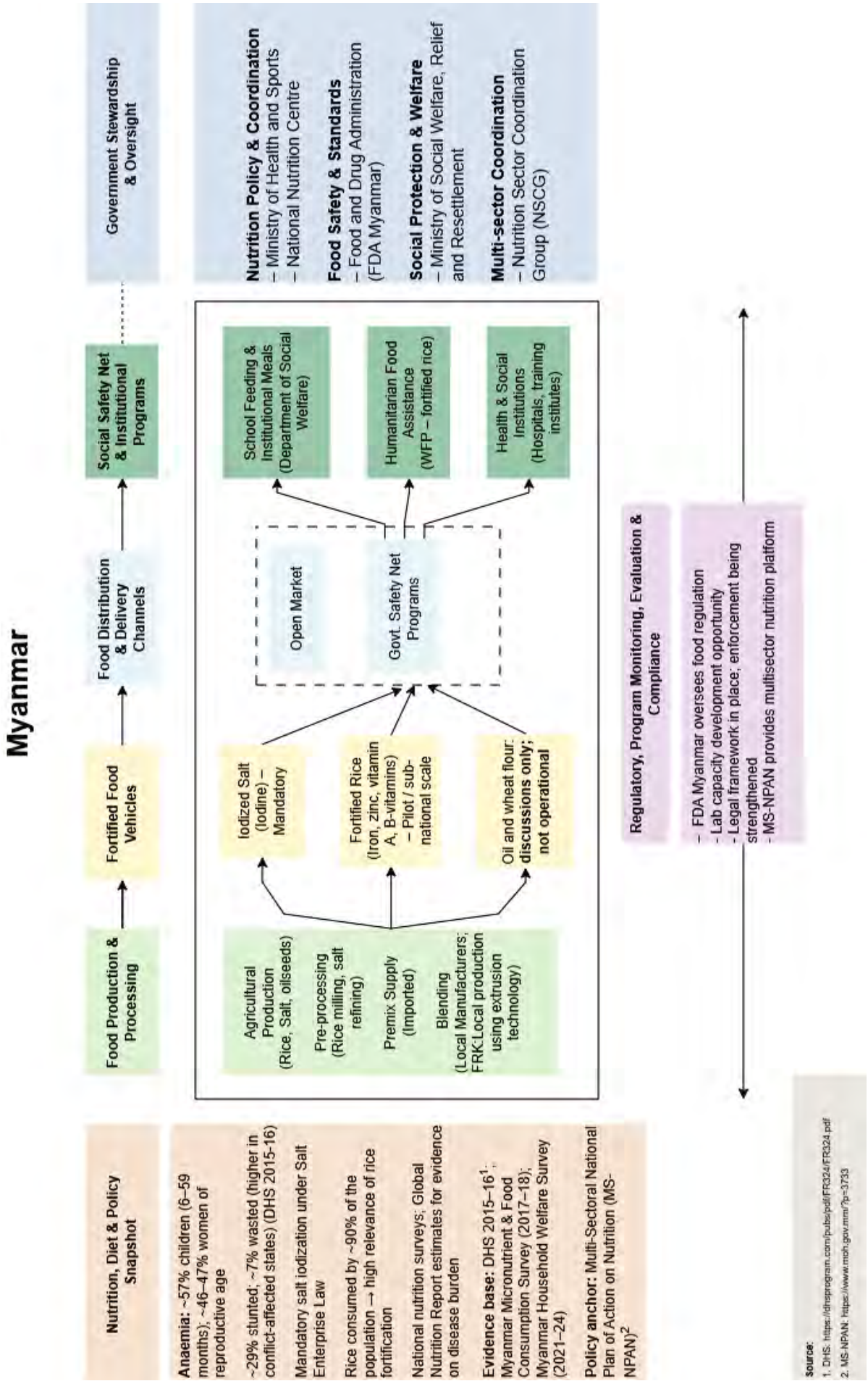
Gaps in the regulatory framework: A critical gap exists because most food vehicles lack mandatory national fortification regulations. The Ministry of Health and Sports issued technical guidance on rice fortification in 2019, but it lacks mandatory force. Without mandatory regulations, compliance is

voluntary and incentive-dependent, reducing the likelihood of population-level scale and impact. Comprehensive standards or a national fortification logo have not been rolled out, which limits consumer awareness and confidence in fortified foods.

Discussions regarding oil and wheat fortification initiated in 2017–18 were stalled amid political instability. Palm oil accounts for 90% of Myanmar's oil imports, making it a technically viable vehicle for vitamin A and D fortification. Regulatory frameworks for oil fortification remain underdeveloped, and policy advocacy has not secured government commitment to mandatory oil fortification (Government of Myanmar 2013).

Recommendations for regulatory strengthening: (i) Develop comprehensive mandatory food fortification legislation providing clear mandates, technical specifications, and enforcement mechanisms across multiple food vehicles; (ii) establish clear roles and responsibilities across government agencies to reduce regulatory fragmentation; (iii) invest in developing International Laboratory Accreditation Cooperation-accredited laboratory capacity; (iv) implement digital traceability systems; and (v) develop a national fortification logo and consumer communication strategy. Refer to Figure 2.9.

Figure 2.9. Myanmar's food fortification ecosystem



2.2.4.9 Monitoring and Evaluation Mechanisms

Myanmar's monitoring and evaluation of food fortification programs faces significant structural constraints that limit the ability to track implementation, assess quality, and evaluate impact on nutritional outcomes.

Laboratory and testing capacity gaps: A critical, widely acknowledged constraint is the absence of International Laboratory Accreditation Cooperation-accredited laboratory facilities capable of testing the micronutrient content of fortified foods. Myanmar cannot independently verify whether fortified foods contain declared micronutrient levels, which is fundamental to quality assurance. The Myanmar Accreditation Body, in partnership with Singapore's Singapore Accreditation Council, has initiated joint assessments, but progress has been slow due to funding constraints. This slow progress leaves fortification of supply chains vulnerable to quality inconsistencies and potential mislabeling.

Digital monitoring and traceability systems: Digital systems for traceability and real-time quality monitoring are entirely absent. Without such systems, there is no systematic method to track fortified rice from production through retail or institutional distribution, making it impossible to identify quality issues or ensure consistent fortification levels throughout supply chains. Real-time monitoring could enable rapid identification and response to production problems, contamination, or adulteration.

Data systems for monitoring nutritional impact: A centralized database of nutrition indicators is absent, making it difficult to assess whether fortification programs achieve intended nutritional outcomes. The most recent nationwide nutrition data comes from surveys conducted during 2015–16 and 2017–18. More recent household welfare surveys provide information on food consumption, but are not specifically designed to monitor the impact of the fortification program (PATH 2019).

Challenging enforcement of fortification standards: Even where regulations exist, enforcement mechanisms remain challenging. The absence of adequate monitoring, testing, and inspection capacity to ensure compliance undermines the effectiveness of regulations. Without consistent enforcement and consequences for noncompliance, producers may reduce fortification levels to cut costs.

Program-level monitoring by implementation partners: Implementation partners conduct the most effective monitoring, particularly by maintaining documentation of fortified rice production volumes, distribution channels, and institutional partnerships. However, this program-level monitoring is limited to specific sites and does not provide comprehensive national-level data. Information on total national production, distribution, and consumption of fortified rice remains incomplete and fragmented.

Recommendations for strengthening monitoring and evaluation: To strengthen monitoring and evaluation systems in Myanmar, several strategic actions are recommended. First, prioritize investment in and accreditation of laboratory infrastructure, preferably through International Laboratory Accreditation Cooperation-recognized mechanisms, potentially in collaboration with established regional laboratories. Second, adopting digital traceability platforms that incorporate technologies such as barcoding or blockchain could enhance supply chain transparency and quality

assurance. Third, establishing centralized databases for nutrition indicators would facilitate systematic tracking of population-level nutritional outcomes. Fourth, regulatory enforcement and inspection capacities require reinforcement to ensure compliance with fortification standards. Fifth, integrating fortification impact assessments into routine national nutrition surveys would enable continuous evaluation of program effectiveness. Finally, developing a national food fortification data dashboard, aligned with established international monitoring frameworks, would support evidence-based decision-making and policy oversight.

2.2.4.10 Stakeholder Ecosystem and Partnerships

Multi-sectoral partnership model: Myanmar's food fortification success, particularly rice fortification, relies fundamentally on strategic partnerships spanning public-sector government agencies, private-sector food producers and retailers, civil society organizations, and international technical and development partners. This multisectoral model represents a key strength and enabling factor.

Public sector partners: The Ministry of Health and Sports serves as the lead government agency for nutrition policy and food fortification. The National Nutrition Centre under the Ministry of Health and Sports plays a central coordinating role and chairs the Myanmar Rice Fortification Working Group, bringing together public, social, and private sector partners. The Department of Food and Drug Administration implements regulatory oversight fortified food production and labeling. The Department of Social Welfare implements institutional feeding programs, increasingly incorporating fortified rice. The Ministry of Health and Sports uses fortified rice in hospital meal programs and training institutes (Ministry of Health and Sports n.d.).

Private sector partners: Local private-sector companies are essential partners who have invested in equipment, training, and quality systems to produce fortified rice using extruder and blending technology. These producers have demonstrated commitment to government quality standards and obtained regulatory approval. Retailers and distribution networks, including supermarket chains and small retailers, serve as key distribution channels, with growing demand indicating market acceptance.

Coordination mechanisms: The Myanmar Rice Fortification Working Group, chaired by the National Nutrition Centre, is the key coordination mechanism that brings together multiple stakeholders to address technical, regulatory, and policy issues. The Nutrition Sector Coordination Group under the Development Assistance Coordination Unit provides broader coordination for nutrition sector activities.

Regional and international partnerships: Myanmar's membership in the Scaling up Nutrition movement connects the country to a global network committed to addressing malnutrition through multisectoral efforts. Regional initiatives facilitated by the FFI Asia-Pacific program provide technical support and advocacy (FFI n.d.).

Partnership achievements: The multisectoral partnership model has enabled: (i) culturally appropriate fortified rice product development using advanced technology; (ii) regulatory approval and commercialization of fortified rice; (iii) production capacity establishment and sustainable supply chain development; (iv) market development and increasing consumer acceptance; (v) integration into institutional feeding programs; and (vi) expansion of humanitarian food assistance using fortified commodities.

Opportunities to strengthen partnerships: Myanmar could: (i) formalize and expand the Myanmar Rice Fortification Working Group to include additional government agencies and stakeholders; (ii) establish dedicated partnerships with regional laboratories to address quality assurance capacity constraints; (iii) enhance knowledge management and documentation of fortification experiences to facilitate learning; (iv) establish structured mechanisms for private-sector consultation to address implementation barriers; and (v) strengthen linkages between nutrition coordination mechanisms and broader food security and social protection sector coordination.

2.2.4.11 Critical Challenges and Policy Reforms Needed

While regulatory frameworks for food fortification exist, coordination between the Department of Food and Drug Administration, the Department of Trade, and the Department of Agriculture remains inadequate. For producers and importers, navigating multiple regulatory requirements creates implementation barriers and uncertainty. Enforcement has been challenging, with limited inspection capacity and inconsistent application of standards.

Absence of mandatory food fortification regulations: A critical policy gap is the absence of national mandatory regulations for food fortification beyond salt iodization. While the Ministry of Health and Sports issued technical guidance on rice fortification in 2019, it lacks mandatory force. Without mandatory regulations, compliance is voluntary and incentive-dependent, constraining scaling efforts because producers cannot be assured of market demand. Regional experience from India, Indonesia, and other countries demonstrates that mandatory fortification regulations enable substantially greater scale and impact than voluntary approaches.

Quality assurance and testing capacity: The absence of International Laboratory Accreditation Cooperation-accredited laboratory capacity poses a critical barrier to ensuring the quality of fortified food and maintaining consumer confidence. Without independent testing capacity, there is no nationally recognized mechanism to verify that fortified foods contain declared micronutrient levels. Additionally, insufficient data exists to assess blending efficiency at scale, limiting the ability to identify and address quality variations.

Limited production of key inputs: Reliance on imported premix for rice fortification creates supply chain vulnerabilities and increases costs. Developing domestic capacity for premix production or negotiating preferential import arrangements could reduce costs and enhance supply chain resilience. Similarly, imported fortification equipment increases implementation costs.

Insufficient population coverage: Current fortification initiatives, while successful in target regions, fall far short of national scale and universal coverage. Fortified rice is concentrated in commercial retail channels in urban and semi-urban areas, leaving rural and remote populations underserved. Coverage through institutional social safety net programs is limited by funding shortages and logistical barriers, particularly in conflict-affected areas, where nutritional vulnerability is often highest.

Conflict and logistical barriers: Ongoing armed conflicts and political instability create severe logistical barriers to delivering fortified foods to conflict-affected populations. Access disruptions due to checkpoints, clashes, and security concerns make consistent supply difficult in some regions. The 2024 flooding and 2025 earthquake have exacerbated logistical challenges and food insecurity.

Challenging monitoring and enforcement mechanisms: The absence of systematic monitoring and quality-assurance systems limits information on program implementation, market quality, and the impact on nutritional outcomes. Challenging enforcement of quality standards limits accountability and the ability to implement corrective actions.

To advance food fortification, the government can develop comprehensive legislation mandating the fortification of key staple foods such as rice, edible oil, and wheat flour. This framework may include clear technical standards, quality benchmarks, and enforcement mechanisms to ensure compliance and public health impact.

Effective regulatory coordination is essential and should involve clearly defined roles across relevant ministries, a functional inter-agency coordination mechanism, and delegated authority for monitoring and enforcement. Investments in national quality assurance infrastructure, such as International Laboratory Accreditation Cooperation-accredited laboratories, digital traceability systems, and periodic market surveillance, will be vital to maintain fortification quality and consumer confidence.

Fortified foods may be integrated into major social protection schemes, such as school feeding, institutional meal programs, and other safety-net initiatives, to maximize reach among vulnerable populations. Parallel efforts will strengthen domestic premix production capacity through targeted incentives and technical support, reducing dependence on imports and ensuring cost efficiency.

Finally, governance and oversight can be enhanced by reactivating and expanding the Nutrition Promotion Steering Committee to sustain high-level political commitment, align multi-sectoral efforts, and institutionalize coordination for long-term fortification progress. Establishing centralized nutrition data systems and fortification monitoring dashboards will enable tracking implementation and nutritional outcomes. Stakeholder engagement should be reactivated on oil and wheat fortification, and a policy roadmap should be developed.

2.2.4.12 Opportunities and Future Directions

Myanmar presents exceptional opportunities for LSFF, given that rice serves as the staple for 90% of the population. This near-universal consumption provides a unique foundation for achieving population-level reach with a single food vehicle. Unlike fortification of foods with limited consumption, rice fortification reaches virtually the entire population across all ages, regions, ethnic groups, and socioeconomic levels, with daily consumption at multiple meals enhancing nutritional impact.

Cultural appropriateness and consumer acceptance: A significant enabling factor is the cultural appropriateness of fortified rice and demonstrated consumer acceptance. Fortified rice requires no change to traditional dietary patterns or cooking practices; consumers prepare and consume it the same way as non-fortified rice. This eliminates a major barrier to fortifying other foods where cultural preferences exist.

Community acceptability has been demonstrated through growing market demand and commercial availability in retail channels. Widespread availability on supermarket shelves and through small retailers indicates that consumers are willing to purchase and consume fortified products when quality is assured.

Established policy framework and government support: Myanmar has established policy frameworks for nutrition and demonstrated government commitment to nutrition as a national priority. The Multi-Sectoral National Plan of Action on Nutrition and institutional coordination mechanisms demonstrate the government's recognition of nutrition as a sectoral priority requiring coordinated multisectoral action. The Ministry of Health and Sports has issued technical guidance on rice fortification and supports the program through regulatory approval and institutional adoption. Government recognition of nutrition as a priority, as demonstrated by high-level political commitment and inter-ministerial coordination (through the Nutrition Promotion Steering Committee and nutrition-sector coordination mechanisms), creates an enabling environment for expanded fortification programs.

Technical expertise and partnership models: Myanmar benefits from access to world-class technical expertise through partnerships with development organizations with extensive global experience in food fortification implementation. These partnerships provide specialized technical knowledge of fortification processes, quality assurance, and implementation logistics, as well as proven organizational models for sustainable production, distribution, and regulatory compliance. The rice fortification program outcomes demonstrate that effective public-private partnerships can be established and sustained in Myanmar. This partnership model, bringing together government, private-sector producers, international technical partners, and civil society, has achieved tangible outcomes including regulatory approval, production capacity development, and commercial product availability.

Growing urban consumer markets: Myanmar's urban population is expanding, and its residents have access to commercial retail channels and greater purchasing power. Growth in commercial retail distribution of fortified rice indicates expanding urban markets for fortified products, creating economic opportunities and incentives for private sector investment.

Regional cooperation and best practice learning: Myanmar's membership in the Scaling Up Nutrition movement and participation in the regional food fortification initiative provide access to learning from peer countries in Southeast Asia and South Asia that have advanced further in fortification implementation. Regional countries, including India, Indonesia, Bangladesh, and Vietnam, have developed mandatory fortification regulations, established quality assurance systems, and achieved substantial population reach. Myanmar can learn from and adapt these experiences.

Humanitarian imperative and development impact: The urgent and growing food insecurity crisis, with 15 million people facing hunger in 2025, creates a moral imperative and a practical opportunity for food fortification to help address it. Fortified foods provide the dual benefit of addressing immediate food insecurity and addressing hidden hunger caused by micronutrient deficiencies.

Specific opportunities for expansion: Beyond rice fortification, opportunities exist for additional food vehicles. Oil fortification is particularly important, as palm oil is widely consumed (constituting 90% of oil imports), and vitamin A and D fortification is technically straightforward and cost-effective (Government of Myanmar 2013). Advocacy to align Myanmar's import policies and fortification standards with ASEAN trade harmonization protocols could leverage Malaysia's technical expertise and the experience of regional producers in oil fortification (ASEAN and UNICEF 2024).

Wheat fortification presents a significant opportunity, particularly given the increasing consumption of bread and noodles among Myanmar's population, especially in urban areas. Renewed

engagement with local millers, the Food Fortification Initiative, and international technical partners could resurrect this agenda.

Strengthening capacity for sustainability: While Myanmar's fortification programs currently depend heavily on international partners' technical support, opportunities exist to progressively strengthen domestic capacity to manage and sustain fortification initiatives. Building domestic expertise in quality assurance, regulatory implementation, production management, and program evaluation would enhance sustainability and reduce dependence on long-term external assistance.

Future directions and strategic vision: A comprehensive future direction for Myanmar's food fortification would involve the following: (i) Scaling rice fortification to universal population coverage through integrated strategies combining commercial market development, mandatory integration into social safety nets, and specific targeting of conflict-affected and remote areas through humanitarian channels; (ii) Developing mandatory fortification regulations for multiple food vehicles (rice, oil, wheat, sugar, milk) with clear technical specifications and enforcement mechanisms adapted to Myanmar's institutional capacity; (iii) Building sustainable domestic capacity for quality assurance, laboratory testing, regulatory enforcement, and program management, reducing long-term external dependence; (iv) Integrating fortification into broader food security and social protection strategies as a key component of comprehensive approaches to addressing hunger and malnutrition; (v) Establishing digital monitoring systems enabling transparent tracking of fortification program implementation, quality assurance, and nutritional outcomes; (vi) Fostering regional cooperation to leverage technical expertise, establish regional quality standards, and facilitate procurement efficiency through economies of scale; (vii) Mobilizing sustained political commitment and resources to ensure fortification receives adequate budget allocation, institutional prioritization, and donor support for multi-year implementation and scaling.

With focused political commitment, adequate resource allocation, technical assistance, and sustained multisectoral partnership, Myanmar has significant potential to dramatically reduce micronutrient deficiency burden through LSFF. Established policy frameworks, demonstrated program implementation capacity, and exceptional opportunity presented by universal rice consumption create a strong foundation for transforming food fortification from a limited pilot initiative into a national strategy that reaches the entire population and substantially contributes to nutrition and health objectives.

2.2.5 Nepal

2.2.5.1 Nutrition and Fortification Ecosystem

Nepal's geographical and demographic characteristics significantly shape its food fortification landscape. A landlocked country between China and India, it encompasses the fertile Terai plains, subalpine forested hills, and eight of the world's ten tallest mountains, creating substantial logistical challenges for implementing nationwide nutrition interventions in mountainous regions with limited infrastructure. The 2021 Census recorded approximately 29.16 million people, with 67.17% living in urban areas and 33.83% in rural areas. Nepal's ethnic and linguistic diversity comprises more than 100 ethnic groups, presenting both opportunities and challenges for nutrition programming. Agriculture remains significant to the economy, with rice as the primary staple, contributing approximately 69% of daily caloric intake and 20% of agricultural gross domestic product. Nepal's 2015 federal democratic constitution created opportunities for economic growth and poverty reduction. However, gross domestic product growth declined to 1.9% in fiscal year 2023 due to anti-inflation measures, with World Bank projections estimating 3.9% growth in fiscal year 2024 and 5% in fiscal year 2025 (National Planning Commission 2024).

2.2.5.2 Nutritional Status and Dietary Practices

2.2.5.2.1 Current nutritional indicators

Recent estimates from the Nepal Multiple Indicator Cluster Survey 2024–25 (NSO 2026) indicate that among children under five years old, 26.2% are stunted, 6.6% are wasted, 16.9% are underweight, and 2.1% are overweight, while the 2022 Nepal Demographic and Health Survey revealed that among children under five years old, 25% were stunted, 8% were wasted, and 19% were underweight. While

significant progress has been made over the long term, the Nepal Multiple Indicator Cluster Survey 2024–25 estimate (26.2%) compared with the Nepal Demographic and Health Survey 2022 (25%) suggests that stunting may be stagnating or slightly worsening, underscoring the need to intensify preventive interventions. However, anemia remains persistent, affecting 43% of children aged 6-59 months and 34% of WRA.

Geographic disparities remain pronounced. In the Multiple Indicator Cluster Survey 2024–25 (NSO 2026), stunting ranged from 36.6% in Karnali Province to 19.2% in Bagmati Province, while wasting ranged from 8.6% in Koshi Province to 4.2% in Bagmati Province. Underweight varied from 23.2% in Madhesh to 9.6% in Bagmati. These differences reflect variation in food security, service access, and socioeconomic conditions across regions.

For children under five years old, overweight remained low in absolute terms (1% in the Nepal Demographic and Health Survey 2022), but the Nepal Multiple Indicator Cluster Survey 2024–25 estimate (2.1%) suggests a potential upward shift, warranting continued surveillance in relation to global commitments to prevent increases in childhood obesity. For WRA, overweight/obesity increased from 13.5% in 2011 to 22.2% in 2016, reflecting shifts in dietary patterns (MoHP, New ERA, and ICF 2023).

2.2.5.2.2 Dietary practices and micronutrient deficiencies

Among children aged 6-23 months, only 51.5% receive minimum dietary diversity. Regarding patterns, 43% consume sweet beverages, and 69% consume unhealthy foods. Among women aged 15-49 years, 56% consume meals with a minimum level of dietary diversity, while 54% consume unhealthy foods, and 66% consume sugary beverages (Ministry of Health and Population, Nepal, New ERA, UNICEF, EU, USAID, and CDC 2018). These patterns underscore the urgent need for comprehensive dietary diversification, fortification, and nutrition education.

Micronutrient deficiencies remain widespread. According to the 2016 Nepal National Micronutrient Status Survey, zinc deficiency affects 20.7%, and iron deficiency affects 28% of children aged 6-59 months (Government of Nepal 2016). Anemia prevalence among children has fluctuated, declining from 48% in 2006 to 43% in 2022, suggesting that while fortification efforts have progressed, intensified interventions remain necessary.

Among pregnant women, anemia declined more consistently from 42% in 2006 to 34% in 2022, demonstrating the progress associated with the iron and folic acid supplementation program. Since the 1980s, Nepal has provided daily iron and folic acid supplements (60 mg iron, 400 µg folic acid) to pregnant women from the second trimester through 45 days postpartum. The Intensification of Maternal and Neonatal Micronutrient Program, launched in 2003, achieved 91% iron and folic acid coverage among pregnant women by 2016, with 71% adhering to the program for at least 90 days. The School Health and Nutrition Strategy (2006) introduced weekly iron and folic acid supplementation for adolescent girls.

2.2.5.3 Nutrition-related Flagship Program

Nepal has made significant progress in improving nutrition outcomes over the past decade through its multi-sectoral approach, beginning with the first Multi-Sector Nutrition Plan (2013–17) and its successor Multi-Sector Nutrition Plan (2018–22). The third Multi-Sector Nutrition Plan (2023–30) builds on these achievements and lessons, responding to persistent malnutrition challenges while

aligning with the constitutional guarantee of the right to food and basic health services. The National Planning Commission developed it in collaboration with key sectoral ministries and development partners. Despite progress such as the reduction in stunting among children under five years old from 41% in 2011 to 25% in 2022 and improvements in maternal and child health services, Nepal continues to face high burdens of wasting (8%), underweight (19%), and anemia among children (43.4%) and WRA (34%) according to Nepal Demographic and Health Survey 2022. The third Multi-Sector Nutrition Plan aims to address these gaps through a strengthened systems-based, nutrition friendly governance approach, enhancing the availability, quality, and equitable access to both nutrition specific and nutrition-sensitive services. It also prioritizes cross sectoral coordination, behavior change, and institutional capacity across all three tiers of government to accelerate progress toward national and global nutrition targets.

National Mid-Day Meal Programme: The National Mid-Day Meal Programme is a major social safety net and nutrition intervention that provides a daily "Mid-Day Meal" to students in government schools, aiming to improve nutritional status and educational retention. The program operates through two primary modalities: a cash-based model in which schools procure local food to prepare fresh meals, and a food-based model (often supported by WFP in remote areas) that provides fortified commodities. The government has significantly increased its fiscal commitment to this program, expanding coverage to all 77 districts and targeting children from pre-primary to Grade 5 to address hunger and ensure minimum dietary diversity during school hours (Government of Nepal 2019).

Golden 1,000 Days (Sunaula Hazar Din): The Golden 1000 Days (Sunaula Hazar Din) campaign is a critical social and behavior change communication initiative focusing on the window of opportunity from conception to a child's second birthday (approximately 1,000 days). This program emphasizes that nutritional damage during this period is largely irreversible and advocates optimal maternal nutrition, exclusive breastfeeding for six months, and appropriate complementary feeding thereafter. Often implemented in collaboration with development partners, the campaign uses community engagement to raise awareness of hygiene, sanitation, and dietary diversity to reduce maternal and child mortality and stunting (UNICEF 2023).

National Vitamin A and deworming programmes: The National Vitamin A Programme is one of Nepal's oldest and most successful public health interventions, initiated in 1993 to combat blindness and child mortality. The program relies on mobilizing female community health volunteers to distribute high-dose vitamin A capsules to children aged 6–59 months biannually (in Baisakh and Kartik). This campaign is integrated with the National Deworming Programme, which administers albendazole tablets to children aged 12–59 months to treat intestinal worms, thereby improving nutrient absorption and reducing anemia (Thorne-Lyman et al. 2022).

Integrated management of acute malnutrition: To address severe wasting, the Nepal government implements the Integrated Management of Acute Malnutrition program, which provides treatment for severe acute malnutrition through both facility-based and community-based care. The program screens children using mid-upper arm circumference tapes and weight-for-length/height Z-scores and treats uncomplicated cases of severe acute malnutrition at outpatient therapeutic centers using ready-to-use therapeutic food, while referring complicated cases to nutrition rehabilitation homes or inpatient therapeutic centers at hospitals. This approach enables decentralized care, making life-saving treatment more accessible in communities rather than relying solely on central hospitals.

Micronutrient supplementation and fortification: The government runs targeted iron and folic acid supplementation programs for pregnant women (from the second trimester through 45 days postpartum) and adolescent girls (weekly iron and folic acid supplementation) to combat high anemia prevalence. These efforts are complemented by the universal salt iodization program, which has achieved near-universal household coverage of adequately iodized salt, contributing to the virtual elimination of iodine deficiency disorders in the country. Additionally, the government mandates that large roller mills fortify wheat flour to include iron, folic acid, and vitamin A (Government of Nepal 2011), and distributes micronutrient powder (Baal Vita) for home fortification of complementary foods for children aged 6–23 months to improve dietary quality.

2.2.5.4 Policy Environment for Food Fortification

National nutrition strategy and coordination: Nepal's National Nutrition Strategy 2020 aligns with the Sustainable Development Goals and aims to improve the nutritional status of newborns, children, adolescents, and women by enhancing service quality and community awareness.

The third Multi-Sector Nutrition Plan (2023–30) strengthens Nepal's commitment to improving micronutrient intake by expanding nutrition-sensitive interventions, including promoting food fortification as part of its broader strategy to enhance the availability, quality, and accessibility of essential nutrients across the population.

The 16th Five-Year Development Plan (2024/25-2028/29) emphasizes food fortification as a game-changing agenda, reflecting heightened political commitment. Constitutional provisions guarantee the right to food and health as fundamental rights (Government of Nepal 2019).

Regulatory framework and standards: The Department of Food Technology and Quality Control under the Ministry of Agriculture serves as the primary regulatory authority. The Food Safety and Quality Control Act 2081 (2024) and Mandatory Quality Standards 2080 formalized mandatory fortification requirements for salt, wheat flour, and complementary foods (Government of Nepal 2024).

Current mandatory fortification includes salt iodization at 30-50 mg/kg, wheat flour fortification for roller mills (iron 60 mg/kg, folic acid up to 1.5 mg/kg, and vitamin A 1 mg/kg included), and processed complementary foods per Codex Alimentarius guidance. Voluntary fortification applies to rice, while edible oil and milk fortification lack mandatory standards. Implementation challenges persist, including limited enforcement capacity, particularly among small-scale producers, inadequate federal-level coordination following federalization, and insufficient monitoring systems. The national standard for fortified rice was published in the Nepal Gazette in August 2023, following Cabinet approval in July 2023, providing regulatory clarity for rice production and commercialization.

2.2.5.5 Industry Capacity and Role of Private Players

Private sector engagement in fortification: Nepal's wheat flour fortification demonstrates the highest level of private-sector participation, with approximately 25 roller mills producing fortified flour that meets national standards and is subject to regular monitoring by the Department of Food Technology and Quality Control. These facilities produce fortified flour containing approximately 60 ppm iron, 1.5 ppm folic acid, and 1 ppm vitamin A (Government of Nepal 2016).

However, significant gaps exist. Small-scale chakki mills, which serve large rural populations, remain excluded from mandatory fortification because of technical and economic constraints,

creating coverage gaps, particularly in areas where they predominate. For rice fortification, the Food Management and Trading Company Limited (FMTCL) serves as the sole producer, supported by the WFP. Production commenced at mills in Rajapur and Janakpur, with 703 tons produced and 357 tons supplied to target districts by 2024.

Cost considerations present significant barriers. Fortification increases production costs through premix acquisition, equipment modifications, and quality control, while consumer demand remains insufficient to justify price premiums. Import dependency for fortificants and premix creates supply chain vulnerabilities. Nepal imports all premix and FRKs with no local manufacturing capability, limiting sustainability and increasing costs. Private-sector opportunities exist through strategic incentives: tax breaks, public procurement preferences, input subsidies, graduated compliance timelines for small-scale producers, and targeted capacity building.

In addition to staple food fortification, Nepal has seen the emergence of domestic private manufacturers investing in fortified and nutrient-dense food products targeted at children and school-age populations. For example, the Baliyo Nepal Nutrition Initiative supported the development and commercialization of fortified complementary foods designed for young children (GNR n.d.), demonstrating the technical feasibility of local production aligned with national nutrition priorities.

Similarly, emerging food manufacturers, including Vertex Foods, have begun investing in fortified and nutrient-dense product lines aligned with school feeding and complementary feeding markets (Vertex FNB n.d.). These initiatives reflect growing domestic technical capacity in product formulation, micronutrient premix integration, packaging, and distribution within institutional channels such as schools.

While these products fall outside traditional staple-based LSFF frameworks, they indicate expanding private-sector engagement in fortified food production and offer potential complementary pathways to improve micronutrient intake among vulnerable populations.

2.2.5.6 Integration with Social Safety Net Programs

National Mid-Day Meal Programme: The National Mid-Day Meal Programme is the primary platform for delivering fortified foods at scale, covering all 77 districts and serving 3.3 million children in 29,000 public schools. Government budget allocation increased fivefold between 2017 and 2022, reaching US$87 million in 2023-24, representing approximately 6% of the national education budget.

The program operates primarily through a cash-based modality implemented by the Center for Education and Human Resource Development, with the WFP providing in-kind support to select districts. The McGovern-Dole International Food for Education and Child Nutrition Program, funded by USDA, provides fortified rice, lentils, vitamin A-fortified vegetable oil, and iodized salt (World Food Programme 2024).

Research findings document the program's positive impact. An assessment of cash-based pilot school meals showed significantly improved school meal availability (+20%), food intake, and children's knowledge of nutrition practices (World Vegetable Center and WFP 2023).

Later, the WFP strategically reduced direct implementation while continuing to provide technical assistance to the government. Between 2017 and 2022, the government significantly increased school meals budgets, signaling a commitment to nutrition-sensitive education. Nepal's 2021

decision to join the School Meals Coalition positioned the country as a leader in nutrition-sensitive education.

The Endline Evaluation of the McGovern-Dole Program (2017-22) documented program effectiveness in improving attendance and learning outcomes while addressing food insecurity. However, coverage gaps remain for secondary school students, representing an important equity consideration.

Complementary social protection programs: Nepal implements complementary social protection programs to enhance the impact of fortification. The Child Grant Program provides cash transfers to families with children under five years old in selected districts. The Senior Citizens' Allowance offers monthly support to citizens aged 68 and above, while the Disability Allowance provides financial assistance based on the severity level. Additional programs include cash transfers and livelihood assistance for single women and marginalized groups, as well as the Prime Minister's Employment Program for unemployed youth. These programs create synergies with fortification by addressing broader determinants of nutritional status and food security. By improving household income and food access, they enhance the effectiveness of fortification by ensuring adequate consumption of fortified foods.

2.2.5.7 Population Reach and Coverage Metrics

Fortification program reach: Universal salt iodization represents the greatest success, with household coverage of adequately iodized salt reaching 98% in 2022, translating to approximately 28 million beneficiaries. This achievement has effectively eliminated iodine deficiency disorders as a public health problem. Wheat flour fortification extends to all roller mills, reaching most urban and semi-urban populations who purchase commercially milled flour. However, excluding small-scale chakki mills creates coverage gaps in rural areas.

School meal fortification reaches 3.3 million children across all 77 districts (School Meals Coalition n.d.), though coverage remains lower in geographically challenging and conflict-affected regions. Rice fortification coverage remains limited, with 357 tons supplied as of 2024. Given that rice constitutes 69% of daily caloric intake, scaling through both public distribution systems and commercial channels offers enormous potential. Current coverage is estimated at only a small percentage of the population.

Complementary food fortification coverage remains inadequate despite the nationwide scale-up since 2019. Multiple Micronutrient Powder (Baal Vita) data indicate that only 40.9% of children received at least one cycle, and 5.1% completed three cycles, indicating substantial implementation gaps.

Coverage disparities and equity: Significant geographic disparities exist across provinces. In Karnali and Sudur Paschim provinces, where stunting prevalence is highest at 36%, the lower availability of fortified food through regular commercial channels creates an equity paradox. Socioeconomic disparities also shape coverage, with wealthier households more likely to purchase commercial fortified foods while poorer populations rely on informal food systems.

2.2.5.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Nepal's fortified staples move through a largely import-dependent yet state-steered supply chain, with procurement and distribution arrangements varying by commodity but converging around public agencies and existing market or health networks.

Iodized salt: Salt is fully imported from India under a government-sanctioned monopoly, with the Salt Trading Corporation as the sole authorized importer and procurement agent, sourcing around 200,000 MT annually from regulated Indian producers and moving consignments through a few southern border points. Salt Trading Corporation manages central warehousing (large depots of about 20,000 MT capacity each) and redistributes to regional depots and an extensive dealer network, combining commercial sales with subsidized distribution in 22 remote hill and mountain districts to maintain availability and price equity (Paudyal et al. 2022).

Wheat flour: Nepal became the first South Asian country to mandate wheat flour fortification in 2011, following a decade of voluntary compliance initiated through a pioneering 2002 tripartite agreement between the Department of Food Technology and Quality Control, the Flour Mills Association, and the Ministry of Health and Population, with technical and financial support from the micronutrient initiative. Wheat is procured from both domestic smallholders and imports, mainly from India, with commercial importers supplying large roller mills while local farmers feed both roller mills and numerous small chakki mills. Fortified flour from industrial roller mills enters the market through normal commercial channels, wholesalers, traders, small shops, and food vendors without a dedicated public distribution system, meaning access depends largely on proximity to roller mill supply chains and consumer purchasing power (Fortify Health n.d.).

Fortified rice: Fortified rice procurement is anchored in the FMTCL, which sources regular rice domestically and imports FRK from regional suppliers, including India. It plans to establish domestic FRK production in the future. The national standard for fortified rice, enacted in August 2023, specifies fortification with iron, folic acid, and vitamin A at levels appropriate for rice-consuming populations. Fortification occurs through FRK blending at FMTCL facilities, where fortified kernels are mixed with regular milled rice in proportions designed to deliver micronutrient targets at typical consumption levels. The standard aligns with international (Codex Alimentarius) and regional (WHO, FAO) guidance on rice fortification. Blended fortified rice is then routed primarily through targeted distribution: WFP-supported school meals and limited public distribution system outlets in remote, food-insecure districts in Karnali, Lumbini, and Sudurpaschim, rather than through open-market channels (FFI n.d.).

FMTCL operates under the Department of Food Technology and Quality Control regulatory oversight, with quality assurance mechanisms embedded in the blending process. However, limited production capacity and a lack of independent monitoring infrastructure have constrained quality consistency. No systematic population-level monitoring of rice consumption patterns or the impact of fortified rice on micronutrient status has been established, representing a significant gap in program evaluation. The 2023 standard publication represents progress in formalizing regulations but has not yet been accompanied by comprehensive monitoring systems or capacity building for enforcement at the retail and household levels.

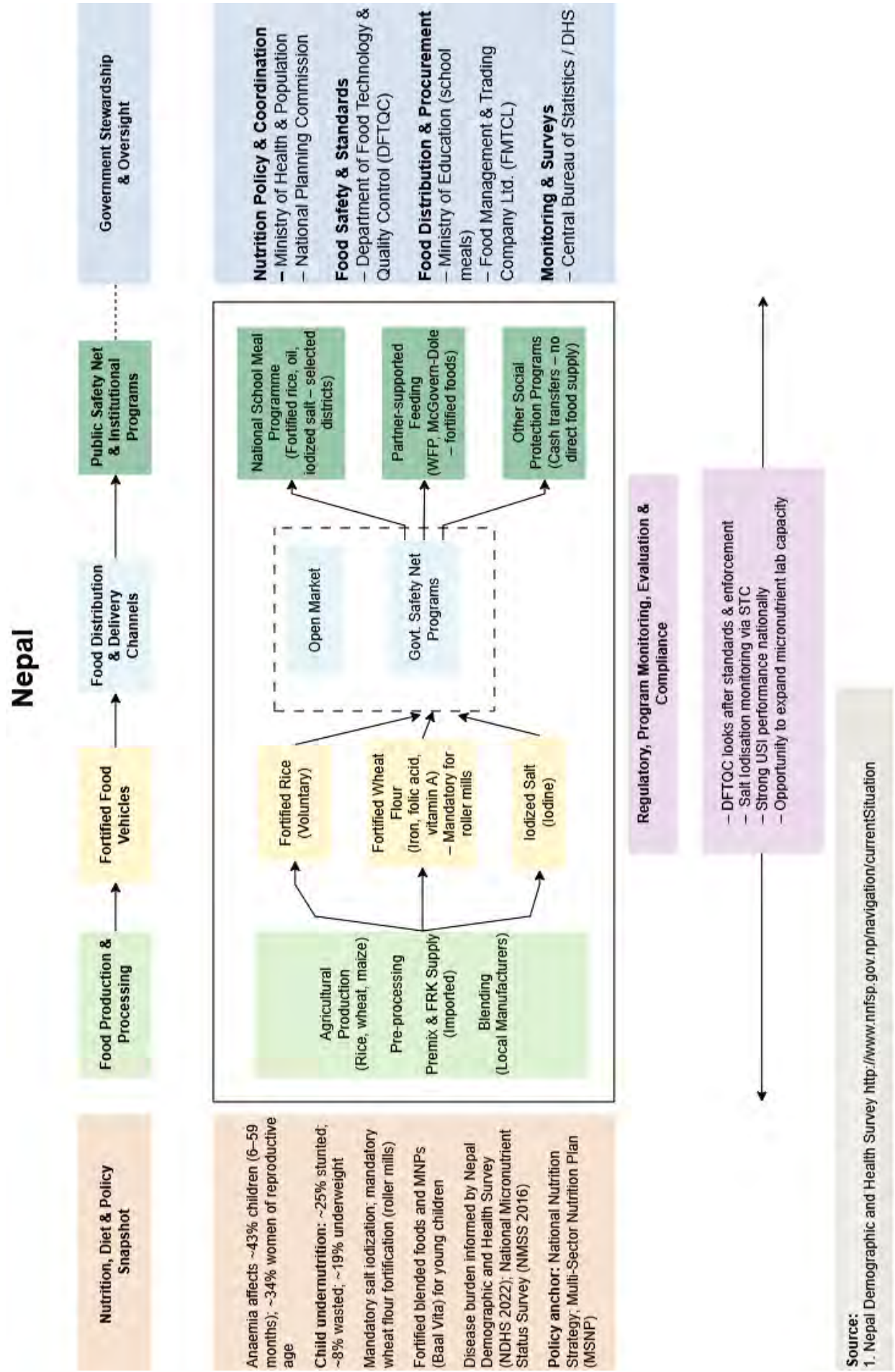
Complementary foods and micronutrient powders (Baal Vita): Fortified blended complementary foods follow a mixed procurement model, combining limited domestic production with commercial imports (e.g., Cerelac) concentrated in urban markets, while micronutrient powders (Baal Vita) are centrally procured from international manufacturers and adapted for Nepal through national partners. Distribution of both fortified complementary foods and micronutrient powders relies on the public health system and community platforms, health facilities, and female community health volunteers, with sachets and products handed to caregivers during facility visits or community outreach, leading to uneven geographic coverage where health and volunteer networks are limited.

Laboratory infrastructure and quality assurance: The National Food and Feed Reference Laboratory in Kathmandu holds ISO/IEC 17025:2017 accreditation, recognized by India's National Accreditation Board for Certification Bodies. The facility is accredited for 282 parameters, including chemical and microbiological tests, providing robust capacity for fortification quality verification at the national level. Regional capacity includes the Food Technology and Quality Control Office in Biratnagar, accredited for 23 parameters across seven food commodities. However, no laboratory is currently accredited under the International Laboratory Accreditation Cooperation for micronutrient testing. Private sector capabilities include ZEST Laboratories & Research Center. Despite these resources, comprehensive micronutrient testing capacity remains insufficient for robust quality assurance (World Bank 2012).

Digital systems and real-time monitoring: Current monitoring systems rely heavily on paper-based documentation with limited digital infrastructure. The Salt Trading Corporation uses salt-monitoring software to track iodine content, representing one of the more advanced systems in Nepal's fortification landscape. However, comprehensive digital systems for quality control and traceability across all fortified products remain underdeveloped.

The Department of Food Technology and Quality Control conducts regulatory monitoring primarily at retail levels, with resource limitations often prioritizing immediate public health hazards over routine surveillance. Internal monitoring by food producers varies significantly, with small-scale industries often lacking the resources for robust food safety management systems. See Figure 2.10.

Figure 2.10. Nepal's food fortification ecosystem



2.2.5.9 Monitoring and Evaluation Mechanisms

Nepal monitors food fortification programs through multiple overlapping systems with varying levels of integration. The Department of Food Technology and Quality Control conducts periodic facility inspections to verify compliance with fortification standards. However, limited human and financial resources constrain the frequency and comprehensiveness of inspections, and inspections are often reactive rather than systematic.

Household-level monitoring is conducted through regular Nepal Demographic and Health Surveys and National Micronutrient Status Surveys, tracking population-level micronutrient status and dietary intake. The 2022 Nepal Demographic and Health Survey provides comprehensive data on anemia prevalence, dietary practices, and nutritional outcome data. However, survey gaps (typically five or more years) limit the ability to track program impact frequently enough for adaptive management.

The WFP and government education authorities conduct program-level monitoring of school meals, tracking reach and beneficiary numbers. Monitoring salt iodization through the Salt Trading Corporation provides data on iodine content and distribution volumes. Despite diverse efforts, integrated platforms connecting monitoring data across programs remain absent.

Evaluation evidence and impact: The Endline Evaluation of the McGovern-Dole Program (2017-22) documented significant achievements in fortified school meal implementation, demonstrating effectiveness in improving attendance and learning outcomes. However, formal impact evaluation data specifically measuring micronutrient impacts on health indicators remain limited.
Health facility monitoring systems track iron and folic acid supplementation coverage for pregnant women and school-age girls. High iron and folic acid coverage (91% among pregnant women by 2016) suggests strong implementation, though adherence rates (71% for 90 or more days) indicate room for improvement (World Food Programme 2022).

Nutrition survey data provide the most comprehensive population-level evidence. Declining anemia prevalence from 53% among children in 2016 to 43% in 2022, and from 46% to 34% among pregnant women, suggests positive trends associated with combined fortification, supplementation, and nutrition-sensitive interventions.

Monitoring and evaluation gaps: Significant gaps persist in Nepal's monitoring and evaluation systems. Real-time monitoring systems capable of tracking implementation quality across dispersed production sites remain absent. Heavy reliance on paper-based documentation limits data accessibility and analysis. Integration across monitoring systems remains minimal, with data existing in separate silos.

Micronutrient testing capacity at the subnational level remains insufficient for routine quality assurance monitoring. Consumer-level data on actual consumption of fortified foods relative to the general food supply remain limited. Evaluation studies specifically measuring the health impacts of different fortification programs remain sparse (DFTQC 2023).

2.2.5.10 Stakeholder Ecosystem and Partnerships

Government ministries and coordination: Multiple government ministries collaborate on nutrition and fortification programs with distinct roles. The Ministry of Health and Population leads health and nutrition policy and micronutrient supplementation initiatives. The Ministry of Education oversees the National School Meal Programme and school-based nutrition education. The Ministry of Agriculture implements food security and nutrition-sensitive agriculture programs. The Ministry of Women, Children, and Senior Citizens focuses on nutrition for vulnerable groups through social protection programs.

The National Planning Commission provides overall nutrition planning through the National Nutrition and Food Security Coordination Committee. However, significant coordination challenges persist following federalization, with fragmented implementation across government levels and capacity limitations at local levels (National Planning Commission 2024).

Development partners: International development partners provide crucial technical and financial support in school meals, food fortification, and emergency nutrition responses. UNICEF supports child nutrition, breastfeeding, and micronutrient programs. The WHO offers policy guidance on nutrition standards and fortification protocols. The Food and Agriculture Organization supports nutrition-sensitive agriculture and food systems. The European Union provides substantial long-term funding for the Multi-Sector Nutrition Plan from 2023 to 2030. Additional partners include the World Bank, which finances large-scale nutrition projects, and Helen Keller International, which implements community-based nutrition programs.

2.2.5.11 Critical Challenges and Policy Reforms Needed

Implementation and enforcement gaps: Significant challenges persist in implementing and enforcing fortification standards. Limited regulatory inspection capacity, particularly for small and medium-scale producers, creates compliance gaps. Excluding chakki mills from wheat flour fortification requirements represents a major coverage limitation.

Geographic barriers compound implementation challenges, with difficult terrain and poor infrastructure in mountainous regions hindering the distribution of fortified foods. Seasonal road accessibility disruptions in remote areas affect the consistent availability of fortified products, particularly during the monsoon season. Enforcement mechanisms face resource constraints at both the federal and provincial levels.

Economic and market barriers: Cost considerations present significant barriers to scaling fortification programs. Fortification increases production costs through premix acquisition, quality control systems, and training, while consumer demand remains insufficient to justify price premiums. Small-scale producers, in particular, lack the capital to make the equipment modifications necessary for compliance.

Import dependency for fortificants and premix creates supply chain vulnerabilities and cost fluctuations affecting program sustainability. Exchange rate volatility and international commodity price fluctuations create unpredictable cost structures, challenging budget planning.

Consumer acceptance varies significantly across regions. Preference for locally milled rice creates resistance to fortified alternatives in the Terai region, where consumers perceive fortified rice as

inferior. Traditional dietary preferences, limited awareness of fortification benefits, and misinformation about safety present additional barriers despite extensive evidence of safety and efficacy.

Technical and capacity constraints: Limited technical capacity constrains program implementation. Local food control authorities and rice millers require enhanced training on quality control procedures, fortification techniques, and adherence to standards. Blending efficiency improvements are needed for uniform micronutrient distribution. Equipment calibration and maintenance challenges impede consistent quality.

Laboratory capacity limitations affect quality assurance. Insufficient micronutrient testing facilities at subnational levels hinder routine monitoring and compliance verification. Shortages of technical personnel create bottlenecks in testing capacity, even when equipment is available.
Human resource limitations include inadequate retention at local levels and post-federalization coordination challenges. Staff turnover in critical positions frequently disrupts institutional knowledge and program continuity.

Quality control and regulatory challenges: Quality consistency across production facilities remains variable. Challenges include inadequate enforcement of standards, particularly among informal and small-scale producers. The absence of reliable supply chains for quality fortificants creates uncertainty about premix quality. Testing gaps allow substandard products to reach consumers. The regulatory framework requires strengthening across multiple dimensions. Clear delineation of responsibilities between government levels remains inadequate. Incentive structures for compliance remain challenging, with penalties for noncompliance often insufficient.

2.2.5.12 Opportunities and Future Directions

Expansion of fortification mandates: Significant opportunities exist for expanding mandatory fortification to additional food vehicles. Edible oil fortification offers high-impact potential, given its widespread consumption across all socioeconomic groups and regions. Dairy milk fortification could address calcium and vitamin deficiencies, though informal milk sectors require thoughtful implementation.

Rice fortification scale-up presents enormous opportunities given rice's centrality in Nepal's food system. Integration with public distribution systems beyond school meals could dramatically expand reach. Private sector engagement could expand the availability of commercial fortified rice. Mandatory rice fortification standards can ensure consistent coverage across all processing facilities.

Amending the micronutrient content of wheat flour fortification to include B complex vitamins and zinc would be beneficial. Including chakki mill flour in wheat flour fortification would significantly expand coverage in rural areas. Technical assistance and financial incentives could help smaller producers comply.

Strengthening quality assurance and monitoring: Digital infrastructure development presents opportunities for real-time monitoring and traceability systems. Investment in digital quality assurance platforms could enhance compliance verification. Blockchain technology applications could improve supply chain transparency.

Expanding laboratory capacity through regional facility development and equipment upgrades would strengthen quality assurance. Pursuing international accreditation would enhance testing credibility. Mobile technology applications could facilitate field monitoring and rapid response.

Integrated monitoring systems connecting production, distribution, and consumption data could provide comprehensive program oversight. Real-time data dashboards tracking fortification coverage, consumption patterns, and micronutrient status would enable adaptive management.

Policy and regulatory enhancements: Developing a comprehensive food fortification strategy would provide the strategic direction currently lacking. A unified approach could improve coordination and resource allocation. Harmonization with global trade standards could enhance export potential. Alignment with Codex Alimentarius and World Trade Organization frameworks would facilitate access to international markets.

Incentive structures, including tax breaks, public procurement preferences, and input subsidies, could encourage private sector participation. Graduated compliance timelines could facilitate the inclusion of small-scale producers. Clear enforcement mechanisms with proportionate penalties could improve compliance.

Capacity-building and partnerships: Continued international partnerships remain crucial for technical and financial support, particularly for premix provision, monitoring systems, and training programs. Long-term investment in supply chains requires sustained donor engagement. Partnership frameworks may emphasize sustainable capacity development and domestic resource mobilization.

Consumer awareness campaigns represent critical opportunities for demand creation and behavior change. National social marketing initiatives, nutrition education programs, and labeling schemes could increase the uptake of fortified foods. Media engagement and community-based education could address acceptance barriers. School-based nutrition education could build long-term awareness.

Domestic capacity development: Developing domestic premix production capacity would reduce dependence on imports and enhance sustainability. Feasibility studies may assess economic viability and technical requirements for local manufacturing. Technology transfer agreements could accelerate local capacity development. Research and development investments could support innovation in fortification technologies and optimal fortification levels for different population groups. Academic partnerships with Nepalese universities could build local research capacity.

2.2.6 Sri Lanka

2.2.6.1 Nutrition and Fortification Ecosystem

Sri Lanka's food security and nutrition landscape is shaped by distinct demographic distribution and geography. The nation's population of 21.76 million comprises 77.4% rural, 18.2% urban, and 4.4% estate-sector residents (Department of Census and Statistics 2024). Food insecurity is highest in the estate sector at 51% of households, followed by 26% in the rural sector, and 15% in the urban sector (World Food Programme 2023). Three primary agro-climatic zones impact food production: the dry zone (about 70% of land area) (Abeysekara, Punyawardana, and Premalal 2015) serves as the main rice cultivation region but is highly vulnerable to droughts and recurrent flooding; the wet zone is dominated by export-oriented plantation crops with relatively limited food crop diversity; and the intermediate zone supports a mix of plantation crops and spices, along with food crops and forest-garden farming systems. However, land fragmentation constrains these systems.

Prior to the 2022 economic crisis, Sri Lanka had achieved sustained reductions in hunger and food insecurity over previous decades. The crisis, however, sharply reversed this trajectory: national food insecurity rose to 28% at the height of the crisis in 2022, improved to 17% by March 2023 amid stabilization efforts, but then rose again to 24% of households by August-September 2023 (World Food Programme 2023). Contributing factors include low wages among estate workers, rural poverty, and household debt, limiting access to nutritious food. Food fortification thus operates within a complex landscape of geographic diversity and economic vulnerability, requiring carefully calibrated policy interventions.

2.2.6.2 Nutritional Status and Dietary Practices

Key findings from national nutrition surveys: The 2022 National Nutrition and Micronutrient Survey conducted by the Medical Research Institute provides comprehensive insights into nutritional status across Sri Lanka. A total of 1,510 children aged 6-59 months were listed in the selected households, and the questionnaire was administered to all of them. However, only 1,346 participated in the anthropometric assessment, and 1,210 were included in the biochemical assessment to fulfill the calculated sample size. Among children aged 6-59 months, stunting (chronic undernutrition) affected 13.7% nationally, with the central province at 21.5% and the estate sector at a concerning 33.1%. Boys were more affected than girls. Nationally, wasting (acute undernutrition) affected 19.8% of children, with the Northwestern Province recording the highest rate at 27.1%. The national underweight prevalence reached 22.7%, with the Northwestern Province at 38.0%.

Micronutrient deficiencies across population groups: Among children aged 6-59 months, anemia affected 14.6%, with iron deficiency at 5.4% and iron deficiency anemia at 1.8%. Vitamin D deficiency affected 26.2% of children, and zinc deficiency affected 15.3%. Iodine status revealed a median urinary iodine concentration of 93.8 µg/L, below the recommended 100 µg/L threshold, indicating suboptimal intake despite Sri Lanka's universal salt iodization program. Among WRA, anemia affected 18.5% of individuals. Among children aged 5 to 9 years, anemia prevalence was 10.2%, while in the 10–17-year age group, it was 18.3% (MRI 2022). These statistics underscore the persistent micronutrient deficiencies that require comprehensive intervention strategies.

Routine Nutrition Information - Family Health Bureau: Sri Lanka's 2025 Nutrition Month data from the Family Health Bureau indicate that undernutrition among young children remains a significant concern, even as overall child survival and service coverage stay high. Among children under five years old, 16.1% are underweight, 10.1% are stunted, and 8.6% are wasted, with moderate wasting at 7.7% and severe wasting at 0.82%, while 0.57% are classified as overweight (Sri Lanka Mirror 2026; Daily Mirror 2026).

For WRA, Sri Lanka has made measurable but incomplete progress in reducing anemia, moving from an estimated prevalence of about one third of women (32.6%) in 2016 to around one fifth (20.9%) by 2023. According to the National Nutrition Month Summary Report 2024 (eRHMIS data), 14.8% of pregnant mothers had hemoglobin less than 11 g/dl before 12 weeks of period of amenorrhea (POA) in January-June 2024, at the national level.

2.2.6.3 Nutrition-related Flagship Program

Sri Lanka currently implements a strong set of government-led nutrition flagship programs that operate across schools, health facilities, communities, and social protection platforms, with a strong focus on children, pregnant and lactating women, infants, and low-income households. Together, these programs seek to reduce undernutrition and micronutrient deficiencies while improving food security and learning outcomes, under the broader guidance of the National Nutrition Policy 2021–2030 and the Multi-Sector Action Plan for Nutrition.

The National School Meal Programme is one of the country's largest and most visible nutrition safety nets. It reaches about 1.4 million primary students across 8,943 schools, with a government allocation of LKR 32 billion for 2026, covering all 100 education zones in all nine provinces. The program targets nutritionally vulnerable students by prioritizing all primary school children in Grades 1–5; children in small schools with fewer than 100 students; learners in special education units and

selected religious institutions; and secondary students based on assessed nutritional need. A major recent enhancement has been integrating fortified rice into school meals, with 75 g of iron- and folic acid-fortified rice provided daily to children in selected districts. This initiative is now set to benefit around 500,000 children across 12 districts. Evidence from implementation shows that regular provision of nutritious morning meals, including fortified rice, has significantly improved attendance (from about 60–70% to 85–95% in some settings) and classroom engagement, making the National School Meal Programme central not only to nutrition but also to education outcomes (World Food Programme n.d.-c; GCNF 2024; MoE n.d.).

The Thriposha Supplementary Feeding Programme is Sri Lanka's longest-standing specialized nutrition intervention and one of the earliest large-scale supplementary feeding initiatives in Asia. Launched in 1973, the program was introduced to address protein-energy malnutrition and multiple micronutrient deficiencies. Thriposha is a precooked blended food based mainly on maize and soy, with added full-cream milk powder, vitamins, and minerals. It targets pregnant women, lactating mothers, and undernourished young children above six months, as these groups are at the highest biological risk of undernutrition. Now operating under Sri Lanka Thriposha Limited as a government-owned entity, the program benefits over 1 million individuals nationwide, with about 90% of the population reached through the public health system via maternal and child health clinics and peripheral health units. Evaluations show that regular nine month consumption of Thriposha can improve hemoglobin, ferritin, and ceruloplasmin levels, and the program is considered particularly effective in plantation communities where leakage is minimal and children receive their full entitlement (Ministry of Health, Nutrition and Indigenous Medicine 2016).

The universal salt iodization program represents Sri Lanka's flagship food fortification success story, achieving near-universal coverage by mandating iodization of all edible salt. Implemented nationwide in 1995, the program is supported by legislation prohibiting the production and sale of non-iodized salt for human consumption and mandating the fortification of potassium iodate at regulated concentrations at both producer and consumer levels. For over two decades of continuous implementation, national iodine surveys have documented stable, adequate iodine status in the population and a sharp decline in goiter prevalence among children aged 6–12 years, from 18% in 2000 to 1.9% in 2016. Household coverage with adequately iodized salt has exceeded 95% since 2005 (IGN 2023). The program is supported by an established monitoring system in which public health inspectors conduct field checks using rapid test kits, while five designated laboratories perform quantitative titration-based iodine testing, ensuring the quality and sustainability of iodine delivery even as the country pursues broader salt reduction objectives.

Building on its salt iodization experience, Sri Lanka has recently expanded its mandatory food fortification agenda through wheat flour fortification regulations. The 2022 Food (Refined Wheat Flour Fortification) Regulations require all refined wheat flour intended for retail sale and bread manufacturing to be fortified with iron and folic acid, with enforcement commencing on January 1, 2024. This reform directly responds to persistent iron deficiency and anemia, especially among WRA and children. Given that wheat flour is consumed more regularly in the estate sector where micronutrient deficiencies are comparatively higher, the fortification strategy is likely to have a proportionately greater impact on nutritionally vulnerable populations; moreover, with only two large-scale wheat flour mills operating in the country, regulatory oversight, monitoring, and quality assurance can be implemented efficiently and effectively. Major wheat millers already possess the technical capacity to blend premix and have prior experience with fortified flour products, such as "Adhi Posha flour". Nonetheless, implementation will need to carefully manage cost implications and

potential effects on product characteristics to secure both compliance and consumer acceptability. If effectively enforced, fortified wheat flour has the potential to provide a sustained source of critical micronutrients to a broad segment of the population that regularly consumes wheat-based foods (USDA 2023).

The Samurdhi Program indirectly anchors the nutrition agenda within Sri Lanka's broader poverty alleviation architecture. Launched in 1994, it reaches roughly one-third of the population, including more than 1.8 million poor families, and provides special categories for broader social protection support through the Aswesuma Welfare Benefit Scheme, credit services via Samurdhi banks, and community infrastructure and workfare schemes. While its primary mandate is alleviating income poverty, Samurdhi also plays an important role in protecting household food consumption and dietary quality, particularly during economic shocks. Recent evidence from the 2022–23 economic crisis period shows that when Samurdhi cash transfers (e.g., LKR 22,500 per household) are combined with mobile phone-based nutrition education via WhatsApp and SMS, beneficiaries demonstrate improved dietary diversity and food security. This positions Samurdhi as a strategic platform for delivering nutrition-sensitive social protection at scale (CPI n.d.). The Sri Lankan government introduced the Aswesuma Welfare Benefit Scheme as a successor to the Samurdhi Programme, the primary social welfare initiative aimed at poverty alleviation since its inception in 1995. Despite its widespread reach, the Samurdhi Programme faced criticism over the years for political influence, inefficiency, poor targeting, and an inability to effectively lift beneficiaries out of poverty. The need for a more streamlined and effective welfare program led to the development of the Aswesuma Scheme, which aims to rectify the shortcomings of its predecessor by providing more targeted financial assistance to vulnerable populations. The Aswesuma Welfare Benefit Scheme is designed with specific eligibility criteria to ensure that only the most deserving individuals and families receive support. Applicants are assessed based on a combination of socio-economic indicators, including household income, family size, employment status, and other factors that contribute to economic vulnerability.

Complementing these large-scale platforms, Sri Lanka has invested in community-level nutrition and early childhood development initiatives that focus on the critical first 1,000 days and pre-school years. Programs such as the Participatory Nutrition Improvement Project work through local structures to strengthen community capacity, promote appropriate infant and young child feeding, and provide supplementary nutrition and health promotion in pre-schools. Government pre-school programs are linked to health facilities to ensure regular growth monitoring, immunization, health check-ups, and caregiver counseling. By embedding nutrition services within existing maternal and child health infrastructure and pre-school settings, these initiatives help reach young children and mothers in their own communities, reinforcing more formal sector programs like Thriposha and the National School Meal Programme (Ministry of Health Sri Lanka 2021).

The Helabojun, a network of restaurants, was introduced around 2012 by the Ministry of Agriculture to promote healthier, locally sourced Sri Lankan traditional foods, support nutrition awareness and dietary change, and empower women through entrepreneurship by creating opportunities to produce and sell indigenous food and beverages made from local agricultural ingredients rather than heavily processed or imported foods (Department of Agriculture Sri Lanka n.d.). More recently, the government has launched an affordable nutrition initiative that leverages the restaurant and foodservice sector to improve access to healthy meals for the wider population. Introduced in March 2025 in collaboration with the National Food Promotion Board (NFPB), the Ministry of Health, and the Ministry of Agriculture, this program encourages participating public and private restaurants to offer

specially designed nutritious meals at prices as low as LKR 200. It also promotes the availability of packaged local food products and healthier snacks at affordable price points. The initiative aims to shift the commercial food environment toward higher nutritional standards, making balanced meals more accessible to low- and middle-income consumers, and to complement targeted safety nets with a more market-based approach to diet improvement.

Taken together, these programs illustrate a multi-layered national response to malnutrition that combines targeted supplementary feeding, staple food fortification, school-based nutrition, poverty-linked cash and in-kind support, community-based services, and food environment interventions. The key strengths lie in their scale (with school meals, Thriposha, universal salt iodization, and Samurdhi all reaching large segments of the population), institutionalization within core government systems, and increasing efforts to integrate fortification into mainstream food channels. At the same time, the report underscores that persistent micronutrient deficiencies, implementation bottlenecks, and monitoring gaps remain, highlighting the need to further strengthen coordination, supply reliability, and impact evaluation across this portfolio of flagship programs.

2.2.6.4 Policy Environment for Food Fortification

The National Nutrition Policy of Sri Lanka 2021-30 provides a comprehensive framework for addressing nutritional challenges and guides food fortification initiatives. The policy aims to achieve and sustain the nutritional well-being of all Sri Lankans by 2030, guided by principles of inclusiveness, the right to safe and nutritious food, a people-centered approach, and evidence-based practices. The strategic framework emphasizes a life-cycle approach, with six priority areas: ensuring food and nutrition security; strengthening multi-sectoral collaboration; establishing legal frameworks for food safety; promoting nutrition across life stages; addressing nutrition in emergencies; and enhancing data-driven decision-making. Expected impacts include reducing stunting to 10%, wasting to below 5%, and micronutrient deficiencies to below 10% by 2030, with food insecurity reduced from 10.3% to 5% (Ministry of Health, Nutrition Division Sri Lanka 2021).

Regulatory frameworks and food safety standards: Under Sri Lanka's food safety regulatory framework, the Ministry of Health is primarily responsible for developing food fortification policies and establishing quality and safety standards. The ministry also oversees monitoring mechanisms to ensure compliance with these standards. Regarding salt iodization, comprehensive legislation mandates specified iodine concentrations, periodically revised based on national survey findings, designates potassium iodate as the exclusive fortificant, and prohibits the production, distribution, and sale of non-iodized salt for human consumption (MRI 2016). In 2022, the Ministry of Health introduced the Food (Refined Wheat Fortification) Regulations, mandating the fortification of refined wheat flour with folic acid and iron, effective January 1, 2024 (Ministry of Health Sri Lanka 2023). However, implementation has faced challenges related to variations in wheat flour extraction rates and cost implications reported by industry stakeholders. Consequently, despite being a legal requirement, the regulation has not yet been fully implemented. Following the successful implementation and evaluation of pilot studies conducted between 2019 and 2020, the cabinet approved the inclusion of fortified rice in school meal programs. The Sri Lanka Standards Institution is mandated to develop commodity-specific standards to ensure quality, safety, and compliance, working collaboratively with the Industrial Technology Institute. This process is undertaken in collaboration with external experts and the Industrial Technology Institute, which provides technical and analytical expertise to support standard formulation and validation (SLSI n.d.).

2.2.6.5 Industry Capacity and Role of Private Players

Local production infrastructure for fortified products: Sri Lanka has developed substantial local infrastructure to support food fortification programs, positioning the country as a potential regional model. Technical assistance from PATH facilitated the establishment of the first FRK manufacturing unit, in collaboration with the WFP, which served as the technical partner, and was launched in March 2024 (NFPB 2024). The Kalankuttiya Rice Processing Unit, located in the North Central Province (dry zone) and established under the NFPB, processes and distributes fortified rice to schools, supporting approximately 109,480 students across the Anuradhapura and Polonnaruwa districts in 2024.

Private sector engagement in wheat flour fortification: The two existing wheat millers possess the technical capacity to implement fortification as required by new regulations, having already produced fortified wheat flour products (Adhi posha specialty wheat flour by Serandib Flour Mills (Pvt) Ltd). Mandatory iron and folic acid fortification may increase production costs and affect product characteristics, posing both technical and commercial challenges that require careful management. Private sector engagement remains essential to scale coverage and ensure the market-based sustainability of fortification initiatives (U.S. Department of Agriculture 2023).

2.2.6.6 Integration with Social Safety Net Programs

Sri Lanka's school meal program represents a significant nutrition intervention, supporting over 1.1 million schoolchildren nationwide. The Ministry of Education identified 1.6 million primary students (Grades 1 5) from 9,134 government schools as potential beneficiaries. The WFP previously operated school meal programs in the Northern Province until 2017, when the government assumed full responsibility, demonstrating commitment to nationally owned interventions (Ministry of Education Sri Lanka 2024).

The fortified rice initiative provides students in vulnerable districts with 75 grams of iron and folic acid-fortified rice daily. In 2024, approximately 232 schools in the Anuradhapura and Polonnaruwa districts participated, benefiting 109,480 students. Following the May 2025 Presidential Secretariat meeting on the school meal and rice fortification program, the school meal program will continue to provide fortified rice to 500,000 school children across 12 districts. Expansion is contingent upon the effective study outcomes and subsequent policy decisions, indicating an evidence-based approach to scale-up. However, irregular supply due to local blending constraints, procurement of rice, the incremental cost of the fortification process, budget allocation among line ministries, and FRK imports have delayed the distribution of fortified rice and its impact assessment, a critical gap in informing evidence-based scale-up decisions.

Other targeted nutrition interventions: The Thriposha Program, launched in 1973 with CARE (Cooperative for Assistance and Relief Everywhere, Inc.) support and nationalized in 2010, stands as one of Asia's earliest large-scale supplementary feeding initiatives. Currently benefiting over 1 million individuals (pregnant women, lactating mothers, infants over six months, and preschool children), Thriposha provides vitamin- and mineral-fortified food supplements with demonstrated health benefits. The impact assessment demonstrated that nine months of consumption improved hemoglobin, ferritin, and ceruloplasmin levels. The program reaches approximately 90% of beneficiaries through the national health system (Hettiarachchi and Liyanage 2010).

Between 2009 and 2012, Sri Lanka implemented a home-based food fortification intervention using dispersible micronutrient powders containing 15 micronutrients, including iron, vitamin A, and zinc, in 12 vulnerable districts. The program demonstrated measurable impact, with anemia prevalence in children aged 6 23 months declining by 11.7% and mean hemoglobin increasing by 0.3 g/dL. Children receiving supplementation showed significantly lower prevalence of iron deficiency anemia (10.1% versus 15.7%) (Medical Research Institute, Sri Lanka 2014). However, coverage was suboptimal at 45.2% of target children, highlighting systemic implementation challenges despite intervention efficacy (UNICEF 2012).

2.2.6.7 Population Reach and Coverage Metrics

The fortified rice initiative reached approximately 109,480 students across 232 schools in the Anuradhapura and Polonnaruwa districts in 2024 and more than 500,000 students across 12 districts in 2025 (WFP 2025). The universal salt iodization program has achieved near-universal coverage through retail salt markets. The Thriposha program benefits over 1 million individuals nationwide, with 90% of beneficiaries accessing it through the national health system (Jayatissa n.d.). Wheat flour fortification, mandated as of January 1, 2024, theoretically extends to all refined wheat flour production, though enforcement and actual market coverage require systematic implementation and monitoring.

Coverage gaps and vulnerable populations: Despite multiple initiatives, significant gaps persist. The estate sector, with 42% of households' food insecure in 2023, requires enhanced targeted programming. Rural areas (77.4% of the population) demonstrate variable coverage with particular gaps in remote districts. The fortified rice program's concentration in 12 districts leaves other vulnerable regions without direct access. WRA, with anemia prevalence of 18.5%, remains particularly vulnerable. The persistence of micronutrient deficiencies-vitamin D deficiency (26.2%), zinc deficiency (15.3%), and suboptimal iodine status (median 93.8 μg/L), suggests that current coverage is insufficient to achieve population-level impact (MRI 2022; World Bank 2021).

2.2.6.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Procurement for Thriposha centers on locally grown maize and soybeans purchased from certified farmer associations at government-supported prices, though limited silo capacity and irregular maize supplies have led to significant production shortfalls. Fortified rice relies on paddy sourced through larger commercial rice mills (typically above 40 tons/day), and FRKs were produced domestically in 2024 as a pilot project, using imported or local micronutrient premix tested in National Accreditation Board for Testing and Calibration Laboratories-accredited laboratories before use.

Thriposha is processed at the Ja-Ela plant located in the Western Province, where maize and soy are cleaned, briefly stored in silos, milled into coarse flour, and blended with micronutrient premixes. The mixture is then extruded into fortified products (Thriposha and Suposha) under defined capacity parameters and strict hygiene protocols (Auditor General's Department, Sri Lanka, 2020). Fortified rice is produced at the NFPB's facility by blending milled rice from commercial mills with FRK at a 1:100 ratio in specialized mixers, followed by batch sampling, laboratory verification of blending uniformity, and packaging to specified technical standards. Within the supply chain, both products are tracked through a digital food fortification quality management system that links procurement (for fortified rice, this is still in process), production, testing, and dispatch for traceability. Storage uses bag storage in shipping containers for raw materials, warehousing with first-in, first-out (FIFO)

rotation for finished products, and pest- and moisture-control measures at central and downstream facilities (including schools) to maintain quality until consumption (National Food Promotion Board 2024).

Thriposha is dispatched from the Ja-Ela factory mainly by rail and lorries (closed trucks) to regional health warehouses and then to maternal and child health clinics and estate health services, where registered pregnant and lactating women and young children receive pre-packed rations during routine visits. Fortified rice flows from the blending facility to provincial and school-level stores and is issued to caterers under the school meal program, while Samurdhi currently uses cash/voucher transfers but is recognized as a potential future channel for in-kind fortified rice distribution once supply chain linkages are formalized (World Food Programme 2022).

The National School Meal Program - Enhancing School Nutrition Initiative (ENSI) serves as the primary channel for distributing rice, reaching 1.6 million primary school students (Grades 1–5) across 9,134 government schools, with a national budget of LKR 16.6 billion (US$50 million) (ReliefWeb 2024). The program operates through four tiers: the Ministry of Education sets policy and budgets; provincial councils transfer funds to zonal offices; zonal educational services officers manage suppliers and oversight; and individual schools handle rice receipt, meal preparation, and service.

Caterers procure rice and other ingredients from local markets based on enrollment and student attendance. Each student receives 75 g (of raw rice) per meal, served five times weekly. Since May 2023, locally produced fortified rice has been piloted, with 735 tons distributed. Schools maintain checklists that track rice receipt, storage (elevation, FIFO, pest control), and cooking practices prescribed by the Ministry of Health through the Ministry of Education (i.e., minimal washing, controlled drainage, mixing cooked rice after cooking). Public health inspectors verify food quality and storage compliance, while a dedicated teacher monitors meal quality and portion sizes through joint tastings. Acceptability research reports 99% student consumption and negligible differences in texture or taste versus non-fortified rice (Agribusiness Centre and WFP 2017).

Quality assurance and laboratory infrastructure: The Industrial Technology Institute operates as an accredited laboratory for testing iron in rice, with folic acid accreditation requiring confirmation. The Sri Lanka Standards Institution testing laboratory can measure iron in rice. The SGS laboratory is accredited to test 300 pesticides in food and agricultural products. The National Institute of Plantation Management in Anuradhapura currently lacks accreditation for measuring iron or folic acid, although it has the testing capacity. The Sri Lanka Standards Institution's Food Testing Laboratory is accredited to ISO/IEC 17025:2017 for tea, milk powder, and edible oils (ITI 2024; ITI n.d.).

Regulatory and standards framework: For salt iodization, comprehensive legislation mandates iodine content at supply chain levels, designates potassium iodate as the sole iodine source, and bans non-iodized salt. For wheat flour, the 2022 regulations mandate folic acid and iron fortification for refined flour intended for retail and bread manufacturing, effective January 1, 2024. For rice fortification, cabinet approval for inclusion in the school meal program was granted in 2019, following acceptability trials and successful pilot studies conducted between 2019 and 2020. The Sri Lanka Standards Institution developed a Specification for Fortified Milled Rice (SLS 1804, 2024) (FAO n.d.). The Standard on Specification for Vitamin and Mineral Premix for Manufacturing Fortified Rice Kernels, as well as the Code of Practice for the Production of Fortified Rice, are expected to be published soon. However, mandatory standards to consolidate fortification regulations across all

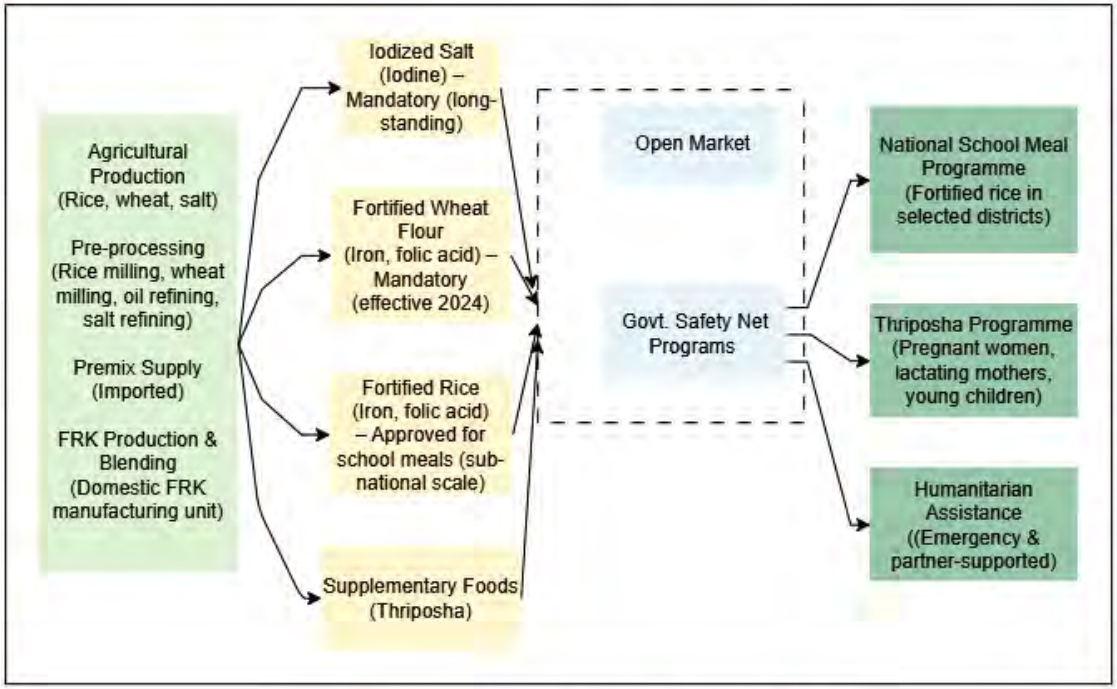
food commodities remain a critical gap that could be addressed by integrating them into a unified fortification law, as implemented in other South Asian countries. The Ministry of Health retains primary policy responsibility, while the Sri Lanka Standards Institution develops commodity-specific standards, highlighting the need for enhanced coordination to ensure consistent implementation (SLSI 2023). Refer to Figure 2.11.

Figure 2.11. Sri Lanka's food fortification ecosystem

Sri Lanka

Nutrition, Diet & Policy Snapshot

- **Anaemia:** ~15% children (6–59 months); ~22% women of reproductive age
- **Micronutrient gaps:** Vitamin D (~26%), zinc (~15%); suboptimal iodine intake persists
- **Dietary pattern:** Rice-dominated diets (~130 kg/capita/year)[2]
- **Fortification policy:** Mandatory salt iodization; mandatory refined wheat flour fortification (iron & folic acid)[3]
- **Rice fortification:** Approved for school meal program; implemented in selected districts
- **Supplementary foods:** Thriposha (fortified blended food) for PLW and young children
- **Delivery platforms:** School meals; maternal & child health system
- **Evidence base:** National Nutrition & Micronutrient Survey (2022)[1]; DHS
- **Policy anchor:** National Nutrition Policy 2021–2030[4]



Government Stewardship & Oversight

Nutrition Policy & Coordination
– Ministry of Health
– Nutrition Division / Family Health Bureau

Standards & Regulation
– Sri Lanka Standards Institution (SLSI)

Food Safety & Enforcement
– Food Control Administration Unit

Education & Program Delivery
– Ministry of Education (school meals)

Regulatory, Program Monitoring, Evaluation & Compliance

– SLSI for standards; MoH for enforcementt
– Piloting of digital system for QA & traceability of fortified rice in school meals
– Limited impact data & testing capacity

Source:

1. NNMS: https://www.mri.gov.lk/wp-content/uploads/2023/05/National-Nutrition-and-Micronutrient-Survey-Sri-Lanka-2022.pdf
2. https://www.cambridge.org/core/journals/public-health-nutrition/article/dietary-intake-and-micronutrient-adequacy-among-adults-in-rural-sri-lanka-findings-from-a-crosssectional-baseline-survey/F0E3B992F25377E8165538DAB9952838
3. SSNPs: https://ffinetwork.org/sri-lanka/
4. NNP: https://nutrition.health.gov.lk/wp-content/uploads/2023/05/NNP-English-book.pdf
5. Thriposha: https://documents1.worldbank.org/curated/en/250481583207938898/pdf/PER-for-Nutrition-in-Sri-Lanka-Assessing-Public-Financing-for-Nutrition-2014-2018.pdf

2.2.6.9 Monitoring and Evaluation Mechanisms

Monitoring infrastructure comprises multiple systems at different levels with varying integration. School meal program monitoring operates through medical officers of health offices and public health inspectors using a standard operating procedure, though systematic documentation remains limited. The universal salt iodization program maintains comprehensive monitoring through the Department of Health with trained inspectors and five laboratory facilities across the country. The Thriposha program monitors through the national health system, with beneficiary tracking. Monitoring for the fortified rice initiative, established through the WFP PATH partnership in 2024, includes quality testing protocols at production and distribution, but field-level monitoring and impact assessment remain nascent.

Evidence gaps and impact evaluation needs: Significant evidence gaps exist regarding the actual impact of fortification initiatives on micronutrient status and health outcomes. The fortified rice initiative, despite reaching 109,480 students, lacks a comprehensive impact evaluation, creating a critical knowledge gap that prevents informed decisions on expansion. The Thriposha program demonstrates health impacts, yet comprehensive population-level assessment and cost-effectiveness analysis remain limited (Hettiarachchi and Liyanage 2010). Wheat flour fortification, newly mandated in 2022, lacks baseline data and evaluation timelines for assessing population-level impact. The effectiveness study announced following the May 2025 Presidential Secretariat meeting will help address this gap.

Data systems and coordination: The national nutrition surveillance system requires strengthening to enable systematic monitoring of micronutrient status. The 2022 National Nutrition and Micronutrient Survey provides a comprehensive baseline, but subsequent surveys are not yet scheduled or funded. Coordination mechanisms between programs operating under different ministries (Health, Education, Agriculture) and development partners (WFP, PATH, UNICEF, FAO) require systematization to ensure data sharing and integrated assessment of effectiveness. Digital quality assurance/quality control systems implemented through NFPB for fortified rice monitoring represent important progress, yet integration into centralized national databases remains incomplete.

2.2.6.10 Stakeholder Ecosystem and Partnerships

Food fortification implementation involves multiple stakeholder groups requiring coordinated action. The Ministry of Health serves as the primary regulatory authority for policy development and quality monitoring. The nutrition division functions as a coordination focal point. The Ministry of Education implements school-level nutrition programs, including school meals and the distribution of fortified rice. The Ministry of Agriculture oversees food supply chain activities, particularly rice production. The Ministry of Trade, Commerce and Food Security helps develop import and domestic production capacity. The Presidential Secretariat's May 2025 meeting on school meal and rice fortification programs indicates high-level political engagement with nutrition priorities.

Development partners and technical support: The FAO provides technical assistance on fortification practices. The WFP provides financial support for school meals and serves as a technical partner for rice fortification launched in March 2024. UNICEF supported nutrition programming, including micronutrient fortification initiatives. PATH provides critical technical support for rice kernel production, quality assurance protocols, and digital quality-monitoring systems, serving as a key technology-transfer partner for sustainable local capacity development. Development partner strategy integration and government coordination require strengthening to avoid duplication.

Community-based organizations and the private sector: Community-based organizations and parents contribute to nutrition programs in some schools, though comprehensive data is not systematically collected. Private sector involvement includes wheat flour millers implementing iron and folic acid fortification, and salt manufacturers providing iodized salt through commercial markets. In addition, public-private ventures such as the Plantation Human Development Trust have partnered with wheat flour millers to produce and distribute fortified products to target groups. While a government entity, the Sri Lanka Standards Institution develops commodity-specific standards and conducts laboratory testing. The Industrial Technology Institute supports fortification capacity through laboratory services and technical consultation. Multiple private-sector actors alongside government agencies require coordination mechanisms to ensure consistent quality and compliance monitoring.

2.2.6.11 Critical Challenges and Policy Reforms Needed

Persistent micronutrient deficiencies and coverage gaps: Despite decades of intervention efforts, micronutrient deficiencies persist at concerning levels in the country. The 2022 survey suggests current coverage is insufficient, reach is inequitable across regions and demographics, and individual program effectiveness requires examination. The 2022 economic crisis exacerbated vulnerabilities, with food insecurity rising to 24% of households in 2023, indicating that broader food security challenges constrain the effectiveness of fortification. The estate sector's 42% food insecurity rate suggests social safety net programs may not adequately target vulnerable populations.

Monitoring, evaluation, and evidence gaps: The monitoring and evaluation infrastructure requires significant strengthening to support systematic assessment of program effectiveness. The fortified rice initiative lacks a timely, comprehensive impact evaluation despite reaching 600,000 students. The Multiple Micronutrient Supplementation Programme demonstrated positive outcomes (11.7% anemia reduction) yet was discontinued without formally documented lessons learned (UNICEF 2012). Laboratory infrastructure shows critical gaps in accreditation for folic acid testing (the Industrial Technology Institute and the Sri Lanka Standards Institution) and lacks the capacity to measure multiple micronutrients simultaneously. The national surveillance system lacks scheduled follow-up surveys following the 2022 baseline. Data collection systems remain fragmented across programs with limited systematic integration.

Implementation challenges and systems constraints: Implementation challenges have constrained program effectiveness and reach. The fortified rice initiative faced irregular supply, preventing systematic impact evaluation. The Multiple Micronutrient Supplementation Programme achieved only 45.2% target coverage. The 2022 economic crisis created profound challenges, with financial constraints limiting government budgets, workforce shortages reducing capacity, and skilled professional emigration diminishing expertise. Infrastructure and access remain uneven, particularly in rural areas. The growing NCD burden has shifted the health system's focus, while challenging health promotion strategies and slow digital adoption constrain effectiveness. Governance issues, significant climate change impacts, and public health threats compound difficulties.

Policy and regulatory gaps: The regulatory environment demonstrates commodity-specific fragmentation, with comprehensive frameworks for salt and emerging wheat regulations, but limited formal rice fortification regulations and absent consolidated policies across staple commodities. Delays in regulations for formal fortified rice, despite cabinet approval and the demonstrated feasibility of FRK production, limit the legal basis for mandatory expansion. The mandatory wheat

flour fortification regulation, effective in January 2024, was implemented without adequate consultation with the industrial sector. This limited the practical feasibility of enforcing compliance as a mandatory requirement and was undertaken without a prior impact assessment; coordination mechanisms across sectors and ministries require strengthening through formal structures. Political commitment, while demonstrated through ministerial meetings, needs to translate into sustained financial allocation. Private sector engagement requires strengthened enforcement mechanisms to ensure compliance and prevent quality degradation.

2.2.6.12 Opportunities and Future Directions

The universal salt iodization program represents Sri Lanka's most successful large-scale initiative, reducing goiter prevalence from 18.6% to 2.1% by 2016, with nearly two decades of sustained implementation. Lessons from this success, including regulatory frameworks, monitoring mechanisms, and public-private partnerships, can be applied to other commodities. Local production capacity for fortified rice kernels through the PATH partnership demonstrates that Sri Lanka possesses the technical foundation for sustainable domestic production. The Industrial Technology Institute's iron-in-rice accreditation, combined with strengthening emerging laboratory capacity, provides a foundation for expanding quality assurance. Thriposha's sustained operation, with demonstrated health impacts and over 1 million beneficiaries, indicates strong government commitment. Integration of fortified rice into existing school meal programs serving 1.1 million students demonstrates the leveraging of established safety-net platforms.

Expanding fortification to additional commodities and populations: Strategic expansion into additional staple commodities, particularly edible oils and potentially milk and sugar, could enhance coverage across diverse populations. Oil fortification with vitamins A and D could address substantial vitamin D deficiency affecting 26.2% of children. Sugar fortification could reach populations with consistent consumption, though consumption patterns data would be needed. The newly mandated wheat flour fortification (effective January 2024) creates an opportunity to systematically monitor compliance and population impact, generating evidence on the effectiveness of mandatory fortification in the Sri Lankan context. A feasibility assessment of milk fortification consumption patterns, infrastructure, and costs could determine viability for scaling beyond school meal components. Geographic expansion of the fortified rice school meal program from Anuradhapura and Polonnaruwa districts to other nutritionally vulnerable districts (particularly the estate sector, with high food insecurity) is a strategic priority, contingent on the study's effectiveness. Consideration of voluntary rice fortification expansion to public distribution and social assistance programs beyond school meals could significantly extend reach to vulnerable non-school populations. Furthermore, the double fortification of salt with additional micronutrients, such as zinc, could simultaneously address a significant micronutrient deficiency (approximately 17.0 % at the national level) in Sri Lanka while reducing associated programmatic cost implications.

Strengthening monitoring, evaluation, and evidence systems: The effectiveness study for school meal rice fortification announced following the May 2025 Presidential Secretariat meeting is a critical priority for generating rigorous evidence and informing expansion decisions. This study may assess changes in anemia prevalence, iron deficiency, and folic acid status among participating children, using comparison groups, and document implementation barriers and facilitating factors.

Planning and funding follow-up micronutrient surveys using the 2022 methodology (at three to five year intervals) would enable systematic population-level trend tracking and cumulative program

impact assessment. A national nutrition monitoring dashboard integrating multiple programs and surveillance systems would enable evidence-based management and help identify emerging challenges. Research partnerships with academic institutions and development partners for rigorous program cost-effectiveness evaluations and population health impact assessments would generate evidence to support investment decisions and adaptive management.

Digital innovation and technology application: Digital quality assurance/quality control systems for fortified rice established through the NFPB and PATH partnership in 2024 represent an opportunity to scale to other commodities and programs. Blockchain technology and traceability systems could improve monitoring of fortified product integrity throughout supply chains. Digital platforms for nutritional surveillance and real-time program coverage, compliance, and outcomes would enable rapid responses. Mobile technology for community engagement and behavior change communication on fortified foods could enhance consumer awareness. Geographic information systems mapping of "nutrition gaps" where fortification coverage is insufficient could guide resource allocation. Integrating climate data with nutrition monitoring to prepare for the impacts of climate variability represents an emerging opportunity given Sri Lanka's geographic vulnerability.

Multi-sectoral coordination and institutional strengthening: Formalizing multisectoral coordination mechanisms, including inter-ministerial committees with defined roles and accountability, would strengthen policy coherence and implementation effectiveness across the Health, Education, Agriculture, and Commerce sectors. Integration of fortification and nutrition objectives into agricultural policies to incentivize nutrient-dense crop production would address the underlying causes of micronutrient malnutrition, alongside fortification.

Development of a comprehensive fortification law consolidating commodity-specific regulations into an integrated policy would clarify the legal basis for staple food fortification and establish standardized quality requirements. Strengthening the Sri Lanka Standards Institution’s capacity and institutional funding for standards development and laboratory accreditation would support the needed quality assurance infrastructure. Capacity-building investment for regulatory inspectors and public health personnel at the central and district levels would enhance monitoring, compliance, and enforcement.

International collaboration and knowledge sharing: Sri Lanka's development of local FRK production capacity positions the country as a potential regional leader and knowledge-sharing partner with other South and Southeast Asian countries pursuing fortification scale-up. Documenting and sharing lessons from the salt iodization program, Thriposha’s long-term implementation experience, and recent rice fortification pilots could provide valuable evidence and practical guidance for countries at earlier stages of development. Participation in regional nutrition forums and the South Asian Association for Regional Cooperation nutrition initiative could enhance knowledge exchange on fortification best practices.

Continued engagement with international agencies (FAO, WFP, PATH) for technical support while building local expertise represents a balanced, sustainable approach to program strengthening. Sri Lanka's potential to serve as a regional training center for fortified rice kernel production and quality assurance could generate revenue while supporting regional capacity development. Collaboration with academic institutions as centers of excellence in Sri Lanka and internationally to conduct rigorous research on fortification effectiveness, compatibility of fortificants with local food materials, acceptability, and sustainability would generate evidence while building research capacity and creating employment for Sri Lankan scientists and researchers focused on nutrition.

2.2.7 Vietnam

2.2.7.1 Nutrition and Fortification Ecosystem

Vietnam's food fortification landscape reflects a critical intersection of public health policy, nutrition science, and implementation challenges as it transitions to a market economy. Over 100 million people in Vietnam face complex malnutrition burdens, including undernutrition, micronutrient deficiencies, and rising obesity. The country has established comprehensive mandatory fortification frameworks but faces significant implementation barriers (OECD 2024).

Geographically diverse, Vietnam spans 331,210 km2, with the Red River Delta (15,000 km^2) and Mekong Delta (40,000 km^2) forming primary agricultural zones that support intensive rice cultivation. Mountainous regions comprise 40% of the land area, creating distinct challenges for food security and nutrition programming. Vietnam's population, estimated at 101.6 million in 2025, comprises 54 ethnic groups, with the Kinh majority at 85.7% (Worldometers n.d.).

Demographic transition significantly influences nutrition programming. The median age increased from 22.7 years (2000) to 33.4 years (2025), while the urban population grew from 25.4% to 41.4% (United Nations, Department of Economic and Social Affairs, Population Division 2024), reshaping dietary patterns and food system dynamics. This transition has contributed to a dual burden of malnutrition, with persistent undernutrition in certain populations alongside emerging obesity in urban areas.

Vietnam's market economy transition has reshaped food systems through sophisticated food processing industries capable of fortification, particularly among large-scale producers. However, diverse informal and small-scale sectors create implementation complexity, requiring coordinated strategies spanning formal and informal food systems while addressing urban-rural disparities.

2.2.7.2 Nutritional Status and Dietary Practices

According to the Global Nutrition Report, Vietnam is classified as "off course" for achieving maternal, infant, and young child nutrition targets. Child stunting decreased from 29.3% (2010) to 19.6% (2020), representing progress while remaining a significant public health concern. Wasting affects 5.2% of children under five years old (lower than the Asian regional average of 8.9%), but overweight prevalence has risen to 7.4% (Global Nutrition Report n.d.). This dual burden reflects the nutrition transition accompanying economic development.

Micronutrient deficiencies represent major public health challenges, justifying fortification interventions. Anemia affects 20.6% of WRA (25.6% of pregnant women and 16.2% of nonpregnant women) and 19.6% of children under five years old. Vitamin A and zinc deficiencies remain significant, with substantial consequences for child development, immune function, and reproductive health (Global Nutrition Report n.d.).

Complementary feeding practices in rural Ben Tre Province revealed gaps: only 71.5% of children aged 6-23 months met the minimum dietary diversity criterion, and 40.8% achieved the minimum meal frequency threshold. Factors associated with poor dietary practices included younger child age, household food insecurity, lack of access to treated drinking water, lower income, and inadequate breastfeeding (Nguyen et al. 2020). Urban areas show markedly different patterns. Consumption of ultra-processed foods and sugar-sweetened beverages has increased substantially, with sugary drinks identified as a critical risk factor for overweight and obesity.

2.2.7.3 Nutrition-related Flagship Program

National School Meal Program: Vietnam's National School Meal Program is the country's largest direct nutrition intervention, covering all kindergartens and about 90% of primary schools. Providing five meals per week during the academic year, it subsidizes VND 10,000–12,000 per child daily in disadvantaged areas to ensure equitable access. Menus provide approximately 30% of daily nutrient needs and have a balanced macronutrient composition in line with Ministry of Health guidelines. By 2022, the program had reached 4.2 million students across 62 provinces, supported by the Ajinomoto School Meal Project digital menu tools and Hazard Analysis and Critical Control Point (HACCP)-certified kitchens. Key challenges include limited training for dietitians and rural-urban disparities in implementation quality (GCNF 2020).

National Nutrition Strategy 2021–30 (Vision 2045): Approved in 2022, the National Nutrition Strategy 2021–30 defines equitable access to nutrition as a fundamental right and sets measurable targets, such as ensuring that 80% of young children receive appropriate diets and reducing anemia in pregnant women to below 23% by 2030. It has adopted a multisectoral approach that integrates fortification, dietary diversity, water, sanitation and hygiene (WASH), and infection control, with targeted action for ethnic minorities and high-burden regions. Alignment with the Scaling Up Nutrition movement and ASEAN frameworks has ensured international accountability and knowledge exchange (Government of Viet Nam 2022).

Government Decree 09/2016 (mandatory food fortification): Decree 09/2016 mandates iodine fortification of salt, and the fortification of wheat flour and vegetable oil with iron, zinc, and vitamin A. Despite clear implementation timelines and high economic returns, enforcement has been challenging because ministerial accountability and coordination remain unclear. As of 2021, progress remained limited, leaving rice the main dietary staple at 135 kg/capita annually, outside mandatory fortification. This represents a missed opportunity for achieving large-scale micronutrient impact.

Social safety net and food security programs: Vietnam's social protection framework integrates cash and food transfers, midday meals, and nutrition-sensitive agriculture to support vulnerable populations, particularly children and women. These programs strengthen both food availability on the supply side and household purchasing power, ensuring access to fortified foods and diverse diets. Efforts prioritize disadvantaged and ethnic minority regions through capacity-building initiatives supported by international partnerships (World Bank 2019).

Zero Hunger program: Launched in 2015, Vietnam's Zero Hunger initiative coordinates across sectors to achieve national food and nutrition security. It promotes resilient agriculture, livelihood diversification, and market linkages for smallholders, thereby improving household access to nutritious food. The program aligns with national sustainable development and food security objectives, forming the backbone of the country's long-term efforts to end hunger and malnutrition (United Nations Viet Nam 2018).

Micronutrient supplementation and essential nutrition actions: Vietnam has expanded from iron-folic acid programs to multi-micronutrient supplementation for women and young children, as well as deworming and treatment for severe acute malnutrition. These interventions form part of essential nutrition actions delivered through a strengthened health system and community health workforce. Capacity-building for health professionals will ensure consistent, evidence-based service delivery across all life stages.

Scaling Up Nutrition movement partnership: As a Scaling Up Nutrition movement member since 2014, Vietnam benefits from global expertise and coordinated technical support from partners such as GAIN, WHO, UNICEF, and PATH. The platform aims to strengthen national leadership, foster the adoption of best practices, and enhance accountability for nutrition targets, thereby positioning the country as both a beneficiary and potential knowledge contributor within the global nutrition community.

Rice fortification (highest-impact opportunity): Given rice's near-universal consumption in the country, fortifying it offers Vietnam the greatest potential for improving population micronutrient status. Although not yet mandated under Decree 09/2016, pilot projects have demonstrated technical feasibility and consumer acceptance. Scaling up mandatory rice fortification, especially through school meals and social safety net programs, could achieve widespread, equitable gains in nutrition across all income groups.

2.2.7.4 Policy Environment for Food Fortification

Vietnam articulates its commitment to addressing nutrition challenges through comprehensive policy frameworks. The National Nutrition Strategy 2021-30 (Prime Ministerial Decision 02QD-TTg, dated January 5, 2022) establishes the right of everyone to equitable access to nutrition and assigns the state responsibility for improving nutrition. Strategy targets include increasing the proportion of children aged 6-23 months receiving an appropriate diet to 65% (2025) and 80% (2030), and reducing household food insecurity to below 8% (and to below 25% in mountainous areas) by 2025 (Ministry of Health Viet Nam 2022).

Government Decree 09/2016/ND-CP mandated the fortification of salt with iodine, wheat flour with iron and zinc, and vegetable oils with vitamin A, with implementation timelines of March 2017 (salt) and March 2018 (flour and oils) (USDA 2016). However, WHO and UNICEF noted in December 2021 that the decree remained unimplemented more than five years after adoption. Vietnam's membership in the Scaling Up Nutrition Movement (since 2014), the Zero Hunger program (2015), and its commitment to the ASEAN Leaders' Declaration on Ending All Forms of Malnutrition (2017) provide additional accountability frameworks. Prior to mandatory fortification, Vietnam permitted voluntary fortification since 2003, with limited market uptake. International evidence shows that voluntary fortification typically fails to benefit the majority of the population, supporting Vietnam's mandatory approach to ensure equitable access to fortified foods.

2.2.7.5 Industry Capacity and Role of Private Players

Vietnam's private-sector food industry demonstrates considerable capacity to implement fortification among large-scale producers, with internal expertise and quality assurance capabilities. A four-year GAIN project engaged 12 producers manufacturing fortified soy sauce, fish sauce, vegetable oil, and flavoring powders with iron, vitamin A, and zinc. The project reached approximately 20 million consumers, with 43% having heard of fortified foods, though only 39% preferred purchasing fortified products. This demonstrated that mandatory fortification creates a level playing field, ensuring that poor and wealthy consumers alike have access to fortified foods (GAIN 2019).

However, challenges persist for smaller producers. Nearly half of Vietnam's rice is milled by small household operations, complicating the implementation of a centralized fortification program. Smaller enterprises often lack the technical expertise, resources, and capital to implement fortification, requiring targeted technical assistance and support. Vietnam's dependence on imports for fortificants and premixes creates supply vulnerabilities.

2.2.7.6 Integration with Social Safety Net Programs

Vietnam's National School Meal Program, coordinated by the Ministry of Education and Training, the Ministry of Health, and the National Institute of Nutrition, achieves near-universal coverage: 100% of kindergartens and approximately 90% of elementary schools. Students receive five meals weekly during the nine-month academic year, with most schools operating in-house kitchens. Government subsidies of VND 10,000-12,000 (approximately US$ 0.40-0.50) per student per day ensure access in disadvantaged regions (Ministry of Education and Training and National Institute of Nutrition 2022).

Menus provide approximately 30% of the daily recommended dietary allowances with balanced macronutrient proportions: 64% carbohydrates, 18% protein, and 18% fat. Recent innovations,

including the Ajinomoto School Meal Project (active since 2012), have introduced digital menu-planning tools in 62 of 63 provinces, HACCP-compliant model kitchens, and nutrition education reaching 4.2 million students. These improvements have enhanced the quality and reach of school meals, particularly in urban areas.

Integrating fortified foods with social safety net programs creates multiplier effects for population nutrition. School feeding platforms offer ideal opportunities to incorporate fortified staples alongside nutrition education, while prioritizing access to fortified foods among vulnerable populations to ensure that disadvantaged groups benefit from fortification initiatives.

2.2.7.7 Population Reach and Coverage Metrics

With a population of 101.6 million, Vietnam represents a substantial fortification target, though reaching this population effectively requires differentiated approaches shaped by significant rural-urban and demographic divides. While 41.4% of the population resides in urban areas, the majority (58.6%) resides in rural areas, where access to fortified, processed foods is typically more limited (General Statistics Office 2024). This divide is further compounded by ethnic disparities: undernutrition remains disproportionately concentrated among ethnic minority populations, who account for approximately 14.7% of the national population and are primarily located in mountainous and remote areas with correspondingly poorer access to nutritious diets and health services (General Statistics Office 2019; UNICEF 2021). Given these overlapping geographic and demographic barriers, rice, as the country's primary staple food and most widely consumed item across both urban and rural populations, emerges as a particularly important vehicle for LSFF. Currently, rice fortification remains at a pilot stage without a mandatory policy, with limited voluntary projects supported by international agencies.

Salt and wheat flour intakes primarily derive from processed foods and meals outside the home, suggesting that mandatory fortification particularly benefits urban populations, while rural areas require targeted interventions.

2.2.7.8 Value Chain, Quality Assurance, and Regulatory Frameworks

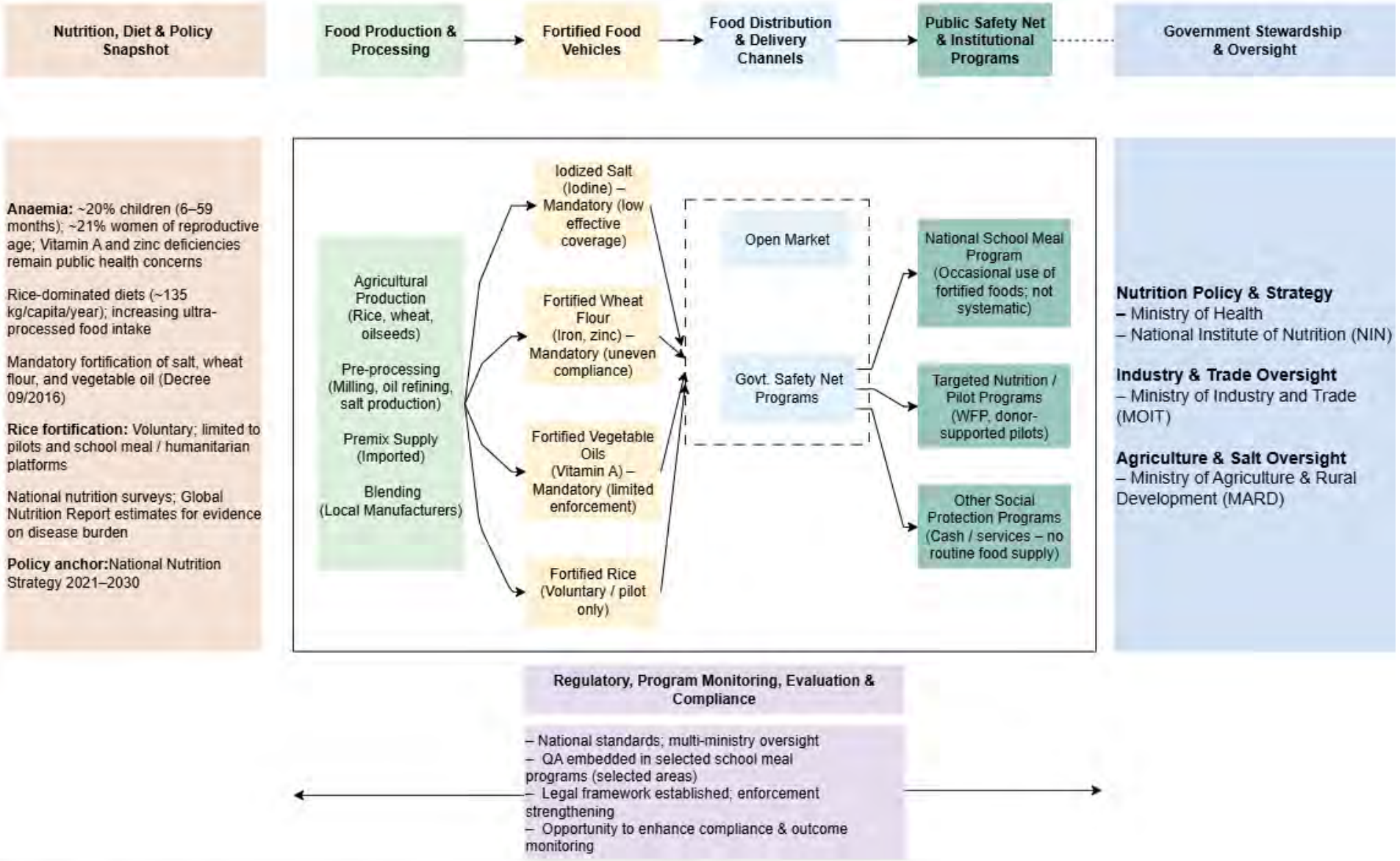
Vietnam's diverse value chains, spanning large-scale formal producers to informal small-scale operations, create implementation complexity for mandatory fortification. The regulatory framework distributes responsibility across multiple ministries: the Ministry of Industry and Trade manages wheat flour and vegetable oil imports, while the Ministry of Agriculture and Rural Development oversees salt fortification (USDA 2016). This multi-ministry coordination has created implementation gaps and unclear accountability mechanisms.

Quality assurance systems require systematic strengthening. While laboratory infrastructure exists for food and micronutrient testing, comprehensive, accredited laboratory mapping and capacity assessments are still needed. The National Institute of Nutrition plays a central role in fortification research and program guidance. Current monitoring approaches primarily focus on process indicators rather than population micronutrient status outcomes. The Global Nutrition Report indicates Vietnam has made no progress in reducing anemia among WRA, suggesting existing fortification interventions may not achieve the desired population-level impact.

International organizations such as WHO, UNICEF, and GAIN have provided technical guidance on fortification standards (World Health Organization 2022; Nguyen et al. 2016). However, Vietnam's dependence on imported fortificants and premixes creates sustainability concerns; developing a domestic supply chain would strengthen program viability. Refer to Figure 2.12.

Figure 2.12. Vietnam's food fortification ecosystem

Vietnam



Source:
1. Global Nutrition Report. https://globalnutritionreport.org/resources/nutrition-profiles/asia/south-eastern-asia/viet-nam/

2.2.7.9 Monitoring and Evaluation Mechanisms

Systematic monitoring and evaluation frameworks represent critical gaps in Vietnam's fortification implementation landscape. Current approaches emphasize process indicators (such as the number of producers implementing fortification) rather than outcome measures of population micronutrient status. While process monitoring provides accountability, outcome-focused evaluation is essential to determine whether fortification achieves its intended nutritional impact.

The National Institute of Nutrition conducts central research and program development, yet systematic national monitoring and evaluation frameworks require strengthening and institutionalization. The Global Nutrition Report's periodic assessments reveal stagnation in anemia reduction targets despite existing fortification policies, indicating that monitoring systems require enhancement to identify implementation barriers.

Micronutrient testing infrastructure is already in place; however, standardized fortification-specific protocols and enhanced rapid testing capabilities are needed. Digital systems offer promising opportunities for real-time quality assurance and traceability, helping monitor fortification efforts while reducing costs. Population-based nutrition surveys could incorporate monitoring of fortification-specific consumption across demographic groups, with periodic biomarker surveys measuring micronutrient status (hemoglobin, vitamin A, zinc) to evaluate population-level impact.

2.2.7.10 Stakeholder Ecosystem and Partnerships

Vietnam's fortification ecosystem encompasses diverse stakeholders with complementary roles. Government ministries Health, Industry and Trade, Agriculture and Rural Development, and Education and Training form the regulatory core, supported by the National Institute of Nutrition as the technical center. International technical partners play essential roles: GAIN has engaged with industry on voluntary initiatives, while WHO and UNICEF provide technical guidance and document enforcement gaps.

The private sector is a critical implementation partner, particularly for large-scale producers of salt, wheat flour, and vegetable oils. Industry engagement is most effective when regulatory mandates establish clear expectations and level-playing-field conditions. Civil society organizations support fortification through consumer education, implementation monitoring, and policy enforcement advocacy, serving as intermediaries between government, industry, and consumers. Academic institutions contribute essential evidence generation for policy refinement through effectiveness evaluations and barrier identification.

2.2.7.11 Critical Challenges and Policy Reforms Needed

Vietnam's fortification program faces significant barriers despite strong regulatory frameworks. Enforcement mechanisms remain challenging: Decree 09/2016 established clear timelines (March 2017 for salt, March 2018 for flour and oils), yet implementation fell short of systematic enforcement (WHO 2021). This reflects insufficient allocation of enforcement resources, limited inter-ministerial coordination, and the absence of consequences for noncompliance.

The multi-ministry regulatory authority has created ambiguity regarding accountability and inconsistent enforcement approaches. Establishing clear inter-ministerial coordination mechanisms, unified enforcement protocols, and accountability structures is essential.

Consumer-side barriers present a further constraint: limited awareness of fortified foods and their benefits continues to restrict demand, particularly outside urban centers. This underscores the rationale for mandatory fortification over reliance on voluntary consumer choice, since mandatory approaches ensure universal access regardless of individual awareness or purchasing preferences.

Industry compliance challenges, particularly for smaller producers lacking technical expertise or capital, require targeted technical assistance and support. Quality assurance and monitoring systems need substantial strengthening through expanded laboratory capacity, standardized protocols, and rapid product testing mechanisms. Raw material and fortification input availability create supply-side vulnerability; building domestic fortification supply capacity and developing regional ASEAN networks would enhance sustainability.

2.2.7.12 Opportunities and Future Directions

Vietnam possesses significant advantages for successful fortification scale-up. Strong policy frameworks exist through Decree 09/2016 and the National Nutrition Strategy 2021-2030, with technical quality and international alignment. Industry capacity exists among large producers, and international technical support is available through GAIN, WHO, and UNICEF. Evidence demonstrates that every dollar spent on salt iodization and flour fortification generates returns exceeding US$10, with benefits extending to cognitive development, reduced disease burden, and productivity gains (Silva et al. 2021; Wu et al. 2021).

Vietnam's middle-income status and a growing food-processing sector create favorable conditions for expansion. Regional learning opportunities exist through ASEAN cooperation and South-South knowledge exchange with Thailand, Indonesia, and the Philippines. Digital technologies offer transformative opportunities for monitoring and quality assurance: blockchain and QR code systems enable real-time, fortified product identification and micronutrient content tracking; digital platforms centralize compliance data; mobile applications enhance consumer education.

Rice fortification represents the highest-impact opportunity for population-level micronutrient improvement given its dominance in dietary intake across all population segments. Mandatory rice fortification with attention to small-scale milling operations would leverage the highest-consumption commodity for maximum impact. School feeding programs offer an ideal platform for incorporating fortified staples alongside nutrition education, with existing near-universal coverage (90% elementary, 100% kindergarten) (Ministry of Education and Training and National Institute of Nutrition 2022).

Social safety-net expansion prioritizing access to fortified foods among vulnerable populations ensures disadvantaged groups benefit, potentially by extending access through commercial markets. The National Nutrition Strategy 2021-30 provides comprehensive frameworks for integrating fortification with broader nutrition interventions, dietary diversity promotion, water and sanitation improvements, and infectious disease control, recognizing fortification's complementary rather than substitutive role in comprehensive nutrition-sensitive development.

2.3 Latin America

Latin America presents a mixed fortification landscape, with countries such as Argentina and Brazil showing relatively strong policy and industry capacity but persistent challenges in enforcement, equity, and coverage. While Argentina has established mandatory wheat flour fortification and Brazil has a mature regulatory and school feeding platform, both countries continue to face the double burden of micronutrient deficiencies alongside rising overweight and obesity. At the regional level, these experiences highlight the importance of integrating mandatory fortification with strong monitoring systems, social protection, and behavior change support to reach vulnerable populations effectively. In Costa Rica and Guatemala, the nutrition challenges are more divergent. Costa Rica shows relatively low levels of micronutrient deficiencies, reflecting the success of its long-standing fortification policies. However, rising rates of obesity and NCDs suggest a double burden of malnutrition. In contrast, Guatemala continues to struggle with high rates of stunting (47%) and considerable micronutrient deficiencies, especially among children. The country's predominantly maize-based diet, with increasing rice consumption in urban areas, suggests a dual approach: sustaining maize-based interventions while exploring the fortification of rice and wheat flour. Guatemala's situation clearly justifies integrated nutrition-sensitive strategies, including fortification, dietary diversification, and social safety nets.

2.3.1 Argentina

2.3.1.1 Nutrition and Fortification Ecosystem

As a country with significant agricultural output and a growing economy, Argentina nonetheless continues to grapple with micronutrient deficiencies, making it a notable example within Latin America's evolving nutrition landscape. The country's geopolitical positioning as the world's third-largest net food exporter, accounting for 15.7% of global food exports, stands in stark contrast to the internal food security challenges affecting significant segments of its population. With a land area of approximately 2.78 million km2, Argentina is the second-largest country in South America and the eighth globally, comprising four geopolitically distinct regions: the Pampas (agricultural heartland), the Andes, the North (Northeast and Northwest), and Patagonia. Each region exhibits markedly different socioeconomic, climatic, and nutritional profiles that fundamentally shape the design and implementation of the food fortification program (USDA 2025).

The country's population of approximately 43.6 million inhabitants is predominantly urban (over 90% urbanization) (The Rio Times 2025), which typically facilitates the reach of mass fortification programs through industrial food supply chains. However, Argentina's fortification ecosystem must navigate a complex macroeconomic environment characterized by persistent inflation, currency volatility, and fluctuations in poverty. As of June 2024, poverty affected 52.9% of the population, nearly doubling from 27.5% in 2019, with extreme poverty (defined as the inability to meet basic food requirements) affecting 18.1% of the population (HRW 2025). Recent economic stabilization efforts in

the first half of 2025 have shown some improvement, with urban poverty declining to 31.6% and extreme poverty declining to 6.9%, though child poverty remains alarmingly high at 45.4% among children under 14 years old (Instituto Nacional de Estadística y Censos 2025).

2.3.1.2 Nutritional Status and Dietary Practices

Argentina exhibits a complex dual burden of malnutrition, reflecting broader dynamics of the nutrition transition. According to the 2024 FAO State of Food Security and Nutrition in the World report, the prevalence of undernourishment stands at 3.2% (2021-23), while severe food insecurity affects 13.1% of the population (2021-23). Child malnutrition remains a pressing concern, with stunting affecting 9.5% of children under five years old (2022), wasting affecting 1.7% (2022), and overweight present in 12.6% of children (2022). In the adult population, obesity prevalence has reached 35.4% among those aged 18 and older (2022), indicating a pronounced nutrition transition toward diet-related NCDs (FAO 2024).

Anemia in WRA (15-49 years) remains a significant public health concern, with a prevalence of 11.9% (2019), though this represents progress toward Argentina's nutrition targets. Critically, low birthweight affects 7.4% of infants (2020) (PAHO 2010) and may have long-term developmental consequences. The Global Hunger Index (2024) data classify Argentina with a score of 6.6, ranking 33rd among 127 countries, reflecting “low hunger” status but with regional variations that indicate substantial pockets of severe food insecurity.

The nutritional challenges are deeply stratified by geography and socioeconomic status. Regional disparities reveal a clear north-south gradient in the burden of malnutrition. The Northeast region, comprising Formosa, Chaco, Corrientes, and Misiones, exhibits the highest malnutrition prevalence, with stunting rates of 11.9% among children. The Northwest region, including Jujuy, Salta, Tucumán, Catamarca, and Santiago del Estero, shows similarly elevated stunting rates of 10.7%. In stark contrast, Patagonian provinces demonstrate significantly lower malnutrition indicators, with stunting at 8.9%, reflecting higher levels of socioeconomic development and infrastructure. Jujuy Province, in particular, exhibits regional malnutrition rates up to 320% higher than national averages, with wasting in children under five years old reaching three times the national average in specific districts, and stunting being 0.7% higher than the national rate. These disparities stem from structural factors, including geographic isolation, chronic poverty, limited infrastructure, challenging health systems, and recurrent climate-related agricultural challenges (Bejarano et al. 2019).

Dietary patterns vary significantly across regions, with important implications for fortification strategy. The “Southern Cone” or “Western” dietary pattern, prevalent in Buenos Aires and southern regions, emphasizes red meat, wine, starchy vegetables, and refined flours. In contrast, the Andean Northwest maintains traditional dietary patterns rich in tubers, legumes, and herbal infusions (Romaguera et al. 2008), reflecting distinct food preferences that must be considered when selecting a fortification vehicle. Argentina's globally renowned beef culture, with per capita meat consumption among the highest worldwide, creates both opportunities and challenges for fortification through nontraditional staples.

Malnutrition is driven by various factors, including micronutrient and macronutrient inadequacies. Beyond poverty and food insecurity, poor dietary diversity, inadequate nutrition practices for maternal, infant, and young child, limited access to diverse food sources, food loss and waste throughout value chains, and climate-induced agricultural volatility all contribute to persistent

micronutrient deficiencies. Iron deficiency remains the most prevalent micronutrient deficiency, affecting WRA and children, with population-level iron deficiency in nonpregnant women reaching 18.7% in earlier assessments. While mandatory wheat fortification has successfully reduced some micronutrient deficiencies (notably folate deficiency through folic acid fortification since 2002), voluntary fortification opportunities in nonmandatory vehicles, such as rice, maize, and calcium, remain substantially underutilized (FFI n.d.).

2.3.1.3 Nutrition-related Flagship Program

Argentina's nutrition policy architecture comprises multiple interconnected programs implemented across different levels of government and implementing agencies, each with distinct target populations, mechanisms, and coverage patterns.

The National Food Security Plan (PNSA), formally established by Law 25.724 of 2003 under the framework of "El hambre más urgente" (The Most Urgent Hunger), represents the foundational food policy instrument. The Ministry of Social Development administers the National Food Security Plan, which targets vulnerable populations, including children up to 14 years of age, pregnant women, persons with disabilities, and elderly individuals living in poverty. Implementation occurs through framework agreements with provincial governments, resulting in significant variation in beneficiary profiles and service delivery mechanisms across jurisdictions. The program provides food assistance through multiple modalities: direct food distribution (nonperishable items), food purchase tickets from retail shops, direct purchases via magnetic cards, support for community kitchens and school canteens, and self-production initiatives through community gardens. Within the National Food Security Plan framework, the program emphasizes complementary services including health and school-based prevention programs, compensatory initiatives targeting high-risk age and social groups, food and nutrition education, training and technical support for market gardens and farms, and capacity-building to overcome poverty among beneficiary populations (Ministry of Social Development Argentina 2003).

The National Plan for a Healthy Argentina, established through Law 27.396 in 2008, represents a paradigm shift from welfare-based food assistance toward health promotion and disease prevention. It prioritizes three components: (i) health promotion and reorientation of health care services for integrated management of chronic diseases, (ii) improved epidemiological surveillance, and (iii) development of foods with reduced salt and trans fat content. This program promotes smoke-free environments, implements communication campaigns for healthy living, and develops initiatives to train and certify institutions in healthy practices. It explicitly aims to combat malnutrition, obesity, and nutrition-related NCDs through systemic improvements in the food environment rather than through targeted food transfers (Ministry of Health Argentina 2008).

Plan Más Vida (PMV), a province-specific program in Buenos Aires Province, represents the most comprehensive fortified food initiative currently operating at scale in Argentina. Targeting low-income families, PMV provides daily fortified milk for children under six years of age, food aid, health monitoring, and maternal and child health services. The program emphasizes iron fortification through milk vehicles and combines nutritional support with health care promotion. However, a short-term evaluation of PMV implementation revealed important limitations in effectiveness: after one year of implementation, anthropometric measurements showed no significant changes, although folic acid deficiency decreased significantly (35.8% to 6.1%) and vitamin A deficiency declined (64% to lower levels). Critically, adherence to the fortified food component was poor, with

high rates of intra-family food dilution and distribution that substantially reduce intended beneficiary consumption of fortified nutrients. This implementation experience underscores the importance of complementary behavior change communication and monitoring mechanisms in fortification programs (Malpeli et al. 2013).

The Argentina Against Hunger Plan, formally approved in 2020 in response to the economic crisis, was an emergency measure to address deteriorating food security conditions (Ministerio de Desarrollo Social, Argentina 2020). This plan seeks to intensify the implementation of actions under the National Program for Food and Nutrition Security, with the explicit aim of promoting and expanding access to the basic food basket (Government of Argentina n.d.). The plan integrated emergency food distribution with efforts to link beneficiaries to formal employment and skills-building opportunities through programs like ProHuerta, established by INTA (the Argentine National Agricultural Technology Institute) in 1990 (Aranguren et al. 2022), as discussed in Public Policies and Food Systems in Latin America, and encourages agroecological cultivation of fresh foods for family and community consumption.

The Prestación Alimentar (Food Allowance Benefit), implemented in 2019 and institutionalized during the COVID-19 pandemic, represents a significant cash transfer mechanism integrated with fortification objectives. Originally targeting families with children up to six years old who were universal child allowance beneficiaries, the program was expanded in 2021 to cover families with children up to 14 years old who were universal child allowance beneficiaries. The Prestación Alimentar functions as a complementary income transfer with unrestricted use, though implementation data show significant gaps in coverage and adequacy. As of 2024, while the universal child allowance reaches over 4 million children (covering approximately 46% of each child's food requirements), when combined with the Prestación Alimentar, coverage reaches 77% of the basic food basket requirements. However, this remains substantially below the 98% coverage achieved in 2021, indicating significant deterioration in real purchasing power despite nominal increases in transfers (Ministry of Social Development, Argentina 2021; World Bank 2024a).

The School Feeding Program, managed by the Secretariat of Education, and implemented by the national, provincial, and local authorities, targets children aged 4-14 years, with particular focus on socioeconomically vulnerable students. This program provides nutritional support integrated with educational objectives, with governance involving collaboration with international organizations, including the World Bank, FAO, UNICEF, and UNESCO, for technical support and capacity-building. Budget execution monitoring through systems such as SITRARED (Sistema de Transferencia de Recursos Educativos) and nutritional coverage tracking through management information systems enable evidence-based program refinement, though regional cost variations and varying levels of nutritional adequacy across jurisdictions persist (Secretariat of Education Argentina 2024).

2.3.1.4 Policy Environment for Food Fortification

Argentina's food fortification policy framework operates through a sophisticated multi-level regulatory system that combines national legislation, harmonized MERCOSUR (Mercado Común del Sur, meaning the Southern Common Market) standards, and provincial implementation mechanisms.

The Argentine Food Code (Código Alimentario Argentino or CAA), established by Law 18,284 (1969) and implemented through Decree 2,126 (1971), serves as the comprehensive legal foundation governing food fortification. Comprising over 1,400 articles across 22 chapters with detailed

technical specifications, the CAA establishes sanitary and commercial requirements for imported and domestically produced foods. The CAA incorporates standards from multiple international reference systems, including Codex Alimentarius, Food and Drug Administration guidance, and European Union regulations, ensuring alignment with global best practices (ANMAT and Secretariat of Agriculture 2025a; Government of Argentina 1969).

Recent regulatory updates have substantially expanded Argentina's range of fortification ingredients. Joint Resolution 8/2025 between ANMAT and the Secretariat of Agriculture, Livestock and Fisheries approved ferrous and ferric glycinate as permitted ingredients for use in dietary supplements and fortified meals through amendments to Article 1,417 of the CAA. These chelated iron compounds offer improved bioavailability compared to traditional iron sulfate, with potential implications for the fortification program's effectiveness. Additionally, Joint Resolution 38/2025 amended Article 1,363 of the CAA, defining fortified foods and establishing that fortified food portions must provide between 20% and 50% of daily reference values for fat-soluble vitamins and minerals, and 20% and 100% of daily reference values for water-soluble vitamins. These regulatory amendments reflect responsiveness to evolving science and technology in fortification (ANMAT 2025b).

Mandatory wheat flour fortification, implemented in 2002, requires adding iron, folate, riboflavin, niacin, and thiamine. This policy achievement has led to documented reductions in NTDs, demonstrating the public health impact of mandatory fortification programs. However, rice and maize fortification remain voluntary rather than mandatory, despite their importance as dietary staples, particularly in lower-income populations and specific geographic regions. While Argentina has regulatory provisions for voluntary calcium fortification of staple foods, allowing 20-50% of the recommended nutrient intake per serving, industry uptake remains minimal, with wheat flour producers declining to participate. This regulatory-implementation gap reflects cost considerations, limited consumer demand, and competing commercial priorities within the food industry (Cormick et al. 2024).

The Healthy Food Promotion Law, enacted in November 2021, represents a complementary public health policy that addresses dietary quality beyond fortification. This law mandates front-of-package warning labels for products high in excess sugars, fats, calories, and sodium, explicitly aiming to improve dietary choices and combat obesity and diet-related NCDs. By enhancing overall dietary quality, the law also supports fortification objectives by creating market incentives for nutritionally improved products.

MERCOSUR's 2024 harmonization of food fortification standards significantly shapes Argentina's regulatory environment. Argentina participates in MERCOSUR technical working groups and the MERCOSUR Food Commission, harmonizing regulations with Brazil, Paraguay, and Uruguay to facilitate regional trade while maintaining nutritional standards. The Common Market Group resolutions on food additives and fortification ingredients are legally binding on member states, creating supranational requirements that prevent member countries from implementing protectionist technical barriers while ensuring minimum nutritional standards. This harmonization has facilitated industry compliance through unified standards while occasionally requiring Argentine authorities to adopt or adapt MERCOSUR resolutions into the CAA.

2.3.1.5 Industry Capacity and Role of Private Players

Argentina's food processing industry, particularly the milling sector, has substantial technical and infrastructure capacity to implement large-scale fortification. The wheat milling industry is the most developed fortification-ready sector, with approximately 170-184 industrial mills operating nationwide, capable of processing over 13.5 MT of wheat annually. These mills are distributed unevenly, with concentrations in Buenos Aires and wheat-producing provinces. Modern mills operate at extraction rates between 72-76% (most commonly 74%), enabling consistent fortification throughout flour production.

However, the milling industry faces significant structural challenges that limit operational efficiency and the expansion of the fortification program. Installed milling capacity substantially exceeds actual production utilization, with historical evidence indicating idle capacity of 50-60%. This excess capacity creates several complications: (i) small- and medium-sized mills operate with high overhead costs compressed between grain producers and bakeries, limiting profitability and investment capacity; (ii) the vast majority of milling companies are small-to-medium enterprises with limited access to financing, constraining technical upgrades and fortification infrastructure investments; and (iii) competition focuses on spot market sales rather than long-term contracts, creating operational uncertainty that discourages capital investment in fortification equipment (Argentrigo n.d.; Zschocke 2019; Miller Magazine n.d.).

The wheat value chain is a major contributor to Argentina's economy, employing an estimated 387,459 people (11.6% of employment generated across Argentina's agrifood chains) across production, milling, processing, transport, and commercialization (Sigaudo and Terré 2021). Argentina's milling industry comprises approximately 285 milling plants distributed nationally, supplying both domestic and export markets (Sigaudo and Terré 2021). Domestic per capita wheat flour consumption has historically ranged from 88 to 100 kg annually, having peaked at 100 kg in 2010 before declining to 88 kg by 2013, the most recent year for which data were available (Calzada and Frattini 2015). Large integrated food companies, such as Molino Cañuelas, operate vertically integrated supply chains—including some of the country's largest individual milling plants—that enable investments in technology, quality assurance, and processed food manufacturing (Calzada and Frattini 2015).

The private sector's role in Argentina's fortification ecosystem extends beyond wheat flour to dairy products, oils, and emerging functional foods. PMV's implementation through private dairy companies demonstrates successful public-private collaboration, though program evaluations noted challenges in effectiveness, suggesting the need for strengthened quality-assurance and behavioral-support mechanisms. The fortified milk market includes voluntary fortification with iron, calcium, and vitamins, though compliance and quality control remain inconsistent. Private companies increasingly market fortified and functional foods, including fermented plant-based products developed by startups such as Food4You in Argentina, which uses lactic acid bacteria fermentation to enhance nutritional profiles while improving texture and flavor (GAIN 2025).

Private sector partnerships operate through regulatory frameworks established by ANMAT (National Administration of Drugs, Food, and Medical Technology) and coordinated through the National Food Commission (CONAL), an advisory body with representatives from the Ministry of Health, the Ministry of Agriculture, the commercial sector, and consumer organizations. CONAL reviews and approves amendments to the CAA, effectively shaping industry-regulatory collaboration. Joint resolutions

between ANMAT and the Secretariat of Agriculture (SAGyP) formalize policy changes and new ingredient approvals, providing industry certainty for adopting fortification technology. However, enforcement capacity challenges persist: only ANMAT (for packaged foods) and SAGyP/SENASA (National Food Safety and Quality Service) (for agricultural products) have direct regulatory authority, while provincial-level agencies have limited resources for consistent monitoring and enforcement (ANMAT and Secretariat of Agriculture 2025a).

2.3.1.6 Integration with Social Safety Net Programs

Argentina's social safety net architecture integrates multiple income-transfer, food-assistance, and health service programs that collectively provide the framework for fortified food distribution and consumption among vulnerable populations.

The Universal Child Allowance (AUH), established in 2009 and Argentina's primary cash transfer program for children, provides conditional income support to children of unemployed or low-income workers. By December 2022, the universal child allowance reached 4.3 million children and adolescents, representing approximately 34.5% coverage of the child and adolescent population. The universal child allowance follows a semi-conditional design: 80% of monthly benefits are paid directly to beneficiary families, while the remaining 20% is deposited in savings accounts for withdrawal upon provision of evidence of school attendance and medical check-ups. This structure intentionally promotes engagement with health and education systems, which could reinforce nutrition-related behavior change messaging and adherence to micronutrient supplementation (EU-LAC Foundation n.d.; Ministry of Social Development Argentina 2022; Development Bank of Latin America n.d.).

However, the universal child allowance's real purchasing power has fluctuated significantly, particularly during periods of high inflation. According to official government data, the combined coverage of the Asignación Universal por Hijo (AUH) and the Prestación Alimentar (Tarjeta Alimentar) reached only 54.8% of the Canasta Básica Alimentaria (basic food basket) by December 2023, before rising to 100% coverage by October-December 2024 following a series of nominal increases—a 351% cumulative increase in the AUH and a 137.5% increase in the Tarjeta Alimentar over the course of 2024 (Government of Argentina 2025). This trajectory illustrates a fundamental challenge in cash transfer program design: coverage adequacy depends heavily on periodic political decisions to adjust transfer amounts, rather than automatic indexation mechanisms tied to inflation.

The Prestación Alimentar (Food Allowance), an income transfer for food purchases without expenditure restrictions, has become an essential complement to the universal child allowance. Originally designed as a targeted nutrition intervention for families with young children, the program now covers universal child allowance beneficiary families with children up to 14 years old, reaching approximately 4 million people, including mothers/fathers with children, pregnant women, people with disabilities, and mothers with seven or more children receiving non-contributory pensions (CAF 2024). The CAF (Development Bank of Latin America and the Caribbean) approved US$400 million in financing in 2024 to support program implementation, recognizing its effectiveness in reaching vulnerable sectors and improving the diversity of food consumption among children and adolescents (CAF 2024).

Community Kitchens (Comedores Comunitarios), implemented through civil society organizations and community-based structures, represent the second-largest indirect food assistance program

managed by the Ministry of Social Development. These kitchens provide prepared meals to community members, particularly children and the elderly, using government-procured food items, including fortified staples. However, traceability at individual levels remains limited, and program effectiveness varies substantially across geographic contexts. The northern regions face greater challenges due to structural poverty, geographic isolation, and challenging infrastructure, while the southern regions benefit from better integration with social policies.

School feeding programs operated through the Secretariat of Education serve as a critical channel for distributing fortified food, particularly to vulnerable school-age children. Multi-level governance involving national, provincial, and local authorities, coupled with partnerships with international organizations, enables technical support and capacity-building. However, variations in per-meal costs across jurisdictions and inconsistent alignment with technical nutritional guidelines create quality disparities. The program's emphasis on building governmental capacity for sustainable management represents a strength, though budget execution monitoring reveals significant disparities between intended and actual nutritional coverage categories across projects (Global Alliance Against Hunger and Poverty n.d.).

The integration of cash transfers with nutritional outcomes remains incomplete in Argentina's system design. While income transfers increase purchasing power, consumption patterns are mediated by food price dynamics, consumer preferences, availability of nutritious foods in local food environments, and household-level food allocation decisions. Evidence from PMV suggests that cash transfers alone are insufficient to improve micronutrient status without accompanying behavior change communication and quality-assurance mechanisms to ensure consistent availability and consumption of fortified food (Malpeli et al. 2013).

2.3.1.7 Population Reach and Coverage Metrics

Argentina's mandatory food fortification achieves substantial population coverage through industrial food systems, while voluntary programs remain largely underutilized.

Mandatory wheat flour fortification achieves near-universal coverage through industrial milling: 100% of industrially milled wheat flour is fortified with iron, folate, riboflavin, niacin, and thiamine. Argentina produces approximately 13.5 MT of flour annually through its 170 industrial mills. Wheat flour is a staple in the Argentine diet, primarily used in bread and pasta. As a result, mandatory wheat fortification reaches an estimated 80-90% of the Argentine population, with particularly high coverage in urban areas that consume industrially produced bread and bakery products (Nutrition International 2020; Richins 2025).

However, rice and maize fortification remain voluntary, creating substantial coverage gaps in populations that consume these staples heavily. Rice fortification is not mandated, and maize flour fortification is similarly voluntary, limiting reach among populations that rely more on these grains. This represents a critical coverage gap in rural areas, lower-income populations, and specific regional diets that emphasize maize consumption.

Prestación Alimentar reaches approximately 4 million beneficiaries, covering universal child allowance beneficiary families with children up to 14 years of age, though coverage remains incomplete relative to the size of the vulnerable population. As of mid-2024, 34% of Argentine children (4.2 million) lived in extreme poverty and could not afford basic food baskets, indicating that

even after accounting for non-contributory pension recipients and other eligible groups, significant populations remain outside social safety net coverage (FUNDEPS n.d.).

Community kitchen reach varies substantially across geographic regions. In northern regions, community kitchens serve critical food security functions for populations with limited purchasing power, though funding has been substantially curtailed since December 2023 due to government spending cuts. The psychological and practical importance of community kitchens in vulnerable communities is demonstrated by dramatic increases in demand when government support ceases, with many kitchens unable to sustain operations without public funding (IFRC 2024).

The school feeding program targets all children aged 4-14 years in public schools, with nutritional support prioritized for socioeconomically disadvantaged students. However, variations in program quality across jurisdictions and inconsistent nutritional adequacy across regions create uneven coverage of micronutrient requirements.

Regional disparities in access to fortified food reflect broader geographic inequalities. Urban areas, particularly the Buenos Aires Metropolitan Area, have achieved near-complete penetration of fortified wheat flour through industrial food systems and retail access. In contrast, rural areas, particularly in Patagonia, Gran Chaco, and the Andean Northwest, face substantial access limitations due to poor road networks, erratic electricity, limited cold-chain infrastructure, and geographic isolation. These disparities contribute to documented regional variations in micronutrient deficiency prevalence, with northern regions exhibiting malnutrition rates two to three times higher than southern regions (World Bank 2024b; Bejarano et al. 2019).

2.3.1.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Argentina's agricultural value chain for fortification-relevant commodities is sophisticated at the production and initial processing stages, but faces significant challenges in distribution, storage, and quality-assurance maintenance throughout the supply chain.

Raw material availability and supply: Argentina produces substantial quantities of fortification-relevant commodities domestically. Wheat production is projected to reach 21 MT annually, with domestic consumption of 6-7 MT, leaving 14-15 MT available for exports and industrial milling. Maize production supplies domestic animal feed and food processing sectors, though data on specific volumes directed to human food fortification applications are limited. Rice production occurs at smaller scales compared to wheat and maize, with limited domestic milling infrastructure. Oilseeds (soybeans and sunflowers) are produced in substantial volumes, supporting the potential for edible oil fortification with vitamins A and D, though current fortification rates remain minimal (USDA 2024; CIMMYT 2024).

Import dependency for certain fortification-relevant inputs creates supply chain vulnerabilities. Fortification premixes (concentrated micronutrient compounds mixed into flour or other food vehicles) are substantially imported, subjecting supply to exchange rate fluctuations, tariff changes, and international market price volatility. Argentina's macroeconomic instability, characterized by currency devaluation and inflation, substantially increases premix costs, particularly for small millers operating on thin profit margins (ANMAT 2025c).

Distribution and cold chain infrastructure: The wheat flour supply chain benefits from well-developed milling and distribution infrastructure concentrated in Buenos Aires and surrounding regions. Approximately 40-60 MT of farm-level storage capacity (comprising 50% silo bags and 50% steel silos) and an additional 70 MT of grain storage in up-country elevators, warehouses, and mills provide substantial storage capacity for grain preservation. However, flour distribution depends on road and port infrastructure, which is highly concentrated in the Buenos Aires region (USDA 2024; SENASA 2024; World Bank 2024c).

For fortified foods that incorporate temperature-sensitive nutrients (vitamins, particularly vitamin A, and fortified milk products), cold chain infrastructure is a critical constraint. Rural areas lack a consistent electricity supply and modern refrigeration facilities, particularly in northern regions where poverty is highest and food insecurity is greatest. The fragmentation of the supply chain among numerous small businesses, particularly in the cold chain segment, creates inconsistencies in safety and quality maintenance during distribution, especially over long distances.

Quality assurance and regulatory framework: The CAA, as the primary quality assurance instrument, establishes comprehensive technical specifications for fortified foods, including ranges of micronutrient content, contaminant limits, packaging requirements, and labeling standards. The enforcement of CAA requirements is carried out through a multi-agency system.

ANMAT operates under the Ministry of Health and bears primary responsibility for regulating prepackaged foods, dietary supplements, additives, and fortification of ingredients. ANMAT maintains the National Food Institute, which manages the National Establishment Registry and National Food Products Registry, requiring food manufacturers and food products to register before commercial distribution. ANMAT Disposition 537/2025 established updated procedures for food import operations, requiring importers to use the Sistema de Información Federal para la Gestión del Control de los Alimentos to manage registration and obtain import authorizations (ANMAT 2025d; ANMAT 2024).

SENASA (National Food Safety and Quality Service), operating under the Secretariat of Agriculture, Livestock and Fisheries, regulates agricultural products and derivatives. SENASA maintains 24 regional and metropolitan supervisory offices nationwide, providing regulatory coverage of agricultural inputs throughout the country. SENASA's extensive field network of 15 regional centers and 356 local offices enable disease surveillance and rapid response to food safety incidents.

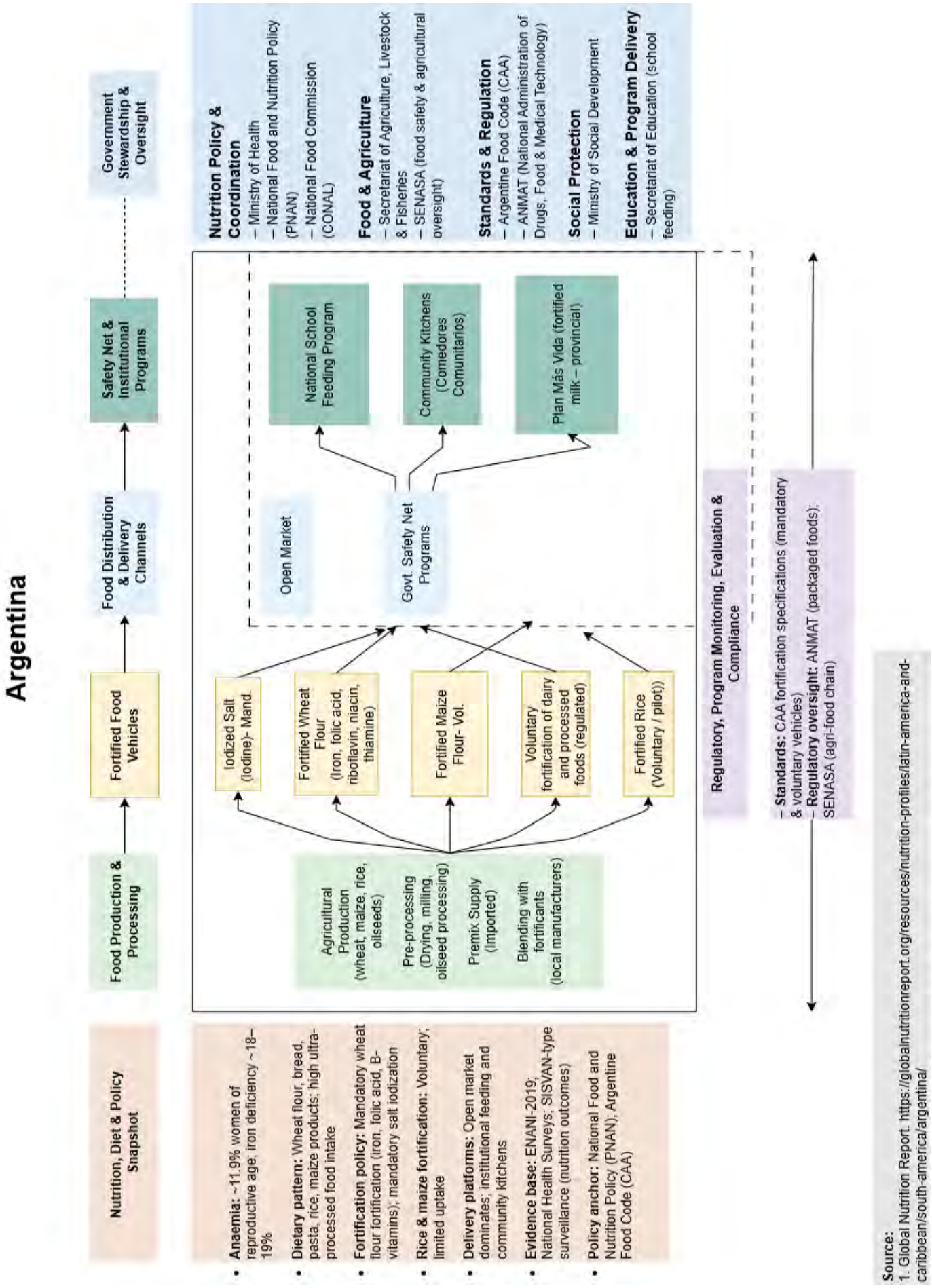
CONAL, comprising representatives from the Ministry of Health, the Ministry of Agriculture, the commercial sector, and consumer organizations, serves as an advisory body that reviews and approves amendments to the CAA. This institutional arrangement enables regular updates to food standards in response to new fortification technologies, ingredient availability, and emerging nutritional evidence.

MERCOSUR 2024 regulations, particularly the Common Market Group Resolutions on food additives and fortification, are legally binding on Argentina and incorporated into the CAA through joint resolutions, ensuring compatibility with regional trading partners while maintaining national discretion in implementation approaches. The Common Market Group issues resolutions (Res.) that set technical standards for food additives, which Argentina incorporates into its national regulations, such as the Argentine Food Code.

Laboratory accreditation and testing infrastructure: The Organismo Argentino de Acreditación (OAA), Argentina's primary accreditation body, is a full signatory to the ILAC Mutual Recognition Arrangement (ILAC MRA), ensuring that OAA-accredited laboratories meet the international ISO/IEC 17025 standards for technical competence and the generation of valid results. Laboratories accredited by OAA may conduct fortification testing, including micronutrient analysis through validated analytical methods (HPLC, LC-MS/MS, ICP-MS, ICP-OES, AAS, and UV-Vis spectrophotometry) (OAA n.d.).

INTI (Instituto Nacional de Tecnología Industrial) maintains various laboratories that test food and agricultural products, including INTI Lácteos, a reference laboratory for milk testing. SENASA also collaborates with laboratories to test plant and animal products for chemical and microbiological contaminants. However, limited data are publicly available regarding the number and distribution of OAA-accredited laboratories specifically capable of fortification testing, their geographic distribution, and their current capacity utilization. This information gap constrains the assessment of Argentina's aggregate laboratory capacity for fortification monitoring and enforcement activities (INTI n.d.). Refer to Figure 2.13.

Figure 2.13. Argentina's food fortification ecosystem



Source:
1. Global Nutrition Report. https://globalnutritionreport.org/resources/nutrition-profiles/latin-america-and-caribbean/south-america/argentina/

2.3.1.9 Monitoring and Evaluation Mechanisms

Argentina's monitoring and evaluation systems for food fortification operate at multiple levels, integrating internal quality control by manufacturers, regulatory monitoring by government agencies, and household/individual-level consumption surveillance.

Internal quality control (factory-level monitoring): Manufacturers implement quality management and control systems to ensure accurate fortification throughout production processes. Fortification testing methodologies must verify nutrient content, uniform distribution, and stability throughout the product's shelf life, accounting for nutrient degradation due to heat, moisture, light, and storage conditions. The Federal Food Control Program within ANMAT establishes general objectives to strengthen surveillance, auditing, and regulatory actions, with the Directorate of Inspection, Surveillance, and Risk Management of the National Food Institute coordinating execution.

Regulatory monitoring: ANMAT implements regulatory oversight through post-market surveillance activities, including inspections of food storage facilities and manufacturing sites, random sampling, and risk-based inspections of imported foods. The "Comprehensive Plan for the Inspection of Establishments, Food Products and Materials in Contact with Food," established through Provision 10873/2017, specifies actions to control chemical and microbiological contaminants, nutritional composition, quality, and labeling in food and food-contact materials (ANMAT 2017).

Laboratory-based monitoring: Verification of fortification compliance depends fundamentally on the laboratory's analytical capacity and performance. Proficiency testing and interlaboratory comparison programs enable quality control and cross-laboratory result verification, though limited information is publicly available on Argentina's systematic implementation of these programs specifically for micronutrient fortification testing.

Household and individual-level monitoring: Food consumption surveys and micronutrient status assessments provide evidence on the impact of the fortification program. Argentina's National Food and Household Survey (2005) and National Health Surveys (periodic) provide dietary data enabling assessment of fortified food consumption patterns, though data availability limitations constrain real-time monitoring (INDEC 2024).

Implementation challenges in monitoring: Despite institutional monitoring frameworks, significant gaps persist. The decentralized implementation model, with provincial-level food control agencies having limited resources and inconsistent enforcement capacity, creates variability in enforcement. Inconsistent laws and inadequate enforcement of food safety regulations across provinces complicate the implementation of a large-scale, consistent fortification scheme. Inadequate monitoring infrastructure in resource-limited provincial jurisdictions hinder compliance verification (Bejarano et al., 2019).

2.3.1.10 Stakeholder Ecosystem and Partnerships

Argentina's food fortification stakeholder ecosystem comprises government agencies at the national and provincial levels, private sector food companies, international organizations, civil society, and academic institutions, each with distinct roles and interests in fortification policy and implementation.

Government agencies (FAO 2020):

- The Ministry of Health and ANMAT establish legislation, approve fortification of ingredients, and monitor packaged food compliance.
- The Ministry of Economy/Secretariat of Agriculture, Livestock and Fisheries, and SENASA regulate agricultural products and food safety at the production levels.
- The Ministry of Social Development implements food assistance programs incorporating fortified foods as distribution vehicles.
- The Secretariat of Education manages school feeding programs incorporating fortified staples.
- Provincial governments and health authorities implement national fortification policies with locally adapted approaches and varying enforcement capacity.

International organizations:

- FAO provides technical cooperation on food security and nutrition policy development.
- WHO/PAHO (Pan American Health Organization) collaborates on micronutrient fortification standards, nutrition surveillance, and capacity building.
- The World Bank finances food assistance program improvements and institutional strengthening.
- UNICEF supports child nutrition interventions and advocacy.
- GAIN provides technical assistance on fortification scale-up and industry engagement.

Private sector:

- Large food companies with milling operations and vertically integrated supply chains (FoodCos such as Molino Cañuelas).
- Small- and medium-sized milling enterprises.
- Dairy companies producing fortified milk products.
- Emerging functional food and fortified food innovators.
- Food processors and packaged food manufacturers.

Civil society organizations:

- Non-governmental organizations implementing community nutrition programs and advocacy.
- Community kitchens and grassroots food security organizations.
- Consumer protection and food safety advocacy groups.
- Faith-based organizations operating soup kitchens and food aid programs.

Academic and research institutions:

- Universities conducting nutrition research and policy analysis.
- INTA (Argentine National Agricultural Technology Institute) provides technical support and research.
- CIMMYT (International Maize and Wheat Improvement Center) collaborates on crop improvement and agrifood systems transformation.

Recent partnership initiatives: Argentina has participated in MERCOSUR (2004) technical working groups to harmonize fortification standards with regional trading partners. FAO partnership frameworks aim to strengthen Argentina's capacity to develop sustainable food systems and ensure nutrition security. CAF's US$400 million financing for the Prestación Alimentar program underscores international financial institutions' commitment to Argentina's social protection architecture. However, coordination among stakeholders for food fortification remains fragmented. CONAL functions as the primary multi-stakeholder forum for discussing fortification policies, but there is limited transparency regarding the frequency of meetings, decision-making processes, and how stakeholder input mechanisms are handled. Additionally, private sector engagement in fortification policy development appears primarily reactive (responding to regulatory changes) rather than proactive (in shaping the fortification agenda), with cost burdens limiting enthusiasm for voluntary fortification expansion (CONAL 2024).

2.3.1.11 Critical Challenges and Policy Reforms Needed

Argentina's food fortification agenda confronts multiple interconnected challenges spanning technical, economic, institutional, and political-economy dimensions, each requiring specific policy responses.

Micronutrient deficiency persistence despite fortification: Despite mandatory wheat fortification since 2002, micronutrient deficiencies remain substantial public health problems. Iron deficiency anemia in WRA persists at 11.9%, child stunting remains at 9.5%, and vitamin A, B12, and zinc deficiencies continue to affect vulnerable populations. These persistent deficiencies, despite fortification implementation, reflect multiple causes: (i) incomplete dietary diversity even among fortified-food consumers, (ii) nutrient bioavailability limitations in current fortification vehicles, (iii) inadequate fortification coverage in nonmandatory vehicles like rice and maize, and (iv) competing dietary inhibitors of micronutrient absorption (high phytate content in cereals, and low animal protein consumption among poor households limiting iron bioavailability) (Acosta et al. 1984).

Voluntary fortification underutilization: Rice and maize fortification remain voluntary, despite their importance as dietary staples for vulnerable populations with high consumption rates in lower-income and northern communities. The absence of mandatory fortification in these vehicles creates an estimated "coverage gap" of 10-20% of the population with substantial reliance on nonfortified rice and maize products. Industry data suggest that voluntary participation remains minimal due to cost barriers and limited consumer demand.

Cost barriers to fortification expansion: Premix costs (65-70% of total fortification expenses), import tariffs on premixes (up to 20-30% in some cases), and value-added tax on fortification inputs create particularly acute cost burdens for small- and medium-sized millers. In price-sensitive consumer markets, the estimated 1% retail price increase required to cover fortification costs can reduce profit margins by up to 43%, substantially undermining competitiveness. These cost dynamics discourage voluntary fortification expansion and limit small-processor participation in existing mandatory programs.

Enforcement and compliance gaps: Out of 142 countries with fortification mandates worldwide, only 36 systematically collect enforcement data. Argentina's capacity for compliance monitoring is still underdeveloped. The decentralized implementation model, in which provincial-level food control agencies operate with limited resources and technical capacity, leads to inconsistent enforcement

across jurisdictions. This challenging enforcement environment creates unfair competitive dynamics; compliant companies absorb the costs of fortification while non-compliant competitors benefit from lower costs. As a result, this may potentially discourage industry participation (Micronutrient Forum 2017).

Regional disparities in infrastructure and access: Northern regions face critical constraints in cold-chain infrastructure, road connectivity, reliable electricity supply, and technical capacity for quality assurance. These infrastructure limitations create substantial geographic disparities in access to fortified food, disproportionately affecting populations with the highest burdens of malnutrition. Additionally, differences in logistics infrastructure between rural and urban areas, combined with low population density in Patagonia and other isolated regions, challenge the cost-effective distribution of fortified foods (World Bank 2024d).

Institutional coordination and policy coherence: Argentina's food fortification agenda suffers from a lack of integrated institutional coordination across sectoral ministries (health, agriculture, social development, education) and administrative levels (national, provincial, municipal). Food policy formulation appears fragmented, with multiple programs in place (National Food Security Plan, National Plan for a Healthy Argentina, PMV, Prestación Alimentar, and School Feeding). Evidence of systematic policy integration is limited, and mechanisms for inter-program coordination, as well as complementarities and alignment among these programs, remain underdeveloped (Aranguren et al. 2022; Stampini, Medellín, and Ibarrarán 2025).

Nutrition financing constraints: The social protection architecture faces severe financing constraints, particularly acute during economic downturns. Between 2021 and 2024, the real purchasing power of cash transfers (such as the universal child allowance and Prestación Alimentar) deteriorated substantially, declining from 98% to 77% of the Basic Food Basket requirements. This indicates that economic instability and budget constraints undermine efforts to fortify food through complementary social safety net programs. Since December 2023, public investment in community kitchens and other food assistance mechanisms has been substantially curtailed, with some government funding being completely discontinued for some programs. These financing constraints raise questions about long-term sustainability and political commitment to food fortification and nutrition security agendas.

Limited evidence on fortification and effectiveness monitoring: Evidence on the fortification program's impact remains limited. The PMV evaluation revealed that despite the distribution of fortified food, there were no significant improvements in anthropometric outcomes after one year of implementation. This was largely due to poor adherence to fortified food consumption and intra-family food dilution, both of which substantially reduced the program's effectiveness. These findings suggest that fortification programs that lack complementary behavior change communication and quality-assurance mechanisms yield limited nutritional benefits. Furthermore, Argentina lacks systematic monitoring systems to track fortification coverage, compliance, and nutritional impact within the food system.

Nutrition transition and double burden of malnutrition: Argentina faces a complex nutrition transition that creates difficult policy decisions. While undernutrition and micronutrient deficiencies continue to affect specific vulnerable populations, obesity (35.4% in adults) and nutrition-related NCDs have emerged as major public concerns. This situation represents a "double burden," indicating that fortification strategies must simultaneously address micronutrient deficiencies while preventing

excess nutrient intake. Traditional fortified foods that are high in calories might worsen obesity in certain populations, even as they adequately address micronutrient needs in others. This underscores the necessity of tailored fortification approaches that account for the specific needs of different populations and contexts (Perez et al. 2019).

Policy recommendations:

1. Expand mandatory fortification to rice and maize flour through CAA amendment and complementary enforcement mechanisms, prioritizing sectors and geographic regions with high consumption.
2. Establish cost-reduction mechanisms, including exempting premixes and fortification equipment from value-added tax and import tariffs, coupled with bulk procurement mechanisms to reduce premix costs through consolidated industry orders.
3. Strengthen enforcement capacity through provincial government training and technical support, coupled with industry co-financing of oversight activities, creating fairer competitive dynamics
4. Implement systematic monitoring systems to track fortification coverage, compliance, and nutritional impact, with quarterly public reporting of program performance metrics.
5. Integrate fortification within a comprehensive nutrition policy explicitly addressing the double burden of malnutrition through fortified food standards designed for different population subgroups and risk profiles.
6. Establish minimum nutritional adequacy standards for food assistance programs (National Food Security Plan, Prestación Alimentar, and school feeding), ensuring these programs systematically distribute fortified foods aligned with specific micronutrient deficiency prevalence.
7. Develop behavior change communication campaigns complementing fortified food distribution, targeting consumer awareness of fortification benefits, and appropriately supporting household-level food allocation decisions (World Bank 2024d).

2.3.1.12 Opportunities and Future Directions

Despite substantial challenges, Argentina's food fortification agenda presents significant opportunities for expansion, innovation, and impact at scale through strategic investments in technology, policy harmonization, and multisectoral coordination.

Emerging fortification technologies: Argentina's food processing sector demonstrates openness to innovation. The recent approval of ferrous and ferric glycinate as permitted ingredients (Joint Resolution 8/2025) reflects regulatory responsiveness to emerging fortification science, as these compounds demonstrate superior bioavailability compared to traditional iron sulfate compounds. These chelated iron forms show promise for improved micronutrient absorption, potentially increasing the effectiveness of existing fortification programs without increasing food consumption. Double fortification technologies (simultaneously adding multiple micronutrients to single-food vehicles) and encapsulation technologies that protect nutrients against oxidation and food-matrix interactions represent additional opportunities for innovation.

Plant-based and functional food innovation: Emerging Argentine startups like Food4You develop fermented plant-based food ingredients using lactic acid bacteria, enhancing nutritional profiles while improving texture and flavor without synthetic additives. These innovations align with consumer preferences for “clean label” products while creating opportunities for fortification in emerging product categories. Bioeconomy development initiatives supported by the Argentine

government provide technical and financial assistance to micro-, small-, and medium-sized enterprises developing value-added, nutrition-enhanced products (IICA 2023).
Market expansion potential: The Latin American fortified food market shows strong growth. Argentina's competitive advantages include established milling infrastructure, technical expertise, regulatory frameworks, and regional export platforms to MERCOSUR partners. Regional market expansion of fortified products through harmonized MERCOSUR standards creates economies of scale, reducing per-unit fortification costs.

Institutional strengthening opportunities: Argentina's laboratory accreditation system (OAA ILAC MRA) provides a foundation for expanded fortification monitoring capacity through investment in laboratory infrastructure, proficiency testing programs, and capacity building. Regional laboratory networks across MERCOSUR countries could facilitate the sharing of expertise and improve resource efficiency in fortification quality assurance.

Policy harmonization and regional leadership: Argentina's participation in MERCOSUR technical forums positions the country as a potential leader in regional fortification policy. Harmonization of fortification standards with MERCOSUR partners while maintaining national flexibility for context-specific approaches could facilitate regional scaling while reducing compliance costs for multinational food companies operating across borders. Argentina's designation as a strategic food security partner for international development could accelerate technical cooperation on fortification with multilateral organizations.

Nutrition-sensitive food system transformation: Shifting toward sustainable, nutrition-sensitive agriculture and food systems aligned with climate action targets (Argentina's goal to reduce food loss by 10-30% and food waste by 5-10% by 2025) creates complementary opportunities for fortification. Reduced food loss throughout value chains directly increases nutritional security by preserving nutrient content. Crop biodiversity enhancement and promotion of neglected yet nutritious traditional foods (particularly Andean crops in the northwest regions) could complement fortification with dietary diversity approaches.

Double-burden mitigation through strategic fortification: Rather than abandoning fortification in contexts of high obesity prevalence, strategic fortification of lower-calorie staple foods (particularly vegetables, legumes, and whole grains) could address multiple nutrition challenges simultaneously. Developing differentiated fortification standards for products explicitly targeting obesity prevention (lower-calorie fortified foods) versus addressing micronutrient deficiencies (micronutrient-dense fortified staples) recognizes Argentina's dual nutrition challenge.

Evidence generation and learning systems: Substantial opportunities exist for rigorous evaluation and impact assessment of the fortification program. Systematic collection of fortification coverage data, monitoring of biochemical micronutrient status among consumers of fortified food, and behavioral research on fortified food adoption and consumption patterns could inform program optimization. Argentina's relatively sophisticated health and nutrition surveillance infrastructure provides a foundation for enhanced monitoring systems.

Workforce capacity development: Investment in technical training for food industry workers in fortification processes, laboratory technicians in micronutrient testing, and health system workers in nutrition assessment and fortified food counseling would strengthen implementation systems.

International partnerships with organizations like FAO and GAIN could provide technical expertise and training support.

Consumer awareness and demand generation: Public awareness campaigns highlighting the benefits of fortification, coupled with clear front-of-package labeling standards, could increase consumer demand for fortified products and reduce consumer skepticism about food fortification. Integrating fortification messaging into existing health promotion campaigns (aligned with the Healthy Food Promotion Law framework) could leverage existing communication channels and consumer engagement mechanisms.

2.3.2 Brazil

2.3.2.1 Nutrition and Fortification Ecosystem

Brazil has established itself as a leader in food fortification within Latin America, supported by a mature food manufacturing sector and institutional frameworks. The country's fortification strategy encompasses mandatory and voluntary approaches across staple foods, reflecting pragmatic responses to persistent micronutrient deficiencies despite decades of economic development.

The fortification ecosystem is anchored by the mandatory enrichment of wheat and maize flours with iron and folic acid, as mandated by the 2002 Brazilian Health Regulatory Agency (ANVISA) Resolution 344, updated by Resolution RDC (Resolução da Diretoria Colegiada or Collegiate Board Resolution) 604/2022. Salt iodization remains mandatory under the same framework. Brazil operates 147 industrial wheat mills, each with a capacity exceeding 20 tons per day, and 17 industrial maize mills, though consistent availability of fortified products remains a challenge.

The regulatory environment was significantly modernized through ANVISA's Resolution RDC 714/2022, which established comprehensive sanitary requirements for food fortification and restoration, and through Resolutions RDC No. 727 and RDC No. 429, which established labeling requirements. Regulations set fortification levels of 4–9 mg of iron and 140–220 μg of folic acid per 100 g of flour, with enforcement through periodic market surveillance (ANVISA 2022).

Despite advanced regulatory frameworks, voluntary rice fortification predominates, with mandatory fortification absent, even though proven technologies such as Ultra Rice have been successfully implemented in school feeding programs. Brazil ranks fifth among global markets for fortified and functional foods, valued at US$10.9 billion in 2011 and projected at US$16.3 billion by 2015, driven by growing health consciousness among middle-class consumers (PATH 2022).

The fortification ecosystem consists of three interconnected layers: government regulatory frameworks, industrial capacity and private sector implementation, and civil society participation through research institutions and non-governmental organizations. This multi-stakeholder ecosystem exhibits substantial gaps between policy intent and implementation realities, particularly in enforcement, compliance monitoring, and achieving measurable nutritional impact across all population segments.

2.3.2.2 Nutritional Status and Dietary Practices

Brazil has a complex nutritional landscape typical of middle-income countries undergoing a rapid dietary transition. This situation involves persistent problems with micronutrient deficiencies alongside increasing rates of overweight and obesity. Data from the Brazilian National Survey on Child Nutrition (ENANI-2019) and the Food and Nutrition Surveillance System (SISVAN) reveal a public health burden shaped by inequality and geographic disparities (Ministry of Health Brazil 2020).

Iron deficiency anemia remains a significant public health challenge, despite two decades of fortification policies. A meta-analysis of 83 studies found that the prevalence of this condition among WRA is 25% (95% confidence interval 23–28%). This rate is even higher in the North and Northeast regions, reaching 30% (95% confidence interval 24–35%). Among pregnant women, the pooled prevalence was 23% (95% confidence interval 20–27%), with the Northeast region at 26% (95% confidence interval 23–29%). These ongoing high rates of iron deficiency anemia, despite mandatory flour fortification since 2004 and national iron supplementation programs for pregnant women since 2005, indicate gaps in program outreach and quality assurance (Macena et al. 2022).

Vitamin A deficiency has improved significantly in recent decades. The findings from ENANI-2019 indicate that vitamin A deficiency is now classified as a mild public health problem, reflecting the combined impact of supplementation programs targeting children aged 6 to 59 months through the National Vitamin A Supplementation Program (NVASP) and broader dietary improvements. However, NVASP coverage remains suboptimal at 41.5%, particularly in regions not prioritized under the Brazil Without Poverty Plan (Ministry of Health 2023a).

Stunting affects approximately 7% of children under five years old, according to ENANI-2019. The prevalence is notably higher among vulnerable populations, ranging from 11–25% by location. Wasting has a prevalence of 2.6% in population surveys, increasing to 5% in children aged 0 to 11 months. Notably, after a sustained reduction from 1974 to 2006, child undernutrition plateaued or worsened after 2006, correlating temporally with disruptions in social protection policies (de Andrade et al. 2024). Additionally, black and brown children under five years old exhibit stunting prevalence that is 9.2–12.3% higher than that of white children. This discrepancy reflects intersecting vulnerabilities of limited household food access and reduced access to quality health services in low-income communities.

The nutrition transition manifests most strikingly in rising rates of overweight and obesity. According to ENANI-2019, the prevalence of excessive weight among children under five years old increased from 6% to 10.1%, while the rate of stunting remained stagnant at 7%. This situation highlights the double burden of malnutrition. Among school-age children aged 5 to 9 years, one in three is overweight, with obesity affecting 16.6% of boys and 11.8% of girls nationally. The Southeast region, which is the most economically developed, shows the highest prevalence of overweight at 40.3% among boys and 38% among girls (Ministry of Health 2020).

Adult obesity increased from 8.9% in 1989 to 26.5% in 2008–09. While the highest prevalence of obesity is still found in high-income populations, it has been increasing rapidly in low-income groups as well. The consumption of ultra-processed foods, sweets, sugar-sweetened beverages, and fried foods is significantly correlated with the risk of overweight in childhood (Monteiro et al. 2004).

Double burden and food insecurity: Approximately 7% of children under five years old suffer from stunting, while an increasing number of children are also affected by overweight (ENANI-2019). At least 50% of children experience multiple micronutrient deficiencies. More than half of the Brazilian population is overweight, and dietary surveys document a high prevalence of inadequate intake of calcium, magnesium, vitamins A, E, and D. This situation reflects the poor micronutrient quality of ultra-processed foods and the persistence of dietary patterns that fail to ensure adequate diversity (Ministry of Health 2019).

Household food security has reversed significantly in recent years. After substantial improvements from 2004 to 2013, the period from 2013 to 2018 witnessed a sharp increase in severe food insecurity across all demographic categories. This trend reflects policy disruptions and economic contraction. The North and Northeast regions have the highest prevalence of severe food insecurity, affecting approximately 50% of households in these areas. In fact, households in these regions are approximately four times more likely to experience food insecurity compared to those in the South and Southeast (IBGE 2019; Ministry of Health 2023b).

2.3.2.3 Nutrition-related Flagship Program

The National School Feeding Program: Established in 1955 and formalized by Law 11.947 of 2009, the National School Feeding Program is one of the world's largest school feeding programs and serves as Brazil's primary institutional mechanism for ensuring adequate nutrition during critical periods of child development. The program reaches 40 million students across all basic education modalities, including approximately 100% of students enrolled in public, municipal, state, and federal schools, as well as philanthropic and religious institutions, making it universally accessible regardless of socioeconomic status and fundamentally grounded in the right to food. With an annual federal budget allocation of R$5.5 billion (approximately US$976 million in 2024), the National School Feeding Program operates under decentralized governance, in which the federal government, through the National Fund for Educational Development (FNDE), establishes nutritional guidelines and transfers resources, while states and municipalities manage execution. Meals provided under the National School Feeding Program must meet students' nutritional needs, with a budget of R$0.33–0.61 per meal (approximately US$0.06–0.14). These meals are required to consist primarily of fresh or minimally processed foods and meet specified micronutrient targets (National Fund for Educational Development 2024).

The National School Feeding Program incorporates fortified foods as a strategic mechanism for delivering nutrition, explicitly listing fortified foods, biofortified foods, and micronutrient supplements as intervention modalities. Through National School Feeding Program meals, fortified wheat flour products (bread, biscuits, pasta) and increasingly fortified rice reach 40 million students daily during the academic year, creating a socioeconomically equitable fortification delivery channel independent of household purchasing power (GCNF 2024).

Approximately 7,347 registered nutritionists employed through the National School Feeding Program have local autonomy to design culturally appropriate, nutritionally adequate menus that emphasize fresh and minimally processed foods, thereby providing professional nutritional oversight often lacking in many fortification programs. A 2023 law expansion mandated that at least 50% of the National School Feeding Program food purchases prioritize women from family farming organizations, up from the previous minimum of 30% for family farming purchases. This change links fortification directly to agricultural support and gender equity.

The National School Feeding Program governance employs a multilevel implementation approach that includes federal-level policy and resource transfers, state-level coordination and training, and municipal-level menu planning and community monitoring through social councils. Established knowledge institutions contributing to this effort include the Research Consortium for School Health and Nutrition, 24 university-based Collaborative Centers for School Feeding and Nutrition, the Institute for Applied Economic Research, and the WFP's Center of Excellence against Hunger in Brazil, all of which provide research support and technical assistance. The governance structure exemplifies multilevel governance, with federal authorities establishing policy and financing, states coordinating implementation, and municipalities managing day-to-day school feeding operations, supported by School Feeding Councils and CECANEs (CECANE n.d.).

Bolsa Família and conditional cash transfers: The Bolsa Família program (recently renamed Programa Auxílio Brasil), established in 2003 as part of the Zero Hunger Strategy, provides direct income transfers to low-income households conditioned on school attendance and participation in nutrition and health monitoring programs. While not exclusively a nutrition program, Bolsa Família profoundly affects household food security and access to food.

Analysis using nationally representative data reveals a complex relationship: Bolsa Família program participation was associated with reductions in stunting prevalence across all demographic subgroups, with the strongest protective effect among children of mothers with fewer years of education (odds ratio 0.75, 95% confidence interval 0.70–0.81). However, the program was concurrently associated with increased odds of overweight/obesity in some subgroups, particularly among children of more educated mothers (odds ratio 1.09, 95% confidence interval 1.06–1.11), suggesting that while income transfers enable consumption, they do not guarantee improvements in dietary quality in contexts of ubiquitous ultra-processed food availability (Higgins and Lokugamage 2015).

Brazil Without Hunger Plan and inter-sectoral coordination: Under the Lula administration, which began in 2023, Brazil reinstituted comprehensive food security governance by forming an InterSectoral Coordination of Food and Nutrition Security (CAISAN), comprising 24 ministries, and developing the multisectoral Brazil Without Hunger Plan to eliminate hunger and food insecurity. The architecture emphasizes integrated approaches addressing agricultural production, food distribution, and nutritional support. The National Conference on Food and Nutrition Security, held in

December 2023, indicates sustained civil society and government engagement with nutrition security as a rights-based priority (Ministry of Social Development 2023).

Supplementation programs: Brazil has implemented the NVASP, targeting children aged 6 to 59 months with mega-doses (100,000 IU for infants aged 6 to 11 months and 200,000 IU biannually for children aged 12 to 59 months).

In addition, the National Iron Supplementation Program, established in 2005, targets pregnant women, postpartum women, and children. This program complements existing fortification strategies. Brazil has pioneered the implementation of the National Strategy for Fortification of Infant Feeding with Micronutrients in Powder (NutriSUS), providing multiple micronutrient powders containing 10–22 micronutrients through primary health care settings. Randomized controlled trials have demonstrated that these initiatives reduce iron deficiency and vitamin A deficiency among Brazilian children, with vitamin A deficiency reduced by 55% and anemia prevalence reduced from 22.3% to 13.8% (Ministry of Health 2024; Ministry of Health 2023c).

2.3.2.4 Policy Environment for Food Fortification

Constitutional and legislative foundations: The 1988 Brazilian Federal Constitution explicitly recognizes food as a social right. This right is operationalized through Decree 7,272 of August 25, 2010, which established the National Policy on Food and Nutrition Security. This policy designates food and nutritional security as a right of all citizens. This decree created the legal instrument through which CAISAN operates, bringing together 24 federal ministries in coordinated policy implementation. This legislative approach positions food fortification not merely as a technical health intervention but as an instrument of rights fulfillment and social justice.

SISAN (Sistema Nacional de Segurança Alimentar e Nutricional, or National Food and Nutrition Security System) integrates federal, state, and municipal entities, as well as civil society, to formulate and implement policies, with the Interministerial Chamber of Food and Nutritional Security as its key executive body. CAISAN coordinates 24 federal ministries (expanded from an initial few) to execute intersectoral policy, including national plans such as PLANSAN (Plano Nacional de Segurança Alimentar e Nutricional, or National Food and Nutrition Security Plan). Decree No. 7,272/2010 further regulates SISAN and institutes the National Policy on Food and Nutritional Security (PNSAN or Política Nacional de Segurança Alimentar e Nutricional).

While SISAN/PNSAN emphasize rights-based access to nutritious food, food fortification operates mainly under health regulations, such as ANVISA standards, serving as a public health tool within this broader social justice framework. No direct SISAN decree mandates fortification as the primary "legal instrument"; instead, interministerial coordination supports nutrition interventions, such as fortification, for equity (Government of Brazil n.d.; Global Alliance Against Hunger and Poverty n.d.-a).

The National Food and Nutrition Policy, updated through governmental coordination, provides the overarching framework for all nutrition interventions, including fortification efforts. The policy establishes guidelines, including promoting adequate and healthy eating practices, conducting food and nutritional surveillance through SISVAN, preventing nutritional deficiency diseases, and providing comprehensive management of nutrition-related health conditions, and explicitly integrates food fortification as a strategic intervention component (Ministry of Health 2023d).

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ANVISA regulatory framework: The Brazilian Health Regulatory Agency (ANVISA) holds the primary authority to establish and enforce food fortification standards through resolutions of its Collegiate Board. The current mandatory fortification standard is outlined in Resolution RDC No. 604/2022, published on February 16, 2022. It establishes requirements for salt fortification with iodine, as well as for wheat flour and maize flour with iron and folic acid. The resolution specifies precise micronutrient ranges ensuring both adequacy and safety: iron must be present at 4–9 mg per 100 g of flour (the original 2002 standards allowed 4.2 mg per 100 g; the revised standard offers greater flexibility by taking bioavailability and processing losses into account), and folic acid should be present at 140–220 μg per 100 g of flour.

Resolution RDC No. 714/2022, published on July 8, 2022, establishes comprehensive sanitary requirements for food fortification and restoration, complemented by labeling requirements in Collegiate Board Resolutions RDC No. 727 and RDC No. 429. These resolutions require foods fortified at or above specified levels to display declarations such as “fortified with vitamins” or “fortified with minerals” on their product labels, with fortification ingredients derived exclusively from ANVISA-authorized substance lists to ensure quality and bioavailability. Additionally, the regulatory framework explicitly requires that fortification not introduce harmful substances, that added nutrients not reach therapeutic levels, and that ingredient sources be bioavailable and safe (FAO n.d.).

Implementation challenges: Despite advanced legislative and regulatory frameworks, Brazil faces significant implementation challenges stemming from structural deficiencies in enforcement capacity and political commitment. Literature on the global regulatory monitoring of fortified foods identifies barriers that are equally applicable to Brazil. About 30% of industry respondents reported a lack of clarity regarding the roles of government authorities. Additionally, respondents perceived political risk associated with regulatory actions and noted insufficient inspectorate capacity and training. Approximately 44% of regulatory respondents identified a lack of trained inspectors and analysts as key challenges, while budget constraints adversely affected both agency capacity and the industry's ability to invest in compliance infrastructure (OECD 2024).

2.3.2.4.1 Industry capacity and role of private players

Wheat milling industry: Brazil is home to 147 industrial wheat flour mills with a capacity exceeding 20 tons per day. These mills essentially dominate the supply of wheat flour for human consumption through industrial channels. Notably, 100% of the wheat flour produced in Brazil's industrial mills comes from industrial-scale operations, meaning that artisanal, informal, or non-compliant production channels contribute only a negligible proportion of the flour supply. However, despite this concentrated industrial capacity, only 38% of industrially produced wheat flour meets fortification standards according to Global Fortification Data Exchange data. This substantial compliance gap indicates that high production capacity alone does not guarantee the availability of fortified products; quality control issues, cost considerations, and inconsistent enforcement undermine fortification objectives (FFI n.d.; FFDx n.d.). Early 2000s technical assessments documented that, of approximately 198 mills operating in Brazil, only about 50% were producing at full capacity due to competition from Argentine wheat flour imports and price controls on wheat products; this structural underutilization indicated economic pressures potentially incentivizing cost-cutting measures, including inadequate fortification investments (USDA FAS 2025).

Maize and rice milling: Industrial maize flour milling operates on a smaller scale than wheat milling, with 17 industrial mills exceeding a capacity of 20 tons per day. This situation presents similar fortification requirements and enforcement challenges. Brazil is the largest rice producer in the Western Hemisphere, but production levels can fluctuate based on weather conditions. For the 2023–24 season, production was estimated at between 7.0-7.2 MT due to severe flooding in Rio Grande do Sul, with a rebound to 8.675 MT forecast for the 2024–25 season (USDA FAS 2025).

The rice milling industry's structure comprises a limited number of large-scale mills, which theoretically supports coordinated adoption of fortification. However, Brazil's fortification legislation does not mandate rice fortification, resulting in a voluntary environment where market forces dictate uptake. Since 2011, PATH and GAIN have partnered on initiatives that have piloted Ultra Rice technology in selected Brazilian municipalities and public school feeding programs. The initiative established a Center of Excellence in Food Fortification at the Federal University of Viçosa to facilitate technology transfer to domestic and international manufacturers. In select municipalities in Mato Grosso do Sul, São Paulo, and Ceará, fortified rice has been integrated into the National School Feeding Program, reaching approximately 65,000 schoolchildren daily (PATH 2022).

Although fortified rice is technologically viable and has demonstrated implementation success, its adoption in the broader market remains limited. This is primarily due to consumer preference for white rice, a lack of regulatory mandates, and insufficient price premiums that fail to incentivize industry investment.

Quality assurance and compliance: The critical gap between industrial capacity and the availability of fortified products highlights considerable deficiencies in compliance and quality assurance. In Brazil, mandatory fortification of wheat and maize flour requires iron at 4–9 mg per 100 g and folic acid at 140–220 µg per 100 g, and ANVISA monitoring found that about 25% of flour analyses in 2020–21 had iron levels outside the legal range, while 51% of folic acid results in 2021 were outside the prescribed limits. A broader analysis of flour samples from 2007–17 found that 37.6% were outside the required iron range, indicating persistent noncompliance over time (InfoAlimentario 2022a).

The cost-effectiveness of wheat and maize flour fortification in Brazil was estimated at approximately US$41 per DALY saved over 10 years, positioning fortification as a highly cost-effective public health intervention by World Bank standards (which classify interventions costing less than US$200 per DALY saved as cost-effective). This favorable cost-effectiveness ratio suggests that compliance problems reflect implementation and enforcement failures rather than economic infeasibility (Shekar et al. 2017).

Internal quality assurance at the mill level constitutes the first critical checkpoint for fortification compliance. ANVISA resolutions outline the requirements for internal quality control procedures to ensure the incorporation of fortification ingredients at specified levels, though regulatory documentation provides limited specificity regarding required methodologies or monitoring frequency. However, external regulatory monitoring through ANVISA sampling provides the second quality assurance checkpoint, although ANVISA's fortification monitoring program faces substantial capacity constraints (InfoAlimentario 2022b).

ANVISA's regulatory framework addresses bioavailability, requiring that fortification ingredients use bioavailable nutrient sources and considering absorption efficiency when setting fortification levels. Iron fortification standards recognize that iron bioavailability varies substantially by compound (ferrous sulfate exhibits greater bioavailability than electrolytic iron powder), as well as by pH-dependent absorption dynamics, and dietary inhibitor interactions. The revised iron range (4–9 mg per 100 g) appears to reflect the accumulating evidence on bioavailability challenges and processing losses.

Furthermore, ANVISA's monitoring in 2019–21 documented a high level of non-compliance with labeling requirements, suggesting that enforcing regulatory requirements for consumer information transparency presents similar challenges to those involved in ensuring compliance with nutrient content regulations. Additionally, many segments of the population have a limited understanding of the purpose and implications of fortification, and evidence of coordinated nutrition education campaigns to address these gaps is limited (ANVISA n.d.).

2.3.2.4.2 Integration with social safety net programs

The National School Feeding Program as the primary integration mechanism: The National School Feeding Program serves as the primary institutional mechanism for integrating food fortification into social protection, ensuring that fortified foods are provided to all school-age children, regardless of their household economic circumstances. Through the National School Feeding Program's universal food provision, fortified wheat flour products (bread, pasta, biscuits) and increasingly fortified rice reach 40 million students daily during the academic year. This integration transforms food fortification from a market-dependent intervention into a rights-based, universally accessible nutrition intervention. The program's decentralized management structure and its mandate to employ municipal nutritionists create local accountability for ensuring nutritional adequacy and food quality (Global Alliance Against Hunger and Poverty n.d.-b; Barbosa et al. 2023).

Bolsa Família and household food purchases: The Bolsa Família program, while not a fortified food program per se, increases households' purchasing power for food, including fortified staples available through formal retail channels. The program includes conditional requirements such as participation in nutrition monitoring through SISVAN and ensuring school attendance. These requirements create opportunities for nutrition education and monitoring. The connection between

Bolsa Família and SISVAN is particularly significant: SISVAN, which became an online platform in 2008 and operates through primary health care facilities, has historically relied on data collected from participation in transfer programs. This integration enables effective population-level monitoring of nutrition trends (Ministry of Citizenship 2023; Ministry of Health 2024).

Social councils and nutrition supplementation integration: The governance of the National School Feeding Program explicitly incorporates social participation through institutional social councils comprising students, parents, teachers, and community members. These councils provide institutional mechanisms for community oversight, quality monitoring, and accountability. The NVASP is increasingly integrating with other health system services, with distribution occurring through health facility contacts, routine immunization programs, and periodic child health days delivering bundled interventions (Institute for Mobility and Social Development 2024).

2.3.2.4.3 Population reach and coverage metrics

The National School Feeding Program coverage and fortification reach: The National School Feeding Program reaches 40 million students in more than 160,000 schools across 5,570 Brazilian municipalities (World Food Programme 2020). The program provides 200 school days of meals annually, with per-student budget allocations varying by education level (Undime 2023).

Wheat flour fortification reaches an estimated proportion of the population corresponding to the percentage of flour available through industrial milling channels. Given that 100% of industrial wheat flour production originates from industrial mills that are theoretically subject to fortification standards, only 38% of industrial flour is actually fortified. This means that the estimated maximum coverage for wheat flour fortification reaches only 38% of the population. This estimate assumes perfect distribution of fortified flour but does not account for consumption of non-fortified artisanal flour or flour from informal channels (FFDx n.d.-a).

Rice fortification coverage remains minimal outside the National School Feeding Program and select commercial retail channels targeting health-conscious consumers. The voluntary nature of fortification and the limited adoption of Ultra Rice technology imply that population-level rice fortification coverage remains below 10% in most regions, except in specific municipalities where the National School Feeding Program has been implemented (GCNF 2024).

National vitamin A supplementation and salt iodization coverage: The NVASP coverage of 41.5% among children aged 6 to 59 months indicates significant gaps in program reach, with geographic variations reflecting program prioritization efforts. The North and Northeast regions, where vitamin A deficiency burden is concentrated, achieve higher coverage through integration into the Brazil Without Poverty Plan.

Salt iodization, mandated by ANVISA regulations, has achieved near-universal coverage in industrially produced salt products distributed through formal retail channels. Additionally, integrating iodized salt into virtually all processed and semi-processed foods further ensures that the population is reached, independent of explicit salt purchases (ANVISA 2024).

SISVAN surveillance coverage: The Food and Nutrition Surveillance System monitors nutritional status and food consumption patterns through primary health care facilities. It has generated data from approximately 21.3 million anthropometric assessments (2008–18) and 442,580 food

consumption records (2015–18). Since its establishment in 2004, SISVAN's coverage has expanded substantially, with particular strength in monitoring vulnerable populations (children under five years old, pregnant women, and beneficiaries of income transfer programs). Additionally, it has gradually improved the representation of older children and adults (Ministry of Health 2024).

2.3.2.5 Value Chain, Quality Assurance, and Regulatory Frameworks

The fortified flour value chain encompasses cereal production, industrial milling, fortification, food manufacturing, distribution, and retail to improve consumer access. Each stage presents specific quality assurance challenges and regulatory oversight requirements.

The fortified flour value chain begins with wheat and maize production by commercial farmers. This production is then directed to industrial mills that are equipped for fortification. The mills source fortification premixes from domestic suppliers or through imports. They add these premixes along with other ingredients at specified levels before distributing the final products through wholesale and retail channels. For wheat flour specifically, the mills deliver flour in bulk to various manufacturers, including bread manufacturers, biscuit producers, pasta manufacturers, and retailers, each of whom may further process flour into consumer-ready products. This multi-stage value chain creates multiple intervention points where quality deterioration or ingredient substitution might occur (FFI n.d.; Brazilian Cooperation Agency n.d.).

The rice fortification value chain diverges from that of wheat/maize in that it lacks a mandatory fortification requirement. In the voluntary approach, individual rice millers decide whether to implement fortification. They can use Ultra Rice premixes or traditional fortification ingredients and market their products to consumers willing to pay a premium for fortified rice.

2.3.2.5.1 Quality assurance systems and bioavailability

Current state and gaps: Internal quality assurance at the mill level serves as the first critical checkpoint for ensuring compliance with fortification standards. Larger, more advanced operations tend to implement rigorous in-line testing and process monitoring, while smaller operations may employ more limited or episodic testing approaches. The second quality assurance checkpoint involves external regulatory monitoring through ANVISA sampling; however, this process faces substantial capacity constraints.

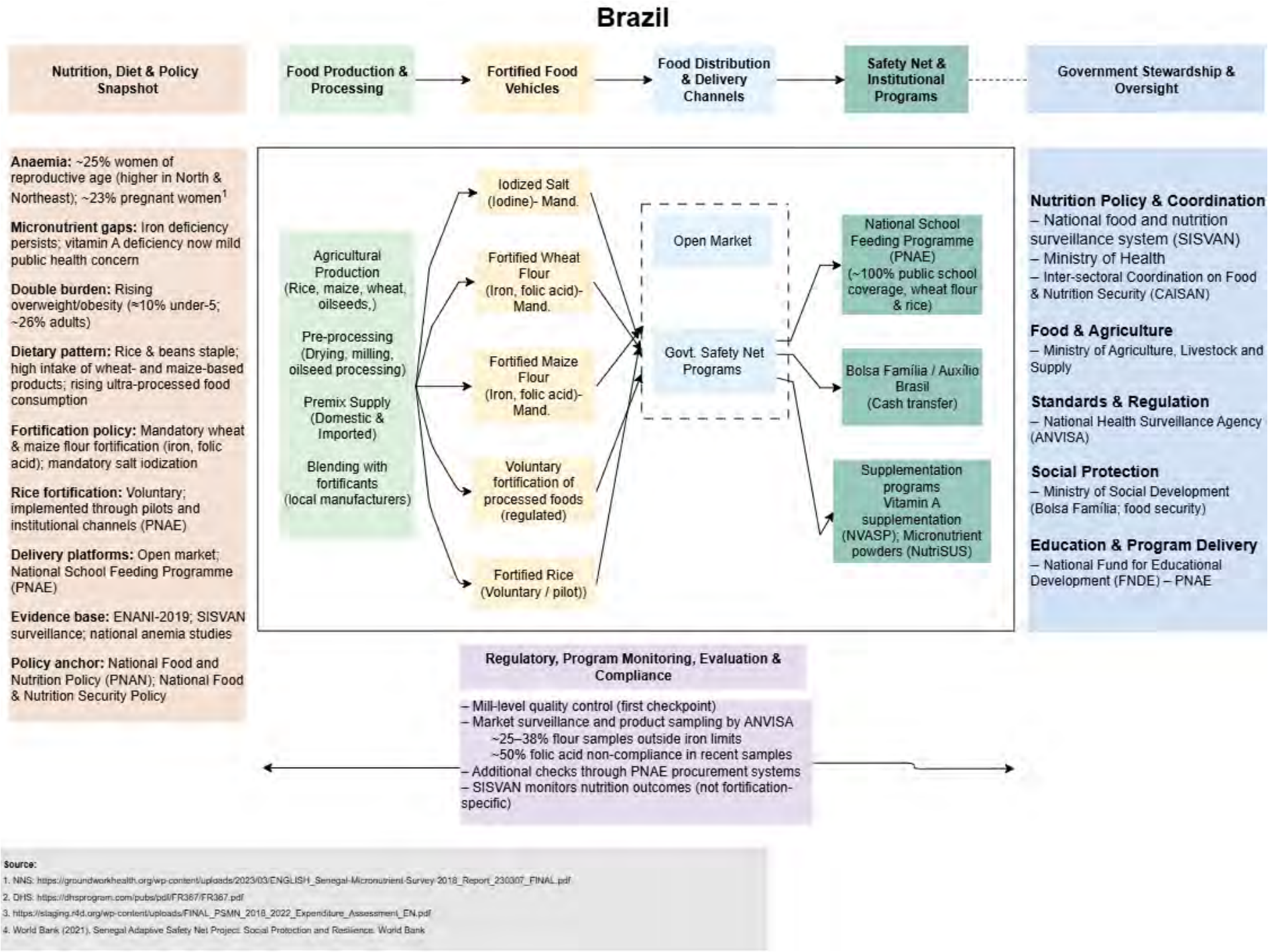
Bioavailability considerations: Post-distribution bioavailability, referring to the actual absorption efficiency of fortified nutrients consumed by population groups, remains poorly monitored in Brazil. Limited research has documented the actual bioavailability and absorption of nutrients in Brazilian populations consuming fortified flour products. Much of the existing evidence comes from controlled research settings and the global literature. This knowledge gap impedes a precise assessment of whether observed reductions in micronutrient deficiency reflect the genuine impact of fortification or are confounded by broader dietary, health, and socioeconomic improvements (dos Santos et al. 2015).

2.3.2.5.2 Regulatory framework effectiveness and reform needs

Brazil's regulatory framework faces challenges on several fronts. A lack of clarity about the roles of federal ANVISA and state and municipal authorities leads to coordination problems and potential oversight gaps. Additionally, political barriers to enforcement appear to inhibit consistent application of compliance and remediation measures, owing to concerns that vigorous enforcement might generate industry opposition (ANVISA 2023).

The OECD's 2024 analysis of regulatory governance for LSFF identified systematic bottlenecks, including insufficient budget allocation for monitoring, burdensome licensing requirements, unclear agency responsibilities, a lack of coordination mechanisms for supervision, and insufficient enforcement action. These systemic challenges resonate closely with Brazil's experience. To address these issues, the report recommends regulatory reforms, including clarifying agency roles and accountability, providing technical support to industry to build compliance capacity, and establishing transparent, proportionate enforcement mechanisms with consistent application (OECD 2024). Refer to Figure 2.14.

Figure 2.14. Brazil's food fortification ecosystem



Source:

1. NNS: https://groundworkhealth.org/wp-content/uploads/2023/03/ENGLISH_Senegal-Micronutrient-Survey-2018_Report_230307_FINAL.pdf
2. DHS: https://dhsprogram.com/pubs/pdf/FR367/FR367.pdf
3. https://staging.r4d.org/wp-content/uploads/FINAL_PSMN_2018_2022_Expenditure_Assessment_EN.pdf
4. World Bank (2021). Senegal Adaptive Safety Net Project: Social Protection and Resilience. World Bank

2.3.2.6 Monitoring and Evaluation Mechanisms

SISVAN, formally established by Ordinance No. 1,156 on August 31, 1990, and enhanced through the creation of the SISVAN Web online platform in 2008, serves as the primary national tool for monitoring the nutritional status and food consumption patterns of users in primary health care. The system generates anthropometric assessments (such as weight, height, and body mass index) and classifies them according to WHO growth standards. Additionally, it collects data on food consumption to document dietary patterns and assess micronutrient adequacy.

From 2008 to 2018, SISVAN recorded 21.3 million anthropometric assessments and 442,580 food consumption records (from 2015 to 2018), providing extensive documentation of nutritional trends. The expansion from regional pilots in the early 2000s to a national scale has enabled the identification of longitudinal trends and vulnerable populations requiring targeted interventions.

However, SISVAN operates primarily as a surveillance system that documents existing conditions rather than as an evaluative system that measures the specific impact of fortification on nutritional outcomes. SISVAN data lack granularity on fortified food consumption or individual-level fortified product intake, limiting causal attribution of nutritional improvements to fortification (Nasser and Maun 2021).

ENANI and fortification compliance monitoring: The Brazilian National Survey on Child Nutrition (ENANI), representing a large-scale household survey that generates nationally and regionally representative data on maternal, infant, and young child nutrition, filled a 13-year gap in comprehensive nutrition survey data following the last similar survey in 2006. The ENANI-2019 survey, conducted in 2019, assessed approximately 14,558 households with children. It estimated the prevalence of micronutrient deficiencies, breastfeeding practices, and dietary patterns among Brazil's child population (Farias et al. 2025).

ANVISA's periodic sampling and analysis of flour products provide market surveillance data that document compliance with fortification standards. However, this surveillance data alone has not driven improved compliance without accompanying enforcement capacity and political will. Consistent rates of similar non-compliance across years (approximately 37.6% in 2007–17 and 25% in 2019–21) suggest that surveillance data alone have not achieved compliance levels that meet public health objectives.

Food security and program-specific monitoring: Brazil maintains systematic monitoring of household food security through the Brazilian Food Insecurity Scale (EBIA), integrated into the Brazilian National Household Sample Survey (PNAD) in 2004, 2009, and 2013, and subsequently incorporated into the Family Budget Survey (POF) in 2018. Assessing food security provides the critical context for interpreting the effectiveness of nutrition programs.

The National School Feeding Program incorporates monitoring systems that track program coverage, budget execution, procurement compliance, and meal provision rates across implementing municipalities. NVASP similarly maintains data on coverage monitoring, enabling the documentation of vitamin supplementation distribution patterns and the identification of geographic gaps.

Impact evaluation and limitations: A critical gap in Brazil's monitoring and evaluation infrastructure is the lack of impact evaluations of fortification. While SISVAN and ENANI document population nutritional status trends and micronutrient deficiency burden, these surveillance systems provide limited evidence of the specific contributions of fortification to changes in nutritional status. Rigorous impact evaluation designs that compare fortification with non-fortification conditions or measure bioavailability and absorption in target populations have been limited in Brazil. These research gaps limit the ability to refine evidence-based policy effectively.

2.3.2.7 Stakeholder Ecosystem and Partnerships

Government and private-sector actors: The federal government manages fortification policy and program implementation through multiple agencies: the Ministry of Health (ANVISA for regulation), the Ministry of Education (FNDE for National School Feeding Program coordination), the Ministry of Social Development (income transfers and food security), and the Ministry of Agriculture (production and food system development). CAISAN, comprising representatives from 24 federal ministries, theoretically provides horizontal coordination across sectoral agencies. However, evidence indicates that interministerial coordination remains limited, with the National School Feeding Program, supplementation programs, fortification policy, and food security governance operating as relatively parallel initiatives with limited integrated planning.

State and municipal governments implement federally coordinated programs while contributing supplementary resources and local adaptation. The approximately 7,347 registered nutritionists employed by municipalities through the National School Feeding Program coordination represent critical frontline actors in ensuring nutritional adequacy and quality assurance.

Industrial millers, flour and rice manufacturers, and food retail corporations constitute the primary private sector actors. Industry associations, such as the Brazilian Association of Wheat Millers and analogous organizations, provide a collective voice for industry interests and technical capacity-building. Private retailers, particularly large supermarket corporations dominating modern grocery distribution, determine product availability and consumer access to fortified goods. However, these retail-level actors have limited direct involvement in fortification advocacy (Miller Magazine 2015).

Research, civil society, and international partners: Brazil's research capacity for fortification and nutrition is concentrated in 24 university-based Collaborative Centers for School Feeding and Nutrition. The Federal University of Viçosa established a Center of Excellence in Food Fortification to facilitate technology transfer and build technical capacity. Academic research institutions, including the Institute for Applied Economic Research, the Research Consortium for School Health and Nutrition, and various federal universities, contribute peer-reviewed research on nutrition interventions and food policy analysis.

Civil society participation in food fortification and nutrition security governance includes nongovernmental organizations that advocate for nutrition and food security. While the literature documents growing civil society participation in food security governance, the extent of fortification-specific mobilization remains less clear than broader food security engagement.

International development organizations, such as PATH, GAIN, the WFP, and bilateral donors, have supported fortification initiatives in Brazil. These initiatives focus particularly on the scale-up of rice

fortification and research into micronutrient powder home fortification. The FAO and WHO provide technical guidance and coordination within international fortification frameworks. However, ongoing international engagement in Brazilian fortification appears limited compared with other low- and middle-income countries, reflecting Brazil's position as a middle-income country with developed technical and institutional capacity.

Coordination mechanisms and gaps: Formal coordination mechanisms linking diverse stakeholders are underdeveloped. While CAISAN provides a governmental inter-sectoral platform, mechanisms enabling government-industry-civil society dialogue on fortification appear limited. While some industry-specific working groups or alliances that address fortification challenges operate informally, there is little documented evidence of sustained collaborative problem-solving to address compliance challenges. Civil society participation in fortification governance appears insufficiently organized to function as a systematic accountability mechanism for monitoring and evaluating the performance of fortification programs.

2.3.2.8 Critical challenges and policy reforms needed

Quality assurance and compliance: The study indicated that fortified flour samples in Brazil frequently fall outside established micronutrient content standards. For example, ANVISA (2022) indicated non-compliance rates of 25% for iron and 51% for folic acid, highlighting a persistent gap in quality assurance.

Multiple factors contribute: Mills, especially smaller operations with limited technical resources, may lack sophisticated quality control infrastructure. Cost pressures may incentivize inadequate fortification as a cost-minimization strategy. Furthermore, the existing regulatory enforcement mechanisms appear insufficient to deter non-compliance, and the technical guidance provided to mills for achieving consistent fortification may also be inadequate. Monitoring and evaluation gaps in LSFF: Despite well-established fortification mandates and routine regulatory surveillance, Brazil has limited evidence on the population-level effectiveness of its LSFF program. Santos et al. (2015) noted that, nearly a decade after mandatory wheat and maize flour fortification was introduced, no nationwide evaluation had assessed its impact on iron and folic acid intake. The study also highlighted substantial variability in micronutrient content among fortified flour samples, indicating implementation inconsistencies that limited reliable assessment of program effectiveness. These findings suggest that strengthening impact evaluation alongside routine compliance monitoring would provide a stronger evidence base for refining Brazil's fortification program (Santos et al. 2015).

Regional disparities and double burden of malnutrition: Brazil's vast geographic territory encompasses regions with substantially different levels of economic development and health system capabilities. The North and Northeast regions, which have lower human development indices and limited institutional infrastructure, experience a higher burden of micronutrient deficiencies and food insecurity. Addressing regional disparities requires explicit geographic prioritization, differential resource allocation, and tailored implementation approaches that recognize context-specific constraints.

Brazil’s substantial experience with food fortification, accumulated evidence base, and technical capacity position the country to serve as a regional and global knowledge leader. The Center of Excellence in Food Fortification at the Federal University of Viçosa could expand its role in technology transfer and capacity-building across Latin America and beyond. Documenting and disseminating Brazil's lessons learned, including assessments of challenges and unsuccessful

approaches, would contribute to global fortification knowledge and support peer learning with other middle-income countries facing similar implementation challenges.

The documented effectiveness of home fortification through multiple micronutrient powders (NutriSUS model) in reducing multiple micronutrient deficiencies simultaneously positions the provision of multiple micronutrient powders as a complementary strategy to large-scale fortification. Scaling NutriSUS from pilot implementation to comprehensive coverage of vulnerable child populations requires assured supply chains, trained health workers, and community mobilization to support caregiving practices that enable consistent use.

The simultaneous prevalence of undernutrition and overweight/obesity within the same populations represents a fundamental challenge for fortification strategies. Fortifying refined grain products may increase overall caloric intake, potentially exacerbating the risk of overweight in populations transitioning to energy-dense diets while addressing micronutrient gaps. Addressing the double burden requires moving beyond single-nutrient fortification strategies toward comprehensive food system approaches, ensuring dietary diversity, and implementing nutrition education to reduce ultra-processed food consumption.

2.3.2.9 Opportunities and Future Directions

Mandatory rice fortification and quality assurance infrastructure: Rice is a critical staple food consumed across all population segments and socioeconomic strata in Brazil, with evidence supporting the feasibility of fortification using the proven Ultra Rice technology, successfully implemented in the National School Feeding Program and select commercial retail markets. Mandatory rice fortification legislation would immediately expand coverage to populations that do not reliably consume fortified wheat/maize flour products, while leveraging the concentrated structure of the rice milling industry to enable rapid implementation.

Enhancing quality assurance infrastructure requires substantial investment at multiple system levels: developing national laboratory reference standards and proficiency testing programs; providing technical support and financial incentives to mills to invest in quality control equipment; and targeted capacity-building for regulatory inspectors, including analytical skills and standardized methodologies. International experience from countries with high fortification compliance (90%+) indicates that investment in industry technical support, combined with consistent regulatory oversight, enables substantial improvements in compliance.

Regulatory modernization and fortification financing sustainability: The ANVISA regulatory framework, while substantive in its technical content, requires modernized enforcement mechanisms and expanded inspection capacity. Establishing transparent, proportionate enforcement protocols with clear compliance criteria, consistent application across all mills, and public communication of enforcement actions would enhance regulatory effectiveness. Digital technologies, including remote monitoring systems and rapid analytical techniques, could reduce monitoring costs and enable more frequent surveillance. Explicit budget allocation to ANVISA for fortification monitoring would ensure sustainable inspection capacity.

The cost-effectiveness of flour fortification, approximately US$41 per DALY saved, makes it a highly cost-effective public health intervention. However, sustainability depends on continuous industry investment in fortification ingredients and infrastructure, government funding for regulatory

oversight, and sustained political commitment to maintain mandatory fortification policies. Economic pressures on mills, currency fluctuations affecting ingredient costs, and potential industry lobbying for policy relaxation represent ongoing threats to fortification sustainability.

Integration with nutrition education and food system approaches: Fortification's effectiveness in reducing micronutrient deficiencies is constrained by limited awareness of the significance of fortified products and the absence of complementary nutrition education. Systematic nutrition education campaigns, integrated into school curricula through the National School Feeding Program, health system contacts, and community health worker outreach, could enhance the utilization of fortified products and support broader dietary improvements that address the double burden of malnutrition. These efforts may emphasize dietary diversity, including legumes and nutrient-dense local foods, rather than positioning fortification as the sole solution to nutritional deficiency.

A fundamental challenge underlying both undernutrition and micronutrient deficiencies in Brazil is inadequate dietary diversity, reflected in high dependence on refined grain-based diets and limited consumption of legumes, vegetables, and other nutrient-dense foods. Fortification of staple grains addresses some micronutrient gaps but cannot replace dietary diversity. Fortification policy must be integrated with agricultural policies that promote crop diversification, protect smallholder production of nutritious foods, and ensure food access through market-based and non-market mechanisms.

Addressing Brazil's nutritional challenges requires integrating fortification policy with food security programs, agricultural support for crop diversification, and food system approaches to ensure dietary diversity. The reinstitution of the Brazil Without Hunger Plan, coupled with agricultural policies supporting family farming and crop diversification, creates opportunities to integrate fortification into broader food system transformation. The National School Feeding Program's mandate for family farming purchases (30–50% of resources) creates market demand that could incentivize production of diverse nutrient-dense foods, particularly in resource-limited regions. Agricultural extension services could promote household production of complementary foods (legumes, vegetables, fruits), reducing dependence on fortified grains as the sole micronutrient source.

Enhanced public-private partnerships and monitoring systems: The successful model of PATH-GAIN collaboration on rice fortification demonstrates the potential of structured public-private partnerships that combine government regulatory authority, industry technical capacity, and international technical expertise. Extension of this partnership approach to wheat and maize flour fortification, with an explicit focus on improving compliance and industry technical support, could accelerate advances in quality assurance. Structured partnerships may include clear performance targets, accountability mechanisms, and benefit-sharing arrangements, incentivizing both public health objectives and industry investment in compliance.

Advancing monitoring and evaluation systems to assess fortification's specific contribution to population nutritional status would strengthen the evidence base for policy refinement. Prospective impact evaluation designs that compare fortification impact across different implementation scenarios, document bioavailability and absorption in target populations, and measure dietary intake alongside biomarkers would provide evidence of accountability for fortification program effectiveness. Integration of fortification-specific indicators into SISVAN and ENANI would enable better tracking of fortification program coverage and population-level outcomes.

Strategic prioritization of resources toward the North and Northeast regions, where micronutrient deficiency burden is concentrated and capacity constraints are greatest, represents an opportunity to address critical health needs while advancing health equity. Differentiated implementation approaches recognizing region-specific constraints would improve program appropriateness and acceptance.

Enhancing community monitoring mechanisms through strengthening the National School Feeding Program Social Councils and extending social monitoring to retail fortification could improve program accountability. Training community monitors in fortification basics, providing tools for simple quality checks, and creating feedback mechanisms linking community concerns to regulatory responses would position communities as accountability actors within fortification governance.

2.3.3 Costa Rica

2.3.3.1 Nutrition and Fortification Ecosystem

Costa Rica stands as a high human development country and a recognized global pioneer in food fortification, demonstrating sustained political and technical commitment to nutrition-based public health interventions for over five decades. With a population exceeding 5 million, the nation has strategically positioned nutrition as a cornerstone of its public health system, anchoring this commitment within its National Health Policy (2016–21) and the National Nutrition Plan, implemented through the Ministry of Health, the Costa Rican Social Security Fund (CCSS), and the Institute for Research and Teaching in Nutrition and Health (INCIENSA). The foundational architecture of Costa Rica's food fortification strategy originates in legislation enacted in 1973 under the National Health Law, which mandated fortification as a national nutrition strategy and positioned the country among the earliest adopters of LSFF in Latin America (START Center 2024).

Several defining characteristics distinguish Costa Rica's fortification ecosystem: (i) multi-vehicle mandatory fortification spanning staple foods consumed across socioeconomic strata, (ii) robust regulatory frameworks with enforcement mechanisms, (iii) coordinated monitoring and surveillance systems integrated with clinical outcomes tracking, and (iv) demonstrated effectiveness in reducing micronutrient deficiency burden while maintaining compliance across industrial and distributed supply chains. This integrated approach, combining fortification with nutrition surveillance and quality assurance, has been cited by PAHO and WHO as an exemplary international practice, providing evidence of the adaptability and scalability of fortification strategies in Latin American

contexts. The Costa Rican model differs from contemporaries in Central America by emphasizing systematic monitoring tied to health outcomes (particularly NTD surveillance) and institutional capacity for continuous program refinement based on epidemiological and biochemical evidence (Martorell et al. 2015; Martorell 2017).

The governance structure reflects an inter-sectoral coordination framework established through the Secretaría de la Política Nacional de Alimentación y Nutrición (SEPAN), which convenes representatives from health, agriculture, economy, education, business, and civil society sectors. This multi-stakeholder governance architecture, codified through Decree 35960 (2010) establishing the National Food Safety Policy, positions fortification within a broader food security and safety mandate rather than as an isolated micronutrient intervention, reflecting contemporary understanding that fortification effectiveness depends on systemic food safety, supply chain integrity, and market access mechanisms. The Costa Rican fortification ecosystem thus operates within a context of institutional maturity, legal clarity, and sectoral integration factors that have enabled sustained compliance and impact across two generations of program implementation (Canadian Food Inspection Agency 2024).

2.3.3.2 Nutritional Status and Dietary Practices

Costa Rica presents a paradoxical nutritional profile characteristic of middle-income countries undergoing a rapid nutrition transition: demonstrable success in combating classical micronutrient deficiencies through fortification, alongside an emerging epidemic of overweight, obesity, and diet-related NCD. This dichotomy shapes contemporary nutrition policy priorities and the evidence base for fortification scale-up decisions.

Micronutrient status improvements: The country has achieved dramatic reductions in key micronutrient deficiencies through systematic fortification. Iron deficiency anemia in children under five years old declined from 19% (1996) to less than 5% (2010), a reduction of more than 75% over 14 years. This decline occurred concurrently with the expansion of fortified vehicles from wheat flour (1958, reformulated in 2002) to include maize flour (with ferrous bisglycinate since 1999), milk products (liquid and powdered, with ferrous bisglycinate since 2001), and rice (through a head-rice enrichment strategy under mandatory regulations). Vitamin A deficiency among preschool children was significantly controlled through sugar fortification initiated in 1975, then suspended from 1982 to 2003 and reinitiated in 2003; this vehicle-level interruption highlights both the vulnerability of disease control gains to policy discontinuity and the robustness of Costa Rican systems in re-establishing intervention effectiveness (Martorell 2017).

Iodine deficiency disorders were effectively addressed following mandatory salt iodization implemented in 1972, representing one of the longest-sustained public health interventions in the country and demonstrating the sustained institutional capacity for compliance enforcement. Folic acid fortification of wheat flour (initiated in 1997) and subsequently expanded to maize flour, rice, and milk has generated documented reductions in NTDs: a 60% reduction in NTD prevalence post-fortification, with NTD-associated infant mortality declining by 76% from 77.01 to 18.66 per 100,000 livebirths. Between 2010 and 2020, the cumulative fortification program (across all vehicles combined) provided an average of 119% of the estimated average requirement (EAR; estimated average requirement = 400 μg/day) for folic acid, indicating systematic adequacy in micronutrient delivery despite variation across individual food vehicles (Castillo-Lancellotti et al. 2012; Benavides-Lara et al. 2023).

Persistent micronutrient gaps: Despite programmatic success, residual micronutrient deficiency burdens persist in specific populations. Anemia among WRA remains at 13.7% (2023), with no recorded progress toward WHO reduction targets, indicating that fortification, while reducing the anemia burden, has not fully addressed the multifactorial etiology (intestinal parasitism, menstrual blood loss, dietary diversity) in this age group. Adolescent populations present micronutrient adequacy challenges that current fortification strategies do not resolve: only a 0.03 probability of calcium adequacy among Costa Rican adolescents despite dairy fortification, reflecting either insufficient milk consumption or inadequate fortification levels for this age group's elevated requirements. Iron inadequacy persists in adolescents (probability of adequacy: 0.01–0.07), suggesting that even bioavailable iron from fortified foods does not fully meet iron requirements in adolescent females experiencing menarche-associated increases in iron losses (Global Nutrition Report 2024; Monge-Rojas et al. 2021).

Nutrition transition and obesity epidemic: The most significant epidemiological shift is the epidemic rise in overweight and obesity: more than 50% of Costa Rican adults are classified as overweight or obese, with parallel increases in childhood and adolescent overweight prevalence. Obesity was formally declared a chronic disease of public health importance in January 2025 through Executive Decree 44780-S, signaling institutional recognition that nutrition policy must address the concurrent prevention of both micronutrient deficiency and caloric/weight excess. Dietary assessment studies indicate that while traditional foods (beans, vegetables, fruits) remain consumed, particularly in rural and lower-income populations, contemporary dietary patterns in urban areas are characterized by high saturated fat content, low polyunsaturated fat and fiber intake, and substantial consumption of sugar-sweetened beverages, processed snacks, and fast foods (Monge-Rojas et al. 2005; Monge-Rojas et al. 2021; World Obesity Federation 2024).

Dietary diversity and food group consumption: Costa Rican adolescents demonstrate higher dietary diversity compared with regional peers (66.5% meet minimum dietary diversity criteria versus 55.6% in Mexico), with rural adolescents (72%) and those of lower socioeconomic status showing higher traditional diet quality than urban counterparts (61%). Rice consumption remains substantial, representing approximately 24% of total calorie intake and 49–68 kg per capita annually, consistent with consumption levels in rice-dependent countries such as Japan. Beans, white rice, and dairy products constitute the traditional dietary pattern protective of diet quality. At the same time, refined grains, processed meats, sugar-sweetened beverages, and energy-dense snacks are negatively associated with overall dietary quality scores in adolescents. This bifurcation, with vulnerable and rural populations retaining higher dietary quality while urban populations experience accelerated dietary transition, shapes targeting strategies for fortification and dietary diversification interventions (Guadamuz-Mayorga et al. 2022; Helgi Library n.d.).

2.3.3.3 Nutrition-related Flagship Program

Costa Rica's nutrition-related flagship programs operate across the life course and integrate fortified foods as systemic delivery mechanisms for micronutrient interventions, embedding fortification within broader nutrition security and educational frameworks.

School Child and Adolescent Food and Nutrition Programme (PANEA): PANEA is the largest-scale fortification delivery mechanism in Costa Rica and serves as the primary nutrition intervention platform for school-age populations. Established in 1974, PANEA has become a centrally funded, school-level program that provides meals to enrolled children in preschool, primary, and secondary

education. During the 2022 school year, PANEA operated in 4,569 public schools, serving approximately 532,084 primary school students and 17,994 preschool-age children. This means that 86% of eligible primary students and 100% of preschool students received food through the program. Meals are provided five days per week throughout the calendar year, with targeting criteria based on socioeconomic vulnerability. Secondary school participation is lower (18% of enrolled students receive food, compared with 100% of primary students), reflecting the program's prioritization of younger children with elevated micronutrient requirements (UNESCO 2020; Majewski 2017).

PANEA menus are designed to meet age-specific nutritional requirements and include fortified milk (with vitamins A and D, iron, and folic acid), wheat flour products (fortified with iron, folic acid, thiamine, riboflavin, and niacin), and iodized salt. Program governance involves centralized decision-making through the Ministry of Public Education, with financial subsidies transferred to school education boards or administrative bodies that procure food domestically (100% domestic sourcing, with no in-kind foreign donations) and prepare meals in accordance with centrally established parameters. Beyond meal provision, PANEA incorporates school garden agricultural projects and nutrition education integrated into school curricula, addressing both direct nutrition provision and behavioral/educational pathways to improved dietary practices (Global Child Nutrition Foundation 2024).

Meal timing has been adjusted to align with school schedules, and program expansion has been a stated success metric; however, coverage fluctuated during the 2022 school year due to natural disasters, economic crises, health epidemics, and food price inflation, highlighting supply chain and fiscal vulnerabilities. PANEA's integration of fortified foods ensures that vulnerable school-age populations receive consistent micronutrient delivery regardless of household-level food diversity or purchasing power, addressing equity objectives in nutrition programming.

Avancemos conditional cash transfer program: Avancemos, operational since 2006, targets economically vulnerable adolescents and youth (ages 12–25) in situations of extreme poverty and social vulnerability, with eligibility determined through the Social Information Record (Ficha de Información Social) and enrollment in secondary education. In 2015, approximately 157,000 secondary students received monthly cash transfers via prepaid cards issued by the National Bank of Costa Rica. These transfers were contingent upon co-responsibilities, including school attendance and completion of the school year. While Avancemos is primarily a human capital investment mechanism rather than a direct nutrition program, its intersection with fortified food consumption through school meal provision and household purchasing patterns creates an indirect pathway through which cash transfers enhance access to and consumption of fortified staples (Hernández Romero 2016).

Universal health coverage and nutrition services: The Costa Rican Social Security Fund (CCSS) provides essential health services to nearly the entire population (>90%), with targeted free services for mothers, children, Indigenous peoples, the elderly, and individuals with disabilities. However, access to specialized nutrition counseling remains severely constrained: the number of nutritionists relative to the CCSS patient population results in extensive waitlists, and most primary care physicians are inadequately trained to provide micronutrient-related counseling. This institutional gap, particularly relevant for managing concurrent micronutrient deficiency and overweight/obesity in the same individuals, represents a critical limitation in translating fortification benefits into broader nutritional improvements, particularly for the prevention of NCDs (Stampini and Tornarolli 2012).

2.3.3.4 Policy Environment for Food Fortification

Costa Rica's policy environment for food fortification is characterized by mandatory legislation, explicit micronutrient specifications, sanctioning mechanisms for noncompliance, and periodic decree-based adjustments responding to epidemiological evidence, creating a framework of regulatory clarity rarely achieved in developing-country contexts.

Legislative and regulatory foundation: The foundational legislation dates to the National Health Law of 1973, which established food fortification as a national public health strategy and authorized the Ministry of Health to establish mandatory fortification requirements for staple foods. This overarching legislative framework has been operationalized through specific executive decrees establishing fortification levels for individual food vehicles, implemented in staggered fashion to reflect epidemiological priorities and technological feasibility: salt iodization (1972), sugar fortification with vitamin A (1975, suspended 1982–2003, reinitiated 2003), wheat flour (1958, reformulated 2002 with improved iron bioavailability), corn/maize flour (various reforms, with the current standard using ferrous bisglycinate), milk (liquid and powdered, current formulation 2001 onward), and rice (mandatory fortification implemented as part of a comprehensive decree system, with head-rice enrichment specified as the technology) (Pereda et al. 2023a).

The National Food Safety Policy (Decree 35960/2010) institutionalizes fortification within broader food safety governance, establishing SEPAN as the inter-sectoral coordinating body and integrating fortification monitoring with food contamination prevention, hygiene standards, and supply chain security. This integration reflects the contemporary understanding that fortification effectiveness requires food safety assurance, that contaminated or unsafe food vehicles negate fortification benefits, and that fortification monitoring systems provide early warning for broader food safety lapses.

Micronutrient-level specifications and program adjustments: Executive decrees specify precise micronutrient concentrations (mg/kg) for each food vehicle. Wheat flour fortification specifies 45–55 mg/kg iron (using ferrous fumarate), with additions of thiamine, riboflavin, niacin, and folic acid at standardized levels. Corn/maize flour includes iron (as ferrous bisglycinate, a highly bioavailable form adopted in 1999), folic acid, thiamine, riboflavin, and niacin. Rice fortification, though mandated by legislation, uses head-rice enrichment technology (extrusion and rinse-resistant coating) to prevent nutrient loss during washing, a technical specification reflecting an understanding of consumer food-preparation practices (Benavides-Lara et al. 2023; Martorell 2017).

Notably, Costa Rica has adjusted fortification specifications in response to emerging scientific evidence and surveillance data. Following concerns regarding excessive folic acid intake (particularly relevant in countries with mandatory fortification across multiple staples), the Ministry of Health convened stakeholder meetings (drawing on a 2008 Chilean example and adopting similar processes in Costa Rica) to address potential adverse effects of cumulative folic acid intake across all vehicles, leading to refined specifications balancing adequacy targets with safe upper intake levels. These dynamic adjustments, informed by INCIENSA surveillance data on serum folate levels and food fortification monitoring, demonstrate institutional capacity for evidence-based regulatory evolution rather than static implementation of historical mandates (Pereda et al. 2023a).

Compliance and sanctioning framework: The regulatory framework specifies producers' and importers' responsibilities regarding food fortification. It requires producers to keep detailed

documentation of premix sourcing, fortification processes, and quality assurance procedures. Ministry of Health inspectors conduct unannounced audits of fortification establishments, with INCIENSA providing technical laboratory support. Non-compliance triggers health orders specifying corrective actions, and systematic noncompliance can result in product seizure, market withdrawal, suspension of operating permits, or product recalls. In 2017, the Ministry of Health analyzed 3,014 samples from fortified foods and issued 29 sanitary orders addressing fortification non-compliance, indicating ongoing enforcement activity. This compliance framework operates within the broader food safety system, where all high-risk food establishments (including fortification facilities) must obtain operating permits and demonstrate compliance with good manufacturing practices and hazard analysis protocols (Pereda et al. 2023a).

Integration with international standards and regional harmonization: The Costa Rican fortification legislation references Codex Alimentarius standards and PAHO/WHO technical guidelines, positioning national requirements within international harmonization frameworks. However, systematic regional harmonization through the Central American Integration System (SICA) and PAHO platforms remains incomplete, with Costa Rica's mandates occasionally diverging from those of Guatemala, Honduras, and Nicaragua on specific micronutrient levels and food vehicles, creating trade policy complexities when fortified goods cross borders. The attached scoping document identifies Central American harmonization of rice fortification standards via SICA and PAHO as a priority for future policy coordination, reflecting the acknowledgment that regional trade integration requires convergence of fortification specifications (Colón-Ramos et al. 2007).

2.3.3.5 Industry Capacity and Role of Private Players

Costa Rica's food milling and fortification infrastructure demonstrates industrial concentration in large-scale mills with documented fortification compliance, coupled with import dependence on food staples and premix inputs, creating a supply chain structure in which a limited number of producers bear primary responsibility for fortification implementation.

2.3.3.5.1 Milling industry structure

Industrial milling capacity is concentrated: Costa Rica operates two wheat flour mills and two maize flour mills with a capacity exceeding 20 tons per day (the threshold for “industrial” classification), producing 100% of domestically milled wheat and maize flour, all of which is fortified. Rice milling capacity is higher (16 industrial mills with a capacity of ≥5 tons per hour of paddy rice processing), yet 100% of industrially milled rice is fortified, indicating comprehensive coverage of the largest-scale production facilities. This industrial concentration creates both advantages (economies of scale in premix purchasing and centralized quality control) and risks (supply disruptions from single-mill failures, limited competition and incentives for innovation) (Food Fortification Initiative 2024).

The private sector demonstrates strong compliance with fortification mandates, with industry stakeholders, including milling associations and importers, actively participating in fortification program governance through consultation mechanisms and adapting to changing specifications. Producer-level internal quality assurance includes documented procedures for premix sourcing, fortification equipment calibration, and product testing, with factories establishing their own laboratory capacity or contracting external testing services to verify fortification compliance prior to government auditing. This dual-layer quality assurance (producer internal monitoring + government external verification) reflects international best practices and distributes the verification burden across public and private sectors (Rowe 2020).

Supply chain and premix sourcing: Most fortification premixes (pre-blended micronutrient compounds) are imported, reflecting global specialization in premix manufacturing and limited domestic pharmaceutical/chemical capacity in Costa Rica. Premix suppliers are predominantly international companies with established distribution networks in Central America, creating a dependency on consistent import flows and pricing subject to global commodity markets. The centralized purchasing power of Costa Rica's milling industry enables negotiation of favorable premix pricing and quality specifications, though supply disruptions (as occurred during the 2022 crisis year with extreme food price inflation) create implementation vulnerabilities (Global Child Nutrition Foundation 2024).

Challenges and gaps in private sector engagement: Despite regulatory mandates and demonstrated compliance in wheat/maize flour, the private rice milling sector has not fully adopted fortification, with significant production continuing in nonfortified channels due to technical barriers (equipment costs), consumer resistance to fortified rice appearance (Costa Rican consumers associate whiteness and looseness with rice quality, and fortification coating may alter sensory properties), and market access challenges in export markets where fortification is not mandated. This gap between regulatory intent and private sector implementation in rice fortification represents a critical frontier in Costa Rican fortification scale-up, requiring targeted incentives, technical support, and consumer acceptance strategies to be overcome (Guadamuz-Mayorga et al. 2022).

2.3.3.6 Integration with Social Safety Net Programs

Costa Rica's social safety net architecture incorporates fortified foods as part of its delivery mechanisms, with school feeding (PANEA) and conditional cash transfer programs (Avancemos) creating systematic access pathways to fortified staples for vulnerable populations. However, integration is structural rather than explicitly designed as nutrition-specific targeting.

School feeding integration: PANEA's centralized procurement of fortified milk, wheat flour products, and iodized salt ensures that enrolled children receive consistent access to micronutrients, independent of household food purchasing power. This integration is particularly significant for children in economically vulnerable households where family-level dietary diversity may be limited and access to fortified products may depend on adequate household income. The program's universal provision to all enrolled primary students (described here as 100% of eligible enrolled children) creates equitable access to fortified foods, reducing the risk that micronutrient deficiencies are associated with socioeconomic status.

The school-level implementation modality, under which individual schools or education boards procure and prepare meals according to centrally specified parameters, embeds fortification compliance within existing institutional infrastructure and reduces the need for separate fortification-specific oversight mechanisms beyond routine school meal quality assurance. Integration with school curricula (including nutrition education) creates pathways for children to develop awareness of fortified foods and their health benefits, potentially extending the impact of behavior change efforts into family-level food purchasing decisions as children mature.

Conditional cash transfer alignment: Avancemos' targeting of school-enrolled adolescents (ages 12–25) in extreme poverty creates an indirect intersection with fortified food consumption through two pathways: (i) school meal provision ensures direct access to fortified food during school hours, and (ii) cash transfers increase household purchasing power for dietary diversification and

potentially for the purchase of fortified staples (wheat flour, fortified milk products, and salt). However, empirical evidence of Avancemos' impact on micronutrient status is limited in the available literature; the program has been evaluated primarily for its impact on school enrollment and completion rather than nutritional outcomes (IDB n.d.).

Gaps in explicit fortification-social protection integration: The integration of food fortification with social safety nets occurs incidentally rather than being a deliberate part of the program design: neither PANEA nor Avancemos explicitly targets fortified food vehicles in their program design documents, nor are fortification specifications integrated into program monitoring and evaluation frameworks, and coordination between PANEA administration (Ministry of Education) and fortification oversight (Ministry of Health) remains largely administrative rather than focused on nutrition outcomes. Opportunities for deepening this integration include the explicit incorporation of fortification targets into school meal specifications and monitoring; inclusion of micronutrient status indicators in Avancemos impact evaluations; and coordination of fortification vehicle selection in social safety net procurement with epidemiological evidence of micronutrient deficiencies among target population (e.g., rice fortification in PANEA menus to address potential gaps in adolescent iron intake).

2.3.3.7 Population Reach and Coverage Metrics

Quantifying the population reach of Costa Rica's food fortification ecosystem requires synthesizing data from multiple sources: production-level fortification coverage (what percentage of staple food production is fortified), consumption-level coverage (what percentage of the population has access to fortified foods), and impact-level coverage (what percentage of the population achieves adequate micronutrient intake from fortified foods).

Production-level coverage: Industrial milling produces 100% of wheat flour (two mills) and maize flour (two mills), all of which is fortified, indicating near-universal production-level coverage for these vehicles. Rice milling presents a more complex picture: 16 industrial mills process rice at scale (≥5 T/h), and industrial mills produce 100% of milled rice distributed through retail channels; however, a secondary market for artisanal/nonindustrial mills and imports may not be fully fortified. Assuming industrial mills dominate retail distribution and consumer access, rice fortification coverage through retail channels is estimated to be near-universal (≥95%) among consumers purchasing domestically milled rice; however, imports (31% of rice consumption) show variable fortification requirements by country of origin (OEC n.d.).

Sugar fortification with vitamin A covers documented sugar production and distribution, though available government reports do not specify exact coverage percentages. Salt iodization coverage is estimated to be universal (≥95%) for domestically consumed salt, reflecting the long institutional history of iodization implementation and compliance monitoring. Milk fortification coverage for both liquid and powdered milk is estimated to be high (≥90%) in the formal retail sector, though informal milk sales (including direct sale from producers and sales of unpasteurized milk) may be exempt from fortification mandates.

Population-level consumption coverage: More relevant than production coverage is the percentage of the population that regularly consumes fortified foods. Because wheat, rice, maize, salt, and milk are staples with near-universal consumption across socioeconomic levels in Costa Rica, population-level coverage of fortification is estimated to be high (≥85%) for at least one fortified food vehicle (with wheat flour being the most widely consumed vehicle). However, coverage varies by socioeconomic status and geographic location (Helgi Library n.d.).

Rural and lower-income populations maintain higher reliance on traditional dietary patterns, including greater consumption of beans, unrefined grains, and diverse vegetables, which may offer some protection against reliance on fortified foods, though fortified staples remain primary calorie sources even in these populations. Urban populations, with a higher reliance on processed foods and convenient staples, likely get more than 90% of their daily consumption from fortified foods.

Vulnerable population targeting: School-age children (with primary enrollment at approximately 99%) have near-universal access to fortified foods through PANEA, with supplemental access through household consumption. Adolescents in secondary school (enrollment of approximately 85% overall, though lower in vulnerable subpopulations) receive fortified foods through school meals in PANEA-participating schools, with additional coverage through Avancemos cash transfers (which reached more than 157,000 beneficiaries), thereby enhancing household purchasing power for fortified foods.

Pregnant and lactating women can access fortified foods through general household consumption and maternal nutrition services provided by the Community Care Support Services (CCSS). However, access to specialized nutrition counseling is constrained by the limited availability of nutritionists. Elderly populations and individuals with disabilities (who are eligible for targeted CCSS services) have access to fortified foods through general supply chains. Nevertheless, efforts to specifically target the elderly through social programs that integrate food fortification remain limited (Primary Health Care Performance Initiative 2024).

Micronutrient adequacy achievement: Biochemical indicators suggest that fortification-derived micronutrients substantially contribute to population adequacy: folic acid fortification contributed an average of 119% of the estimated average requirement across all vehicles during 2010–20, indicating that folic acid intake from fortified foods was sufficient to meet the estimated average requirement at the population level. Iron adequacy in children under five years of age improved markedly following fortification (anemia prevalence declining from 19% to <5%), though persistence of anemia in WRA (13.7%) indicates incomplete adequacy despite fortification, likely due to multifactorial causes (intestinal parasitism, menstrual blood loss, and limited dietary diversity alongside consumption of fortified staples) (Benavides-Lara et al. 2023).

Calcium adequacy remains problematic, particularly in adolescent populations, with only a 0.03 probability of adequacy in Costa Rican adolescents despite dairy fortification, suggesting that either milk consumption is insufficient to achieve adequacy or fortification levels are inadequate for adolescent requirements. This gap indicates that production-level and consumption-level coverage statistics do not directly translate to nutritional adequacy, particularly for micronutrients where bioavailability, competing dietary factors, and physiological requirements vary across populations.

2.3.3.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Costa Rica's fortification value chain extends from international premix suppliers through domestic milling facilities and retail distribution to consumer households, with quality assurance embedded at multiple points through a combination of producer self-monitoring and government oversight mechanisms, creating a system distinguished by institutional maturity and enforcement consistency rare in developing-country contexts.

Fortified food production process: The fortification process for flour-based products follows standardized protocols: raw/unfortified flour receives premix additions (pre-blended micronutrient compounds) during milling, with mixing equipment calibrated to distribute premixes homogeneously throughout flour batches. The MASECA facility (Grupo Bimbo's Costa Rican operation) exemplifies this process: raw flour is fortified with premixes, and the fortified flour is then subject to quality verification before distribution to retail channels and food service providers.

For rice, the head rice enrichment strategy involves coating individual rice grains with a nutrient-fortified coating (extrusion and rinse-resistant technology), allowing grain-by-grain fortification without wholesale changes to rice sensory properties that would otherwise deter consumer acceptance. This technology-specific approach reflects an understanding that rice fortification success in Costa Rica requires maintaining consumer-preferred sensory characteristics (whiteness, looseness) while achieving micronutrient enrichment, a balance not achieved through simple nutrient-dusting approaches.

Rice fortification presents unique supply chain considerations: Head rice enrichment technology (extrusion and coating of rice grains with a nutrient-fortified coating) requires specialized equipment and technical expertise, limiting the number of facilities capable of rice fortification. Costa Rica's rice fortification implementation has used MASECA (a Grupo Bimbo subsidiary operating a flour fortification facility) as a model case, demonstrating the technical capacity of multinational agribusiness firms to implement fortification in Central American contexts. Domestic rice millers, focused on producing conventionally milled (nonfortified) rice for export and domestic markets, have not yet fully adopted rice fortification technology despite mandatory legislation, leaving a gap that requires private sector engagement strategies to accelerate equipment investment and process modifications.

Internal producer-level quality assurance: Regulatory requirements mandate that producers maintain internal quality assurance procedures, including documentation of premix sourcing (certificates of analysis from premix suppliers), fortification process monitoring (equipment calibration records and batch logs), and internal product testing (either through producer-laboratory facilities or through contracted external testing services). Producers must obtain fortification seals from the Ministry of Health, contingent on demonstrating process controls and product testing that conform to regulatory specifications. This internal monitoring layer distributes the verification burden to producers, creating efficiency advantages and embedding quality assurance into production systems rather than relying exclusively on post-hoc government verification (Pereda et al. 2023a).

External government verification and monitoring: INCIENSA, the Institute for Research and Teaching in Nutrition and Health under the Ministry of Health, provides the technical laboratory capacity for government fortification monitoring. INCIENSA operates national reference center laboratories and coordinates with regional reference laboratories nationwide, conducting microbiological and chemical analyses of fortified food samples collected from production sites, distribution points, and retail markets. The Ministry of Health's Direction of Regulation of Products of Sanitary Interest develops annual food control plans in coordination with INCIENSA, establishing sampling priorities based on risk classification of foods, history of noncompliance, and surveillance data (Canadian Food Inspection Agency 2024).

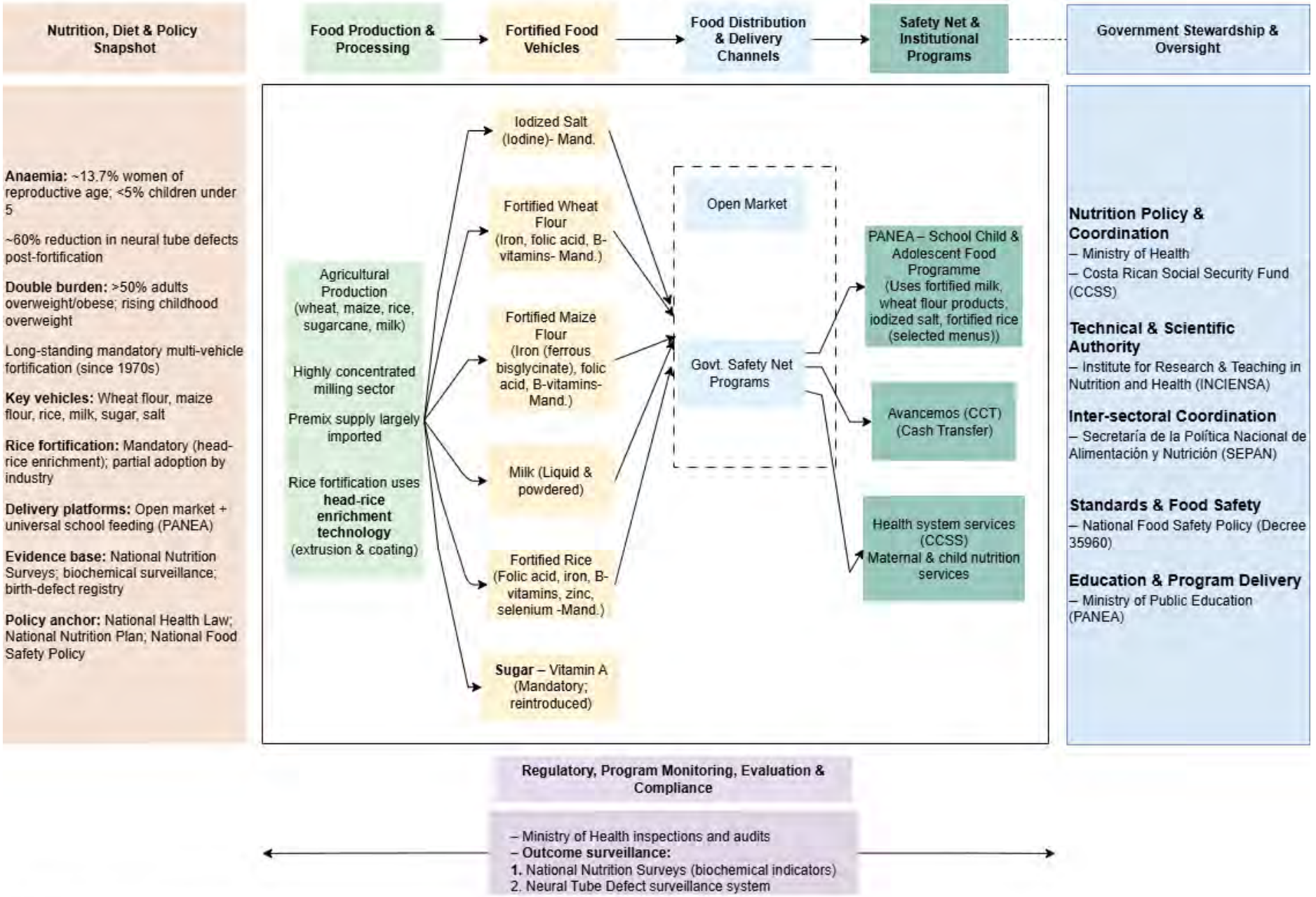
Sampling protocols are designed to verify conformity with fortification standards: Wheat and maize flour samples are analyzed for iron, B1 (thiamine), B3 (niacin), B6 (pyridoxine), B12 (cobalamin), and folic acid. Rice samples are analyzed for thiamine, niacin, folic acid, vitamin B12, selenium, and zinc. Milk samples are examined for added vitamins and minerals, while salt samples are analyzed for iodine and fluoride. These results are compared against regulatory specifications (minimum and, in some cases, maximum levels) to prevent overfortification. If deviations are found, corrective action processes are triggered, requiring producers to remediate compliance issues within specified timeframes. Noncompliance may lead to product seizure, market withdrawal, or facility suspension (Benavides-Lara et al. 2023).

Quality assurance integration with food safety systems: Fortification monitoring is integrated into broader food safety verification, with the same inspection frequency and protocols applied to fortification facilities as to all high-risk food establishments. Environmental monitoring for food contaminants (pesticide residues, microbiological hazards, allergens, heavy metals) occurs in parallel with fortification monitoring to ensure that fortification benefits are not negated by contamination risks. This integration reflects an institutional understanding that food fortification and food safety are interdependent; a contaminated fortified food vehicle can undermine the intended benefits of fortification by introducing additional health risks.

Monitoring and evaluation cycle integration: Costa Rica uniquely integrates fortification monitoring with epidemiological surveillance of health outcomes (neural tube defects, folate status, and anemia prevalence), creating feedback loops through which production-level monitoring data inform policy adjustments. For example, INCIENSA's analysis of folic acid fortification levels in wheat, corn, rice, and milk (2010–20) directly informed reassessment of folic acid specifications to ensure that cumulative folic acid intake from all vehicles remained within safe ranges while maintaining NTD prevention effectiveness. This evidence-based adjustment cycle, based on integrating production monitoring, biochemical surveillance, and health outcome tracking, distinguishes Costa Rican program management from more static regulatory approaches found in some other developing-country contexts.

Challenges and remaining gaps: Despite sophisticated quality assurance systems, several gaps remain: (i) monitoring of fortified processed foods (bread, baked goods, prepared meals) remains limited, with focus primarily on raw fortified ingredients; (ii) informal sector foods (street foods, family-based food preparation businesses) may not be routinely monitored for fortification compliance; (iii) imported fortified foods may not be subject to Costa Rican fortification standards if they originated in countries with different specifications; and (iv) capacity constraints in INCIENSA regional laboratories sometimes result in delayed sample analysis, reducing the responsiveness of enforcement actions to detected noncompliance. Refer to Figure 2.15.

Costa Rica



Source:
1. Global Nutrition Report. https://globalnutritionreport.org/resources/nutrition-profiles/latin-america-and-caribbean/central-america/costa-rica/

2.3.3.9 Monitoring and Evaluation Mechanisms

Costa Rica's monitoring and evaluation systems for food fortification represent a significant institutional achievement: systematic integration of production-level fortification verification, population-level biochemical surveillance, health outcome tracking, and quality assurance mechanisms, creating feedback loops through which program implementation is continuously refined based on evidence of impact.

Fortification monitoring program: INCIENSA operates a dedicated fortification monitoring program analyzing samples of fortified foods collected from production facilities and retail markets. Sampling occurs on standardized schedules: samples are collected on Mondays and transported to INCIENSA laboratories for microbiological and chemical analysis (approximately 6,000–7,000 analyses annually). Analysis protocols specify which micronutrients are tested for each food vehicle: wheat flour (iron, thiamine, riboflavin, niacin, folic acid); maize/corn flour (iron, thiamine, riboflavin, niacin, folic acid); rice (thiamine, niacin, folic acid, vitamin B12, selenium, zinc); milk (added vitamins A and D, iron, folic acid); sugar (vitamin A); and salt (iodine, fluoride) (Pereda et al. 2023a).

Results are documented in laboratory reports and compared against regulatory specifications (minimum and, in some cases, maximum acceptable fortification levels). Nonconformances are reported to the Ministry of Health, which issues health orders specifying corrective actions required from producers or importers; if corrective actions are not implemented within specified timeframes, the ministry may seize products, withdraw products from the market, issue recalls, or suspend operating permits. During 2017, analysis of 3,014 samples resulted in 29 sanitary orders addressing fortification noncompliance, indicating ongoing detection and correction of implementation lapses (Canadian Food Inspection Agency 2024).

National nutrition surveys and biochemical surveillance: Costa Rica conducts national nutrition surveys at approximately 10-year intervals (conducted in 1996 and 2008–09, with future surveys planned) to measure biochemical indicators of micronutrient status in population samples. These surveys include serum folate determination (using solid-phase radioimmunoassay methodology), hemoglobin measurement (to assess anemia prevalence), and collection of dietary intake data to assess food consumption patterns and micronutrient adequacy at the population level. The data from national nutrition surveys provide the evidentiary basis for assessing the impact of fortification programs on population micronutrient status and for identifying residual population subgroups with inadequate micronutrient intake despite fortification availability.

Results from the national nutrition surveys have directly informed fortification policy adjustments: for example, the 1996 and 2008–09 national nutrition survey data on rice, milk, corn, and wheat flour consumption were used to establish fortification levels ensuring that 100% of the estimated average requirement for folic acid would be met through consumption of fortified foods. This consumption-based approach to establishing fortification levels, rather than using arbitrary micronutrient specifications, reflects a sophisticated understanding that fortification effectiveness depends on the intersection of fortification intensity (mg micronutrient per kg food) and population consumption patterns (kg food consumed per day) (Benavides-Lara et al. 2023).

NTD surveillance system: Costa Rica operates an integrated surveillance system for NTDs combining health outcome tracking (birth defects register), biochemical marker surveillance (serum folate monitoring), and fortification monitoring (folic acid levels in fortified foods). The Costa Rican Birth

Defects Registry Center systematically tracks NTD incidence and mortality across the country, with surveillance data collected from maternity services (institutional deliveries account for virtually all births in Costa Rica, enabling comprehensive ascertainment).

The surveillance system highlighted a 60% reduction in NTD prevalence post-fortification implementation (comparing the pre-fortification 1996–2000 period to the post-fortification 2001–09 period) and a 76% reduction in NTD-associated infant mortality (from 77.01 to 18.66 per 100,000 livebirths). This integration of population health outcome surveillance with fortification program monitoring enables assessment of whether fortification implementation translates into documented health improvements, a capacity absent in many developing country programs that monitor fortification compliance but not corresponding health impacts (Castillo-Lancellotti et al. 2012).

Monitoring data interpretation and feedback loops: Fortification monitoring, biochemical surveillance, and health outcome data are integrated through inter-institutional coordination. The INCIENSA research directorate analyzes trends in fortification monitoring results and biochemical surveillance, preparing reports that inform the Ministry of Health's policy decisions on fortification-level adjustments. For example, recognition of the 119% average folic acid contribution from all fortified vehicles during 2010–20 (exceeding the 100% EAR target) prompted discussions on optimizing individual vehicle fortification levels to maintain adequacy while reducing potential excess folic acid intake (Benavides-Lara et al. 2023).

However, monitoring and evaluation systems remain incomplete in several domains: (i) monitoring of adolescent-specific micronutrient status is limited (the national nutrition surveys do not systematically oversample adolescents, limiting detection of age-specific deficiency gaps); (ii) monitoring of dietary intake in different population subgroups (by socioeconomic status, geographic region, vulnerable groups) is limited, constraining the ability to identify populations with inadequate fortified food access; (iii) monitoring of fortified food consumption patterns through household dietary intake surveys occurs at extended intervals (approximately 10 years), limiting the timeliness of evidence for program adjustments; and (iv) linkage between fortification monitoring results and specific food industry corrective actions remains partially documented, limiting transparency and accountability.

2.3.3.10 Stakeholder Ecosystem and Partnerships

Costa Rica's food fortification ecosystem comprises a diverse stakeholder network spanning government institutions, private sector actors, international agencies, academic institutions, and civil society organizations coordinated through formal and informal mechanisms that enable multi-sectoral policy development and implementation.

Government institutions: The Ministry of Health holds primary regulatory authority over fortification policy and enforcement, with the Direction of Regulation of Products of Sanitary Interest responsible for developing regulations, establishing fortification standards, issuing operating permits, and enforcing compliance through inspection and sanctioning. INCIENSA, as a public research institute under the Ministry of Health's supervision, provides technical laboratory capacity for fortification monitoring, conducts national nutrition surveys, and serves as a scientific advisory body informing policy decisions. The Ministry of Public Education, through the division overseeing school feeding, implements PANEA and coordinates with the Ministry of Health on menu specifications incorporating fortified foods (Global Child Nutrition Foundation 2024; Martorell et al. 2015).

The Secretaría de la Política Nacional de Alimentación y Nutrición (SEPAN) serves as the intersectoral coordinating mechanism, convening representatives from health, agriculture, economy, education, business, and civil society sectors to develop a comprehensive food and nutrition policy. This inter-ministerial coordination structure reflects institutional recognition that nutrition policy success requires alignment across health, education, agriculture, and economic development domains, representing a sophisticated governance approach enabling broader policy integration beyond fortification into food security, food safety, and agricultural productivity simultaneously (Canadian Food Inspection Agency 2024).

Private sector actors: Food milling companies (wheat, maize, rice mills) and importers bear primary responsibility for fortification implementation and internal quality assurance, with representatives participating in stakeholder consultations informing policy adjustments. Industry associations (millers' associations, importers' associations, consumer associations) provide collective representation and coordinate industry responses to regulatory changes (Pereda et al. 2023a, b).

Premix suppliers, predominantly international companies (multinational pharmaceutical and chemical firms), provide fortification inputs and technical support for equipment calibration and process optimization. Retail distribution networks (supermarkets, small retailers, informal markets) serve as the final distribution channel through which consumers access fortified foods, with supermarkets typically more likely to stock compliant fortified products than informal retailers.

International and academic institutions: PAHO (Pan American Health Organization) and WHO provide technical guidelines for fortification vehicle selection, micronutrient specifications, and monitoring approaches; Costa Rica's fortification standards often reference PAHO/WHO recommendations, creating de facto harmonization with international best practice. The FFI, a global advocacy network, has documented Costa Rica's fortification program as a case study exemplar for developing-country contexts, providing international visibility and technical support (Food Fortification Initiative 2024).

The University of Costa Rica conducts blind testing of fortified food samples, providing independent verification of government laboratory results and contributing academic capacity to fortification research. INCIENSA also conducts research, including studies on dietary intake patterns, micronutrient status trends, and the impact of fortification, generating the evidence base for policy adjustments (Benavides-Lara et al. 2023).

Civil society and consumer advocacy: The National Association of Consumers participates in inter-sectoral discussions on fortification policy and advocates for consumer interests in fortification specifications and food labeling. Civil society organizations working on nutrition, food security, and public health contribute to advocacy for specific fortification decisions (e.g., supporting rice fortification in school meal programs, addressing persistent anemia in WRA).

Coordination mechanisms: Inter-institutional coordination occurs through multiple mechanisms: (i) formal inter-sectoral commissions (SEPAN) meeting periodically to review fortification policy; (ii) technical working groups convening government, industry, and academic experts to advise on specific fortification decisions (e.g., micronutrient level specifications); (iii) annual meetings between the Ministry of Health and industry representatives to review fortification monitoring results and discuss compliance issues; and (iv) incorporation of fortification considerations into broader food safety governance structures, ensuring that fortification does not operate in isolation from food safety oversight.

Partnership with international organizations: Costa Rica benefits from technical partnerships with PAHO, WHO, and other international agencies that provide training, guidelines, and technical support to strengthen its fortification program. However, formalized north-south partnerships with bilateral donors (e.g., USAID, GIZ, bilateral development agencies) appear limited compared to country programs in Sub-Saharan Africa, reflecting Costa Rica's relatively high levels of economic development and its institutional capacity to finance fortification programs independently.

Gaps and challenges in stakeholder engagement: Despite sophisticated multi-stakeholder coordination, several gaps are evident: (i) consumer awareness campaigns regarding fortification and micronutrient health benefits remain limited, with awareness dependent on decades-old programs (2009 national surveys showed 80% awareness of fortified foods, but contemporary awareness data are limited); (ii) alignment between fortification (micronutrient deficiency focus) and emerging obesity prevention strategies (caloric excess focus) remains incomplete, with limited institutional mechanisms for coordinating these sometimes-competing nutrition policy objectives; (iii) engagement of small-scale rice millers in rice fortification implementation remains limited, reflecting insufficient technical support, equipment financing mechanisms, or market incentives for adoption of fortification technology in this segment; and (iv) formalization of supply chain transparency tracking fortified foods from production through retail to consumption remains incomplete, limiting accountability for fortification compliance across the value chain.

2.3.3.11 Critical Challenges and Policy Reforms Needed

Costa Rica's food fortification program, despite institutional maturity and documented effectiveness, faces challenges spanning micronutrient adequacy gaps, nutrition transition management, institutional capacity constraints, and financing mechanisms requiring deliberate policy reforms to sustain fortification benefits while addressing emerging nutrition epidemiology.

Persistent micronutrient deficiency gaps: Though the country has advanced systems for food fortification, anemia in WRA remains at 13.7% (2023), with limited progress toward reduction targets.

Policy reforms required to manage nutrition transition alongside fortification include: (i) integration of fortification with food reformulation policies limiting sodium, added sugars, and saturated fats in fortified foods; (ii) prioritization of fortified whole grains over refined grains in government procurement (school feeding programs and social assistance), shifting the vehicle base toward products supporting both micronutrient adequacy and chronic disease prevention; (iii) development of fortification standards for processed foods and convenience foods consumed in increasing quantities by urban populations, ensuring that dietary transition does not result in either inadequate micronutrients or excess calories; and (iv) coordination of fortification policy with population-level food-based dietary guidelines promoting consumption of legumes, vegetables, fruits, and diverse animal-source foods rather than reliance on fortified staples.
Policy reforms addressing institutional capacity gaps include: (i) expansion of nutrition workforce through training programs and targeted recruitment of nutritionists into public health system positions; (ii) integration of nutrition education into primary care physician training, enabling basic nutrition counseling without requiring specialized nutritionist appointments; (iii) development of task-sharing models where nurses, health educators, or community health workers provide nutrition counseling under nutritionist supervision, expanding capacity without a proportional increase in specialized workforce; and (iv) integration of fortification information into routine clinical counseling, ensuring that health care providers actively promote consumption of fortified foods as part of treatment protocols for micronutrient deficiency or anemia management.

Monitoring and evaluation system strengthening: While Costa Rica operates sophisticated monitoring systems to track fortification compliance and health outcomes, opportunities exist to strengthen evaluation mechanisms to support ongoing program optimization. Policy reforms include: (i) expansion of national nutrition surveys to include adolescent oversampling, enabling age-specific micronutrient status assessment and identification of adolescent-specific intervention targets; (ii) integration of fortified food consumption tracking into routine dietary intake surveys, enabling assessment of the proportion of micronutrient intake derived from fortified versus natural food sources; (iii) development of fortification impact indicators in national health surveillance systems (e.g., tracking anemia prevalence by population subgroup and micronutrient status by age), enabling identification of populations where fortification is not achieving intended benefit; and (iv) formalization of cost-effectiveness analysis of fortification programs, demonstrating health gains per dollar invested and supporting resource allocation decisions across competing nutrition interventions.

2.3.4 Guatemala

2.3.4.1 Nutrition and Fortification Ecosystem

Guatemala faces significant challenges in its nutrition landscape, marked by chronic undernutrition with emerging issues related to diet-induced NCDs. Since the 1950s, the country has pioneered food fortification in Latin America, starting with salt iodization. However, micronutrient deficiencies remain a widespread public health concern, particularly in rural and Indigenous communities (Martorell and de Romaña 2017).

The institutional framework for food fortification in Guatemala is anchored in Decree Law 44-92 (1992), which mandates the fortification of staple foods. This legislation places Guatemala alongside Costa Rica as an exemplary country with comprehensive mandatory fortification legislation that outlines specific micronutrient levels, defines stakeholder responsibilities, and establishes enforcement sanctions. The Ministry of Public Health and Social Assistance (MSPAS) serves as the primary regulatory body responsible for enacting, enforcing, and monitoring compliance with fortification standards (Pereda et al. 2023; United States Department of Agriculture 2023).

The National Commission for Food Fortification, Enrichment, and/or Equivalence (CONAFOR), established in 1992 as an independent, intersectoral entity, coordinates and supervises food fortification programs. CONAFOR comprises representatives from government, the private sector, research institutions (particularly the Institute of Nutrition of Central America or INCAP), and civil

society. This institutional innovation proved critical during politically turbulent periods (1998-2004) when CONAFOR's facilitation enabled the program to withstand constitutional challenges and maintain momentum (Pereda et al. 2023).

Guatemala's fortification ecosystem is integrated into the broader National System of Food and Nutritional Security (SINASAN), established by law in 2005. The Secretariat of Food and Nutritional Security (SESAN), a presidential body, coordinates intersectoral action across multiple ministries and civil society. This multilevel governance structure reflects an understanding that addressing malnutrition requires coordinated action across food production, distribution, consumption, and utilization (Secretaría de Seguridad Alimentaria y Nutricional 2007; Segura-Pérez et al. 2016).

2.3.4.2 Nutritional Status and Dietary Practices

Guatemala exhibits one of the world's most severe nutritional crises. The prevalence of child stunting stands at approximately 42.8-49.3%, making it the highest rate in Central America and among the highest globally. Over the past two decades, stunting has decreased by only 5.1 percentage points, which is significantly slower than in peer countries. This chronic malnutrition is causally linked to approximately 45% of deaths in children under five years old (Ballard Brief 2021).

Micronutrient deficiencies are pervasive and intersect with socioeconomic vulnerability. The prevalence of anemia in children under five years old averages 32%, with particularly high rates among younger age groups: 71% among infants aged 6 to 8 months, 70% among those aged 9 to 11 months, and 58% among children aged 12 to 17 months. Geographically, rural areas report anemia prevalence of 35.2%, compared to 27.2% in urban areas. Among WRA, anemia prevalence is 24.5% (Global Nutrition Report 2024; Palacios et al. 2020).

Additionally, zinc deficiency affects 34.9% of children under five years old nationally. The prevalence is notably higher in rural areas, at 41.8%, compared to 24.8% in urban areas. Furthermore, the poorest quintile has approximately twice the prevalence of zinc deficiency as the wealthiest quintile (51.0% versus 27.3%), illustrating how economic vulnerability compounds nutritional risk (FANTA 2015).

Folate and vitamin B12 deficiencies represent emerging concerns identified in nationally representative surveys. Red blood cell folate deficiency affects one-third of children aged 6 to 59 months, with higher prevalence among younger children and in the poorest households. Vitamin B12 deficiency affects approximately half of children in this age group, with Indigenous children and children from the poorest families experiencing a disproportionate burden. Among WRA, the prevalence of vitamin B12 deficiency is 29.6% in rural areas compared with 16.4% in urban areas (FANTA 2015; Wong 2022).

Dietary patterns reveal heavy reliance on staple carbohydrates with insufficient micronutrient density. Corn and corn products account for 40% of total calorie availability nationally, while beans provide bulk but limited micronutrient diversity. Children lack adequate intake of vegetables, meat, and eggs, resulting in a food energy deficit of 101 kilocalories per person per day in 2016. Poorest households concentrate consumption on corn, beans, and low-cost processed foods (FANTA 2015).

Obesity and diet-related NCDs present significant challenges. Currently, 29.6% of adult women and 17.6% of adult men live with obesity. The prevalence of diabetes is 12.0% among adult women and 10.4% among men, indicating the coexistence of undernutrition and overweight/obesity, which is a common characteristic of the nutrition transition occurring in middle-income countries (Asfaw 2007).

2.3.4.3 Nutrition-related Flagship Program

Guatemala's nutrition intervention architecture comprises multiple complementary programs coordinated through SESAN's Strategic Plan for Food and Nutritional Security (PESAN).
School Feeding Program (Programa de Alimentación Escolar).

The School Feeding Program is the largest universal nutrition intervention, reaching 2,079,759 primary school students and 574,762 preschool children. Administered by the Ministry of Education with intersectoral coordination, the program operates through a decentralized management structure wherein schools procure food and parents' organizations manage disbursements (Secretaría de Seguridad Alimentaria y Nutricional 2007; Segura-Pérez et al. 2016).

Since the 2021 legal reform, the program shifted from in-school meals to take-home rations distributed approximately every 45 days. This change helped maintain continuity during the COVID-19 pandemic, although it initially reduced the nutritional impact compared to meals served in schools. The program specifically includes fortified foods as vehicles for micronutrient delivery, with nutrition requirements set by a commission of nutritionists (World Food Programme 2025).

A joint Fill the Nutrient Gap analysis of Guatemala and Peru found that served school meals reduce the cost of nutrient-adequate diets by over 50% and provide greater dietary diversity and micronutrient content than take-home rations. Fortification and supplementation further enhance nutritional outcomes, particularly for adolescent girls. Infrastructure limitations, particularly inadequate kitchen equipment, hinder the revival of in-school meal preparation (World Food Programme and Inter-American Development Bank 2025).

2.3.4.3.1 Conditional cash transfer program-Mi Bolsa Segura

The Ministry of Social Development (MIDES) operates “Mi Bolsa Segura,” a conditional cash transfer program targeting 22,863 families across 16 municipalities. As part of broader Latin American conditional cash transfer (CCT) movements, this program aims to increase household food purchasing power while incentivizing health service utilization. Evaluations of similar CCT programs across Latin America document consistent positive impacts on child health and nutrition outcomes for the poorest families (Segura-Pérez et al. 2016).

CCTs function through multiple pathways: direct income transfers increase household resources for food purchases; behavioral conditions promote health service utilization; and properly designed information components support dietary diversification and nutritional practices. In Guatemala, technical analysis suggests that redesigning the CCT program to strengthen linkages with multisectoral nutrition strategies is a priority for maximizing its impact.

2.3.4.3.2 World Food Programme operations and social protection integration

WFP has operated in Guatemala since 1974, providing essential food security and nutrition services, including emergency preparedness, social protection strengthening, support for school meals, and resilience-building programs. During crises, WFP provides emergency cash-based transfers and food assistance. The organization also distributes fortified complementary foods and delivers logistics services. Additionally, WFP's nutrition brigades provide counseling, conduct assessments, and support the Ministry of Public Health in delivering food supplements (World Food Programme 2025a).

2.3.4.4 Policy Environment for Food Fortification

Guatemala's policy environment features comprehensive mandatory legislation, sustained political commitment, and continuous regulatory refinement responding to implementation experience and evolving evidence.

Legislative framework: Decree Law 44-92 (1992) mandates the enrichment, fortification, or equivalence of foods necessary to address nutritional deficiencies in the population's habitual diet. This decree established fortification as a legal obligation with binding responsibilities for producers and importers and defined enforcement mechanisms.

Guatemala mandates fortification of four primary vehicles: wheat flour, maize flour, sugar, and salt. This portfolio reflects historical experience (salt iodization since the 1950s and sugar fortification since the 1970s) and evidence-based vehicle selection based on consumption patterns across income and geographic groups. The legislation also explicitly prohibits the distribution, sale, or marketing of nonfortified versions of these mandatory foods (Pereda et al. 2023).

Tax exemption for micronutrient premixes serves as a key compliance incentive. Enforcement mechanisms include requirements that producers retrieve noncompliant production batches from distribution, with additional penalties determined by the Ministry of Health. Labeling regulations require nutrition labels on fortified products to include fortification levels, and the marketing of fortified foods is controlled by the MSPAS (United States Department of Agriculture 2023).

Regulatory standards and technical specifications: The National Quality System (SNC), overseen by the Commission of Standards (COGUANOR) within the Ministry of Economy, establishes voluntary technical standards for micronutrient specifications in food fortification. Standards issued before 2005 were mandatory; after 2005, COGUANOR standards became voluntary unless explicitly adopted into binding regulations by the MSPAS. This post-2005 transition created potential compliance variability, as adoption depends on government action rather than on automatic legal force.

Through Government Decree 969-99, the MSPAS has been authorized to regulate food products and establish norms aligned with the national quality system. This dual-track governance allows COGUANOR to propose technical specifications while MSPAS enacts binding regulations and coordinates compliance monitoring through field inspections and laboratory testing.

Policy coordination and inter-institutional mechanisms: CONAFOR functions as the central multistakeholder coordination mechanism, uniting government agencies (such as MSPAS, the Ministry of Economy, and the Ministry of Agriculture, Livestock and Food), private sector producers, research institutions (such as INCAP), civil society, and international partners. Its primary statutory role is to coordinate and supervise the development and implementation of food fortification programs.

Regulatory monitoring and policy reviews occur periodically: Decree Law 44-92 mandated review processes in 1992, 2000, 2010, and 2023, reflecting the intention to reassess fortification levels, monitoring procedures, and labeling requirements based on evolving evidence (Fiedler and Helleranta 2010).

Policy gaps and reform opportunities: Despite comprehensive legislation for wheat flour, maize flour, sugar, and salt, Guatemala has not yet mandated rice fortification, representing a notable policy gap given rice's potential as a fortification vehicle and existing regional precedents in Costa Rica, Honduras, and Panama. Implementing mandatory rice fortification could significantly extend fortification benefits to populations that consume little wheat or maize flour.

Premix composition is not clearly stipulated in Article 350 of Guatemala's sanitary regulations, meaning premix micronutrient levels, which are critical determinants of final product fortification adequacy, are not subject to oversight by the Ministry of Health. Premix suppliers operate without government-specification oversight, creating a potential quality-assurance vulnerability.

2.3.4.5 Industry Capacity and Role of Private Players

Guatemala's food industry has significant processing capacity across fortification vehicle sectors; however, ongoing monitoring is necessary to ensure consistent capacity utilization and compliance. The Guatemalan sugar industry is a well-established and export-oriented sector with significant production capacity. In the 2023/24 marketing year, ten operational sugar mills produced 2.58 MT of sugar, making Guatemala the world's fourth-largest exporter. The industry has expanded dramatically: from 369,143 MT in 1982/83, representing a six-fold increase, driven by technological improvements and expanded cultivation (US Department of Agriculture Foreign Agricultural Service 2023).

The sugar mills are also energy self-sufficient, with an installed generation capacity of 992 MW, making them independent of national electrical grids (ASAZGUA and United States Department of Agriculture 2024). This energy independence reduces operational constraints and demonstrates technological sophistication. Additionally, the sugar fortification program with vitamin A is a mature, long-established program that benefits from automated feeding systems that ensure consistent premix addition. The industry has demonstrated technical capacity to implement quality control measures, including internal testing and compliance documentation (United States Department of Agriculture 2025).

Flour milling capacity: Guatemala's corn milling capacity ranges between 3,000 and 3,500 tons per month, with a storage capacity of 37,000 MT. Wheat flour milling capacity uses modern industrial mills with extraction rates of 72 to 76%, which is typical for the Latin American region. The wheat flour industry includes both large modern mills and smaller artisanal producers, creating heterogeneous compliance challenges: larger mills have the technical capacity to automate fortification by consistently adding premix and implementing internal quality control, while smaller millers may require capacity building and ongoing technical support (United States Department of Agriculture 2026; Nutrition International 2021).

2.3.4.5.1 Private sector organization and engagement

The Guatemalan Association of Exporters (AGEXPORT) and the Guatemalan Sugar Association (Asazgua) represent the primary industry associations. Asazgua comprises 11 sugar mills and coordinates industry advocacy on policy matters, including fortification requirements. The Latin American Association of Industrial Millers (ALIM) plays a key role in regional coordination, with Guatemalan millers participating in regional fortification forums (ASAZGUA and United States Department of Agriculture 2024; Pereda et al. 2023).

In the private sector, involvement in food fortification primarily focuses on compliance. Producers are responsible for internal monitoring and maintaining proper fortification in accordance with documented procedures, yet regulations do not mandate standards for internal monitoring procedures, creating variable quality assurance practices across facilities. Some larger companies implement international standards such as Safe Quality Food (SQF) certification, which provides external credibility and market access, though uptake remains concentrated among larger exporters.

2.3.4.6 Integration with Social Safety Net Programs

Fortified foods serve as delivery vehicles within Guatemala's social protection architecture, linking nutrition-specific interventions with income support and behavioral health programs targeting vulnerable populations.

School feeding integration: The School Feeding Program explicitly incorporates fortified foods as primary vehicles for fortification, recognizing schools as platforms for reaching all children regardless of socioeconomic status. The program's universal coverage model creates equity advantages over targeted programs and sustains consumption of fortified products during critical developmental periods (World Food Programme 2025b; Global Child Nutrition Foundation 2024).

Conditional cash transfer linkages: Mi Bolsa Segura increases household purchasing power for food, creating demand for all available foods, including fortified staples. However, evidence from broader Latin American CCT evaluations indicates that while cash transfers increase household food consumption, the impact depends on contextual factors including food availability, relative prices of nutritious foods, and household nutrition knowledge. Direct supplementation of fortified foods alongside cash transfers, in which beneficiary households receive bundles of fortified staples, can enhance nutritional outcomes beyond those achieved with cash alone (Segura-Pérez et al. 2016).

Guatemala's PESAN and SESAN coordination mechanisms provide institutional pathways for aligning fortification programs with CCT program design, though documented integration efforts remain limited. Opportunities exist to strengthen CCT conditionality around child growth monitoring linked to micronutrient supplementation and fortified food consumption counseling (Secretaría de Seguridad Alimentaria y Nutricional 2007; Segura-Pérez et al. 2016).

Emergency food assistance: WFP operations in Guatemala include emergency distribution of fortified complementary foods during crises and support for both disaster response and protracted displacement situations. Integrating fortified foods into emergency baskets ensures crisis-affected populations receive micronutrient-supplemented support, though supply chain sustainability and quality consistency require ongoing technical management.

2.3.4.7 Population Reach and Coverage Metrics

The population-level reach of fortified foods represents a critical but incompletely documented dimension of Guatemala's fortification program performance. Available evidence indicates substantial consumption of mandatory fortified vehicles across all income groups, although important equity gaps remain (Food Fortification Data Exchange n.d.).

Food Fortification Assessment Coverage Toolkit (FACT) data: FACT assessments that use standardized population-based methodologies provide rigorous estimates of coverage. Data from

the Global Fortification Data Exchange (GFDx) show that fortified wheat flour is widely available and consumed, although consumption patterns vary by geography and socioeconomic status. Similarly, maize flour fortification reaches substantial segments of the population, particularly in rural and Indigenous areas where maize consumption is predominant.

Sugar fortification has nearly universal reach, given that sugar is a common component of the Guatemalan diet across all income levels; however, actual vitamin A concentrations vary, suggesting gaps in monitoring and assurance of compliance (Fiedler and Helleranta 2010).

Coverage gaps and equity concerns: Even with significant availability of fortified food, the persistence of micronutrient deficiencies in nationally representative surveys indicates that coverage, meaning availability, access, and actual consumption, remains incomplete. Specifically:

- Folate and vitamin B12 deficiencies persist at high prevalence despite wheat and maize flour fortification, suggesting either insufficient consumption of fortified foods among vulnerable groups, suboptimal bioavailability of fortification compounds, or dietary patterns not primarily relying on fortified staples (Global Nutrition Report 2024).
- Indigenous and low-income populations show disproportionate deficiency burdens relative to national averages, indicating that while fortified foods may be nationally available, equitable distribution and affordable access to adequate quantities remain challenging.
- Rural-urban disparities in micronutrient deficiency prevalence (e.g., 35.2% versus 27.2% for anemia in children under five years old) suggest that fortified food supply chains, retail availability, or purchasing patterns may not reach rural populations uniformly (FANTA 2015).

These equity gaps indicate that fortification, while necessary, requires complementary interventions, including promotion of dietary diversification, behavior change communication, and, potentially, targeted supplementation for the highest-risk groups.

2.3.4.8 Value Chain, Quality Assurance, and Regulatory Frameworks

Guatemala's fortification value chain extends from premix procurement through production, distribution, retail, and household consumption, with quality assurance mechanisms embedded at multiple points.

Premix procurement and supplier management: Premix procurement occurs through both international suppliers and domestic formulation services. However, Guatemala's regulatory gap regarding premix composition creates supplier accountability challenges: neither the MSPAS nor any agency publishes specifications for acceptable premix suppliers or fortification compound standards, leaving producer selection entirely to individual facilities. This absence of premix supplier registration or certification requirements creates potential quality risk, particularly for smaller mills that lack the technical capacity to independently verify premix micronutrient content and purity (Fiedler and Helleranta 2010).

Best practices in fortification programs include national premix supplier lists with approved suppliers meeting international standards, regular premix batch testing, and certification of premix suppliers by recognized accreditation bodies. Guatemala's current approach relies on producer diligence rather than regulatory oversight, resulting in variable quality assurance (Pereda et al. 2023).

Production-level quality control: Internal monitoring by producers represents the first quality assurance checkpoint. Larger sugar mills implement automated premix feeding systems with consistency dosing capabilities, while flour mills vary in technical sophistication. Regulations require producers to establish internal qualitative and quantitative monitoring procedures, but no standardized operating procedures are mandated, resulting in heterogeneous approaches.

Quality control methods at production facilities include physical inspection (color, odor, texture), documented weights and measures of premix addition, and, where facilities can do so, chemical testing of fortified products. However, the absence of mandated standard operating procedures means that smaller producers may implement ad hoc testing without documented protocols or quality thresholds.

2.3.4.8.1 Government monitoring and compliance verification

The Ministry of Health, through its Department of Regulation and Control of Food and Beverages, conducts external monitoring at multiple points in the distribution chain:

- Industry-level inspection: Regional Ministry of Health offices inspect flour mills, obtaining samples for fortification content analysis. Sampling frequency and protocols are defined in operating manuals.
- Point-of-sale monitoring: Market-level monitoring occurs to verify that fortified products are available for sale and that labeling complies with regulations.
- Household-level annual sampling: Sugar products are sampled annually from households to verify sustained fortification and the appropriateness of fortification levels. The samples are submitted to national laboratories for micronutrient content analysis, and the results are documented in compliance reports. Guatemala maintains the confidentiality of technical compliance reports, meaning compliance percentages and mill-specific performance data remain confidential rather than publicly disclosed, in contrast to comparative cases (e.g., Chile), where public reporting creates transparency and accountability incentives.

2.3.4.8.2 Laboratory infrastructure and technical capacity

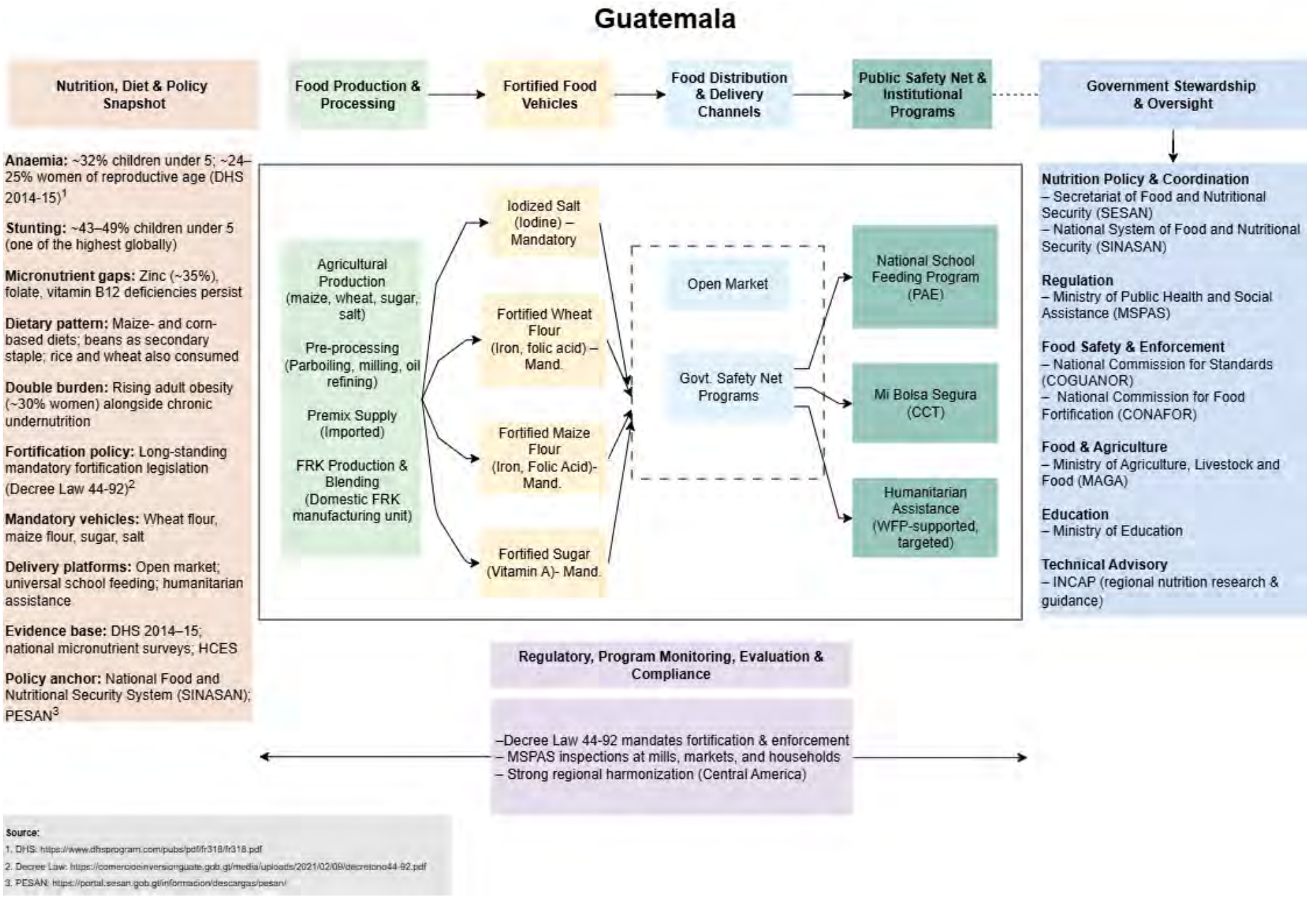
Guatemala's laboratory infrastructure for fortification monitoring includes both government and reference laboratory capacities. International reference laboratories (e.g., INCAP) provide validation services and technical guidance on monitoring methodologies (United States Department of Agriculture 2023).

The Ministry of Economy serves as an oversight body to monitor the Ministry of Health's activities, ensuring alignment with national standards and regulations, though published documentation provides limited articulation of this oversight role in operational terms.

2.3.4.8.3 Regulatory enforcement and penalties

Sanctions for noncompliance include requiring producers to recall production batches from distribution when fortification is inadequate, as well as penalties imposed by the Ministry of Health. However, published regulations do not specify penalty amounts or enforcement procedures, creating potential inconsistency in enforcement rigor across cases, in contrast to Costa Rica and Chile, which specify defined penalties and document enforcement histories. Refer to Figure 2.16.

Figure 2.16. Guatemala's food fortification ecosystem



Source:
1. DHS: https://www.dhsprogram.com/pubs/pdf/fr318/fr318.pdf
2. Decree Law: https://comercioinversionguate.gob.gt/media/uploads/2021/02/09/decretono44-92.pdf
3. PESAN: https://portal.sesan.gob.gt/informacion/descargas/pesan/

2.3.4.9 Monitoring and Evaluation Mechanisms

Guatemala's monitoring and evaluation architecture comprises multiple levels of data collection, analysis, and reporting designed to track program implementation fidelity and population-level nutrition impact.

2.3.4.9.1 Compliance monitoring systems

The Ministry of Health coordinates compliance monitoring through defined sampling schemes described in operating procedure manuals, encompassing the following:

- **Production facility sampling:** Samples collected at flour mills and sugar facilities at defined frequencies (reportedly annually for sugar).
- **Point-of-sale sampling:** Retail-level sampling verifies that fortified products remain in distribution channels and labeling requirements are met.
- **Household sampling:** Sugar products are sampled annually from households to verify sustained adequate fortification and assess whether degradation occurs during storage and distribution.

Laboratory analysis determines the micronutrient content and assesses compliance with national standards. The reports include compliance percentage calculations and recommendations for corrective actions when noncompliance is identified. Unlike Chile and Costa Rica, which publicly report compliance statistics, Guatemala keeps technical reports confidential, limiting external accountability mechanisms and reducing incentives for continuous industry improvement.

2.3.4.9.2 Population-level nutritional status monitoring

The DHS, conducted periodically (most recently in 2014/15), provides nationally representative anthropometric data on child stunting, wasting, and underweight. DHS data include anemia measurements from hemoglobin testing, enabling prevalence estimation at national and regional levels.

The Household Consumption and Expenditure Survey (HCES), fielded by SESAN and partners every three to five years, collects detailed household-level food consumption and expenditure data, enabling assessment of fortified food availability, consumption frequency, quantity relative to fortification standards, and micronutrient intake calculations. Micronutrient status surveys using biomarker analysis (hemoglobin for anemia; red blood cell folate and serum B12 for deficiencies; zinc; and iron biomarkers) provide a direct assessment of population nutritional status independent of fortified food consumption. This approach enables evaluation of whether fortification programs achieve the intended health impact.

2.3.4.9.3 Specific fortification impact evaluations

Research studies have quantified the impact of the fortification program on the population's micronutrient status. An analysis of wheat flour fortification's impact using HCES data estimated that fortification benefits substantially more households than previously recognized, identifying opportunities to extend benefits through semolina flour fortification. Vitamin A analysis of household sugar samples indicated that current vitamin A fortification levels may be excessive and warrant review to optimize costs (Wong et al. 2022).

A 2021 study documenting folate and vitamin B12 status of children in Guatemala provided the first nationally representative prevalence estimates of these deficiencies, identifying that one-third of children had red blood cell folate deficiency and half had vitamin B12 deficiency. Vulnerable subpopulations (younger children, Indigenous children, and poorest households) showed a disproportionate burden. This research identified gaps in the effectiveness of current fortification coverage and provided data guiding potential policy adjustments.

2.3.4.9.4 Gaps and limitations in monitoring systems

Critical monitoring gaps include the following:

- **No public compliance reporting:** The absence of transparent national-level compliance statistics prevents external accountability and reduces industry competitive incentives for improvement.
- **Limited routine fortification impact evaluation:** Periodic rather than continuous monitoring of fortification impact on population micronutrient status means program adjustments occur infrequently based on outdated data.
- **Incomplete coverage assessments:** While FACT-type assessments have been conducted regionally, comprehensive current Guatemala coverage data on all fortified vehicles are not readily available in recent public reports.
- **Equity monitoring limitations:** Standard monitoring systems often do not disaggregate compliance data by mill size, geographic region, or socioeconomic consumption patterns, limiting the ability to identify and address equity-specific compliance gaps.

2.3.4.10 Stakeholder Ecosystem and Partnerships

Guatemala's fortification stakeholder ecosystem encompasses governmental agencies across multiple sectors, private industry actors, research institutions, international organizations, and civil society, with varying degrees of coordination formality and engagement consistency (Government of Guatemala 2007).

2.3.4.10.1 Government stakeholders

The Ministry of Public Health and Social Assistance (MSPAS): It is the primary regulatory and enforcement authority for fortification, operating through the Department of Regulation and Control of Food and Beverages. MSPAS's responsibility includes enacting regulations, monitoring compliance, enforcing sanctions, and coordinating technical activities with INCAP (United States Department of Agriculture 2023).

Ministry of Economy: It oversees the National Quality System (SNC) and COGUANOR, which develop voluntary technical standards. The Ministry of Economy participates in CONAFOR and reviews monitoring activities conducted by MSPAS.

Ministry of Agriculture, Livestock and Food: It manages agricultural commodity production policies, grain import regulations, and oversight of food safety for raw commodities. The Ministry of Agriculture, Livestock and Food participates in nutrition policy coordination through SESAN and intersectoral committees for the school feeding program.

Secretariat of Food and Nutritional Security (SESAN): It is the presidential-level coordination body responsible for implementing the PESAN and coordinating across sectoral agencies and development partners. SESAN facilitates alignment of fortification with broader nutrition programs and social protection systems.

Ministry of Education: It administers the School Feeding Program, which uses fortified foods as the primary vehicles for delivering micronutrients to all children. The Ministry of Education's participation is critical for aligning school meal planning with fortification standards.

2.3.4.10.2 Private sector stakeholders

Sugar Industry (Asazgua and individual mills): It is the primary stakeholder in mandatory sugar fortification and implements vitamin A fortification in sugar produced for domestic consumption and exports. Large mills operate modern facilities with technical fortification capacity; smaller mills may require technical support.

Flour milling industry: Wheat flour and maize flour producers implement mandatory fortification. Large modern mills implement automated fortification systems, while smaller artisanal millers may have more limited technical capacity and require targeted capacity building (United States Department of Agriculture 2026; Nutrition International 2021).

Food processing and manufacturing sector: Processed food manufacturers that use fortified flour or other fortified ingredients as inputs depend on upstream fortification compliance; those downstream manufacturers represent indirect beneficiaries of regulated fortification assurance.

2.3.4.10.3 Research and technical institutions

Institute of Nutrition of Central America and Panama (INCAP): It is the primary regional research institution providing technical guidance on fortification standards, monitoring methodologies, and policy recommendations to the MSPAS. INCAP serves as MSPAS's primary technical advisor and conducts research on the impact and coverage of fortification.

National University of Guatemala and private universities: They conduct nutrition research, train health professionals, and conduct technical evaluations of fortification programs. University capacity contributes to the development of the monitoring system and evidence generation.

2.3.4.10.4 Civil society and international partners

Micronutrient Forum and Global Fortification Network: These organizations provide regional and global technical resources, facilitate cross-country learning on fortification policy and implementation, and support evidence synthesis for policy dialogue.

UNICEF and Pan American Health Organization (PAHO): These organizations provide technical assistance on nutrition policy and program design to support Guatemala's alignment with regional and global nutrition targets.

2.3.4.10.5 CONAFOR as central coordination mechanism

CONAFOR continues to function as the primary formal multistakeholder coordination body, uniting representatives from government agencies (MSPAS, Ministry of Economy, and INCAP), the private sector, research institutions, civil society, and international development partners.

CONAFOR's statutory role includes supervising the implementation of the food fortification program and addressing disputes or technical challenges that arise during implementation. Recent CONAFOR meeting frequency and agenda setting are not consistently documented in publicly available sources, suggesting potential gaps in routine intersectoral coordination.

2.3.4.11 Critical Challenges and Policy Reforms Needed

Guatemala's fortification program, despite foundational legislative and institutional strength, faces multiple challenges that limit program effectiveness and require strategic policy reforms.

2.3.4.11.1 Nutrition financing constraints

Guatemala invests only 2.4% of its gross domestic product in health, which is the lowest in Latin America (Tschida et al. 2021). This substantially limits its public sector capacity to implement, monitor, and enforce nutrition programs. Within this constrained health budget, nutrition allocations are disproportionately limited: in 2013, Guatemala allocated only Q637.2 million (approximately one-third of the required investment) for nutrition services. In 2016, only 0.15% of its gross domestic product was allocated to nutrition, far below the estimated 0.50% required for adequate program coverage (FANTA 2017). This financing gap has direct consequences for fortification program sustainability: (i) insufficient resources for regular compliance monitoring and laboratory testing; (ii) limited capacity building for industry, particularly smaller mills; (iii) inadequate monitoring and evaluation systems for tracking population impact; and (iv) reduced incentives for government enforcement of sanctions.

Policy reform needed: Secure, dedicated, and predictable nutrition financing through multi-year budget allocations and innovative financing mechanisms (e.g., nutrition bonds, private sector cost-sharing arrangements).

2.3.4.11.2 Coverage gaps and equity disparities

The persistence of micronutrient deficiencies despite three decades of mandatory fortification indicates substantial coverage gaps. Many individuals, particularly those in rural and Indigenous populations, either do not consume adequate amounts of fortified foods or face access/affordability barriers preventing sustained consumption.

Specific equity challenges include the following:

- **Rural-urban disparity:** Rural populations show higher micronutrient deficiency prevalence (anemia 35.2% rural versus 27.2% urban), suggesting either lower availability of fortified food in rural supply chains or reduced purchasing power to acquire fortified products.
- **Indigenous and non-Indigenous disparity:** Indigenous children show markedly higher folate and B12 deficiency prevalence than non-Indigenous populations, indicating that while fortification programs may reach Indigenous communities, consumption patterns or fortification vehicle selection may not optimally address Indigenous dietary preferences (Wong et al. 2022).
- **Socioeconomic gradient:** The poorest quintile shows approximately double the zinc deficiency prevalence of the richest quintile (51.0% versus 27.3%), indicating that poverty-related constraints to adequate food consumption are not offset by fortification alone.

The following policy reforms are needed:

- Conduct comprehensive equity-focused assessments of fortified food availability, affordability, and consumption across geographic regions and socioeconomic groups.
- Expand fortification beyond the current four vehicles to include additional commonly consumed foods (e.g., rice, edible oils) to increase dietary flexibility.

- Integrate fortification with targeted supplementation programs for the highest-risk groups (pregnant women, young children in the poorest communities).
- Strengthen behavior change communication around fortified food consumption benefits, particularly in Indigenous and rural communities.

2.3.4.11.3 Quality assurance and compliance gaps

Multiple elements of Guatemala's fortification system create the following quality assurance risks:

- **Premix supplier oversight gap:** The absence of regulatory specifications for premix suppliers means supplier selection depends on producer diligence.
- **Opaque compliance monitoring:** Confidentiality of compliance reports prevents transparency and limits external accountability mechanisms.
- **Variable internal monitoring standards:** The absence of mandated standard operating procedures results in inconsistent quality assurance across facilities.
- **Incomplete regulatory specification:** Key regulatory documents do not clearly specify premix composition levels.

The following policy reforms are needed:

- Establish a national premix supplier certification system with approved supplier lists and regular testing requirements.
- Develop and mandate standardized operating procedures for internal quality assurance at production facilities, with training and capacity building.
- Implement transparency in compliance monitoring through periodic public reporting of mill-specific compliance percentages and national aggregate data.
- Revise and clarify regulatory specifications to explicitly include premix composition levels and acceptable fortification compound types.

2.3.4.11.4 Limited integration with nutrition strategy

While fortification legislation exists and CONAFOR coordinates implementation, fortification represents a standalone program rather than a fully integrated component of Guatemala's multisectoral nutrition strategy. School feeding programs incorporate fortified foods, but integration with CCT programs, behavior change communication, and health-system micronutrient supplementation remains ad hoc.

Policy reform needed includes embedding fortification as an explicit priority within PESAN implementation plans, with defined roles for each sector (health for monitoring and supplementation, education for school feeding fortification, agriculture for supply chain development, social protection for CCT program design linking cash with the promotion of fortified food).

2.3.4.11.5 Monitoring and evidence gaps

Guatemala has conducted nationally representative micronutrient status surveys to assess the impact of fortification. However, routine monitoring of the impact of fortification on population nutrition remains limited. The periodic HCES and DHS surveys occur every three to five years, creating temporal gaps between assessments that limit responsiveness to emerging issues.

The following policy reforms are needed:

- Establish continuous monitoring systems (e.g., sentinel surveillance in representative communities) to provide more frequent data on fortification impacts between major national surveys.

- Implement mandatory collection and public reporting of compliance data at regional and mill levels.
- Conduct periodic fortification coverage assessments (FACT-type evaluations) integrated into national monitoring systems.

2.3.4.12 Opportunities and Future Directions

Despite identified challenges, Guatemala has substantial opportunities to strengthen the effectiveness of its fortification program through strategic policy adjustments, expanded vehicles, enhanced coordination, and leveraged partnerships.

2.3.4.12.1 Rice fortification expansion opportunity

Three Central American countries (Costa Rica, Honduras, and Panama) have successfully implemented mandatory rice fortification legislation. Given that rice is a significant staple in Guatemalan dietary patterns and that Guatemala has successfully implemented fortification of wheat and maize flour, expanding rice fortification is a feasible policy addition.
Mandatory rice fortification could extend the benefits of fortification to 60,000 households currently not covered by wheat and maize flour fortification, increasing fortified food consumption by 68% of the population by diversifying fortification vehicles. Key requirements include: (i) assessment of rice consumption patterns across socioeconomic and geographic groups; (ii) engagement with the rice industry to assess technical capacity and cost implications; (iii) development of rice-specific fortification standards and monitoring protocols; and (iv) legislative action to mandate rice fortification with a defined implementation timeline.

2.3.4.12.2 Edible oil fortification

While not currently mandatory in Guatemala, edible oil is an important dietary staple and a potential fortification vehicle used in multiple Latin American countries. Oil fortification with vitamins A and D requires technical adaptation (microencapsulation to prevent oxidative losses), but successful implementation exists at the regional level. Oil fortification could address vitamin A and D deficiencies, particularly in rural populations with high oil consumption.

2.3.4.12.3 Strengthened industry partnerships for quality assurance

Industry stakeholders (Asazgua, flour millers' associations) serve as partners in co-investment in fortification quality assurance improvements. Private sector actors benefit from improved compliance (enhanced market access for certified fortified products, reduced regulatory penalties, improved brand reputation). Models exist in Costa Rica and Brazil where private sector quality assurance systems interface with government monitoring.

2.3.4.12.4 Integration with school-based nutrition programs

Schools are ideal platforms for distributing fortified foods, monitoring consumption, and promoting behavior change in nutrition. The existing School Feeding Program reaches 2.6 million students and provides standardized meals or take-home rations that incorporate fortified foods. Opportunities include the following:

- Linking school meal fortification with micronutrient supplementation (iron-folic acid for adolescent girls), creating synergistic micronutrient delivery.
- Training teachers and parents in fortified food preparation and nutritional benefits.

- School-based monitoring of child growth linked to fortified food and supplement consumption, generating local impact evidence.
- School gardens producing micronutrient-rich vegetables to complement fortified staples for dietary diversity.

2.3.4.12.5 Leveraging conditional cash transfer programs

Guatemala's Mi Bolsa Segura program reaches 22,863 families with predictable cash transfers, creating infrastructure for behavior change communication and complementary nutrition services. Evidence from Latin American CCT evaluations demonstrates that CCTs with explicit nutrition components achieve greater nutrition impact than transfers alone.

Opportunities include the following:

- Adding fortified food literacy and nutrition education components to the CCT program conditions
- Coupling CCT transfers with fortified food bundles delivered through school or health facility channels
- Linking growth monitoring (a CCT condition) with tailored nutrition counseling emphasizing fortified food consumption
- Integrating CCT program data systems with nutrition surveillance to enable responsive program adjustments

2.3.4.12.6 Renewable energy advantage for green fortification

Guatemala's sugar industry generates substantial renewable energy (992 MW installed capacity), and the broader agro-processing sector is investing in climate-smart production. Fortification infrastructure improvements (efficient processing, temperature-controlled storage, automated premix systems) can be designed to leverage renewable energy availability, reducing the carbon footprint and demonstrating sector sustainability credentials.

2.3.4.12.7 Regional learning and capacity exchange

Costa Rica and Chile have achieved higher fortification compliance and more transparent monitoring systems than Guatemala, Honduras, and Nicaragua, which represent peers managing fortification programs with similar resource constraints. The following opportunities exist for systematic regional learning:

- Study visits and experience exchange programs for Ministry of Health staff, industry representatives, and CONAFOR members to Costa Rica to learn compliance monitoring approaches and public-private partnership models.
- Peer mentoring programs with Chilean and Costa Rican regulatory officials to support Guatemala's monitoring system development.
- A regional platform for documenting and disseminating fortification policy innovations and implementation lessons.

2.3.4.12.8 Research agenda and evidence generation

Gaps in understanding fortification's impact on Guatemalan populations warrant targeted research investments:

- **Coverage and consumption studies:** Comprehensive FACT-type assessments documenting fortified food availability, affordability, and actual household consumption patterns disaggregated by geography, ethnicity, and socioeconomic status.

- **Fortification vehicle optimization:** Research on optimal fortification compound selections to maximize bioavailability and impact in Guatemalan dietary contexts.
- **Complementarity research:** Studies examining the synergistic impact of fortification combined with supplementation, dietary diversification, and behavior change communication versus fortification alone.
- **Implementation research:** Evaluations of quality assurance innovations, compliance monitoring approaches, and private sector engagement models to identify scalable improvements.

2.3.4.12.9 Policy window and political momentum

Guatemala's 2023 Decree Law 44-92 regulatory review cycle represents a policy window for strengthening systematic fortification. Alignment with international nutrition commitments (SDG 2 on ending malnutrition and Scaling Up Nutrition movement priorities) and ongoing sectoral dialogue through SESAN create political space for policy innovation. The demonstrated success of fortification in reducing vitamin A deficiency to non-public-health-problem levels (now <5%) provides proof of concept for fortification's effectiveness and establishes a precedent for policy refinement.

3. Public-Private Partnerships in Food Fortification: Roles, Innovations, and Impact

3.1 Multisectoral Necessity and Strategic Roles

Food fortification is inherently multisectoral, requiring collaboration among governments, industry, civil society, and academia. Governments provide regulatory frameworks and public financing. For example, food fortification in India is driven by close coordination between the Department of Food and Public Distribution (DFPD) and FSSAI, with the DFPD aligning its procurement and program delivery (public distribution system, Mission Poshan 2.0, PM POSHAN) with FSSAI's fortification regulations. The FSSAI sets standards, quality norms, and the "+F" labeling framework, while the DFPD translates these into tender conditions and supply-chain requirements for public distribution staples, thereby guiding and nudging private sector millers and manufacturers to comply. The private sector complements these efforts through innovation, production, distribution, and consumer engagement. National and international organizations, civil society organizations, and donors contribute to pilot programs, policy advocacy, and community outreach. Through the Food Fortification Resource Centre, FSSAI provides technical guidance, premix specifications, and equipment checklists, helping lower entry barriers for small and large food-business operators. The FoRTrace portal, which is integrated with the Food Safety Compliance System, enables end-to-end digital traceability of fortified rice from FRK producers to state warehouses, ensuring quality, preventing adulteration, and supporting real-time monitoring. A large-scale training supported by PATH in multiple states on FoRTrace enabled the system to be adopted and used efficiently. Furthermore, academic institutions play a crucial role in generating important evidence on dietary patterns and the efficacy of interventions. A notable example is research on biofortified crops such

as vitamin A-rich orange sweet potatoes (Saltzman et al. 2017). An integrated, coordinated approach ensures that these contributions lead to sustainable and scalable fortification programs.

3.2 Public Sector Contributions to Food Fortification

Public sector authorities and regulatory bodies in Global South countries have independently driven LSFF through policy formulation, mandatory standards, and enforcement mechanisms. For example, in Ethiopia, the Ministry of Industry launched the National Food Fortification Program in 2024, mandating fortification of edible oil, wheat flour, and salt, while the Ethiopian Standards Agency enforces standards like ES 6133:2021 for oil and ES 6132 for flour. In India, the FSSAI sets national fortification regulations, licenses mills, and conducts compliance testing, enabling the distribution of fortified rice through public systems like the public distribution system, Mission Poshan 2.0, and PM POSHAN, reaching over 800 million beneficiaries. In Senegal, from 1994 to 2009, the Senegalese government mandated the fortification of wheat flour, edible oil, and salt, with the Senegalese Association for Normalization aligning its standards with ECOWAS/UEMOA for regional trade. In Ghana, the Food and Drugs Authority and Ghana Standards Authority enforce wheat flour and oil fortification pursuant to Gazette No. 92 (2010). Regulatory bodies in these countries independently established standards, monitored compliance through inspections and laboratory testing, and integrated fortified foods into safety nets without relying on external partners. This autonomous leadership ensured policy alignment with national nutrition strategies such as Ethiopia's Seqota Declaration and India's fortified rice scale-up.

3.3 Private Sector Contributions to Food Fortification

The private sector plays a pivotal role in addressing technological, supply-chain, and behavioral barriers to fortification. The International Finance Corporation (IFC), as the private sector arm of the World Bank Group, supports private sector actors in multiple ways to strengthen food security and nutrition. The IFC Nutrition in Agribusiness Strategy supports IFC's goal of strengthening nutrition security through private sector solutions. It is built around three pillars: mainstream nutrition in IFC's portfolio by promoting investments in nutritious and biofortified foods across production, processing, and distribution and leveraging advisory programs such as food fortification and smallholder nutrition; integrate nutrition as a cross-cutting theme across sectors; and address investments in sugar-sweetened beverages and foods high in fat, sugar, and salt by supporting product reformulation and, over time, managing exposure to such investments.

The IFC and the Global Agriculture and Food Security Program have funded projects that link small farmers to processors such as PRAN in Bangladesh, supporting on-site improvements in food safety and quality systems that can underpin fortified products. IFC's advisory services explicitly aim to "increase nutritional intake and adoption of high-yield and innovative technology" by linking smallholders to better seeds, inputs, and markets, including nutrition-focused products. Through the Global Agriculture and Food Security Program Private Sector Window, IFC has supported over 89 agribusiness investment projects and 101 advisory projects, reached more than 1.9 million farmers, and improved productivity, storage, and market linkages that facilitate the supply of more nutritious and fortified foods (International Finance Corporation n.d.).

The Asian Development Bank (ADB) provides financing for projects in developing member countries that support economic growth and social development. It finances a project after a thorough process that considers the project's development impact, alignment with ADB's strategy, and feasibility. The process includes feasibility studies, safeguard assessments, stakeholder

consultations, and ultimately, approval by the ADB's Board of Directors. The ADB recognizes the importance of nutrition and managing micronutrient deficiencies, as these affect the availability of a healthy and productive population. ADB's Strategy 2030 (ADB 2018) recognizes that food security and nutrition are fundamental to overall development and well-being, and it is committed to addressing these issues through a multifaceted approach that encompasses agricultural development, poverty reduction, and sustainable development practices.

ADB prioritizes specific commodities, delivery platforms, and population groups in its development initiatives, focusing on the most vulnerable and poorest countries. Specific commodities include food and agricultural items. It supports social protection programs and initiatives to reduce poverty and vulnerability. It prioritizes support for countries with high poverty rates and those facing vulnerabilities. ADB focuses on improving the lives and livelihoods of women and children through nutrition and health care initiatives. However, ADB adapts its support to each country's specific needs, taking into account its unique circumstances.

ADB considers several criteria when financing nutrition programs, including the country's need for concessional assistance, the project's alignment with ADB's strategy, and the potential for impact and sustainability. The proposal should focus on integrating nutrition into broader development plans and strengthening public financial management for nutrition programs while maintaining the integrity of the climate.

ADB's LSFF programs have faced challenges in ensuring inclusivity, capacity-building, and monitoring, as well as a weak research component. Lessons learned highlight the importance of integrated approaches that involve government and the food industry and align with national policies and systems.

ADB uses a multifaceted approach to assess the impact of its investments, emphasizing both qualitative and quantitative data. Digital systems play a crucial role in enhancing monitoring, evaluation, and accountability, providing real-time insights and enabling more efficient data collection and analysis. Moreover, it uses its design and monitoring framework to define project objectives, indicators, and monitoring systems at the outset. ADB uses digital platforms for project management and data collection through robust data management systems employing modern data analytics. Currently, it is exploring AI and machine learning to improve data analysis and forecasting.

ADB continues to play a catalytic role in nutrition development and large-scale food fortification (LSFF) efforts in the region. It advocates for and promotes multisectoral ownership, overall capacity-building, and encourages research to improve the nutritional status of communities. It promotes holistic approaches to poverty reduction that address and mitigate the underlying risks of poor nutrition by supporting complementary activities to improve nutrition and empower women and other vulnerable populations. ADB also collaborates with various actors to enhance the effectiveness and scale of its LSFF interventions. Partners include WHO, FAO, research institutions, UNICEF, the private sector, and agencies engaged in this work. Its regional food fortification initiative, including the first major public-private partnership, demonstrates its commitment to collaborative problem-solving and addressing public health issues. The objectives of ADB's collaboration are to harmonize interventions, scale up impact, share knowledge and best practices, and promote sustainability.

ADB recognizes its role in facilitating North-South and South-South knowledge exchange as crucial to amplifying its LSFF efforts. By facilitating knowledge exchange, ADB can help share best practices and lessons learned from diverse experiences to support effective and sustainable LSFF interventions in partner countries. ADB also recognizes the value of North-South knowledge exchange, particularly in leveraging expertise and resources from developed nations to complement South-South collaborations.

In terms of innovation, companies such as BASF have developed advanced delivery technologies, including microencapsulation and hot-melt extrusion to preserve nutrient stability, particularly for heat-sensitive vitamins and minerals. Biofortification partnerships such as those among Bayer, HarvestPlus, and Syngenta have led to the cultivation and distribution of zinc-rich wheat and vitamin A-enriched maize in South Asia and Africa (HarvestPlus 2023). Large food manufacturers, including Nestlé, have adopted dual fortification techniques to ensure product appeal and nutrient retention, as seen in fortified Maggi bouillon cubes in West Africa.

Small and medium enterprises also play a key role: in Nigeria, Promasidor reaches rural customers with fortified powdered milk via informal channels (Business Monitor 2026), while PRAN in Bangladesh distributes fortified snacks through more than 1,000,000 retail outlets (HarvestPlus 2023). Innovations in the cold chain, such as USDEC's (2025) ultra-high-temperature milk and Danone's shelf-stable yogurt, enable nutrient delivery without refrigeration in tropical climates (FMCG Asia 2023).

Private companies also excel at consumer engagement and behavioral change. Tata Salt's "Desh Ka Namak" campaign and Kellogg's multimedia drive have helped normalize fortified products as part of daily household nutrition. Nestlé's NIDO Fortigrow positions fortification as an investment in children's cognitive and physical development (Nestlé n.d.), while Danone's Shokti+ offers affordable fortified dairy to vulnerable populations in Bangladesh (Tasnim et al. 2022). Social marketing efforts, such as Unilever's Project Shakti, empower rural women as health ambassadors and micro-entrepreneurs (Hindustan Unilever Limited 2024).

3.4 Public-Private Partnerships in Action

Strategic public-private collaborations have proven critical for scaling food fortification. In the Philippines, the Department of Health and United Laboratories launched a social marketing campaign to distribute weekly iron and folic acid supplements, improving iron status among women and adolescent girls (Paulino et al. 2005). In Bangladesh, GAIN partnered with BRAC (Bangladesh Rural Advancement Committee) and Renata Ltd. to scale production and community-based distribution of Pushtikona micronutrient powder (Afsana et al. 2014), reaching 1.3 million sachets per month through 80,000 health workers (GAIN 2012). BRAC is a global leader in pioneering and scaling proven solutions to poverty and inequality, having been founded in 1972 in post-war Bangladesh as a small relief effort. A global micronutrient powder initiative between DSM (a Netherlands-based premix supplier) and the WFP reduced anemia and stunting in Bangladesh, Nepal, and Kenya, reaching up to 15 million people annually (Sight and Life 2013).

In West Africa, Helen Keller International, UEMOA, and the cooking oil industry collaborated to make oil fortification mandatory, expanding access to fortified products for over 35 million children across ECOWAS countries (Exemplars in Global Health 2022; Sablah et al. 2012). In Senegal, GAIN and CLM (Nutrition Coordination Unit/Cell for the Fight Against Malnutrition) led efforts to establish the national fortification alliance, train producers, and launch mass media campaigns, resulting in 96%

of flour and 76% of oil samples meeting fortification standards (Faye et al. 2025). In Tanzania, the SAFO initiative by GIZ and BASF supported technical capacity-building and government engagement, enabling cooking oil fortification to reach 30 million people by 2012 (Gradl 2012).

A noteworthy example of integrated innovation is Kenya's "Super Porridge" project for the arid and semi-arid land regions (Citizen Digital 2023). Led by the National Council for Nomadic Education and Tetra Pak, with technical input from DSM, JetLak Foods, and Ingredion, the project created a shelf-stable, fortified porridge for school feeding programs (Nutrition Insight 2023). Using local climate-resilient crops, the porridge provided 15 essential micronutrients, improved school attendance from 72% to 95%, and reduced underweight prevalence from 45.8% to 11.6% in just six months. This multisectoral approach not only addressed malnutrition and education gaps but also supported local farmers and employment.

Another scalable global example is rice fortification, a fortification technology that embeds micronutrients into rice-shaped extruded grains made from rice flour (PATH n.d.). These are blended with traditional rice (at 1:100 or 1:200 ratios), preserving taste and texture while delivering vital nutrients such as iron, vitamin A, and zinc. Rice fortification has demonstrated high stability during storage and cooking, and clinical trials across eight countries have shown significant reductions in anemia and vitamin deficiencies. In India, the technology costs just US$0.41 per child per year in school meals and has been adopted in large-scale public programs. In summary, public-private partnerships play a vital role in advancing food fortification by combining the strengths of government policy, private sector innovation, and community-based delivery. These collaborations have enabled scalable, cost-effective solutions to tackle micronutrient deficiencies globally. Sustained coordination, inclusive strategies, and local adaptation remain key to maximizing impact and achieving long-term nutritional resilience.

In India, public-private collaborations have expanded food fortification beyond safety-net programs into the open market, especially for fortified rice and fortified milk. Policy signals from the Government of India, FSSAI standards, and large-scale procurement for schemes such as the public distribution scheme, PM POSHAN, and TPDS have drawn in many FRK manufacturers and dairy brands to scale up fortified products for both mass consumption and retail channels.

Several millers and food companies now market fortified rice in the open retail market, often under dedicated "health" or "nutrition" sub-brands that sit alongside their mainstream labels. Examples include Daawat Sehat (LT Foods), Asbah Power Rice (DCP Foods Pvt Ltd), and "Aarogya" by Sri Padmalaya Rice Mill (Andhra Pradesh), which are fortified rice brands launched specifically for the open retail market. These examples illustrate that, beyond the government-led FRK supply chain, private brands are creating "fortified" tiers in the open market, using claims on iron, folic acid, vitamin B1 (thiamine), vitamin B3 (niacin), vitamin B6 (pyridoxine), vitamin B12 (cobalamin), as well as other micronutrients, often with FSSAI-compliant fortification standards and the "+F" logo (Food Safety and Standards Authority of India n.d.).

Milk fortification has been one of the most visible private sector driven fortified food streams in India, with both large cooperatives and private dairies launching vitamin-A and vitamin-D-fortified variants in the open market. Several dairy players in India are actively producing and marketing fortified milk under the FSSAI "+F" logo, contributing to the national fortification agenda. Mother Dairy (NDDB) has long fortified toned milk and now offers fortified variants (toned, double toned, skimmed) across multiple states, reaching large urban populations in cities such as Delhi, Punjab, Lucknow,

Hyderabad, Mumbai, and Chennai. Additionally, private brands such as Creamline Dairy (“Enrich D”), Nestlé a+ Nourish Milk, Heritage Foods, Britannia, Hatson Agro, Milk Mantra, and others have introduced fortified milk products in the open market, typically emphasizing vitamin A and D fortification (Food Safety and Standards Authority of India 2024).

The jump in the number of FRK and fortified-rice manufacturers in India is closely tied to explicit policy decisions and regulatory standards that created a predictable, large-scale demand environment. The Government of India mandated the fortification of rice supplied under key social-safety-net schemes (public distribution systems, PM POSHAN, and TPDS), with targets (The Statesman 2024) of over 100 lakh tons of fortified rice in the central pool. This created a long-term, guaranteed-demand pipeline for FRK manufacturers, directly incentivizing investment in FRK plants and premix capacity. The lists of FRK manufacturers maintained by FSSAI and industry platforms show that the number of FRK-capable units has grown across states, with over 300 listed FRK suppliers and multiple premix manufacturers now operating in India. Many of these units were established or scaled up after the announcement of national rice-fortification mandates, as millers and specialty FRK producers aligned with government procurement and private brand contracts (Food Industry Capacity and Skill Initiative 2021).

4. Learnings from the Countries Implementing Food Fortification

Over 80 countries, spanning both industrialized and developing regions, have demonstrated that food fortification is an effective, evidence-based approach to addressing micronutrient deficiencies (Dary and Mora 2002). In Sub-Saharan Africa, enriching staple foods such as wheat, maize, and rice flour has proven practical and impactful in reducing widespread nutrient deficiencies.

4.1 Best Practices for the Implementation of Food Fortification

Decades of scientific assessments and national surveys have built a strong evidence base underpinning fortification policies. In multiple countries, baseline studies on micronutrient deficiencies, dietary intake, and food consumption patterns shaped fortification strategies.

For instance, Nigeria's early evidence linking goiter prevalence to iodine deficiency led to the introduction of mandatory salt iodization in 1992 (Ogunmoyela et al. 2023). Similarly, the 2011 National Micronutrient Status Survey in Bangladesh generated critical data on edible oil consumption and vitamin A intake across demographic groups, guiding the design and rollout of the national edible oil fortification initiative. In India, large-scale nutrition surveys such as NFHS and the Comprehensive National Nutrition Survey revealed persistent deficiencies in iron, folic acid, vitamin B12, and vitamin D, catalyzing policy responses through FSSAI's fortification framework established in 2016.

These evidence-generation efforts demonstrated the potential of staple food fortification to improve nutritional outcomes, which subsequently informed national scale-up strategies across diverse contexts. These strategies are discussed in the sections below.

Nigeria: Nigeria represents one of Africa's earliest and most comprehensive fortification programs. The first large-scale milestone came in 1993 with the introduction of iodized salt, achieving around 98% coverage by 2005. Building on this, the government mandated fortification of four major staples in 2002: wheat and semolina flour with vitamin A, B-complex vitamins, zinc, and iron; maize flour with vitamins A and B9 and zinc; and sugar and vegetable oil with vitamin A (Resnick et al. 2021). To ensure compliance, two dedicated institutions were established: the Standards Organization of Nigeria to develop fortification standards and the National Agency for Food and Drug Administration and Control to oversee the market. The National Fortification Alliance, a multi-stakeholder forum integrating government, industry, academia, and media, supported these efforts. Despite these achievements, assessments highlighted continued gaps in iron and vitamin A levels in processed foods, reinforcing the need for stronger enforcement and quality monitoring.

Indonesia: Indonesia's fortification journey is characterized by phased and food-specific progress. The country introduced mandatory fortification of salt with iodine, wheat flour with iron, and cooking oil with vitamin A, the latter regulation coming into effect in 2020 (Dewi and Mahmudiono 2021). This structured, phased approach enabled gradual scale-up while building technical capacity within domestic industries and regulatory systems.

India: In India, wheat, rice, and edible oil, given their widespread consumption, serve as the primary vehicles for fortification. The FSSAI introduced regulations in 2016 mandating the fortification of wheat and rice flour with iron, folic acid, and vitamin B12, and edible oil with vitamins A and D. The Food Safety and Standards (Fortification of Foods) Regulations, 2018, further defined norms,

standards, and labeling requirements, including the mandatory display of the "+F" fortification logo for consumer awareness.

India's success story in salt iodization also provides important lessons. The universal salt iodization (USI) initiative, institutionalized under the National Iodine Deficiency Disorders Control Programme, achieved over 90% household coverage by 2019 (NFHS-5). Integration with the public distribution system, mobile testing vans, and mass communication campaigns such as "Dhan ho iodized namak ka" ensured both supply chain efficiency and consumer behavioral change.

The rice fortification program, approved for nationwide expansion through TPDS and other welfare schemes (Mission Poshan 2.0 and PM POSHAN), illustrates India's large-scale, system-driven approach. Rolled out through a phased plan from 2021–22 to 2023–24, the initiative ensured distribution of over 322 lakh tons of fortified rice, covering nearly all states and union territories, and is now further extended till 2028 (Department of Food and Public Distribution 2023). This structured rollout demonstrates India's commitment to combating malnutrition through systemic food fortification, leveraging existing welfare schemes to maximize reach and impact.

Bangladesh: Learning from earlier supplementation strategies, Bangladesh launched its edible oil fortification program in 2013 to provide vitamin A through an everyday food vehicle. The Ministry of Industries, supported by the Global Public Foundation, coordinated among 19 major refiners to ensure compliance. The Bangladesh Standards and Testing Institution strengthened its capacity for testing and verification, while behavior change communication improved consumer awareness. Legislative action through the Oil Fortification Bill secured legal and institutional backing for sustained implementation (Ebata et al. 2021). The initiative now covers an estimated 75% of the population, demonstrating how targeted regulation, strong coordination, and sector-focused leadership can yield nationwide impact.

Sri Lanka and Nepal: Sri Lanka and Nepal showcase effective, scalable food fortification models through their USI programs. Sri Lanka's USI, launched in 1995, reduced goiter prevalence from 18.6% to 2.1% by 2016 through mandatory iodization standards (50 ppm at production and 25 ppm at the consumer level) and strong public-private partnerships. Nepal's program, guided by the 1999 Iodized Salt Act, expanded iodized salt coverage from 55% in 1998 to 98% by 2022, virtually eliminating goiter via robust government oversight and cross-border supply coordination with India.

Both countries integrated fortified rice into school meal programs to reach vulnerable children through existing safety-net programs. In Sri Lanka, post-2019 pilots enabled the distribution of fortified rice to 600,000 primary students in 232 schools in 12 districts, supported by PATH's FRK technology transfer and WFP collaboration. In Nepal, the National School Meal Programme serves 3.3 million children with a US$87 million budget, introducing fortified rice in food-insecure provinces under WFP–McGovern-Dole support and shifting from in-kind to cash-based modalities during COVID-19 with a focus on local procurement.

Costa Rica: Costa Rica is a global exemplar of integrating fortified food systems. Since the 1950s, the country has fortified wheat flour, maize flour, sugar, milk, and salt, guided by strong legislation and inter-agency coordination. Continuous scientific evaluation has improved nutrient formulation. For example, it has switched from reduced iron to more bioavailable ferrous fumarate in wheat flour and ferrous bisglycinate in maize flour. By combining fortification of multiple staples with robust monitoring and quality control, Costa Rica has nearly eliminated anemia and NTDs (Martorell et al. 2015).

4.2 Structural Challenges for the Implementation of Food Fortification

Coordination challenges across ministries: While country chapters document fortification policies, delivery platforms, and emerging opportunities in depth, experiences across the 16 countries reveal a common set of structural implementation challenges that constrain scale and impact. First, coordination across ministries and agencies remains uneven in most settings, with overlapping mandates between health, food safety, agriculture, trade, and social protection authorities leading to fragmented decision-making, slow regulatory processes, and unclear accountability for fortification outcomes. Multisectoral committees or working groups often exist on paper, but limited resources, irregular meetings, and weak links to high-level political forums hinder their effectiveness in resolving bottlenecks or driving national scale-up.

Premix supply and financing constraints: Premix supply and financing are recurring constraints, particularly for countries that depend on imported premix and equipment. Exposure to international price volatility, foreign exchange shortages, and import duties raises production costs and discourages both public procurement and private investment in fortification, especially among small- and medium-sized processors. In several contexts, the absence of pooled procurement mechanisms, tax waivers, or targeted subsidies means that premix costs are passed on to consumers, limiting demand in highly price-sensitive markets.

Monitoring and compliance gaps: Monitoring and compliance systems are often underdeveloped relative to the ambition of fortification mandates. Many countries lack ILAC- or International Organization for Standardization-accredited laboratories, standardized sampling protocols, and digital traceability tools needed to verify fortification levels, track product flows, and enforce regulations consistently across regions. Decentralized inspectorates frequently operate with limited budgets, technical capacity, and transport resources, leading to uneven enforcement, quality inconsistencies, and weak deterrence of non-compliance.

4.3 Fragmented Industry Structures

Fragmented industry structures complicate implementation, especially where staple foods are produced and distributed through numerous small mills, oil refineries, or informal enterprises. While large industrial players can usually absorb premix costs and meet technical standards, small-scale processors often lack capital, equipment, and technical support, creating parallel formal and informal markets where non-fortified products remain widely available. In such settings, voluntary fortification or poorly enforced mandates struggle to achieve population-level coverage because a significant share of the supply lies outside effective regulatory reach.

4.4 Low Consumer Awareness of Fortified Foods

Low and uneven consumer awareness of fortified foods is a cross-cutting barrier that limits both demand and political pressure for sustained investment. In many countries, consumers are unfamiliar with the purpose and benefits of fortification, may distrust product changes, or perceive fortified staples as more expensive without clear added value. Weak social and behavior change communication, the absence of recognizable fortification logos, and limited integration of fortification messaging into broader nutrition campaigns contribute to this awareness gap, reducing uptake even when fortified products are technically available.

4.5 Key Learnings

The following are the global experiences that converge on several common success factors:

a. **Integration with universal food systems and safety nets:** Fortification may be conceived as part of broader food system strengthening, rather than a standalone intervention. Integration with existing universal programs maximizes reach and ensures sustainability through established funding and delivery mechanisms
b. **Regulatory mandates and enforcement:** A coherent legal framework characterized by clearly defined standards, effective monitoring mechanisms, and regular inspection is fundamental to ensuring regulatory compliance. Illustrative examples include the FSSAI in India, the National Agency for Food and Drug Administration and Control in Nigeria, and the Bangladesh Standards and Testing Institution in Bangladesh. In Sri Lanka, the Food Control Administration Unit's 2022 wheat flour regulations, effective from January 2024, strategically leveraged millers' pre-existing iron and folic acid fortification capacities. Similarly, Nepal's 2011 mandate followed successful voluntary efforts and extended coverage to all roller mills nationwide. Conversely, in contexts characterized by fragile or fragmented governance structures, such as Myanmar and Nigeria's fragmented states, institutional weaknesses have undermined effective regulatory enforcement and compliance oversight.
c. **Public-private partnerships and multisectoral coordination:** Strategic collaboration with large-scale processors facilitates rapid scale-up and promotes standardized quality control, whereas targeted support for small-scale producers is essential to ensure inclusivity and equitable market participation.

   Effective multisectoral coordination has proven critical to the success and sustainability of fortification initiatives. In Sri Lanka, the National Nutrition Policy (2021–30) adopts an integrated framework that embeds food fortification within broader health, education, and agricultural strategies. Similarly, Nepal's Multi-Sector Nutrition Plan II, overseen by a high-level steering committee, promotes federal coherence and intergovernmental alignment in implementing nutrition interventions.

d. **Efficient supply chains:** Decentralized production, logistics optimization, and real-time monitoring help maintain consistency and minimize nutrient loss. Supply chain resilience is critical for long-term sustainability. Countries may invest in domestic premix and FRK production capacity, develop miller networks, and ensure that industry compliance is economically sustainable.

e. **Community engagement and demand creation:** Behavior change campaigns, school-based programs, and public communication address misinformation and boost consumption. Concurrent investment in consumer awareness, strategic marketing, visual communication, and messaging in local languages, as well as behavior change communication, is essential for sustained adoption and compliance. For example, widespread misinformation alleging that fortified rice was being replaced with "plastic rice" was effectively countered through media engagement, which showed that so-called plastic rice would be considerably more expensive to produce than natural rice, dispelling the myth and reinforcing public confidence.

f. **Robust monitoring, evaluation, and adaptation:** Periodic surveys, fortificant content testing, and impact assessments enable evidence-based policy refinement. For example, the PATH-WFP

collaboration in Sri Lanka established FRK manufacturing and digital quality assurance/quality check systems, positioning it as a regional model, whereas Nepal's rice blending began in 2024 with WFP support but lacks local FRK production. Both nations underscore the integration of fortification into safety nets (Thriposha food supplement in Sri Lanka reached 1 million pregnant and lactating women, infants, and preschoolers; Nepal's child grants complemented by meals) while addressing coverage challenges through pilots, consumer acceptance trials, and laboratory strengthening for quality assurance.

g. **Laboratory infrastructure and accreditation gaps:** Phased investment in laboratory infrastructure, training, and accreditation partnerships (with regional reference labs, international accreditation bodies) may be prioritized. Initially, reliance on private sector laboratories and regional testing services can help bridge capacity gaps.

h. **Robust quality assurance and quality control:** Quality assurance is not optional. It is fundamental to program credibility, consumer trust, and health impact. Governments must invest in laboratory infrastructure, train technical personnel, use digital tools, and establish enforcement mechanisms. Where government capacity is limited, capacity-building partnerships with private sector organizations and international technical agencies are essential.

4.6 Synthesis

Large-scale food fortification is a key strategy to address widespread micronutrient deficiencies, especially anemia, across Africa, Asia, and Central America. Countries such as Ethiopia, Ghana, Madagascar, Nigeria, India, Sri Lanka, Nepal, Bangladesh, and Costa Rica face varying burdens of malnutrition, with women and children most affected.

Fortification approaches reflect local diets and supply chains: wheat flour, edible oil, and salt dominate in Africa; salt, edible oil, rice, and other staples are prioritized in Asia; while Costa Rica demonstrates mature, diversified programs including sugar and milk. These interventions are anchored in national nutrition and food security policies, though data gaps (notably for zinc and folate) remain.

Implementation efforts capitalize on established delivery platforms, leveraging school meal programs, social safety nets, and universal salt iodization initiatives, and are supported by growing multisectoral coordination among the health, agriculture, and trade ministries. Nevertheless, persistent structural and systemic constraints, including the predominance of small-scale milling operations, regulatory complexity, weak enforcement mechanisms, and limited consumer awareness, continue to limit the program's impact. Strengthened governance frameworks, robust quality-assurance systems, and demand-generation strategies are vital to achieve the full nutritional benefits of food fortification initiatives.

A significant distinction across countries is the extent to which fortification is integrated with universal social safety net programs, which serve as efficient delivery mechanisms for reaching vulnerable populations.

Strong integration (India, Bangladesh, Indonesia, and Nepal): India has leveraged its massive social safety net programs, the public distribution system, Mission Poshan 2.0, and PM POSHAN school meal schemes to deliver fortified rice to over 700 million beneficiaries. Bangladesh targets 15 million vulnerable individuals through the Vulnerable Women Benefit Program and Food Friendly Program. Indonesia has reached 23 million individuals through its Bantuan Pangan Beras (rice food aid) program. These integration strategies maximize population reach and ensure sustained funding. In Nepal, the National School Meal Programme is a critical platform for delivering fortified foods (fortified rice, lentils, vitamin A-fortified oil, iodized salt) to vulnerable primary school children across all 77 districts, covering about 3.3 million children in 29,000 public schools.

School-based delivery (Central America, Ethiopia): Costa Rica, Guatemala, and Ethiopia incorporate fortification through universal or targeted school meal programs, ensuring consistent delivery during critical stages of childhood development. Costa Rica's long-term success partly reflects this embedded approach.

Limited integration (Ghana, Senegal, Myanmar, and Sri Lanka): Some countries lack comprehensive government-led safety nets, limiting the potential for fortification to achieve universal reach. These contexts must rely on voluntary private sector compliance and smaller pilot programs, reducing population coverage.

Together, these lessons illustrate that fortification's success depends on an ecosystem of scientific evidence, policy commitment, multisectoral coordination, and sustained consumer engagement. For countries in the Global South, customizing these models to local contexts, choosing the right food vehicles, integrating fortification into social safety nets, supporting national-level biofortification initiatives, and maintaining strong political will can maximize nutritional impact and program sustainability.

5. Global South Collaboration and Knowledge Transfer: Case Study

In low- and middle-income countries with limited diet diversity and overstretched health systems, food fortification offers a proven, cost-effective nutrition solution. Yet, success depends not only on national commitment but also on strong Global South partnerships that align financial, technical, and regulatory support with a shared long-term vision. This chapter examines how such collaborations advance food fortification and nutrition outcomes across five dimensions: knowledge transfer, financing and logistics, policy development, equity, and sustainable ownership.

5.1 Knowledge Transfer and Capacity Building

Sri Lanka's rice fortification initiative, aligned with its national nutrition policy, exemplifies effective Global South collaboration focused on knowledge transfer and localization. The WFP supported rice fortification interventions from 2015 to 2023 by providing technical assistance, capacity-building, policy and supply chain support, and donating fortified rice and FRK to strengthen national safety-net and school feeding programs. Other international partners, such as PATH and GAIN, facilitated access to fortified rice technology, technical training, and cost-sharing for initial equipment investments, while local millers adapted the technology to national rice varieties and nutritional priorities such as iron and folic acid fortification. With government endorsement, national standards, and growing private sector participation, the program evolved from external support to sustained local ownership. This transition from technology transfer to self-reliant production highlights how capacity-building and contextual adaptation can ensure sustainable nutrition interventions.

Launched in 2023, Millers for Nutrition is an industry-led coalition coordinated by TechnoServe that supports millers across eight countries in Africa and Asia, including India, to fortify staple foods such as rice, flour, and edible oil with essential vitamins and minerals, aiming to reach 1 billion people by 2026. Through free technical training, business support, product testing, and digital tools, the initiative strengthens millers' capacity to produce high-quality fortified foods. Key partners such as MC Mühlenchemie, Hexagon Nutrition, and Sanku provide specialized technical assistance to both large and small millers. This north–south collaboration exemplifies how private sector partnerships and capacity-building can accelerate national fortification efforts and reduce malnutrition.

5.2 Financial and Logistical Support

Food fortification demands significant investment in infrastructure, premix supplies, quality control, and monitoring; costs often exceed the capacity of many low- and middle-income countries, making international funding vital. Ethiopia's iodized salt program illustrates this Global South collaboration: with donor support from UNICEF, USAID, and the Canadian government, the program established iodization equipment, producer training, and regulatory systems, raising national coverage from 15% to over 90% between 2008 and 2014. Crucially, by aligning external assistance with local institutions rather than imposing models, the program fostered ownership and sustainability, enabling continued success even after donor funding declined.

5.3 Regulatory and Policy Alignment

Robust food fortification programs depend on clear legal mandates, harmonized standards, and effective enforcement. In the early 2010s, ECOWAS, with support from GAIN and the European Union, harmonized wheat flour and vegetable oil fortification standards across member countries. This Global South collaboration streamlined compliance for regional producers, strengthened monitoring systems, promoted cross-border trade in fortified foods, and enhanced governments' ability to enforce regulations consistently (WFP 2018).

5.4 Promoting Equity in Nutrition Food Fortification

Food fortification promotes nutritional equity by reaching marginalized populations lacking access to diverse diets and health care. A strong example is Rwanda's "Shisha Kibondo" initiative, developed in partnership with USAID and the Clinton Health Access Initiative. This locally produced fortified complementary food for infants and young children used homegrown ingredients and was distributed through government health centers, ensuring affordability and cultural acceptability. Global South collaboration combined international technical expertise in formulation and fortification with local leadership in production, quality control, and community outreach, addressing critical nutrient gaps during the first 1,000 days of life and advancing equity from the start.

5.5 Long-term Sustainability and Local Ownership

For food fortification programs to be resilient and enduring, they must evolve from donor-driven initiatives into nationally led strategies. Tanzania's oil fortification program exemplifies this transition. Initially supported by GAIN and SNV, the program equipped small- and medium-scale producers to meet national standards. Over time, local industries began sourcing premix independently and engaging in national quality assurance systems, while the government assumed full regulatory oversight. This progression illustrates how Global South collaborations, when designed with sustainability in mind, can successfully seed programs that mature into nationally owned systems.

5.6 Global South Learning Exchange on Advancing LSFF: An Event by PATH

PATH and GIZ organized a two-week Global South learning exchange visit to India in January 2025 to tackle key micronutrient deficiencies that vary by country. As part of the immersion visit, 16 delegates from seven countries, including Burkina Faso, Côte d'Ivoire, Ghana, Madagascar, Nigeria, Senegal, and Sri Lanka, visited India to gain first-hand experience from the country's flagship rice fortification program. Delegates engaged with policymakers, researchers, technical experts, academics, FRK manufacturers, and key institutions, including FSSAI, DFPD, IIT Delhi, the National Institute of Food Technology Entrepreneurship and Management, and Sir Vithaldas Thackersey College of Home Science. The visit included tours of FRK and premix production facilities as well as a public school to observe fortified rice preparation and distribution under the PM POSHAN scheme, providing a comprehensive view of India's rice fortification value chain. Five key takeaways from the Global South learning exchange include the following:

- Invest in locally sustainable manufacturing systems.
- Strengthen policy and regulatory support frameworks.
- Promote resilient and diversified supply chains.
- Establish South South Centers of Excellence.
- Implement community awareness and strategic communication strategies and initiatives.

South-South knowledge exchange with countries like Bangladesh, India, Pakistan, and Kenya could provide valuable lessons for program improvement. Bangladesh's rice fortification experience through both public distribution systems and commercial channels offers relevant lessons. India's experience with large-scale rice fortification through the public distribution system provides important insights. Pakistan's experience in scaling up wheat flour fortification offers regional relevance. Kenya's experience with edible oil fortification could inform Nepal's emerging initiatives.

Regional collaboration on regulation, digital tools, and public-private partnership models could enhance program effectiveness. Harmonized standards across South Asian countries could facilitate trade. Shared laboratory services for specialized testing could increase capacity. Joint procurement of fortification premix could leverage regional purchasing power.

Food fortification is not just a technical challenge. It is a collaborative endeavor that requires vision, commitment, and cooperation. Global South partnerships play a transformative role in making fortification feasible, effective, and sustainable across low- and middle-income countries. Successful Global South partnerships in food fortification are characterized by alignment with nationally defined priorities, strong government stewardship, and investments in institutional capacity. These collaborations integrate technical expertise from high-income contexts with local knowledge and systems to design adaptive, evidence-informed interventions. Emphasis on rigorous learning, capacity strengthening, and financial transition mechanisms ensures sustainability beyond external funding cycles. As demonstrated through initiatives such as Millers for Nutrition and national experiences in Ethiopia, Rwanda, and Tanzania, such partnerships exemplify how shared accountability, long-term engagement, and contextual adaptation can accelerate progress toward equitable and sustainable nutrition outcomes in low- and middle-income countries.

5.7 Key Observations

Persistent anemia (affecting 45-68% of children and women), along with vitamin A and zinc deficiencies, underscores the need for LSFF across these nations. Cereal-based diets favor staples as vehicles, though challenges like small-scale milling and premix costs persist. In Africa, Ethiopia has advanced mandatory wheat/oil fortification amid foreign-exchange hurdles, reaching 89% oil coverage via large refiners like Phibela; Ghana has leveraged rice imports for centralized pilots; Madagascar's ANFA (Alliance Nationale pour la Fortification Alimentaire, or National Food Fortification Alliance) has coordinated salt/flour/oil fortification despite laboratory gaps; Nigeria's 28-57% wheat coverage highlights compliance needs in the National Home-Grown School Feeding Programme; and Senegal has built oil/flour mandates amid urban-rural disparities. Asia shows Bangladesh at 75% oil fortification; India's fortified rice through the public distribution system and school meals covers 700 million people; Indonesia phases in multi-vehicle standards; Myanmar pilots rice amid governance issues; Nepal integrates fortified foods into meals for 3.3 million schoolchildren; and Sri Lanka/Vietnam advance FRK through safety nets, addressing fragmented milling. Latin America has excelled with voluntary wheat, oil, and rice fortification in Argentina and Brazil; Costa Rica's rice/wheat/maize/milk/salt mandates have contributed to NTD reductions; and Guatemala aligns flour/oil fortification with schools, boasting strong enforcement. Cross-cutting strengths include safety-net leverage (e.g., Ethiopia's Productive Safety Net Programme for 8 million people, Sanku dosifiers for 4 million), public-private partnerships (e.g., Nigeria's National Food and Nutrition Policy), and innovations such as IoT monitoring, while opportunities lie in premix localization and consumer campaigns to close urban-rural gaps.

5.7.1 Policy commitment and program scope

Broad policy commitment with scope variation: Ten of the sixteen countries analyzed have enacted national food fortification policies, either mandatory or voluntary. However, the scope and ambition of these policies vary considerably.

Multi-commodity fortification: African countries, including Nigeria, Senegal, and Ethiopia, exhibit broad policy commitment, with mandatory or pilot fortification of multiple commodities targeting diverse micronutrient deficiencies. Nigeria leads with the widest range of mandatory fortification covering wheat, maize, oil, and salt, with rice under pilot implementation. This comprehensive approach reflects recognition of multiple concurrent micronutrient deficiencies across the population.

Selective/graduated approach: Ghana has adopted a more conservative policy approach. It currently mandates only salt iodization, with voluntary fortification programs for wheat flour and oil. This reflects a phased implementation strategy, allowing government capacity and industry readiness to develop before expanding mandates.

Latin American leadership: Costa Rica has implemented one of the most mature and sustained fortification systems globally, with mandatory fortification of salt, sugar, wheat flour, and milk since the early 1970s. Sustained political commitment, robust institutions (Instituto Costarricense de Investigación y Enseñanza en Nutrición y Salud and the Ministry of Health), and early recognition of micronutrient deficiencies as a public health priority have enabled this long-term success.
Asian hybrid models: India and Bangladesh employ hybrid approaches integrating mandatory and voluntary provisions. India mandates fortified rice across government social safety net programs (public distribution system, Mission Poshan 2.0, PM POSHAN), while permitting voluntary fortification of oil, milk, and wheat flour in the commercial sector. Bangladesh implements a combination of voluntary market-based fortification and mandatory provisions in targeted programs, with recent regulatory strengthening through the Draft Food Fortification Regulation 2023.

Fragmented policy landscape: Myanmar faces a challenging policy landscape beyond salt iodization, with rice and oil fortification remaining at the pilot stage and enforcement limited. The market structure, dominated by small-scale private producers and limited government-led social safety nets, constrains the feasibility of universal mandatory fortification.

5.7.2 Population reach and coverage metrics

Coverage of food fortification programs varies widely across countries and is strongly influenced by delivery mechanisms and policy commitment. India has achieved mass reach, covering over 800 million people through large-scale platforms such as the public distribution system, Mission Poshan 2.0, and PM POSHAN schemes, while Bangladesh has reached around 15 million vulnerable individuals, though its market-based coverage remains uncertain. Countries such as Indonesia and Guatemala have achieved substantial reach, benefiting 10–50 million people through rice and school meal initiatives. In contrast, Ghana, Senegal, Ethiopia, and Myanmar have limited or urban-focused programs reaching fewer than 10 million people, primarily through school feeding and safety nets. Costa Rica stands out with near-universal coverage sustained by decades of mandatory fortification across retail markets. However, across all contexts, a major gap is limited rural coverage, driven by challenging infrastructure, restricted market reach, and low distribution capacity, which perpetuates significant urban–rural disparities in access.

5.7.3 Quality assurance and regulatory frameworks

The effective implementation of food fortification programs depends on robust quality assurance systems, well-equipped laboratory infrastructure, and consistent enforcement of standards. Countries such as Costa Rica and India have made significant progress in this area. Costa Rica's Instituto Costarricense de Investigación y Enseñanza en Nutrición y Salud serves as a regional benchmark, reflecting strong institutional leadership, accredited laboratory systems, and sustained investment in infrastructure and skilled human resources. Similarly, India's FSSAI has established robust fortification standards, mandatory quality-assurance requirements for manufacturers, and comprehensive monitoring frameworks. Additionally, to strengthen quality control, FSSAI has introduced the Fortified Rice Quality Management System through a FoRTrace application for real-time monitoring across different stages of production and the supply chain. However, many countries continue to face major challenges in quality assurance. Ethiopia and Myanmar lack ILAC-accredited laboratories and struggle to enforce standards and build consumer trust, while Nigeria's fragmented milling sector and limited state-level laboratory capacity constrain monitoring. Indonesia's vast geography hampers consistent quality control, and South Asian countries such as Bangladesh and Nepal have inadequate domestic laboratory facilities for micronutrient testing and verification.

5.7.4 Monitoring and enforcement mechanisms

Monitoring approaches for food fortification vary widely across countries. India follows a comprehensive system led by FSSAI, combining regulatory oversight, stringent quality assurance by manufacturers, and periodic evaluation through national nutrition surveys, supported by regular sampling and testing at production and retail stages. Costa Rica demonstrates strong government–industry collaboration, with producers conducting internal quality control complemented by external government verification and import checks. In contrast, countries like Ghana and Senegal have monitoring frameworks that exist on paper but face implementation challenges due to limited technical and institutional capacity, particularly among smaller producers. Myanmar exhibits minimal enforcement, with limited government capacity and a fragmented regulatory system that leads to inconsistent compliance verification.

5.8 Conclusion

The experience of the 16 countries affirms LSFF's scalability: Ethiopia's National Food Fortification Program and Productive Safety Net Programme evolution signal momentum; Ghana's import strategy offers replicable pilots; Madagascar's ProSAR bouillon and MIKASA labs build resilience; Nigeria's National Home-Grown School Feeding Programme rice push targets 10 million pupils; Senegal's flour/oil progress sets the stage for rice expansion. Bangladesh's oil success inspires neighbors; India's NDDB/FSSAI rice/milk model reaches large populations; Indonesia's standards harmonize industry; Myanmar's pilots gain traction; Nepal's school integration serves millions; and Sri Lanka/Vietnam's FRK-safety-net blends ensure equity. Argentina/Brazil's multisectoral voluntary efforts provide scale lessons; Costa Rica's 2001 rice mandate, which contributed to reductions in NTDs through centralized industry implementation, exemplifies maturity; and Guatemala's school synergies sustain gains. Collectively, political will via declarations (Seqota, National Home-Grown School Feeding Programme), public private partnership platforms (Millers for Nutrition, ANFA), South South exchanges like PATH GIZ India immersion, and a focus on local ownership overcome barriers, positioning stakeholders to fortify staples for enduring nutrition security, productivity, and climate resilience across the Global South.

6. Recommendations for Advancing Fortification Programs

6.1 Public Sector

6.1.1 Strengthen regulatory frameworks and institutional capacity

- Establish dedicated regulatory agencies with a clear mandate, authority, and protected budget for fortification oversight (model: FSSAI in India and INCIENSA in Costa Rica).
- Invest in laboratory infrastructure and accreditation, including the purchase of testing equipment, training of micronutrient analysts, and pursuit of ILAC accreditation.
- Develop comprehensive fortification standards specifying food vehicles, micronutrient levels, testing protocols, and labeling requirements.
- Establish routine monitoring systems, including facility inspections, product sampling and testing, and compliance reporting.

6.1.2 Expand coverage through integration with universal programs

- Embed fortification within social safety nets (public food distribution, school meals, and targeted nutrition programs like Thriposha in Sri Lanka) to maximize reach and ensure equity.
- Establish government procurement policies mandating fortification in targeted publicly procured foods alongside tax concessions to facilitate the importation of fortificants.
- Develop subsidy mechanisms ensuring that low-income populations have access to fortified foods without affordability barriers.
- Establish geographic and demographic targets, ensuring that rural populations and vulnerable groups receive equitable coverage.

6.1.3 Support supply chain stability

- Invest in domestic premix production capacity, reducing foreign exchange dependence and supply vulnerability.
- Establish FRK production facilities, with government procurement commitments ensuring demand.
- Develop miller networks and associations, facilitate communication, capacity building, and compliance.
- Offer targeted support to small and medium producers, including subsidized equipment, technical training, and quality assurance assistance.

6.1.4 Drive consumer awareness and demand

- Launch sustained social and behavior change communication campaigns emphasizing the health benefits of fortified foods and the importance of micronutrients.
- Integrate fortification messaging into broader nutrition education and health communication programs.
- Train health and nutrition workers to promote fortified foods and provide counseling on optimal consumption.
- Support private sector marketing of fortified products through strategic partnerships and co-branded campaigns.

6.2 Private Sector

- Adopt fortification as a quality standard, differentiating products and building consumer preference.
- Invest in technology and innovation, improving nutrient delivery, stability, and product quality.
- Engage with supply chain partners to ensure the consistent availability of quality premix and fortified ingredients.
- Participate in standard-setting and regulatory processes, ensuring that requirements balance nutritional goals and commercial viability.
- Support consumer awareness campaigns, educating populations about fortification and nutrition.

6.3 International Organizations and Development Partners

- Support evidence generation through rigorous evaluation of program implementation and health outcomes.
- Facilitate capacity-building for regulatory agencies, laboratory personnel, and industry actors.
- Provide technical assistance in standard-setting, quality assurance, and program design.
- Support knowledge transfer through documentation of lessons learned, facilitation of peer learning, and dissemination of best practices.
- Allocate strategic financing for infrastructure development (laboratories, production facilities) and pilot programs demonstrating feasibility.
- Promote political commitment through engagement with policymakers and the development of business cases for fortification investment.

6.4 Research and Learning

- Conduct systematic impact evaluations assessing fortification program effectiveness in reducing the micronutrient deficiency burden.
- Conduct implementation research to understand barriers to scale-up and identify solutions that work in varied contexts.
- Evaluate sustainability mechanisms, identifying transition strategies from donor support to national/private sector financing.
- Research consumer behavior, understanding preferences, willingness to pay, and drivers of demand.
- Study supply chain optimization to identify efficiency improvements and cost reductions.

Annexures

Annexure 1

Table A1. Global fortification legislation status (GFDx-aligned, 2025)			
South and South-East Asia			
Country	Mandatory fortification (key vehicles)	Voluntary/partial	Legislative status summary
India	Salt (iodization), wheat flour (selected states/programs), edible oil (vit A/D)	Rice (policy-driven, not universal law)	Mixed (mandatory + program-driven expansion)
Bangladesh	Salt (mandatory iodization), edible oil (vit A mandatory)	Wheat flour (voluntary/limited mandatory)	Mixed (strong mandatory for salt and oil)
Nepal	Salt (mandatory iodization), wheat flour (mandatory)	—	Predominantly mandatory
Sri Lanka	Wheat flour (mandatory), Salt (mandatory iodization)	Rice (pilot/voluntary)	Mandatory (core staples)
Myanmar	Salt (mandatory iodization)	Wheat flour, oil (voluntary/limited)	Mostly voluntary (except salt)
Vietnam	Wheat flour (mandatory), salt (mandatory iodization), edible oil (mandatory vit A)	—	Strong mandatory framework
Indonesia	Wheat flour (mandatory), salt (mandatory iodization)	Rice (voluntary/pilots)	Mandatory (major staples)
Africa			
Country	Mandatory Fortification (Key Vehicles)	Voluntary / Partial	Legislative Status Summary
Nigeria	Sugar, Salt	—	Comprehensive Mandatory
Ghana	Wheat flour, Edible oil, Salt	—	Mandatory (multi-vehicle)
Senegal	Wheat flour, Edible oil, Salt	—	Mandatory (regional WAEMU alignment)
Madagascar	Salt (mandatory iodization)	Wheat flour/oil (limited voluntary)	Mostly Voluntary (except salt)
Ethiopia	Salt (mandatory iodization), Wheat flour (mandatory)	Oil (partial/expanding)	Mandatory (expanding scope)

Latin America			
Country	Mandatory Fortification (Key Vehicles)	Voluntary / Partial	Legislative Status Summary
Brazil	Wheat flour & maize flour (iron + folic acid mandatory)	Oil (voluntary)	Mandatory (core staples)
Argentina	Wheat flour (mandatory)	—	Mandatory
Costa Rica	Wheat flour, Maize flour, Rice, Milk (multi-micronutrient mandatory)	—	Highly Comprehensive Mandatory
Guatemala	Sugar (Vit A), Wheat flour, Salt (iodized)	—	Mandatory (diverse vehicles)

Sources: Food Fortification Initiative (n.d.), Global Fortification Data Exchange (n.d.)

Annexure 2

Table A2. Micronutrient fortification standards comparison					
Country	Commodity	Fortificants (s)	Level(s) (units)	Source type	URL(s) and notes
India	Rice (fortified)	Fe (Ferric pyrophosphate or NaFeEDTA), folic acid, vit B12 Also optional: Zn, it A, B1, B2, B3, B6	Fe: 28–42.5 mg/kg (FPP) or 14–21.25 mg/kg (NaFe A); folic acid: 75–125 µg/kg; B12: 0.75–1.25 µg/kg; Optional: Zn 10–15 mg/kg, vit A 500–750 µg RE/ kg, B_1 1–1.5 mg/kg, B2 1.25–1.75 mg/ kg, B3 12.5–20 mg/kg, B6 1.5–2.5 mg/kg	Regulation (FSSAI)	Regulation (FSSAI) FSSAI Fortification Reg. 2018 (India) (Food Safety and Standards Authority of India 2021)
India	Wheat flour (atta/maida)	Fe (as above), folic acid, vit B12 Also optional Zn, vit A1, B1	Fe: 28–42.5 mg/kg (as FPP or other forms) or 14–21.25 mg/kg (NaFeEDTA); folic acid: 75–125 µg/kg; B12: 0.75–1.25 µg/kg; Optional: Zn 10–15 mg/kg, vit A 500–750 µg RE/kg, B1 1–1.5 mg/kg	Regulation (FSSAI)	FSSAI Reg. 2018 – Fortified Flour (India) (Food Safety and Standards Authority of India 2021)
India	Vegetable oil	Vit A and D	Vit A: 6–9.9 □g RE/g (i.e., 6,000–9,900 µg/kg); vit D: 0.11–0.16 µg/g (110–160 µg/kg)	Regulation (FSSAI)	FSSAI Reg. 2018 – Fortified Oil (India) (Food Safety and Standards Authority of India 2021)
India	Salt	Iodine (optional Fe)	Iodized salt: 20–30 ppm iodine at manu-facture, 15–30 ppm at retail; Double-fortified salt: +Fe 850–1100 mg/kg	Regulation (FSSAI)	FSSAI Reg. 2018 – Fortified Salt (India) (Food Safety and Standards Authority of India 2021)

Bangladesh	Edible oil	Vit A (retinyl palmitate/acetate)	15–30 mg/kg (ppm) vitamin A	Regulation (Press)	Bangladesh Edible Oil Fortification (Ministry of Industry) (Dhaka Tribune 2024)
Bangladesh	Salt	Iodine	Salt law mandates ~45–50 ppm KIO_3 (≈ 27–30 ppm I) at production; 20 ppm (retail); 15 ppm (household) (Revised 2023)	Regulation (NI report)	Bangladesh Iodized Salt Law. (Nutrition Int. summary) (Nutrition International n.d.)
Bangladesh	Wheat flour	Fe, folic acid, vit B12 (voluntary)	Voluntary standard: likely ~60 mg Fe, 1.5 mg FA, 0.02 mg B12 per kg	Regulation (BSTI)	BSTI standards exist, but are not public. (No official source found)
Nepal	Wheat flour	Vit A, Fe, folic acid	Vit A: ~1 mg/kg; Fe: 60 mg/kg; folic acid: 1.5 mg/kg	Regulation (WB report)	World Bank/WHO summary (Mandatory standard gazette 2011) (World Bank 2012)
Nepal	Salt	Iodine	~50 ppm iodine (Salt Trading Corp. fortifies at 50 ppm) (WHO recommends 15–40)	News (gazette)	Nepal Iodized Salt Act. (Salt Trading Corp. target) (The Kathmandu Post 2025)
Sri Lanka	Wheat flour	Iron (NaFeEDTA or Fe fumarate/sulfate), folic acid	Fe: NaFeEDTA 35–40 mg/kg or Fe fumarate/-sulfate 55–60 mg/kg; folic acid: 2–3 mg/kg	Regulation (USDA)	Sri Lanka Flour Fortification Reg. (Official 2022 reg 15)
Sri Lanka	Salt	Iodine	Iodized salt mandated; production level 15–30 ppm (max 35 ppm), retail ≥ 15 ppm	Regulation (WHO brief)	WHO country brief 16 (2018)
Myanmar	Rice	Voluntary pilot: multinutrient sprinkles (WFP)	Pilot formulas may include ~50–70 mg/kg Ca, 52–60 µg/kg vit A, 4–5 mg/kg Zn. No mandatory standards.	Program report (WFP)	(Fortification profile: No laws; WFP fortified rice pilot values) (Food Fortification Initiative n.d.)

Vietnam	Salt	Iodine	Mandatory iodization (Decree 09/2016); actual targets unspecified publicly	Regulation (Decree)	VN Decree 09/2016 (mandates iodized salt) (US Department of Agriculture 2016)
Vietnam	Wheat flour	Fe, Zn	Mandatory fortification (Decree 09/2016) requires adding Fe and Zn; levels are set by national standards (not published).	Regulation (Decree)	VN Decree 09/2016 (Article 6 mandates Fe, Zn in flour) (US Department of Agriculture 2016)
Vietnam	Vegetable oil	Vit A	Mandatory fortification (Decree 09/2016): Vit A required; levels per national standard (not found).	Regulation (Decree)	VN Decree 09/2016 (Article 6 mandates Vit A in edible oils) (US Department of Agriculture 2016)
Indonesia	Salt	Iodine (as KIO_3)	Mandatory iodization (SNI 3556:2010/2016) – 30 ppm KIO_3 (≈ 18 ppm I) (below WHO rec).	Regulation (UNICEF)	UNICEF landscape analysis (United Nations Children's Fund 2024) (SNI 3556:2010/2016)
Indonesia	Wheat flour	Iron, Zn, vit B1, vit B2, vit B3, folic acid (mandatory)	Legal requirement for Fe, Zn, B1, B2, B3, folic acid, etc. (SNI 3751:2001; updated 2018) "Specific levels not available in open sources."	Regulation (SNI/UNICEF)	Government SNI 3751/2018; details in industry reports (Bagriansky et al. 2023)
Nigeria	Wheat flour	Fe, Zn, folic acid, vit B (mandatory)	Law mandates Fe, folic acid, vit B, etc. (SON/NAFDAC). For example, wheat flour: 60 mg Fe/kg, 1.5 mg folic/kg (in practice)	Regulation (NAFDAC)	NAFDAC Food Fort. Reg. 2021 (Mandatory levels table; e.g. Fe 60 mg/kg, folic acid 1.5 mg/kg) (World Bank 2012)
Nigeria	Vegetable oil	Vit A (mandatory)	Vit A ~6,000 IU/kg (~2 mg/kg) (as per NAFDAC); margarine 25,000 IU/kg (older spec)	Regulation (NAFDAC)	NAFDAC Food Fort. Reg. 2021 (Oil: 6,000 IU/kg vit A)

Nigeria	Sugar	Vit A (mandato-ry)	Sugar is mandated to be fortified with vit A (15 µg/g = 15 mg/kg) based on SON 2016 standards	Regulation (SON)	SON-FME FDA Standard; (Official source not publicly available. Industry sources report this level)
Nigeria	Salt	Iodine	Mandatory iodized salt (SON), typically 30–50 ppm iodine at production. Exact current values not located.	Regulation (SON)	SON salt iodization standards exist; NAIIS surveys used SON 1992 at 50 ppm KIO_3
Nigeria	Rice	**Mandatory:** Folate, iron (micronized Ferri pyrophosphate), zinc, vit B12 (Cyanocobalamin) **Voluntary:** B6 (Pyridoxin Hydrochloride), B3 (Niacinamide), and vit B1 (Thiamin mononitrate)	Still in pilot phase	Regulation (SON)/ NAF-DAC/ FCCPC	NCP by SON (NCP 0124:2024 Code of Prac-tice for Rice fortification)
Nigeria	Bouillon cubes	**Guided voluntary:** Iron, folate, zinc, vit B12	Still in process: Current voluntary with iron, folate, zinc, and vit B12 at 15% NRV	Regulation (SON)/ NAF-DAC/ FCCPC	15% NRV (NCP 0123:2024 Code of Practice for Rice fortification) NIS 293:2024 Standard for Bouillon
Nigeria	Bouillon cubes	**Guided voluntary:** Iron, folate, zinc, vit B12	Still in process: Current voluntary with iron, folate, zinc, and vit B12 at 15% NRV	Regulation (SON)/ NAF-DAC/ FCCPC	15% NRV (NCP 0123:2024 Code of Practice for Rice fortification) NIS 293:2024 Standard for Bouillon
Ghana	Wheat flour	Fe (NaFeEDTA), vit A, folic acid, etc.	Mandatory Fe (60 mg/kg as NaFeEDTA), folic acid 1.25 mg/kg, vit A 100 µg/kg (GS 809–813, 2006) (values from internal reports)	Regulation (GSA)	Ghana Stan-dards (GS 809–813:2006) (Wheat flour fortification levels; e.g., Fe 60 mg/kg, FA ~1.2 mg/kg)

Ghana	Vegetable oil	Vit A (mandatory)	Mandatory vit A (~10,000–15,000 IU/kg = 3–4.5 mg/kg) (GS 811:2006) (as per national standard)	Regulation (GSA)	Ghana Standards (GS 811:2006) (Oil: vit A ~5000–15000 IU/kg, est.)
Ghana	Salt	Iodine	Salt iodized: Production 50 ppm KIO_3 (≈ 30 ppm I), retail ≥15 ppm	Regulation (GSA)	Ghana Standards (GS 152:1996/2006) (Nyumuah et al. 2012)
Senegal	Wheat flour	Fe, folic acid, etc. (mandatory)	Mandatory fortification (wheat flour Fe 60 mg/kg, folic acid 1.5 mg/kg, vit A) – based on WAFP model	Regulation (CILSS)	Senegal uses UEMOA standards; no specific public document found
Senegal	Salt	Iodine	Mandatory iodized salt (15–45 ppm) as per UEMOA/WHO guidelines	Regulation (UEMOA)	Senegal follows regional iodization norms; no unique source
Madagascar	Salt	Iodine	Mandatory iodized salt (30–60 ppm KIO_3) - enforced since 1997	Regulation (WHO)	WHO country profile: Madagascar requires 20–40 ppm iodine (local sources vary)
Ethiopia	Wheat flour	Fe, Zn, vit B (mandated 2022)	Wheat flour fortification (mandated 2022): iron, zinc, vitamins B1, B2, B3, B6, B9, B12 (levels per draft standards)	Regulation (Nutrition Intl)	Ethiopia Mandate (2022). (Government decree for mandatory wheat/oil fortification) (Nutrition International 2022)
Ethiopia	Vegetable oil	Vit A (mandated 2022)	Mandatory vit A in oil (likely 15 mg/kg standard)	Regulation (Nutrition Intl)	Ethiopia Mandate 2022. (Government decree for mandatory wheat/oil fortification) (Nutrition International 2022)

Ethiopia	Salt	Iodine (manda-tory)	Universal salt iodization (USI) in place (30–40 ppm) – Ethiopia's USI program since 2014.	Regulation (USAID)	Ethiopia's USI law (Salt iodization PVO standard)
Brazil	Wheat and corn flour	Fe (ferrous fumarate) and folic acid	Iron: 4–9 mg/100 g (40–90 mg/kg) flour; folic acid: 140–220 µg/100 g (1.4–2.2 mg/kg)	Regulation (ANVISA)	ANVISA RDC 604/2022. (RDC 2002/2022) (infoAlimentario, 2022)
Brazil	Salt	Iodine	Mandatory iodization (40 ± 15 ppm); production ~60 ppm to yield ~30–50 ppm in retail.	Regulation (Decree)	Brazilian Normative Instr. No. 69/2010
Brazil	Sugar	Vit A (mandatory)	Mandatory vit A in sugar (typically 15 mg/kg)-per RDC 90/2001	Regulation (ANVISA)	ANVISA RDC 90/2001 (Sugar vit A fort.)
Argentina	Wheat flour	Fe, folic acid, B vitamins (fortification)	Fortification mandated since the 1950s: e.g., Fe 4–14 mg/100 g (40–140 mg/kg), FA 1.2–2.2 mg/kg, B1 (2–5 mg/kg), B2 (1–4 mg/kg) (Current law RA no. 24.111)	Regulation (Mercosur)	Mercosur Technical Regs (RGM 4/97, 5/99, 19/01) not directly cited (values from Codex and past studies)
Costa Rica	Wheat flour	Fe (ferrous fumarate), folic acid	Fe: 55 mg/kg (ferrous fumarate); folic acid 1.4 mg/kg (FA 1400 µg/kg).	Program report (CDC)	US CDC (2015) (Costa Rica fortification) (Martorell et al. 2015)
Costa Rica	Sugar	Vit A	Vit A: 5.0 mg/kg sugar (added from 2003 onward).	Program report (CDC)	US CDC (2015) (Costa Rica program)
Costa Rica	Salt	Iodine	Mandatory iodization (50 ppm at production to yield ~20 ppm household).	Regulation (Decree)	Decree 36506 (1972); WHO's FACT (Costa Rica) indicates 50 ppm KI at production (≈ 30 ppm I)

Guatemala	Wheat flour	Fe (fumarate), folic acid, B vitamins	Ferrous fumarate 45 mg/kg; folic acid 1.8 mg/kg; vit B12 1.1 µg/kg	Regulation (Decree)	Guatemalan fortification decree (RS 86-2000); specifics from Ministry reports (Imhoff-Kunsch et al. 2007)
Guatemala	Maize (nixtamal)	Vit B1, B2, B6, B12; folic acid; vit A	Nixtamalized maize fortification (added in the 2010s): vit B1 3 mg/kg, B2 1.5 mg/kg, B6 4 mg/kg, B12 1.1 µg/kg, folic acid 2 mg/kg, vit A 5 mg/kg. (INSPI order)	Regulation (INSPI)	INSPI Technical Handbook (Guatemala Ministry) – notes mandatory fortification of tortilla flour.
Guatemala	Sugar	Vit A	Mandatory fortification of sugar with vit A (30 IU/g ≈ 10 µg/g); typical standard 5 mg/kg	Regulation (Decree)	Decree 54-2001 (sugar Vit A); level ~5 mg/kg (allegedly)
Guatemala	Salt	Iodine	Mandatory iodized salt (50 ppm KIO_3 production, 30 ppm in consumer salt)	Regulation (Law)	Law 90-1980; regulations (Standard NS 42). (WHO/INSPIRE data)

Notes: Where official regulations were not publicly accessible, we referenced reputable program reports or standards (e.g., WHO/UNICEF, Nutrition Intl, WFP). In some cases (Nigeria, Senegal, Madagascar, Argentina, etc.), we inferred typical levels from regional norms or industry reports, though we found no direct sources; these instances are noted in the "notes" section. Quality assurance/testing protocols (e.g., methods like ICP-AES for iron, titration/kit for iodine) are described in some program sources (e.g., Nepal's DFTQC labs). However, detailed methods are beyond the scope of available citations. All values and sources mentioned are current as of the latest regulations/assessments found (2025).

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