

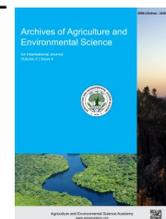


e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



REVIEW ARTICLE



Nutrition governance in Uganda's food fortification programme: A systematic review of regulatory frameworks, institutional capacity, financing mechanisms and programme evaluation

Grace Bunanukye Bwengye^{1*} , Archileo. N. Kaaya¹, Abel Atukwase¹, Gaston Tumuhimbise¹, Mildred Barungi³, Michael Ahimbisibwe² and Ivan Muzira Mukisa¹

¹Department of Food Technology and Nutrition, Makerere University, Kampala, Uganda

²Department of Agricultural and Biosystems Engineering, Makerere University, Kampala, Uganda

³Uganda Development Corporation, Government of Uganda, Kampala Uganda

*Corresponding author's E-mail: gracebwengye@gmail.com

ARTICLE HISTORY

Received: 19 November 2025
Revised received: 21 February 2026
Accepted: 03 March 2026

Keywords

Food fortification
Industry compliance
Institutional capacity
Nutrition governance
Uganda

ABSTRACT

Uganda's food fortification programme presents a paradox of strong legislative intent but weak implementation, with significant implications for public health and nutrition governance. Despite mandatory regulations enacted in 2005 and amended in 2011, compliance remains uneven only 30% of maize flour and 50% of cooking oil meet national fortification standards, compared to 95% for salt. This review synthesizes findings from over 220 documents spanning policy and institutional performance to assess Uganda's fortification landscape. Key challenges include fragmented institutional mandates among UNBS, NDA, and MoH, and limited enforcement capacity with weak penalties and infrequent inspections. Comparative analysis with countries like South Africa, Bangladesh, and Vietnam reveals that clear mandates, fiscal incentives, and robust monitoring systems are critical to success. Uganda's placement in the lower-left quadrant of the global Fortification Performance Matrix characterized by low compliance and immature policy systems underscores the need for integrated reforms. These include revising legislation, expanding fiscal incentives, strengthening institutional capacity, and aligning food vehicles with consumption data. The review concludes that without strategic investment in governance and enforcement, Uganda risks missing the full potential of food fortification to combat micronutrient malnutrition and achieve its national nutrition targets.

©2026 Agriculture and Environmental Science Academy

Citation of this article: Bwengye, G. B., Kaaya, A. N., Atukwase, A., Tumuhimbise, G., Barungi, M., Ahimbisibwe, M., & Mukisa, I. M. (2026). Nutrition governance in Uganda's food fortification programme: A systematic review of regulatory frameworks, institutional capacity, financing mechanisms and programme evaluation. *Archives of Agriculture and Environmental Science*, 11(1), 140-149, <https://dx.doi.org/10.26832/24566632.2026.1101020>

INTRODUCTION

Micronutrient malnutrition commonly referred to as "hidden hunger" remains challenge to global public health, affecting over two billion individuals worldwide (García-Casal *et al.*, 2014; Aaron *et al.*, 2017; Bourassa *et al.*, 2023). Deficiencies in essential nutrients such as iron, vitamin A, iodine, and zinc contribute to increased morbidity and mortality, particularly among children under five and women of reproductive age. Vitamin A deficiency is responsible for up to 500,000 cases of childhood blindness

annually, while iron deficiency remains a leading cause of anaemia, impairing cognitive development and economic productivity (Bustreo *et al.*, 2003; Rowe, 2020). The global response includes interventions such as dietary diversification, supplementation, biofortification, and industrial food fortification with the latter recognized as one of the most cost-effective and scalable strategies (Bustreo *et al.*, 2003; Rowe, 2020). Uganda represents a critical case study in the implementation of food fortification programs (Neufeld *et al.*, 2017). Despite adopting mandatory fortification regulations in 2011 with the initial voluntary

phase in 2005, high rates of micronutrient deficiencies persist. National surveys reveal that 32% of women and 53% of children under five suffer from anemia, while vitamin A deficiency remains prevalent in rural regions (MOH, 2017; UBOS, 2022). Uganda's reliance on staple foods such as maize flour, wheat flour, edible oils, and iodized salt makes it a suitable candidate for fortification interventions. The scope of this review is three-fold. First, it examines the governance structures underpinning Uganda's food fortification programme, including legislation, regulatory frameworks, policy frameworks, institutional mandates, planning, financing and evaluation. Secondly, the review explores industry compliance and challenges faced by SMEs in meeting regulatory requirements. Thirdly, it evaluates institutional capacity, focusing on the ability of government regulatory agencies to coordinate, monitor, and enforce fortification programs, and the integration of fortification into national planning, financing, and monitoring systems. By synthesizing empirical studies, policy documents, and comparative insights, this review aims to provide a comprehensive understanding of Uganda's food fortification landscape. It seeks to inform policy reforms, fortification programme reviews, guide future research, and support the development of integrated, evidence-based nutrition strategies that can accelerate progress toward national and global health goals.

METHODOLOGY

This review employed a narrative synthesis approach to critically examine the governance, industry compliance, and institutional capacity underpinning Uganda's food fortification programme. Literature was sourced from reputable academic and institutional databases, including PubMed, Web of Science, Elsevier, Wiley Online Library, Springer Link, Taylor & Francis, Science Direct, Google Scholar, Access Science, ProQuest eBook Central, and relevant government repositories such as the Uganda Ministry of Health, Uganda Bureau of Statistics (UBOS), and the Uganda National Bureau of Standards (UNBS). Additional grey literature was retrieved from global organizations including the World Health Organization (WHO), Global Alliance for Improved Nutrition (GAIN), Food Fortification Initiative (FFI), USAID, and the Codex Alimentarius Commission. Search terms were selected to reflect the thematic scope of the review. Key combinations included: "food fortification in Uganda," "micronutrient deficiencies and public health," "industry compliance with fortification standards," "fortification legislation and governance," "institutional capacity for fortification programs," "monitoring and evaluation of fortified foods," "premix regulation in Uganda," and "regional harmonization of fortification standards." Documents were considered relevant if they contained any of the core phrases "food fortification," "micronutrient malnutrition," "compliance," "governance," or "institutional capacity" regardless of the remaining title content. The review focused on literature published between the year 2010 to 2025 to ensure contemporary relevance and policy alignment. A total of 220 documents were evaluated, including

peer-reviewed articles, policy briefs, technical reports, national strategies, and regional guidelines. Each document was assessed for its contribution to understanding the legislative framework, regulatory framework, industry practices, institutional roles, and systemic challenges in Uganda's fortification landscape. Where applicable, comparative insights from other low and middle-income countries (LMICs) were incorporated to contextualize Uganda's experience within broader regional and global trends. By synthesizing findings across these diverse sources, the review offers a comprehensive and up-to-date reference for researchers, policymakers, development partners, industry and civil society actors engaged in nutrition governance, food fortification, public health, and food systems transformation.

GLOBAL CONTEXT OF FOOD FORTIFICATION

Food fortification is a widely supported, cost-effective public health strategy aimed at addressing micronutrient deficiencies worldwide (Allen *et al.*, 2006). It involves adding essential nutrients to staple foods and condiments. Fortification plays a critical role in achieving global nutrition goals, such as those outlined in the United Nations' Sustainable Development Goals (SDGs) related to health and hunger. The economic benefits are significant, with a return of \$27 for every dollar invested in fortification through productivity gains and healthcare savings. However, challenges remain, including weak enforcement of regulations, inadequate monitoring capacity and lack of effective public-private partnerships (Bell *et al.*, 2024). The success of food fortification programs globally has been well-documented, illustrating its effectiveness in addressing micronutrient deficiencies and improving public health outcomes. Nearly 140 nations implement national salt iodization initiatives, 102 of which are compulsory. Additionally, 85 countries require the fortification of at least one type of cereal grain such as maize, rice, or wheat with iron and folic acid, and over 40 countries mandate the addition of vitamin A or D to edible oils, margarine, or sugar (Olson *et al.*, 2021). Switzerland initiated iodized salt fortification in 1923, setting a precedent for combating iodine deficiency and effectively reducing goiter cases nationwide (Thakur *et al.*, 2023). In the USA, food fortification began with iodized salt in 1924, which significantly reduced goiter prevalence. In Guatemala, vitamin A fortification of sugar, introduced in 1975, led to a remarkable decrease in vitamin A deficiency from 22% to 5% within just one year (Karki *et al.*, 2025). Costa Rica's iron fortification initiative achieved notable reductions in iron deficiency anemia, with anemia rates dropping from 19% to 4% among children and from 18% to 10% among women of reproductive age (Jadhav *et al.*, 2019).

GOVERNANCE AND POLICY FRAMEWORKS

Global policies and legislation for fortification play a critical role in standardizing food fortification efforts worldwide. A study by Allen *et al.* (2006) highlights that the success of food fortifica-

tion programs is often contingent upon the existence of a supportive legislative frameworks. It emphasizes that global policies provide a blueprint for countries to develop and enforce their fortification standards, ensuring that fortified foods meet the necessary nutrient requirements of public health concern. Through the Codex Alimentarius Commission (CAC), WHO and FAO are instrumental in promoting fortification as a public health strategy (WHO & FAO, 2006). The CAC, established by the FAO and WHO, provides international guidelines on food fortification as part of its mission to promote food safety and quality across the world. The CAC recommends that staple foods such as salt, flour, and oil, widely consumed across populations be fortified to address regional micronutrient deficiencies effectively (WHO & FAO, 2006). Figure 1 presents a systemic view of Uganda's food fortification challenges, structured around four interdependent pillars: governance, compliance, financing, and institutional capacity. Each pillar is linked to specific constraints. Governance suffers from weak enforcement, limited or non-budget contribution from regulatory bodies to fortification activities and lack of penalties; compliance is undermined by low adherence to standards by SMEs in maize flour and edible oil despite high self-reported compliance; financing is constrained by high premix costs, limited or non-budget contribution from regulatory bodies to fortification activities and absence of subsidies or tax incentives; and institutional capacity is limited by overlapping mandates and weak monitoring systems among regulatory bodies. The arrows connecting these components emphasize how weaknesses in one area reinforce failures in others, creating a cycle of underperformance that hampers the effectiveness of Uganda's fortification programme. Transparency and monitoring are additional key components of the CAC's approach to fortification. Codex guidelines advocate for clear labeling of fortified products to inform consumers about nutrient content and discourage unsubstantiated health claims. Furthermore, the CAC emphasizes the importance of ongoing monitoring and evaluation to ensure that fortification programs adapt to changing health needs and remain effective (WHO & FAO, 2006). The General Principles for the Addition of Essential Nutrients to Foods (CAC/GL 07-1987, updated in 1989 and 1991) outlines the guidelines for adding essential nutrients to foods for purposes such as restoration, ensuring nutritional equivalence in substitute foods, and fortification.

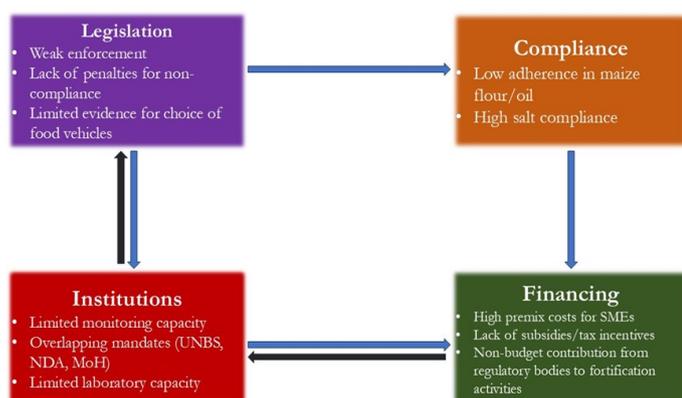


Figure 1. Systemic barriers to fortification in Uganda: Interlinked challenges in governance, compliance, financing, and institutional capacity.

UGANDA'S LEGISLATION ON FOOD FORTIFICATION

The Government of Uganda through the Food Fortification Regulations (2005) as amended in 2011 enshrined in the Uganda Food and Drugs Act 1959 enforces mandatory food fortification to enhance public nutrition by requiring the fortification of salt, wheat flour, maize flour, and edible oils and fats. Salt iodization has been mandatory since 1993, while broader food fortification mandatory regulations were introduced in 2011. These regulations mandate that wheat and maize flour mills producing at least 20 metric tons (MT) per day, as well as oil industries producing 10 MT of oils or fats per day, must fortify their products to meet national standards. The law also applies to all imported wheat flour, maize flour, and oils and fats, ensuring they comply with Uganda's national fortification standards (MOH, 2011); (USAID, 2023a). Arising from the legislation are the food fortification standards for the four food vehicles harmonized with the regional standards of East, Central, and Southern Africa (ECSA) region and, therefore, both support regional trade and align with domestic food fortification regulations (USAID, 2022a). Vosti et al. (2024) calls for a strong legislative framework after observing inconsistent compliance among industries, varying fortification levels, and inadequate monitoring mechanisms from government which hinder the effectiveness of Uganda's fortification programs. Gaps exist in fortification legislation as observed by van der Meer & Schebesta (2020), and generally affect effective implementation of fortification programmes. The Food Fortification Regulations, 2011 fall short of specific safety limits for nutrient intake and provisions to ensure effectiveness and safety (USAID, 2022b). While Uganda has made significant progress in establishing policies and legislation for food fortification, there are notable gaps with the legislative framework. Uganda just like some other Sub-Saharan countries, the choice of food vehicles for the fortification programme is questioned due to lack of sufficient evidence. Kyamuhangire et al. (2013) argues that the choice of maize flour for mass fortification lacked sufficient evidence, highlighting the dominance of small-scale maize millers (SMEs) which negatively affect the fortification of maize flour and the consumption of wheat as a food vehicle is only consumed in urban areas therefore causing a gap in micronutrient consumption in rural areas with less consumption of wheat. Vosti et al. (2024) are in agreement with this assertion. Some countries like South Africa and Bangladesh have developed effective legislation. South Africa's Food Fortification Programme, which mandates the fortification of maize meal and wheat flour with essential vitamins and minerals, has effectively reduced micronutrient deficiencies, particularly among women and children (Labadarios et al., 2008), while Bangladesh's legislation requiring Vitamin A fortification in edible oils, supported by clear standards and active oversight from the Bangladesh Standards and Testing Institution (BSTI), has successfully addressed vitamin deficiencies.

The legal framework for food fortification in Uganda faces notable gaps that hinder the effectiveness and reach of the programme. Current regulations mandate fortification for certain

foods; however, enforcement mechanisms and penalties for non-compliance remain weak, reducing adherence among producers (USAID, 2022a). The lack of provisions for regular monitoring and evaluation impedes the program's capacity to track public health impacts and enforce accountability. Legal support for subsidies or tax incentives for fortification equipment and supplies is also insufficient, placing financial burdens on producers and affecting programme sustainability. Furthermore, Uganda's fortification regulations are not fully integrated with other national nutrition policies such as the Uganda Nutrition Action Plan (UNAP), risking redundancy and inefficiency (USAID, 2022a). A study by Theriault *et al.* (2024) indicates that Kenya's legislation provides clarity of stakeholder roles. Of the stakeholders consulted, 78% of them expressed positive views regarding the clarity of the legislation. The Uganda National Drug Authority (NDA) is designated to oversee the importation and in-country management of fortificants and premixes. Although NDA oversees fortificants and premixes, its implementation has encountered obstacles due to the absence of clear supportive legislation within the NDA for treating premixes as food ingredients. This lack of specific legal provisions limits the NDA's capacity to effectively regulate and maintain quality control over premixes used in food fortification, creating gaps in enforcement along the fortification value chain (USAID, 2023a). Comparative Table 1 presents a global overview of food fortification legislation, enforcement mechanisms, and programme performance across eight countries and organizations. It highlights the diversity in legal frameworks, regulatory authorities, food vehicles covered, and monitoring systems. Uganda's regulatory structure, while regionally harmonized and mandatory for large-scale producers, suffers from weak enforcement, limited incentives, and fragmented institutional mandates. In contrast, countries like South Africa, Bangladesh, and Vietnam demonstrate strong oversight, clear penalties, and robust monitoring systems that have led to measurable public health improvements. The table underscores the importance of integrated governance, fiscal support, and institutional clarity in achieving effective fortification outcomes.

INSTITUTIONAL CAPACITIES

Institutional capacities play a key role in the successful implementation and sustainability of food fortification programs. Uganda's food fortification program is marked by coordinated efforts and shared responsibilities among key regulatory agencies such as the UNBS, URA, and NDA, each with mandates to enforce compliance across border control, production, and marketing. The UNBS has implemented comprehensive food safety regulations and standards within the framework of existing laws, establishing institutional protocols for inspection, auditing, information sharing, and laboratory testing. Uganda's regulatory infrastructure also includes a national fortification alliance called the National Working Group on Food Fortification (NWGFF), created in 2002 based on WHO's recommendations. Each agency within this system has well-defined roles in moni-

toring and enforcement (USAID, 2023b). The establishment of the NWGFF facilitated coordinated stakeholder engagement, including successful advocacy for waiving import duties on fortification technologies and premixes. However, its functionality and adequacy need to be investigated. In contravention to a recommendation by Laviolette (2018), parliamentarians are not included on this platform. Lack of capacity on the government side to establish partnerships and collaborations between the industry, regulatory bodies, wholesalers and retailers is a critical capacity gap that limits the effectiveness of fortification programs (Mkambula *et al.*, 2020; Mannar & Hurrell, 2018). Coordination challenges manifested into weak inter-agency collaboration and fragmented governance structures undermine programme coherence and effectiveness. The limited technical expertise within relevant institutions caused by inadequate staff training and a shortage of skilled personnel in regulatory bodies significantly constrains their ability to effectively perform their mandated functions (Ebata *et al.*, 2021).

In LMICs, data collection on food fortification coverage and impact remains limited. Few national programs systematically report on the coverage, quality, or impact of fortified foods. The data is usually a one time off and not tracked over time making it difficult to assess progress (Hoogendoorn *et al.*, 2016). The absence of streamlined data collection and analysis systems hinders regulatory agencies' ability to track compliance and promptly address non-compliance. It also makes it difficult to review food fortification programs. Lack of political will from the leadership in regulatory agencies represents another significant challenge in food fortification regulation. This results to non-commitment to budgets for fortification and capacity building for technical staff. This uncertainty contributes to the persistence of non-compliant products in the market and hampers the overall effectiveness of fortification programs (Luthringer *et al.*, 2015). Luthringer *et al.* (2015) identified insufficient funding and limited human resources as obstacles to effective regulatory monitoring and fortification sustainability. This shortage affects inspection frequency, quality, and overall regulatory reach, with many agencies unable to adequately detect non-compliance or enforce standards. Chile's regulatory monitoring system for food fortification not only benefits from strategic national funding and efficient practices but is also supported by a trained cadre of inspectors. These inspectors play a crucial role in implementing procedural audits and product sampling, ensuring that quality standards are consistently met (Rowe *et al.*, 2018). Another commonly identified gap is the insufficient laboratory and testing capacity within regulatory agencies. The absence of an operational budget for repairing broken equipment leads to prolonged downtime in testing laboratories, resulting in delayed turnaround times for fortified food test results (Luthringer *et al.*, 2015). South Africa has put in place a strong laboratory testing capacity by having the right human resources, laboratory equipment and reagents. National Health Laboratory Service (NHLS), which operates a network of approximately 226 pathology labs, is equipped to perform a range of tests, including specialized tests for fortified foods, which

Table 1. Global comparison of food fortification frameworks: legal mandates, enforcement, and monitoring across eight jurisdictions.

Country / Organization	Year of Legislation/Policy	Legal Framework	Regulatory Authority	Food Vehicles Covered	Enforcement Mechanism	Penalties / Incentives	Monitoring & Evaluation Provisions	Key Features / Notes	References
Uganda	2005 (amended 2011)	Food Fortification Regulations under Food & Drugs Act (1959)	UNBS, MoH, NDA, URA	Salt, wheat flour, maize flour, edible oils & fats	Q _{mark} certification, annual audits, limited inspections	Weak penalties; limited incentives for premix import	Limited; FACT surveys, UDHS, UNPS; weak enforcement	Mandatory for mills >20 MT/day; salt iodization since 1993; weak compliance in maize/oil	MOH 2011; USAID 2022a; UBOS 2022
South Africa	2003	Regulations on Fortification of Certain Food-stuffs	Dept. of Health	Maize meal, wheat flour	Regular inspections, strong oversight	Clear penalties for non-compliance	National surveys, lab testing	Significant reduction in micronutrient deficiencies	Labadarios <i>et al.</i> , 2008
Bangladesh	2013	Edible Oil Fortification Law	BSTI (Bangladesh Standards & Testing Institution)	Edible oils (Vitamin A)	Mandatory compliance, factory inspections	Strong penalties; clear standards	Routine monitoring, BSTI labs	Improved vitamin A status	USAID, 2023a
Vietnam	2011	Food Safety Law	Ministry of Health	Salt, flour, oils	Mandatory recertification every 3 years; monthly sample submission	Penalties for non-compliance; hygiene certification	Strong monitoring, sample testing	Clear responsibilities; strong compliance checks	Wirth <i>et al.</i> , 2012
USA	1920s onward (iodized salt 1924; folic acid 1998)	FDA regulations; Food Fortification Policy	FDA, USDA	Salt, flour, cereals, milk (vitamin D), others	Strong regulatory oversight; labeling requirements	Penalties for misbranding; incentives via public health programs	National Nutrition Monitoring System; CDC surveys	Salt iodization, folic acid fortification reduced NTDs	Thakur <i>et al.</i> , 2023
Russia	1998 (salt iodization law); 2019 (fortification draft law)	Federal Law on Food Safety; regional fortification acts	Rospotrebnadzor (Consumer Protection Agency)	Salt (mandatory iodization in some regions); flour fortification debated	Weak enforcement; fragmented regional adoption	Limited penalties; lack of strong incentives	Limited national monitoring; uneven implementation	Patchy compliance; political resistance to mandatory fortification	UNICEF 2020; WHO & FAO 2006
European Union (EU)	1990s-present	EU Regulation (EC) No 1925/2006 on addition of nutrients to foods	European Food Safety Authority (EFSA)	Voluntary fortification of cereals, dairy, margarine; mandatory iodized salt in some states	Harmonized labeling, safety assessments	Incentives via market access; penalties for unsafe claims	EFSA monitoring; national nutrition surveys	Mostly voluntary; strong consumer protection focus	WHO & FAO, 2006
Codex WHO / FAO	1987 (updated 1991)	General Principles for Addition of Essential Nutrients to Foods (CAC/GL 07-1987)	Codex Alimentarius Commission	Salt, flour, oil, sugar (recommended staples)	Voluntary adoption by member states	Guidance only; no penalties	Emphasis on monitoring, labeling, safety	Global blueprint for national legislation	WHO & FAO 2006

NATIONAL PLANNING FOR FOOD FORTIFICATION

helps ensure compliance with food fortification standards (<https://www.health.gov.za/food-control/>). Addressing these gaps requires targeted investments in capacity-building, improved resource allocation, and strengthened partnerships between government, industry, and civil society (UNICEF, 2020).

For overall government ownership of fortification programs, Namugumya *et al.* (2020) recommend integration of fortification into the wider sector mandates. Development Planning plays a critical role in cascading financing from the higher level to the relevant MDAs through a programmatic approach. The integra-

tion of food fortification into national development strategies and reflects a substantial commitment at the political level (Darwar *et al.*, 2023). Effective fortification planning should align with global and regional frameworks, such as the Sustainable Development Goals (SDGs), which advocate for improved nutrition as part of the broader agenda for sustainable development. Mannar *et al.* (2018) argued that such alignment ensures that national efforts resonate with international priorities, facilitating support from multilateral organizations and enhancing accountability. A critical step towards establishing a food fortification system is the allocation of a dedicated budget within the national development plan. According to Darwar *et al.* (2023), this allocation is the foundation for initiating and sustaining fortification programs, as it enables the structuring of resources necessary for the fortification process, from initial setup to ongoing regulation. Effective food fortification requires the collaboration of various stakeholders, including government agencies, the private sector, civil society organizations (CSOs), and development partners. García-Casal (2014) stresses that fortification planning should incorporate input and actions from all relevant actors, as this collaboration enhances resource allocation, knowledge sharing, and implementation efficiency. This puts emphasis on stakeholder consultation and ownership of fortification programs. Planning for food fortification should consider the existing legislative environment, standards, and institutional structures governing food systems and nutrition. Teachout *et al.* (2021) argued that fortification efforts must align with established regulations and food safety standards to ensure efficacy and compliance. Integrating fortification within the broader legislative framework minimizes regulatory conflicts between institutions and other actors and also supports sustainable implementation. Incorporating impact or outcome evaluations into the planning phase is vital to measure the effectiveness of fortification efforts. According to Martorell *et al.* (2015), impact evaluations provide valuable feedback, allowing policymakers to adjust fortification strategies as needed and to demonstrate the program's effectiveness in addressing micronutrient deficiencies.

UGANDA'S APPROACH TO FOOD FORTIFICATION PLANNING

The Third National Development Plan (NDPIII) 2019/20-2024/25 through the Agro-industrialization programme (AGIP) and Human Capital Development Programme (HCD) prioritized the enforcement of compliance for micronutrient food fortification of the already identified food vehicles such as maize flour, wheat flour, edible oils and fats and iodized salt; increased consumption of fortified foods in schools and putting in place a policy and law for food fortification. However, a gap exists as the relevant MDAs such as UNBS, URA, MOH and the Ministry of Education and Sports (MOES) did not capture these interventions in their strategic plans, work plans and budgets (NPA, 2020). Uganda currently uses a programmatic approach to planning, budgeting, implementation and reporting. With the programmatic approach, if an intervention is not captured at the

lower levels, then it doesn't attract any government financing implying non-implementation. The fourth National Development Plan (NDPIV) 2025/26-2029/30 has integrated food fortification interventions in the AGIP, HCD and the private sector development programme (PSDP). The AGIP has focused on enforcing compliance to food fortification standards for recommended food vehicles just like NDPIII. The HCD focused on promotion of local manufacture of fortificants; updating the national fortification guidelines, development of the food fortification Policy; review and updating of the national industrial food fortification strategy (2017-2022); the PSDP has focused on supporting and facilitating the key actors in the national food fortification program with product and system certification. All these interventions have been provided for in the Programme Implementation Action Plans (PIAP), however their integration into MDA strategic plans, work plans and budgets should be investigated. The partnership between the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and MOH gave birth to the Uganda food and Nutrition policy of 2003 which is a higher level policy to guide the planning and implementation of industrial food fortification (MAAIF & MOH, 2003). It specifically calls for promotion of food fortification with appropriate micronutrients and fortification of selected foods with nutrients that are commonly deficient in the diet. While it is silent on the specific nutrients, food vehicles and compliance enforcement (MAAIF & MOH, 2003), this document is over 20 years old and requires review to align to the current requirements. Born out of the Uganda Food and Nutrition policy 2003 are the first and second Uganda Nutrition Action Plans (UNAPI and UNAPII). The UNAPIII is currently under development. These are the overall action plans to implement nutrition in the country of which food fortification is a key strategy to address micronutrient deficiencies in the population (NPA, 2011; OPM, 2020). Though these documents address food fortification, the level of integration and comprehensiveness are unknown (Taylor *et al.*, 2023).

UGANDA'S APPROACH TO FOOD FORTIFICATION FINANCING

Food fortification financing in Uganda is largely donor dependent. Since 1993 to 2023, eight donor projects have financed food fortification in Uganda. These projects are majorly implemented by United Nations Children's Education Fund (UNICEF), United States Agency for International Development (USAID) and GAIN. UNICEF majorly focused on micronutrient supplementation and salt iodization advocacy in the early years of fortification, USAID has majorly focused on technical assistance and capacity-building programs while GAIN has majorly focused on fortification impact evaluations, feasibility studies, training for food processors, and fortification trials for staple foods like maize, wheat, and edible oils (USAID, 2022a). However, a comprehensive review is needed to ascertain the precise funding per project and to document the specific interventions financed under each initiative. Government of Uganda has eliminated

financial barriers within the private sector through waivers of import duty on equipment and premix. Government has zero-rated exercise duty on the importation of food fortification equipment as well as micronutrient premixes. However, these components are still paying Value Added Tax (VAT) (USAID, 2022a). Most countries in the region such as Rwanda, Burundi and Tanzania have classified premix as a pharmaceutical product and thus doesn't have to pay VAT (GAIN & PHC, 2018). The disproportionate cost implications of maize flour fortification in Uganda present a significant challenge (Bobrek *et al.*, 2021). Studies indicate that the incremental cost of fortification is higher for micro and small-scale mills, with costs per metric ton reaching \$13 and \$9, respectively, compared to \$7 for medium-scale mills. These costs constitute up to 20% of annual operational expenses for the smallest millers, creating financial barriers to fortification adoption (Vosti *et al.*, 2024). Additionally, the cost of fortification equipment for micro-scale mills is 2.7 times higher than general milling equipment, further discouraging participation. While large-scale mills benefit from economies of scale, small-scale operators face difficulties in maintaining market competitiveness while adhering to fortification requirements, highlighting the need for targeted financial support to enhance program viability and reach (Vosti *et al.*, 2024). A rapid assessment of the impact of the Corona Virus Disease (COVID-19) on Food Fortification Regulation Compliance in Uganda study conducted by (MOH & FFI, 2021) found that Government of Uganda regulatory agencies face financial constraints that limit their capacity to conduct quantitative analyses of premixes. As a result, they rely on Certificates of Analysis (COA) issued by producers (exporters) prior to shipment. While this approach minimizes immediate costs, it leaves room for discrepancies, as the quality of the premixes provided by producers often fails to meet expectations despite the certification.

MONITORING AND EVALUATION (M&E) OF FORTIFICATION PROGRAMS

Food fortification monitoring is the continuous and systematic process of collecting, analysing, reviewing, and utilizing information on fortification program inputs, activities, outputs, and outcomes to evaluate performance against established criteria. Its key aspects are coverage and quality control (Pachón & Dary, 2018). The primary goal is to identify challenges, enabling timely corrective actions to enhance program effectiveness (Pena-Rosas *et al.*, 2008; Allen *et al.*, 2006). It also determines the program's cost-effectiveness and long-term sustainability, providing critical insights for decision-making and program improvement (Pena-Rosas *et al.*, 2008). Evidence from multiple studies indicates that robust M&E systems are crucial for food fortification success. Furthermore, M&E evaluates consumption patterns to determine whether fortified foods are consumed in adequate amounts by the intended population (Pachón & Dary, 2018). Additionally, M&E examines program management processes, including governance structures, resource allocation, and the involvement of stakeholders, to ensure the program is running

efficiently and identify areas for improvement (Pachón & Dary, 2018). A monitoring framework for fortification programs can be divided into internal monitoring and external or regulatory monitoring. Internal monitoring is conducted by food producers and involves production facility staff overseeing industrial processes to ensure adherence to quality assurance procedures. This process aims to produce a product that meets quality control standards (Rowe *et al.*, 2018). External monitoring is managed by government agencies and performed by national inspectorate bodies at key points such as production facilities, customs or entry points, and retail or commercial outlets. Regulatory monitoring includes verification, inspection, and audits of QA or QC systems and fortification inputs like micronutrient premixes. These combined efforts ensure that fortified foods consistently meet regulatory and safety requirements (Rowe *et al.*, 2018). Fortification monitoring process can involve a range of actors depending on the country. These often include ministries such as Health, Commerce, or Trade, as well as inspection bodies like Bureaus of Standards, Food Control Agencies, or Revenue Authorities (Rowe *et al.*, 2018). The institutions responsible for monitoring food fortification in Uganda include UNBS, MOH, Ministry of Trade, Industry, and Cooperatives (MOTIC), URA and NDA. The Uganda Bureau of Statistics (UBOS) and MOH are tasked with conducting impact evaluations of food fortification programs. Additionally, NWGFF, as an umbrella body, can choose to monitor and evaluate these initiatives. Development partners such as USAID, GAIN, the Food Fortification Initiative (FFI), and Nutrition International (NI) also play roles in monitoring and evaluating food fortification efforts in Uganda (USAID, 2022a). However, gaps persist in data quality, timely reporting, and comprehensive coverage across all regions. Internationally two MIS tools namely FORTIMAS and Fortify-MIS have been developed and used to implement monitoring and evaluation of food fortification programmes (GAIN & PHC, 2018). FORTIMAS collects data on coverage of fortified foods at household level and the micronutrient status of the population regularly consuming fortified foods (GAIN & PHC, 2018). FortifyMIS is a digital management information system that supports offline data entry, automatically uploading information to the system once an internet connection is available. Designed to streamline data collection, FortifyMIS keeps food control agencies informed about fortification practices and potential challenges. This system enhances efficiency and supports proactive oversight of food fortification programmes (GAIN & PHC, 2018). The Nutrition Initiative in 2003 designed the Fortification Rapid Assessment Tool (FRAT). FRAT is designed to help stakeholders assess whether fortification is a viable public health intervention for addressing micronutrient deficiencies, identify potential food vehicles for fortification and evaluate their suitability for micronutrient fortification (Micronutrient Initiative, 2003).

Uganda developed an M&E framework that was supposed to operationalize Uganda's fortification standards. In order to increase laboratory capacity for testing micronutrients in fortified foods, the USAID Strengthening Partnerships, Results, and In-

novations in Nutrition Globally (SPRING, 2018a) project supported UNBS to certify five laboratories including Uganda Industrial Research Institute (URI), Chemiphar Laboratories Ltd, Mukwano Industries laboratory, BIDCO Uganda Limited laboratory, and Reco Industries Laboratory (SPRING, 2018b). However, the performance of these laboratories is unknown. Furthermore, these labs belong to competitor companies and are centrally located in Kampala rather than being decentralized. National Industrial Food Fortification Strategy 2017-2022 has an attendant M&E framework which spells out the result area, indicator, indicator definition, data collection method, frequency of reporting and responsible agency. However, this strategy is expired and the results framework falls short of indicator baselines and targets meaning it doesn't actually measure the intended parameters (MOH, 2017). Uganda with support from GAIN in 2015 conducted an impact evaluation of food fortification programme in Uganda using the FACT tool to establish micronutrient status and consumption of fortified foods (GAIN, 2017). However, it was the last study of such nature to be conducted. This means Uganda is not aware of a comprehensive status of food fortification. The Uganda Bureau of Standards (UBOS) has integrated some food fortification indicators in the UNPS for the mandatory food vehicles which include wheat flour, maize flour, edible oil and fat and salt (UBOS, 2020). However, level of integration needs to be evaluated (Kyamuhangire *et al.*, 2013; Vosti *et al.*, 2024).

UGANDA'S CURRENT TOOLS AND GAPS

Uganda's food fortification programme is underpinned by a suite of regulatory and institutional tools that reflect both ambition and constraint. Institutionally, UNBS leads technical audits and Q-mark certification, while MoH oversees policy coordination. The National Drug Authority regulates premix importation (USAID, 2023a). Despite this architecture, critical gaps persist. Enforcement is weak: out of 17 certified maize mills, 11 (65%) were found non-compliant with fortification standards (MOH & FFI, 2021). Regulatory ambiguity especially around NDA's role creates loopholes in premix quality control. Financial incentives are limited; while import duties on equipment and premix are waived, VAT remains (GAIN & PHC, 2018). Data systems are fragmented, and consumption data is sparse, undermining evidence-based targeting. Moreover, the expired National Industrial Food Fortification Strategy (2017–2022) leaves Uganda without a current strategic framework aligned to evolving dietary patterns and regional standards.

Conclusion and recommendations

Although still donor-supported, Uganda's food fortification programme has transitioned from a donor-driven initiative into a nationally legislated public health strategy. Notable progress has been made in establishing mandatory fortification regulations, harmonizing standards with regional frameworks, and integrating fortification into national development plans. However, the program's effectiveness remains constrained by weak enforce-

ment, fragmented institutional mandates, limited domestic financing, and insufficient data systems. The expired Industrial Food Fortification Strategy (2017–2022) must be updated to reflect emerging public health needs. Fiscal incentives should be expanded to include VAT exemptions on premix and fortification equipment. Research gaps remain a major barrier to evidence-based policymaking. Uganda has not conducted a comprehensive impact evaluation of its fortification programme since the 2015 GAIN FACT survey. New studies are needed to assess health outcomes, especially in rural and underserved populations. Consumption data is also limited, particularly regarding maize flour and wheat flour, whose selection as food vehicles lacked robust pilot evidence. Looking ahead, Uganda must transition toward an integrated governance and financing model. Fortification should be embedded into national budgets and linked to social protection schemes such as the Parish Development Model (PDM) to enhance affordability and reach. Digital platforms like Fortify-MIS and the Nutrition Information Platform (NIPN) must be scaled and further integrated into national surveys to enable real-time monitoring, adaptive policy design, and accountability. In conclusion, Uganda's food fortification programme is at a transitional stage. With strategic reforms, robust data systems, and sustained political commitment, the country can transform its fortification landscape into a model of nutrition governance and industry compliance not only for East Africa, but for the continent at large.

DECLARATIONS

Author contribution statement: Conceptualization: B.G., I.M.M and A.K.; Methodology: I.M.M.; M.A, M.B., B.G. and Z.Z.; Formal analysis and investigation: B.G. and I.M.M.; Resources: A.K., M.B., I.M.M and M.A; Data curation: B.G.; Writing original draft preparation: B.G.; Writing review and editing: I.M.M., A.K., A.A., G.A; Visualization: M.A.; Supervision: A.K and I.M.M.; Project administration: I.M.M. and A.K.; Funding acquisition: None. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest: The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Ethics approval: This study did not involve any animal or human participant and thus ethical approval was not applicable.

Consent for publication: All co-authors gave their consent to publish this paper in AAES.

Data availability: The data that support the findings of this study are available on request from the corresponding author.

Supplementary data: No supplementary data is available for the paper.

Funding statement: This study was self-funded by the researcher.

Additional information: No additional information is available for this paper.

Open Access: This is an open access article distributed under the terms of the Creative Commons Attribution Non-Commercial 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) or sources are credited.

Publisher's Note: Agro Environ Media (AES) remains neutral with regard to jurisdictional claims in published maps, figures and institutional affiliations.

REFERENCES

- Aaron, G. J., Friesen, V. M., Jungjohann, S., Garrett, G. S., Neufeld, L. M., & Myatt, M. (2017). Coverage of large-scale food fortification of edible oil, wheat flour, and maize flour varies greatly by vehicle and country but is consistently lower among the most vulnerable: Results from coverage surveys in 8 countries. *Journal of Nutrition*, 147(5), 984S-994S. <https://doi.org/10.3945/jn.116.245753>
- Allen, L. de Benoist, B., Dary, O., & Hurrell, R. (2006). Guidelines on food fortification with micronutrients. Geneva: World Health Organization and Food and Agriculture Organization of the United Nations. <https://www.who.int/publications/i/item/9241594012>
- Bell, V., Rodrigues, A. R., Ferrão, J., Varzakas, T., & Fernandes, T. H. (2024). The Policy of Compulsory Large-Scale Food Fortification in Sub-Saharan Africa. In *Foods* (Vol. 13, Issue 15, pp. 1–30). <https://doi.org/10.3390/foods13152438>
- Bobrek, K. S., Broersen, B., Aburto, N. J., Garg, A., Serdula, M., Beltrán Velázquez, F., Wong, E. C., & Pachón, H. (2021). Most national, mandatory flour fortification standards do not align with international recommendations for iron, zinc, and vitamin B12 levels. *Food Policy*, 99. <https://doi.org/10.1016/j.foodpol.2020.101996>
- Bourassa, M. W., Atkin, R., Gorstein, J., & Osendarp, S. (2023). Aligning the Epidemiology of Malnutrition with Food Fortification: Grasp Versus Reach. *Nutrients*, 15(9), 1–9. <https://doi.org/10.3390/nu15092021>
- Bustreo, F., Harding, A., & Axelsson, H. (2003). Can developing countries achieve adequate improvements in child health outcomes without engaging the private sector? *Bulletin of the World Health Organization*, 81, 886–895.
- Darwar, R., Rowe, L. A., Chadha, M., Rosas, A. M. S., & Arabi, M. (2023). A blueprint for fortification planning and programming: Lessons learned from an analytical review of existing fortification frameworks. *Maternal and Child Nutrition*, <https://doi.org/10.1111/mcn.13571>
- Labadarios, D., Swart, E., & Maunder, E. (2008). Executive summary of the National Food Consumption Survey Fortification Baseline (NFCS-FB-I), South Africa, 2005. Pretoria: Department of Health, Republic of South Africa.
- Ebata, A., Thorpe, J., Islam, A., Sultana, S., Mbuya, M. N. N., Mkambula, P., Mbuya, M. N. N., Rowe, L. A., Sablah, M., Friesen, V. M., Chadha, M., Osei, A. K., Ringholz, C., Vasta, F. C., Gorstein, J., Olson, R., Gavin-Smith, B., Ferraboschi, C., Kraemer, K., Laviolette, L. (2021). Regulatory monitoring of fortified foods: Identifying barriers and good practices. *Nutrients*, 12(2), 880–888. <https://doi.org/10.3390/nu13041118>
- FAO. (2023). The State of Food Security and Nutrition in the World 2023. In *The State of Food Security and Nutrition in the World 2023*. <https://doi.org/10.4060/cc3017en>
- GAIN & CDC (2017). Fortification Assessment Coverage Tool (FACT) survey in Uganda, 2015. Geneva: Global Alliance for Improved Nutrition. <https://www.gainhealth.org/resources/reports/fortification-assessment-coverage-tool-fact-survey-uganda-2015>
- GAIN, & PHC. (2018). Regulatory monitoring of national food fortification programs: A policy guidance document. Geneva: Global Alliance for Improved Nutrition. <https://www.gainhealth.org/resources/reports/regulatory-monitoring-national-food-fortification-programs>
- García-Casal, M. N. (2014). Planning and Implementing Food Fortification Programs to Combat Micronutrient Malnutrition: Iron. *Food and Nutrition Sciences*, 05(10), 880–888. <https://doi.org/10.4236/fns.2014.510097>
- Hoogendoorn, A., Luthringer, C., Parvanta, I., & Garrett, G. S. (2016). *Food Fortification Global Mapping Study 2016: Technical assistance for strengthening capacities in food fortification*. 211.
- Jadhav, M. H., Mannar, M. G. V., & Wesley, A. S. (2019). A case study on the scaling-up of double fortified salt through the public distribution system of a food security program in Uttar Pradesh, India: experiences, challenges, and achievements. *Journal of Global Health Reports*, 3, e2019075.
- Karki, R., Karki, K., Bashyal, A., Parajuli, R., Rai, D., Adhikari, A., Jha, S., Bhattarai, S., Dhakal, S., & Jonchhe, S. (2025). Biobased Fortification: Current Challenges and Perspectives. *Sustainable Food Fortification: Biobased Approaches and Strategies*, 1–52.
- Kyamuhangire, W., Lubowa, A., Kaaya, A., Kikafunda, J., Harvey, P. W. J., Rambelosen, Z., Dary, O., Dror, D. K., & Allen, L. H. (2013). *The importance of using food and nutrient intake data to identify appropriate vehicles and estimate potential benefits of food fortification in Uganda*. 34(2), 131–142. <https://doi.org/10.1177/156482651303400202>
- Laviolette, L. (2018). Financing and Sustainability of Food Fortification. In *Food Fortification in a Globalized World*. Elsevier Inc. <https://doi.org/10.1016/b978-0-12-802861-2.00009-2>
- Luthringer, C. L., Rowe, L. A., Vossenaar, M., & Garrett, G. S. (2015). Regulatory monitoring of fortified foods: Identifying barriers and good practices. *Global Health Science and Practice*, 3(3), 446–461. <https://doi.org/10.9745/GHSP-D-15-00171>
- MAAIF & MOH. (2003). Uganda Food and Nutrition Policy. Kampala: Government of Uganda.
- Mannar, M. G. V., Garrett, G. S., & Hurrell, R. F. (2018). Future Trends and Strategies in Food Fortification. In *Food Fortification in a Globalized World* (pp. 375–381). Elsevier. <https://doi.org/10.1016/b978-0-12-802861-2.00040-7>
- Mannar, M. G. V., & Hurrell, R. F. (2018). Food Fortification. In *Food Fortification in a Globalized World* (pp. 3–11). Elsevier. <https://doi.org/10.1016/B978-0-12-802861-2.00001-8>
- Martorell, R., Ascencio, M., Tacsan, L., Alfaro, T., Young, M. F., Addo, O. Y., Dary, O., & Flores-Ayala, R. (2015). Effectiveness evaluation of the food fortification program of Costa Rica: Impact on anemia prevalence and hemoglobin concentrations in women and children. *American Journal of Clinical Nutrition*, 101(1), 210–217. <https://doi.org/10.3945/ajcn.114.097709>
- Micronutrient Initiative. (2003, September). Fortification rapid assessment tool (FRAT). Developed by PATH Canada under contract to the Micronutrient Initiative. Ottawa, Canada: Micronutrient Initiative. <https://www.nutritionintl.org/resources/fortification-rapid-assessment-tool-frat>
- Mkambula, P., Mbuya, M. N. N., Rowe, L. A., Sablah, M., Friesen, V. M., Chadha, M., Osei, A. K., Ringholz, C., Vasta, F. C., & Gorstein, J. (2020). The unfinished agenda for food fortification in low- and middle-income countries: Quantifying progress, gaps and potential opportunities. *Nutrients*, 12(2). <https://doi.org/10.3390/nu12020354>
- MOH, Ministry of Health. (2011). *The Food and Drugs (Food Fortification) (Amendment) Regulations, 2011. Arrangement of Regulation*. 30, 385–387.
- MOH, Ministry of Health. (2017). *Uganda industrial food fortification Strategy 2017–2022*. August 2017.
- MOH, & FFI, Ministry of Health and Food Fortification Initiative. (2021). *A Rapid Assessment of the Impact of COVID-19 on Food Fortification Regulation Compliance in Uganda*. May, 2021.
- Namugumya, B. S., Candel, J. J. L., Talsma, E. F., & Termeer, C. J. A. M. (2020). Towards concerted government efforts? Assessing nutrition policy integration in Uganda. *Food Security*, 12(2), 355–368. <https://doi.org/10.1007/s12571-020-01010-5>
- Neufeld, L. M., Baker, S., Garrett, G. S., & Haddad, L. (2017). Coverage and utilization in food fortification programs: Critical and neglected areas of evaluation. *Journal of Nutrition*, 147(5), 1015S-1019S. <https://doi.org/10.3945/jn.116.246157>
- NPA, National Planning Authority. (2011). Uganda nutrition action plan 2011–2016. *Scaling Up Multi-Sectoral Efforts to Establish a Strong Nutrition Foundation for Uganda's Development*, 1, 64.
- NPA, National Planning Authority. (2020). Third National Development Plan (NDPIII) 2020/21–2024/25. *Uganda Vision 2040, Third*, 341.
- Olson, R., Gavin-Smith, B., Ferraboschi, C., & Kraemer, K. (2021). Food fortification: The advantages, disadvantages and lessons from sight and life programs. *Nutrients*, 13(4). <https://doi.org/10.3390/nu13041118>
- OPM, Office of the Prime Minister. (2020). *Uganda Nutrition Action Plan (2020–2025): Leaving no-one behind in scaling up nutrition actions*. 1–108.
- Pachón, H., & Dary, O. (2018). Consumption Monitoring: Coverage, Provision, and Utilization. *Food Fortification in a Globalized World*, 291–297. <https://doi.org/10.1016/B978-0-12-802861-2.00030-4>

- Pena-Rosas, J. P., Parvanta, I., Van Der Haar, F., & Chapel, T. J. (2008a). Monitoring and evaluation in flour fortification programs: Design and implementation considerations. *Nutrition Reviews*, 66(3), 148–162. <https://doi.org/10.1111/j.1753-4887.2008.00019.x>
- Rowe, L. A. (2020). Addressing the fortification quality gap: A proposed way forward. In *Nutrients* (Vol. 12, Issue 12, pp. 1–17). MDPI AG. <https://doi.org/10.3390/nu12123899>
- Rowe, L. A., Luthringer, C. L., & Garrett, G. S. (2018). Regulatory Monitoring of Mandatory Fortification Programs. In *Food Fortification in a Globalized World* (pp. 283–290). Elsevier. <https://doi.org/10.1016/b978-0-12-802861-2.00029-8>
- SPRING, Strengthening Partnerships, Results, and Innovations in Nutrition Globally. (2018a). The state of maize flour fortification in Uganda (pp. 1–48). Arlington, VA: SPRING Project. <https://dec.usaid.gov/dec/content/Detail.aspx?docID=KRCTF-01273>
- SPRING, Strengthening Partnerships, Results, and Innovations in Nutrition Globally. (2018b, May). Uganda: Final country report. Arlington, VA: SPRING Project. <https://www.spring-nutrition.org/publications/reports/uganda-final-country-report>
- Taylor, J. R., Ferruzzi, M. G., Ndiaye, C., Traoré, D., Mugalavai, V. K., De Groot, H., & Hamaker, B. R. (2023). Entrepreneur-led food fortification: A complementary approach for nutritious diets in developing countries. *Global Food Security*, 36, 100674. <https://doi.org/https://doi.org/10.1016/j.gfs.2023.100674>
- Teachout, E., Rowe, L. A., Pachon, H., Tsang, B. L., Yeung, L. F., Rosenthal, J., Razzaghi, H., Moore, M., Panagides, D., Milani, P., & Cannon, M. J. (2021). Systematic process framework for conducting implementation science research in food fortification programs. *Global Health Science and Practice*, 9(2), 412–421. <https://doi.org/10.9745/GHSP-D-20-00707>
- Thakur, S., Singh, A., Insa, B., & Sharma, S. (2023). Food fortification in India as malnutrition concern: a global approach. *Sustainable Food Technology*, 1(5), 681–695. <https://doi.org/10.1039/d3fb00079f>
- Theriault, V., Kirimi, L., Wineman, A., Kinyumu, E., & Tschirley, D. (2024). Assessment of the policy enabling environment for large-scale food fortification: A novel framework with an application to Kenya. *PLOS Global Public Health*, 4(5), e0003211. <https://doi.org/10.1371/journal.pgph.0003211>
- UBOS, Uganda Bureau of Statistics. (2020). Uganda National Panel Survey report 2019/2020 (pp. 1–76). Kampala, Uganda: Uganda Bureau of Statistics. <https://doi.org/10.48529/nqzx-f196>
- UNICEF, United Nations Children's Fund. (2020). Advancing large-scale food fortification: UNICEF's vision and approach for persisting micronutrient deficiencies. New York, NY: UNICEF.
- USAID, United States Agency for International Development. (2022a). Landscape analysis of food fortification in Uganda. *Gomal University Journal of Research*, 38(04). <https://doi.org/10.51380/gujr-38-04-01>
- USAID, United States Agency for International Development. (2022b). Report for the review of food fortification marketing strategies, and promotional messages, materials and interventions. Washington, DC: USAID. Retrieved from <https://dec.usaid.gov>
- USAID, United States Agency for International Development. (2023a). Mapping the food fortification regulatory monitoring systems and processes for quality and safety of fortified foods in Uganda. Washington, DC: USAID Advancing Nutrition. Retrieved from <https://dec.usaid.gov>
- USAID, United States Agency for International Development. (2023b). The National Working Group on Food Fortification: Terms of reference. Washington, DC: USAID. Retrieved from <https://dec.usaid.gov>
- van der Meer, L. N., & Schebesta, H. (2020). The internal market, incomplete: EU, Dutch and Belgian legislation on maximum food fortification with micronutrients. *European Food and Feed Law Review*, 15(3), 212–230. <https://doi.org/10.2139/ssrn.3624024>
- Vosti, S., Baker, E., Moorthy, D., Mazinga, M., & Dary, O. (2024). Firm-Level and Public-Sector Costs Make Small-Scale Maize Flour Fortification Challenging in Uganda. *Food and Nutrition Bulletin*. <https://doi.org/10.1177/03795721231223052>
- Vosti, S., Jarvis, M., Johnson, Q., Some, J., Somda, H., Tarini, A., Engle-Stone, R., & Adams, K. (2022). Estimating the Costs of Alternative Large-Scale Food Fortification Programs in Burkina Faso: A MINIMOD Tool for Informing Policy Discussions. *Current Developments in Nutrition*, 6(Supplement_1), 612–612. <https://doi.org/10.1093/cdn/nzac060.070>
- WHO & FAO. (2006). Implementing effective and sustainable food fortification programs. *Guidelines on Food Fortification with Micronutrients*, 341.
- Wirth, J. P., Laillou, A., Rohner, F., Northrop-Clewes, C. A., Macdonald, B., & Moench-Pfanner, R. (2012). Lessons learned from national food fortification projects: experiences from Morocco, Uzbekistan, and Vietnam. *Food and Nutrition Bulletin*, 33(4 Suppl), 281–292. <https://doi.org/10.1177/15648265120334s304>