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# Implementation gaps in food safety interventions: evidence from a multi-vocal review focusing on animal-source foods in Ethiopia

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**Background:** Food safety in Sub-Saharan Africa, including Ethiopia, is shifting from identifying risks to implementing solutions, especially in the production, handling, and processing of animal-source foods. These foods are an essential and highly nutritious part of human diets in Ethiopia but pose significant health risks due to a high prevalence of foodborne illnesses which originate from consumption of infected animal products or from contamination along the value chain.

**Objective:** This study aimed to analyze the current food safety intervention landscape in Ethiopia, to identify critical gaps and challenges related to the implementation of interventions aimed at improving the safety of animal-source foods.

**Methods:** A multi-vocal literature review was conducted, combining published sources, grey literature, and key stakeholder interviews. Framework analysis was conducted using the Consolidated Framework for Implementation Research. Data consisted of 26 documents (four peer-reviewed literature from the systematic literature review and 22-grey literature) and 14 key informant interviews.

**Result:** We identified six specific implementation gaps based on the domains of the framework, focusing on different aspects of animal-source food safety including workforce, product value chains, technology, finance and policy. These gaps include a limited focus on milk and meat value chains, inadequate infrastructure capacity, insufficient data and documentation, a lack of regulatory enforcement, and a limited understanding of the relationship between food safety and food security. These challenges limit the overall reach, application, and scalability of animal-source food safety measures in Ethiopia.

**Conclusion:** This study constitutes the first exploration of implementation gaps across the animal-source food safety intervention landscape in Ethiopia. We identified several positive aspects that could contribute to the success of interventions, including renewed government commitment, financial support from development partners, and the presence of regional legal frameworks. However, the interventions were often fragmented and lacked

crucial cooperation between key implementation and regulatory stakeholders. Addressing these challenges will require a clearer articulation of national food safety goals, strengthened cross-sectoral collaboration, and strategic investment in critical infrastructure. Ultimately, building a coherent, well-coordinated, and resilient food safety system is essential not only for safeguarding public health but also for enhancing food security and supporting sustainable development in Ethiopia.

#### KEYWORDS

animal source food, Ethiopia, food safety intervention, implementation research, multi-vocal literature review

## 1 Introduction

Food safety is a complex field of study and practice that aims to ensure the safety of food and prevent foodborne illnesses. It is influenced by a range of factors throughout the food chain, from production and processing to storage, distribution, preparation, and consumption. Lack of resources, limited knowledge and awareness, fragmented governance, difficulty in bringing about behavioral change, and supply chain complexities are common challenges in food safety, particularly in low- and middle-income countries (LMICs) (Centers for Disease Control and Prevention, 2022; Jaffee et al., 2018; World Health Organization, 2022). Inadequate implementation of existing food safety interventions poses an additional barrier.

While all foods can have food safety issues, animal-source foods (ASFs), including foods sourced from poultry, fish, pigs, as well as ruminants like cattle, sheep and goats, are a special area of concern (Neumann et al., 2002). ASF are essential for ensuring food and nutrition security, particularly in LMICs, according to the Food and Agriculture Organization (FAO) and the World Health Organization (2002). In Ethiopia, a low-income country in Sub-Saharan Africa, about 37% of children under five are stunted (World Bank, 2019). The consumption of unsafe ASFs contributes to foodborne illnesses, including diarrhea, which compromise nutrient absorption and exacerbate the risk of chronic undernutrition among young children (World Health Organization, 2003). ASFs provide vital nutrients (Feyissa et al., 2016), and only 17% of Ethiopia's population consumes ASFs daily (World Bank, 2019). However, the production, handling, and processing of ASFs in Ethiopia pose significant food safety risks, leading to a substantial burden of foodborne diseases (FBDs) (Keba et al., 2020).

Among the foods most likely to cause FBDs, ASFs pose a significant risk (Grace, 2023; Havelaar et al., 2022; Sapp et al., 2022). Ethiopia has therefore placed increased emphasis on enhancing food safety in the entire ASF value chain, from production to consumption (Grace et al., 2018; Woldeyohannes et al., 2023), and several interventions have been implemented in the country, such as training food handlers, improving infrastructure and equipment, and strengthening regulatory frameworks (Grace, 2015b). Despite these efforts, food safety remains a significant concern due to the complexity

of the issues involved, including a lack of awareness, inadequate infrastructure, financial constraints, and weak regulatory enforcement (Grace, 2015a; Grace, 2015b; Grace, 2017). Moreover, key knowledge gaps remain, such as intervention effectiveness, contextual relevance, policy-practice disconnects, and limited stakeholder engagement (Ayalew, 2013; Feyissa et al., 2016; Grace et al., 2018). Therefore, a better understanding of the implementation and knowledge translation processes and practices can help bridge the gap between current knowledge of food safety interventions and their actual application.

Implementation research (IR) is a rapidly developing field which addresses the adaptation and use of evidence-based interventions in targeted settings such as public health departments and programs, to improve population health (Lobb and Colditz, 2013). The Consolidated Framework for Implementation Research (CFIR) is a widely utilized framework within IR for comprehending and enhancing implementation of evidence-based practices in diverse settings. It provides a comprehensive set of constructs (factors) that influence the implementation process and their interrelationships (Damschroder et al., 2022). The CFIR framework encompasses five main domains that influence the implementation of interventions: innovation, inner setting, outer setting, individual, and implementation processes (Damschroder et al., 2022). IR and CFIR provide the methodology and tools to identify gaps that could be addressed to improve the implementation of food safety interventions. This study aims to analyze the current food safety intervention landscape using the lens of IR through the CFIR framework, in order to identify critical implementation gaps and challenges in improving ASF safety in Ethiopia, thereby informing more effective policy and practice.

## 2 Materials and methods

### 2.1 Study settings

The study was conducted within the Addis Ababa City Administration, encompassing its 11 sub-cities and federal offices. The responsibility for ensuring food safety regulations and inspections in Ethiopia is shared among multiple government bodies, including the Ethiopian Food and Drug Authority, the Ministries of Trade and Industry, and the Ministry of Agriculture, as well as their regional offices, local authorities, and municipalities. The Food and Nutrition Policy 2018 in Ethiopia focuses primarily on nutrition, and very little on food safety. There are other regulations and standards related to food safety, but these are outdated and dispersed. To ensure food

Abbreviations: ASF, Animal-source foods; CFIR, Consolidated framework for implementation research; FBDs, Foodborne diseases; IR, Implementation research; KII, key informant interviews; LMICs, Low- and middle-income countries; MLR, Multi-vocal literature review; SLR, Systematic literature review.

safety, established food industry organizations in Ethiopia have implemented globally recognized certifications like Good Hygienic and Manufacturing Practices and Hazard Analysis Critical Control Point, which allows ASF processors to receive Ethiopia Food and Drug Authority (EFDA) certification. However, small-scale production systems, domestic abattoirs, and traditional market settings, which supply the majority of food consumed in Ethiopia often lack the necessary capabilities to manage and control food risks and are largely outside of the scope of the formal regulatory system.

## 2.2 Study design

We carried out a multi-vocal literature review (MLR) that integrated a systematic review of published and grey literature with qualitative key informant interviews involving pertinent stakeholders in the ASF food safety domain. A MLR is a broader analysis of existing literature that goes beyond systematic literature reviews (SLRs) by incorporating a wide range of sources and viewpoints. It aims to capture the richness and diversity of voices and interpretations surrounding a particular topic, leading to a more nuanced and holistic understanding (Garousi et al., 2019). In Ethiopia context where the availability of published research on food safety intervention is limited Multivocal literature review method (MLR) is particularly well-suited. The first step was conducting a SLR, followed by interviews and sourcing additional grey literature from the participants. The SLR is guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, which provides a structured framework for conducting systematic reviews (Page et al., 2021), the qualitative elements of the study are reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007, Supplementary Table 1).

### 2.2.1 Literature review

The literature review encompassed three categories of published and grey literature: (1) peer-reviewed publications, (2) gray literature, specifically unpublished Doctor of Veterinary Medicine and Master of Science (DVM and MSc) student theses from selected veterinary universities in Ethiopia; and (3) gray literature, specifically published or unpublished documents or reports from 2012 up to the current period, related to food safety interventions and accessed through key informants (during the interviews).

#### 2.2.1.1 Systematic literature review

An SLR protocol was formulated according to the PRISMA guidelines (Alemayehu et al., 2022). The inclusion criteria included literature categories 1 (peer-reviewed research articles) and 2 (gray literature) from above. The search was limited to studies published in English or Amharic between April 2012 and May 2024 from Ethiopia. Exclusion criteria included, those focused solely on non-animal food safety, those not related to food-borne hazards and diseases, those conducted solely in laboratories or on-station research, as well as those focusing primarily on prevalence or risk factor analysis.

A search strategy was devised incorporating syntax adjustments for each database, including PubMed, Scopus, CAB Direct, AJOL, and Web of Science, by integrating pertinent keywords and Boolean operators. The first author, MB underwent training on construction of search strategy and SLR at UU library and ILRI Capacity Building.

To identify studies not captured in the database search, we employed additional strategies such as hand-searching reference lists from relevant review articles and consulting experts in the field. Furthermore, we contacted seven universities offering veterinary medicine programs, namely Addis Ababa, Jimma, Wollo, Haramaya, Gonder, Bahirdar, and Hawassa universities, through a formal request for collaboration with the Ministry of Agriculture (MoA), to access unpublished DVM and MSc theses. In addition, we also conducted searches via institutional websites and university catalogues for relevant DVM and MSc theses. As a result of the systematic literature review, four peer-reviewed papers were identified (see Figure 1 and Table 1).

For SLR screening, the titles were reviewed by a single reviewer (MB) to screen out publications obviously unrelated to ASF and Ethiopia. In the next step, the abstracts of all selected articles were assessed by two independent reviewers (MB and DG) against the predefined inclusion and exclusion criteria. The full-text articles of studies that met the inclusion criteria were retrieved and thoroughly reviewed by two independent reviewers (MB and DG) to ensure that they met all of the criteria and to extract relevant data for analysis. In the event of any disagreements, they were resolved through discussion or consultation with a third reviewer (FM or MD).

#### 2.2.1.2 Additional gray literature (category 3 literature)

Twenty-two documents were gathered from interview participants, with 12 coming from development partners who supported the project, and the remaining from various government sources. Out of the total of 22 documents (Table 1), 11 were draft documents pertaining to an endorsed strategy, policy, curriculum, or legal document; while the remaining were intervention reports by government and projects, unpublished research studies, presentations of project activity results, and training materials related to animal source food safety.

### 2.2.2 Key informant interviews

We carried out key informant interviews with stakeholders from various sectors at federal or national level, including federal government agencies, academia, animal product associations, research institutions, international organizations, and development partners. At the city administration level, participants were from the Addis Ababa Bureau of Urban Agriculture, Addis Ababa Public Health Bureau, and Addis Ababa Trade Bureau. Since Addis Ababa is the capital of Ethiopia and houses all federal government offices as well as numerous national and international organizations, it provided easy access to diverse stakeholders.

Participant sampling: A purposive sampling method was employed to identify experts from a range of sectors, involved in the implementation of ASF safety interventions over the past decade. The study focused on key institutions and stakeholders directly involved in implementing, regulating, or supporting food safety interventions, such as regulatory bodies, donors, and academia. They were identified from literature, expert feedback and the authors' knowledge and experience of the Ethiopian food safety environment. Those who were newly hired or did not have food safety responsibilities were excluded from the study. A total of 20 relevant stakeholders were identified, and contacted in-person, or reached through email, with a support letter from MoA. Additionally, other individuals with expertise and insights into food safety interventions for ASF in Ethiopia were identified through snowballing from the initial

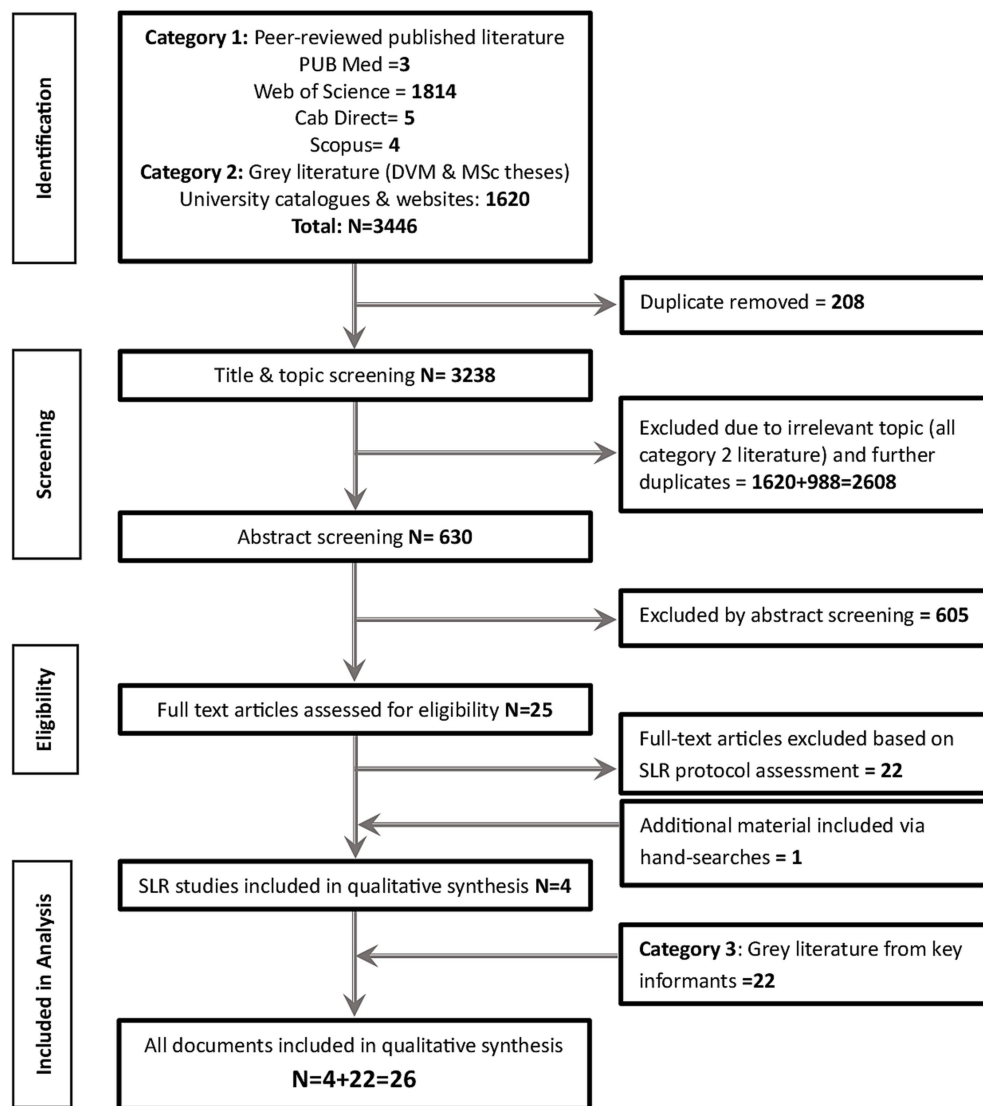


FIGURE 1  
PRISMA flow chart showing literature selection process for SLR and qualitative synthesis.

group. Fourteen of the 26 invited participants agreed to participate in the study (Table 2). Participants held various roles across different organizations, including general titles such as directors, senior experts, and researchers including principal investigators. One participant was female, while the remaining 13 were male. The primary reasons for non-participation were that the individuals reported not conducting activities related to ASF safety interventions, were non-responsive to email communication, or expressed a lack of interest in participating in the study.

**Data collection:** Data were collected between May 2022 and April 2023. Interviews were conducted using a semi-structured interview guide that comprised five principal inquiries and associated probes focusing on the techniques and strategies utilized in the food safety interventions, obstacles and facilitators experienced by the stakeholders during the implementation process, the source of funding for the intervention, and their suggestions for improving food safety in the Ethiopian context. The

guide also explored motivations, innovations and target value chains for the interventions that were described. In addition, interviewees were requested to provide concrete examples to support their statements. Prior to the interview, participants were provided with detailed information regarding the purpose and scope of the study, after which they were asked to give their informed consent to participate.

The interviews were conducted either at the participant's workplace or virtually via the Microsoft Teams application, with the first author conducting all interviews except for one, which was conducted by a different data collector from the same research group as the first author due to potential bias arising from the first author's previous professional position. To maintain a focused environment, only the interviewer and interviewee were present during the interview. All interviews were conducted in either Amharic or English, lasted between 25 min and 120 min, and the audio records were transcribed verbatim.



**TABLE 1 Overview and identifier numbers for literature included in the analysis.**

Identifier	Published literature
SL01	Evaluation of Postmortem Inspection Procedures to Diagnose Bovine Tuberculosis at Debre Birhan Municipal Abattoir (Woldemariam et al., 2021)
SL02	MILK Symposium review: Community-tailored training to improve the knowledge, attitudes, and practices of women regarding hygienic milk production and handling in Borana pastoral area of southern Ethiopia (Amenu et al., 2020)
SL03	Study on effect of acetic acid spray on <i>Escherichia Coli</i> load and meat PH at an export abattoir, Modjo, Ethiopia (Wudie et al., 2013)
SL04	Training of Trainers on Meat Hygiene to Improve Food Safety of the Domestic Meat Supply Chain in Ethiopia (Langford et al., 2018)

Identifier	Grey Literature
GL01	Kebede Amenu: Improving Handling Practices and Microbiological Safety of Milk and Milk Products in Borana Pastoral Communities, Ethiopia. 2019 (ILRI, 2020)
GL02	Amenu et al. (2018): Guide for training of pastoralists (women) in Borana Zone, Oromia Region, Ethiopia on good milk production, handling and processing practices and prevention of the transmission of milk-borne zoonotic diseases (CGIAR, 2020)
GL03	Animal welfare and meat hygienic handling impact on meat safety (Amharic) 2014
GL04	Curriculum for MSc degree in Meat Processing Technology, 2018
GL05	Meat Inspection and Safety Proclamation, 2023 (Draft)
GL06	Programs or Activities Carried Out with Dairy Directorate and Global Alliance for Improved Nutrition (GAIN), (Report)
GL07	A Proclamation to Provide for Animal Health and Welfare (Draft)
GL08	Food Safety and Quality Strategy for Primary Agricultural Produce, 2023–2030.
GL09	Standardization of Domestic Abattoirs in Ethiopia. 2016
GL010	Milk and Milk Byproduct Proclamation, 2018 (Draft in Amharic Version)
GL011	Policy Brief AKLDP Tech Brief PPP Abattoirs, 2017 (AKLDP, 2017)
GL012	Meat Inspection and Safety Regulation (Draft), 2023
GL013	Livestock Trade policy. 2022 (draft Amharic Version)
GL014	Gap Analysis Food Safety & Milk Quality at Selected Dairy Factories & Recommendations, 2022
GL015	Mission report: Assessment and Recommendations for Milk Quality Regulations in Ethiopia, 2022
GL016	BRIDGE Food Safety Activities Accomplishment, 2022
GL017	ENSURE Ethiopia Dairy Project: Final Project Report Oct 31, 2018 - April 30, 2023 (4 and 1/2 years)

(Continued)

**TABLE 1 (Continued)**

GL018	An Intervention Study on the Effect of Training on the Knowledge, Attitudes, and Practices of Dairy Farmers Regarding Milk Hygiene, and Microbial Contamination of Raw Milk in Central Ethiopia, (Draft Report)
GL019	USAID Year IV-Annual Report FY 2020 (October 2019–September 2020) Feed the Future Ethiopia Value Chain Activity
GL020	USAID Year V-Annual Report FY 2021 (October 2020–September 2021) Feed the Future Ethiopia Value Chain Activity
GL021	USAID Year III-Annual Report FY 2019 (October 2018–September 19) Feed the Future Ethiopia Value Chain Activity
GL022	Feed the Future Innovation Lab for Livestock Systems: Report on Train-The- trainer Course on Meat Hygiene. 2018 (USAID, 2020)

## 2.3 Data analysis

A deductive theory-driven framework analysis approach was used to analyze the data from the SLR, grey literature, and key informant interviews (KII), and synthesize the results. Qualitative synthesis was conducted using NVivo software (QSR International, 2020). We used the most updated version of the CFIR framework in the analysis. The use of CFIR framework for analysis is a deviation from the published protocol for SLR and grey literature review (Alemayehu et al., 2022).

The CFIR outcomes addendum included in the most recent modification was not utilized in the analysis to maintain a focus on the implementation aspects (Damschroder et al., 2022). Some of the constructs were redefined for operational reasons, in accordance with the scope of this study. All original definitions and operational modifications pertaining to CFIR domains and construct for the study are described in [Supplementary Table 2](#). The key modifications were as follows: (1) One sub-domain (Individuals) and one construct (Engaging in the Implementation Process) for example, were not included due to lack of data; (2) ‘Assessing Context’ construct in the Implementation Process domain was incorporated under ‘Local Conditions’ in the Outer Setting domain due to significant overlaps; and (3) To ensure consistency, we followed the definitions of innovation and implementation (process or strategies) as outlined in the CFIR guide (Damschroder et al., 2022), i.e., innovation was defined as “the thing” being implemented that continues after the implementation was completed whereas, implementation process and strategies were used to implement the innovation and therefore end when the implementation is complete.

The constructs and sub-constructs within the five domains of the CFIR, with the modifications described above, were then used to code the data ([Supplementary Table 2](#)). All codes were abstracted further into categories and themes ([Supplementary Table 3](#)). During the analysis, we prioritized examples that were supported by multiple sources, data, or publications to enable triangulation. Furthermore, examples that covered multiple constructs were deemed the best fit or categorized under several constructs if applicable. Initial coding was

TABLE 2 Participant identifiers and demographic characteristics of key informants.

Participant identifier	Institution/Section	Sector
ID.01	Animal Health Directorate	Ministry of Agriculture and Affiliated institutes: Ethiopia Agriculture Authority (EAA); Livestock Development Institute (LDI)
ID.02	Dairy Development Directorate	
ID.03	EAA-Quarantine Import and Export Inspection and Certification Directorate	
ID.04	LDI-Meat Development Directorate	
ID.05	LDI-Dairy Development Directorate	
ID.06	Holeta Agricultural Research Center (HARC)	Ethiopian Institute of Agricultural Research (EIAR)
ID.07	EFDA-Food Quality and Safety Inspection and Control Directorate	Ministry of Health (MOH): Ethiopian Food and Drug Authority (EFDA)
ID.08	SNV - Netherlands Development Organization (Stichting Nederlandse Vrijwilligers) - BRIDGE project	Development Partner
ID.09	USAID-Feed the feature	
ID.10	GOHI (Global One Health Initiative)-TARTAR project	
ID.11	Private sector – animal product association	Private Sector
ID.12	AAU: Addis Ababa University with ILRI: International Livestock research institute	Academia: National and international research or academic institutions
ID.13	AAU-ENSURE project	
ID.14	Addis Ababa Urban Agriculture	City Administration

conducted by MB and reviewed by MD. Final codes, categories and themes were reviewed and agreed on, by all authors.

## 2.4 The research team

The first author (MB) is a female native Ethiopian with proficiency in the local language and extensive knowledge of the food safety system and its various stakeholders through her prior work with the Ministry of Agriculture. She brought an insider perspective with a practice-based understanding of the topic and context. Four of the co-authors were veterinarians (DG, TK, JL, FM), one is a public health physician with expertise in intervention design and implementation research (MD), and two have significant experience in qualitative research (MD, DG). TK, DG, and FM also possess extensive knowledge of food safety issues in Ethiopia through their longstanding collaboration with the International Livestock Research Institute (ILRI). The team brought together a unique combination of emic and etic perspectives and multi-disciplinary expertise.

## 2.5 Ethical approval and protocol registration

Ethical clearance to carry out the study was obtained from the Ethiopian Public Health Institute Institutional Review Board, with the protocol number EPHI-IRB-477-2022, and from the International Livestock Research Institute, with reference number ILRI-IREC2022-18. As the key informant interview participants hold high positions within their organizations, information on participant characteristics has been limited for maintaining confidentiality. In addition, the authors reviewed and approved the SLR protocol, prior to its submission to the International Prospective Register of Systematic Reviews (PROSPERO), where the protocol was registered

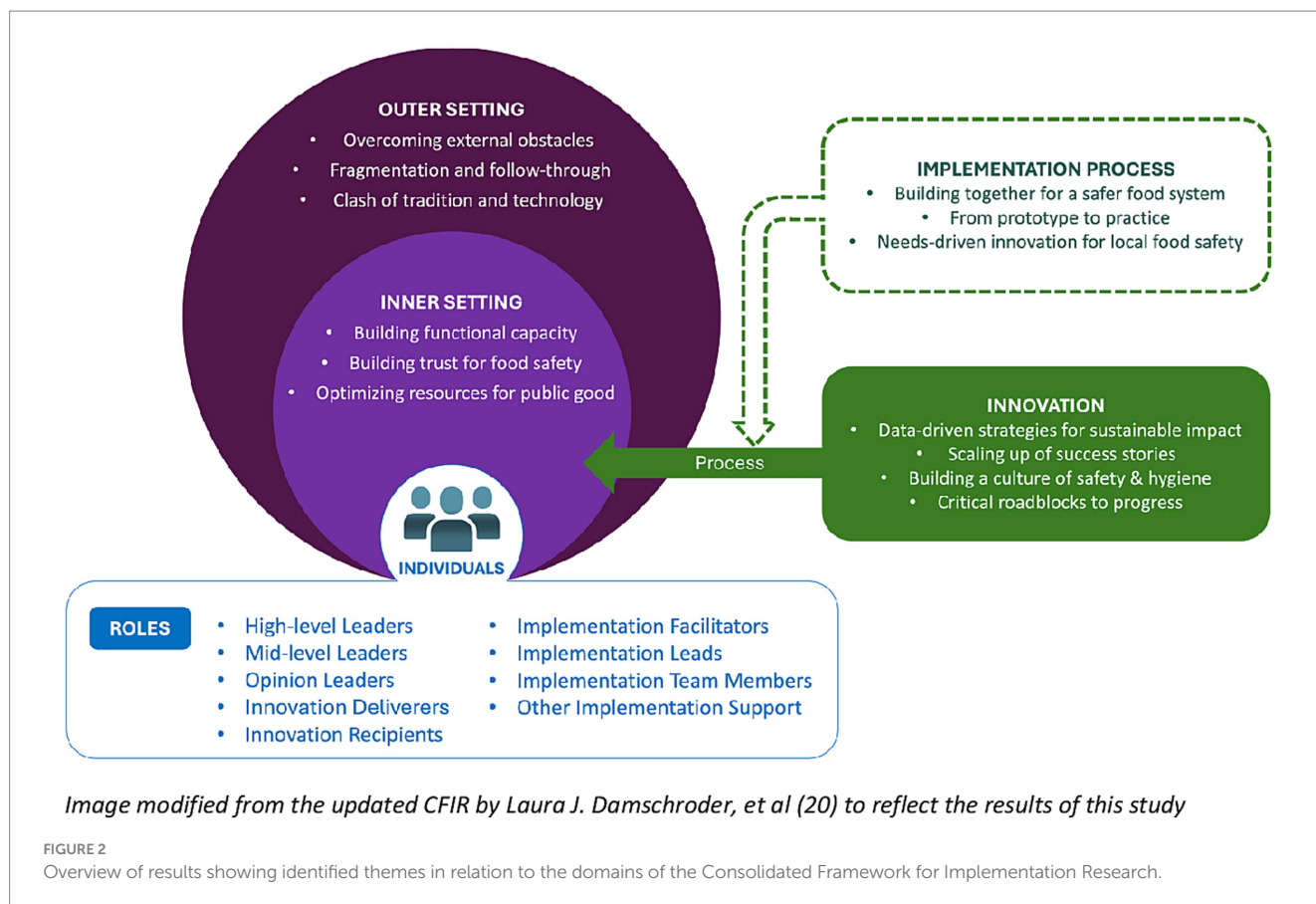
prospectively (Alemayehu et al., 2022). Prior the interview, participants received detailed information about the study's purpose and scope and provided informed consent to participate.

## 3 Results

The results of the framework analysis are presented in Figure 2 and Supplementary Table 5. Supplementary Table 5 includes additional information in the form of specific examples pertaining to each category and the source information for each in the form of specific Interview identifier (ID) 01–14, Systematic Literature Review identifier (SLR) 01–04 or Grey Literature identifier (GL) 01–22. The results are further described below in text under each CFIR domain using narrative synthesis. The results are exemplified using quotes that include clarifying text by the authors in square brackets [...] and ending with in-depth interview identifiers [ID#].

### 3.1 Innovation domain

The Innovation domain focused on the type and nature of interventions implemented and we identified six types of innovations based on the CFIR definition from 30 unique projects or initiatives: (1) system capacity innovations (focus on institutional capacity building); (2) workforce and value chain capacity innovations (focus on individual capacity building); (3) hygiene and safety practice innovations; (4) technology and technique innovations; (5) financial and technical innovations; and (6) policy and strategy innovations. These innovations primarily focused on red meat and milk value chains. The most frequently implemented innovation was capacity building of work force and (or) value chain actors, with training emerging as the dominant intervention strategy. Many projects incorporated multiple types of innovations simultaneously, reflecting



the complex nature of food safety interventions. An overview of identified innovation types with additional details about interventions strategies and implementers and beneficiaries are detailed in [Supplementary Table 4](#).

We identified four overarching themes within the innovation domain: (Centers for Disease Control and Prevention, 2022) data-driven strategies for sustainable impact; (Jaffee et al., 2018) scaling up of success stories; (World Health Organization, 2022) building a culture of safety and hygiene; and (Neumann et al., 2002) critical roadblocks to progress. These themes provide insight into both enabling factors and persistent challenges in the implementation of ASF food safety interventions.

The use of evidence-based practices and considerations for future sustainability were found to vary in different projects or initiatives which further affected the impact and continuity of innovations. Some innovations had a robust evidence base, and projects attempted to put steps into place for its continuation after implementation. For example, the ENSURE project improved practices significantly, and training materials were shared with the government for scale-up.

*“...ENSURE cannot go on forever....We hope these manuals will be delivered to the relevant Ministry of Agriculture and other stakeholders, enabling further scale-up...” [ID.13]*

Some innovations were evidence-based but found to be both ineffective and incompatible with local practices. For example, an initiative from AAU-ILRI which aimed to enhance milk hygiene using stainless containers among pastoralists, showed no significant impact

on microbial load and went against local preference for traditional containers. Some innovations were effective in small-scale testing, like using acetic acid to reduce *E. coli* on carcasses but would need to undergo further field testing for effectiveness.

Several projects described strategies and tools that they used to improve the outcomes of their intervention. For example, using a detailed SOP for meat inspection improved tuberculosis detection over routine methods, and “Glo Germ” was effective in teaching food safety techniques. Adaptable innovations, such as SNV’s milk marketing regulation in Oromia, were applied in other regions like Amhara. Interviewees emphasized the importance of tailoring interventions to the local context; however, they also acknowledged that such adaptations must be carefully balanced with the need to uphold nationally and internationally recognized food safety standards.

*“..... our training materials are tailored to the local context rather than copied from international sources. For instance, when training milk collection centers, we found no comparable local examples, making customization challenging. Understanding the local society and conditions is essential; generic recommendations often fail to address real needs. Our past experiences highlight the importance of grasping the specific context to provide effective solutions....” [ID.13]*

Several roadblocks to progress were described including the lack of data to develop new evidence-based innovations, inadequate funding and challenges to sustainability of interventions. Lack of dedicated or ear-marked funding was identified as a major roadblock.

*“... Well, to be honest, it is difficult to say that there is a place [in budgets] where it [funding] is allocated specifically for food safety. What happens is that there are general budgets that help to do few activities required by the Ministry of Agriculture, and we use that budget for the food safety activities...” [ID.01]*

Overall, funding sources were identified as mainly government and development partners; and interventions sources were credible entities like MoA, MoH, Ethiopian Institute of Agricultural Research, and development partners.

## 3.2 Outer setting domain

In this domain, three themes were identified: overcoming external obstacles; fragmentation and follow-through; clash of tradition and technology.

Food security was often prioritized over food safety, due to a lack of understanding of the critical linkages between food safety and food security among critical public sector stakeholders. This was a major hindrance for many food safety initiatives as interventions were prioritized to improve production of meat and milk products rather than the safety of the products.

*“... When we discussed this [food safety issues] among stakeholders, they asked [us], “Why are you talking about food safety in a country where there is no food security?” [ID.13]*

The outer setting significantly affects organizational operations and strategies. Disruptions from unforeseen events, such as the civil war and COVID-19, along with issues like inadequate equipment usage and confusion among stakeholders, hindered implementation. A key example was the use of non-food-grade equipment for milking, despite available alternatives, which negatively impacted a SNV intervention. Traditional beliefs and practices also posed barriers, though profit potential has slowly changed attitudes. For example, AAU-ILRI interventions found that selling milk, once taboo among Borena pastoralists, became acceptable as a profitable venture. Local practices like drying meat were viewed as more reliable than newer technologies in areas lacking refrigeration, while risky practices like consuming raw milk persisted due to cultural norms. Moreover, a lack of follow-through on potential consequences of interventions in seemingly unconnected sectors or areas could lead to challenging situations or exacerbate local conditions.

*“... Due to its complexity [interconnectedness of food safety with other sectors or issues], the management is also very complex. It means you cannot handle one [issue] alone, the other [another related issue] may become more difficult.... For example, we carried out.... training, and .... introducing containers [for milk storage and transportation?]. But what we experienced .... there was a kind of severe water shortage which led to a general unhygienic situation...” ID.12*

Political support, enabling environments, and international collaborations were identified as crucial for successful implementation. However, gaps in multi-actor inclusions and system-level connections often undermined efforts. A projects like ENSURE, which engaged

with local governments and community leaders, was an exception by effectively accessing/OR involving key stakeholders. Challenges such as poor political commitment and weak enforcement of national legal frameworks, exemplified by draft policies were not endorsed, suspended in the middle, poor basic infrastructural capacity and conflicting interest between different government structures further hindered food safety progress.

Social and market pressures, including advocacy via social media and labor turnover driven by better wages in other sectors, were found to influence changes. However, no examples of performance-measure pressures were identified, and financing concerns had already been addressed under innovation factors.

## 3.3 Inner setting domain

Three themes were identified for this domain: building functional capacity; building trust for food safety; optimizing resources for public good. The inner setting domain explores organizational contexts affecting performance, highlighting disparities in infrastructure and workforce management across different levels. Universities like Mekelle and Addis Ababa boast advanced facilities, yet overall weak institutional capacity, particularly in lab resources and workforce expertise, hampering food safety efforts. Participants stressed the need for standardized frameworks and stronger enforcement to address infrastructure and capacity challenges in the food safety sector. Small-scale dairy producers often lacked basic infrastructure like clean water, electricity, and transport, while export abattoirs are better equipped than domestic ones. Factors such as low wages, high turnover, and insufficient training in domestic abattoirs negatively impacted hygiene, in contrast to strict export regulations.

*“... Export abattoirs are well-organized and meet international standards. A few regional abattoirs also meet export standards and are relatively safe. However, at the district level, basic sanitation is lacking. The infrastructure is substandard, often relying on rusty knives or tools, and there is poor management of sewage and waste. We still have significant work to do regarding environmental issues and food safety.” [ID.04]*

Funding sources—whether public, private, or donor-backed—played a crucial role in these disparities. For example, private sector initiatives, such as a commercial farm’s disease management training, and projects like SNV’s focus on milk adulteration regulations, represent tensions for change at local and systemic levels. However, food safety incentives like branding or the MoA’s certification programs have limited impact without a sustainable regulatory environment.

Many food safety programs relied heavily on external funding, like the ENSURE project for milk value chain training. While these interventions address immediate gaps, they may not be sustainable post-project. Yet, resources from projects, such as USAID-Fintrac’s tank-washing system for dairy farms, are intended to offer longer-term solutions by leaving infrastructure in place even after project completion.

*“... One of the challenges we face is coordinating our work in the absence of adequate funding. For instance, there is no support for*



*conducting research. Even when there is a government budget, it often doesn't extend to supporting companies or establishing laboratories...” [ID.07]*

### 3.4 Individual domain

This domain focused on the individual characteristics of those involved in the implementation of interventions. The key informants in this study had various roles in the implementation process, including mid- to high-level and implementation leaders, facilitators, and team members (Table 3). On one hand, the innovation deliverers represented in the interventions come from a range of sectors such as government, externally funded projects, collaborative efforts between government and external projects, academia, research institutes, and private sector institutions. On the other hand, the recipients of the innovation included various individuals and value chain actors, such as women in the pastoral Borena region who received milk hygiene training, abattoir workers in urban and peri-urban areas of Addis Ababa, Oromia, Amhara, South, and Tigray, as well as relevant regional offices and government bodies, associations, cooperatives, and regulatory bodies. The data did not however allow for a further assessment of the need, capability, and motivation factors of the ‘Characteristics’ subdomain in the CFIR framework.

### 3.5 Implementation process domain

In this final domain, we identified three themes that cut across the eight unique innovations (Supplementary Table 4): building together for a safer food system; from prototype to practice; and (needs-driven innovation for local food safety). The domain of the implementation process focused on the methods used in rolling out interventions, where collaboration among stakeholders was key to improving food safety and hygiene in Ethiopia. For example, the Livestock Development Institute (LDI) worked with government and NGOs on meat safety and created a national task force on milk safety. In policy development, teams from the Ministry of Trade (MoT), MoA, and the Policy and Research Institute collaborated on livestock trade policies. Similarly, research partnerships, like the University of Florida’s collaboration with Ethiopian institutions under the Feed the Future initiative, focused on improving meat handling and hygiene through

assessments and training. However, participants identified gaps in terms of inclusion of different sectors which would have a bearing on overall implementation.

*“...The current system shows limited involvement from private sector participants in creating strategic and legal frameworks. It is suggested that all stakeholders should contribute to and engage in the development process of any intervention. However, the existing approach is not comprehensive enough and tends to focus on a select few stakeholders, resulting in broader participation being overlooked...” [ID.14]*

Need assessments were often conducted by the innovation deliverers, either institutionally or through funded calls, using methods like risk-based prioritization or leveraging previous studies. These assessments mostly addressed public health concerns or high-risk groups, driven by foodborne pathogens or export standards. Only a few initiatives were based on market demands or specific requests from stakeholders. Most needs assessments resulted in more training and awareness sessions which were more financially feasible.

*“...As a regulatory body, we regularly inspect food processing facilities using checklists for monitoring and evaluation. After each [needs] assessment, we provided capacity-building initiatives, which include awareness programs and training...” [ID.11]*

The planning of interventions typically began as pilot projects with the goal of long-term government adoption. For instance, the AAU-ENSURE project trained participants in milk safety, transferring materials to the government for ongoing use, despite challenges from the MoA’s productivity focus. Another example was the stakeholder forum (MoT, MoA, and MoH), which enforced milk safety regulations.

Training programs were adapted to meet local needs, such as SNV’s revision of their adulteration control plan to train regulatory bodies on milk quality. The ENSURE project also adapted its training materials to local contexts, ensuring they addressed community-specific needs. Additionally, the project engaged external entities for monitoring and evaluation, keeping local stakeholders informed of progress, which advanced transparency and collaboration.

### 3.6 Summary of implementation gaps

A summary of the results revealed six main implementation gaps that impact ASF safety interventions in Ethiopia. These gaps were either identified across multiple CFIR domains, or identified primarily in one domain but impacted all (indicated in brackets):

- 1 The focus of the identified innovations was milk and meat value chains, thus largely neglecting poultry and fish. (Innovation, impacts all domains)
- 2 Among the identified innovations, the greater allocation of resources was towards capacity building rather than critical infrastructural challenges that require significant financial investments. There was limited building of system capacity mainly through provision of new equipment. Capacity building of workforce and value chain actors through training programs

TABLE 3 Role characterization of interview participants as per CFIR.

CFIR role characterization as per Individuals Domain	Interview participant Identifiers
A. High-level Leaders	ID01-05, ID07
B. Mid-level Leaders	ID06, ID11, ID14
C. Opinion Leaders	--
D. Implementation Facilitators	ID08, ID09
E. Implementation Leads	ID13, ID12
F. Implementation Team Members	ID10
G. Other Implementation Support	--

mitigates in part the deficiency in workforce capacity (both their numbers and expertise) that was also identified. (Innovation, Inner Setting)

- 3 Insufficient attention towards the sustainability of interventions, i.e., their long-term continuity beyond the project period. This is related primarily to a reliance on external short-term funding but also to other factors like burdensome government procurement systems for consumables and equipment not produced in the country; and limited scale-up of locally effective interventions due to lack of funding or limited involvement of key regulatory and implementation players that would ensure future uptake of projects by the government. (Innovation, Inner Setting, Implementation Process)
- 4 There was a lack of understanding among decision-makers (government) and other stakeholders regarding the relevance of food safety to food and nutrition security. This was reflected in the lack of alignment in priorities, workflow and communication structures between and within sectors (from the federal to regional, or kebele levels), leading to unclear responsibilities for food safety between sectors and inadequate allocation of human resources both in terms of numbers and expertise at the federal and regional levels. (Outer Setting, Inner Setting)
- 5 Lack of enforcement of existing legal frameworks was identified from federal to kebele (the smallest administration unit levels) across multiple domains due to poor basic infrastructural capacity (electricity, clean water) and conflicting interests between different government sectors. (Outer setting, impacts all domains)
- 6 The study also highlighted an overall lack of evidence and documentation related to food safety innovations in Ethiopia. This meant that the rationale and evidence relating to the details of the intervention strategies, their development and implementation process and effectiveness of the implemented interventions were insufficiently documented, thereby limiting the evidence-base for future interventions. (Innovation, impacts all domains)

## 4 Discussion

Our study, to the best of our knowledge, is the first exploration of ASF safety interventions in Ethiopia, providing a snapshot of the major implementation gaps. We identified six types of innovations from all the projects described in the data; and six implementation gaps covering single or multiple CFIR domains, focusing on different aspects of ASF safety including workforce, product value chains, technology, finance and policy. In addition, the predominant focus on milk and meat value chains and the lack of evidence and documentation limits the overall scope, application and scale-up of ASF safety practice in Ethiopia.

Our data revealed that interventions primarily focused on the value chains of milk and meat products derived from cattle, sheep, goats, pigs, and camels, while poultry and fish were largely overlooked. This is concerning given the growing global demand for poultry and fish products, as well as their potential to harbor pathogens (Havelaar et al., 2012). A literature review by Gazu et al. (2023) found that pathogens such as *E. coli*, non-typhoidal *Salmonella* spp., and *Listeria*

*monocytogenes* were present in poultry and egg value chains, with contamination rates ranging from 1.9 to 37% across various stages of production and distribution. Additionally, zoonotic nematodes such as *Contracaecum*, *Eustrongylide*, and *Capillaria* were commonly found in fish, along with the zoonotic trematode *Clinostomum* and the zoonotic cestode *Ligula intestinalis* (Sorsa et al., 2019). However, there is a lack of data on the zoonotic transmission of these pathogens to humans. A 2020 study revealed that ASF consumption among families in Addis Ababa included meat (32%), eggs (28%), fish (2%), and dairy products (46%) (Abdelmenan et al., 2020). Considering these local consumption patterns, it is necessary to prioritize the poultry value chain as well. Moreover, evidence from studies on fish consumption in Ethiopia indicates that the intake of raw or undercooked fish persists in certain communities, posing notable public health risks associated with inadequate handling practices and low awareness of foodborne hazards along the supply chain. Microbiological assessments of fish samples have identified a predominance of mesophilic bacterial flora, including *Bacillus* spp., *Salmonella* spp., *Escherichia coli*, and *Staphylococcus* spp., highlighting potential contamination risks (Bedane et al., 2022; Admasu et al., 2023).

Our research also revealed that the interventions typically concentrated on workforce capacity development, such as training and the provision of awareness-raising materials, while major challenges to food safety, such as basic infrastructure, were largely disregarded. This is consistent with other studies that emphasized the prevalent focus on training of food value chain actors. The importance of building capacity at various levels (Woldeyohannes et al., 2023) to improve the skills of professionals and empower individuals and communities to adopt and maintain safe food practices is often highlighted (Kwoba et al., 2023). However, there is limited evidence on the effectiveness, sustainability, and scalability of training interventions (Kwoba et al., 2023), which further indicates how critical it is to differentiate and regularly evaluate professional workforce training programs which are essential for improving food safety standards. Other studies identify the lack of basic infrastructure, including electricity, clean water, and roads, as the most significant challenge. Grace (2015a) and Woldeyohannes et al. (2023) however found that while there were several interventions focusing on infrastructure (such as rural roads, electricity, water), these were often for development and did not overlap with required areas for food safety. Food safety interventions therefore addressed this issue the least, likely due to the need for substantial financial investments and political support. Achieving food safety at scale, however, requires foundational investments in people, infrastructure, and institutions, which demand sustained attention from technical agencies, government ministries, and donors (Kwoba et al., 2023; World Health Organization, 2022; World Health Organization, 2023; Zavala Nacul and Revoredo-Giha, 2022).

The majority of our study's participants and literature emphasized the significance of multi-stakeholder collaborations, specifically the One Health approach, in addressing complex issues such as food safety in Ethiopia and elsewhere. These collaborations were reported to offer the advantage of gathering diverse perspectives, expertise, and resources to develop comprehensive strategies and implement effective interventions, which aligns with existing literature promoting participatory approaches in public health and development initiatives (Kwoba et al., 2023; World Health Organization, 2023). However, the sustainability of these interventions was often undermined as most

interventions excluded crucial implementation and regulatory stakeholders, such as the private sector, community representatives, and authorities such as the Ethiopian Standards Agency and the Ministry of Finance. Structural dissimilarities between the federal and subnational levels particularly at regional, woreda, and kebele administrations pose significant challenges to the effective implementation of food safety interventions. While federal institutions for example maintain dedicated departments such as Veterinary Public Health and the Ethiopian Agricultural Authority, equivalent structures are often lacking at lower levels. Instead, responsibilities are commonly delegated to individual focal persons (e.g., meat inspectors), who frequently operate without adequate institutional support or mandates, especially concerning food items like dairy, poultry, and fish. These structural gaps undermine coordination and contribute to fragmented and inefficient implementation efforts (FAO/WHO, 2006; Grace et al., 2019). In addition, the government's heavy reliance on externally-funded projects, as observed in this and other studies, not only undermines the long-term viability of interventions but also hampers efforts to institutionalize food safety practices within existing systems (Bebbington et al., 2006). This scenario exemplifies a broader trend in development interventions, where initiatives frequently struggle to transition from donor-driven models to locally-owned and sustainable efforts (Benson and Jordan, 2011). To tackle this critical challenge to food safety interventions in Ethiopia, it is imperative to implement strategies that promote local ownership, build institutional capacity, and mobilize resources from diverse stakeholders, ensuring the continuity and scalability of food safety interventions beyond the duration of externally-funded projects (Gaventa and Barrett, 2010).

The challenge of differentiating between food security and food safety, as identified by decision makers, has led to difficulties in prioritizing food safety. Several studies suggest that food security was frequently prioritized over food safety, not only due to limited awareness of their interconnection among key public sector stakeholders, but also because of the pressing need to address widespread food insecurity. This tendency reflects a pragmatic response to urgent population-level challenges. However, it also poses a significant barrier to food safety initiatives, as interventions often focused on increasing the quantity of meat and milk production rather than ensuring the safety and quality of these products (Grace, 2015a; Benson and Jordan, 2011). According to Vipham et al. (2020), ensuring the safety of livestock products is crucial for achieving food security goals (Vipham et al., 2020). However, addressing food safety issues requires a coordinated and collaborative one-health approach, which has been found to be challenging due to unclear definitions and priorities (Kwoba et al., 2023; World Health Organization, 2023). This lack of understanding and unclear sectoral responsibilities has resulted in food safety being overlooked in favor of revenue-generating activities, such as production. This ambiguity exacerbates existing challenges and contributes to a notable human resource gap in both quantity and expertise at federal and regional levels (FAO/WHO, 2006). To address this issue, it is essential to establish clear responsibilities, implement capacity-building initiatives, and promote intersectoral collaboration to establish effective food safety governance structures that protect public health and promote sustainable development.

The study further revealed that the enforcement of food safety regulations in Ethiopia remains inadequate, primarily due to

insufficient infrastructure and competing interests among various governmental sectors. Although the country possesses established food safety policies and regulatory frameworks, the central challenge lies in their effective implementation and inter-sectoral coordination, rather than in the absence of appropriate legislation. The study conducted in LMICs by Hoffman et al., supports this finding by highlighting that a major obstacle to improving food safety is the limited resources and institutional capacity of public bodies tasked with these functions. Without adequate infrastructure, enforcement becomes difficult and inconsistent. Moreover, while some sectors are responsible for ensuring hygienic and safe production of animal products, the necessary infrastructure is often managed by separate sectors, leading to coordination challenges and potential conflicts of interest (Hoffmann et al., 2019). This observation also agrees with the WHO report, which identifies a key challenge for national governments in coordinating functions across all levels—local, regional, and national—while ensuring impartiality and preventing conflicts of interest (World Health Organization, 2022).

The lack of available evidence and data has been highlighted throughout this study starting with the limited number of peer-reviewed publications to the lack of published reports or documents describing implemented interventions. Several interviewees were unable to provide data or documents to support their descriptions of implemented food safety interventions in Ethiopia. This lack of documentation has significant implications for understanding the baseline status, avoiding duplication, and planning future evidence-based interventions. Previous research has highlighted the challenges in improving food safety in LMICs, including data hurdles and limited information, which makes it difficult to target interventions effectively and allocate resources where they are most needed (Grace, 2015a).

## 5 Methodological considerations

This study employed the CFIR to analyze implementation gaps, representing a methodological shift from the originally planned Theoretical Domains Framework (TDF). This decision was made after data collection, when it became evident that the emerging themes extended beyond individual-level behavioral factors, TDF's primary focus, and aligned better with CFIR's broader emphasis on organizational, contextual, and system-level determinants. While this *post hoc* change may limit comparability with studies using TDF and resulted in some CFIR constructs being underexplored due to the original interview design, we mitigated this by conducting triangulation with available grey and published literature. The use of CFIR allowed for a more comprehensive interpretation of multi-level implementation dynamics in Ethiopia's food safety interventions. In addition, due to the limited number of eligible published studies identified through the systematic literature review (SLR), we did not proceed with a meta-analysis. Recognizing this limitation, we complemented the SLR with a multivocal literature review approach, which allowed us to include additional insights from grey literature and key informant interview. This was done to enrich the analysis and provide a more comprehensive understanding of food safety interventions in the Ethiopian context.

Recall bias could be another limitation, as individuals may find it challenging to accurately recollect past events or experiences, which could impact the accuracy of the self-reported data. Nevertheless, the

findings were corroborated by interview data as well as published and grey literature, thus enhancing the trustworthiness of the study. Although preexisting relationships may prove advantageous, the first author's (MB) prior professional connection with participants due to her previous employment in MoA might have contributed to socially desirable responses or confirmation bias, which was minimized through triangulation. Additionally, her knowledge of the practices in the field could have biased data collection and analysis. This potential limitation was addressed through regular discussions in the team and the use of reflexive notes and analytical memos, which MB diligently maintained throughout the data collection and analysis process.

## 6 Conclusion

This study represents a novel investigation into the implementation gaps within Ethiopia's animal source food (ASF) safety intervention landscape. While we identified several positive aspects that could contribute to the success of interventions namely, renewed government commitment, financial support from development partners, and the presence of regional legal frameworks, the interventions were often fragmented and lacked crucial cooperation between key implementation or regulatory stakeholders. These gaps are compounded by the predominant focus on milk and meat value chains, limited infrastructure capacity, insufficient evidence and documentation, and a generally limited understanding of food safety and regulatory enforcement. Collectively, these factors restrict the reach, application, and scalability of ASF safety measures. Addressing these challenges will require a clearer articulation of food safety goals across relevant sectors and enforcement of existing regulatory frameworks. Government agencies, particularly those in agriculture, health, trade, and standards, should take the lead in establishing a national coordination mechanism to streamline planning, implementation, and accountability, and in investing in critical infrastructure. Development partners and donors can play a critical role in supporting the expansion of cold chain systems, laboratory capacity, and workforce development, particularly at subnational levels. Private sector actors, including food processors and producers, should be engaged in co-developing practical training programs and compliance systems that are both locally relevant and aligned with regulatory standards. Investing in these targeted actions is essential not only for safeguarding public health but also for building trust in the food system, enhancing economic opportunity, and ensuring sustainable food and nutrition security.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

Ethical clearance to carry out the study was obtained from the Ethiopian Public Health Institute Institutional Review Board, with the

protocol number EPHI-IRB-477-2022, and from the International Livestock Research Institute, with reference number ILRI-IREC2022-18. Prior the interview, participants received detailed information about the study's purpose and scope and provided informed consent to participate.

## Author contributions

MB: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. DG: Conceptualization, Funding acquisition, Methodology, Supervision, Validation, Writing – review & editing. TK-J: Conceptualization, Supervision, Validation, Writing – review & editing. FM: Methodology, Validation, Writing – review & editing. JL: Conceptualization, Supervision, Validation, Writing – review & editing. MD: Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Validation, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. During the preparation of this work the author(s) used Paperpal, an AI-based academic language editing program to improve the clarity of the written text. The author(s) have reviewed and edited



the content further and take(s) full responsibility for the content of the manuscript.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2025.1546347/full#supplementary-material>

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