

Review Article

A Comprehensive Review of the Ethiopian Food Quality Management System: Challenges, Innovations, and Pathways for Transformation

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Abstract

This comprehensive review provides an extensive analysis of Ethiopia's food quality management system, examining its historical evolution, current challenges, and future directions. The analysis reveals a system at a critical juncture, characterized by progressive policy frameworks alongside significant implementation gaps. Approximately 80-90% of food transactions occur through informal channels where regulatory oversight is minimal, hygiene practices are often inadequate, and infrastructure is lacking. Foodborne illnesses impose a substantial burden, with estimated economic costs reaching USD \$723 million annually from select pathogens alone. Despite these challenges, Ethiopia has developed ambitious policy instruments, including the National Food Safety Management Plan (2025-2029) and established the Ethiopian Food and Drug Authority as a lead regulatory agency. This review synthesizes evidence from over 120 sources across multiple sectors to analyze the complex interplay between governance structures, market dynamics, technological innovations, and socio-cultural factors that shape food safety outcomes. I identify critical leverage points for systemic improvement, including differentiated regulatory approaches for formal and informal sectors, strategic infrastructure investments, behavior-centered interventions, and strengthened multi-sectoral coordination through a One Health approach. The paper concludes with a detailed implementation framework for transforming Ethiopia's food safety system, emphasizing context-specific solutions, evidence-based interventions, and the need for sustained political commitment and investment to protect public health and support economic development.

Keywords

Food Safety, Food Quality Management, Informal Sector, Food Policy, Foodborne Disease, Traditional Markets, Consumer Behavior, Regulatory Systems

1. Introduction

1.1. Background and Significance

Food safety represents a fundamental pillar of public health, economic development, and social stability in Ethiopia, a nation of approximately 120 million people with an agriculture-

dependent economy contributing about 34% to GDP [1, 2]. The integrity of the food system directly impacts multiple Sustainable Development Goals, particularly those related to health (SDG 3), hunger eradication (SDG 2), and economic growth (SDG 8). In Ethiopia, foodborne diseases impose a

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dual burden: directly affecting population health through illness and mortality, and indirectly constraining economic development through healthcare costs, lost productivity, and limitations on agricultural trade [3]. Recent estimates suggest that foodborne hazards account for a significant proportion of the country's disease burden, with children under five, pregnant women, and immunocompromised individuals being particularly vulnerable [4].

The Ethiopian food system is characterized by remarkable diversity and complexity. It encompasses traditional subsistence farming, emerging commercial agriculture, extensive pastoral systems, and a vibrant urban informal food sector that supplies approximately 70-80% of food to urban populations [5]. This diversity presents both challenges and opportunities for food safety management. On one hand, the predominance of small-scale producers and informal market channels complicates regulatory oversight and standardization. On the other hand, localized food systems offer potential advantages for traceability and community-based control mechanisms that could be harnessed for improved food safety outcomes.

1.2. Historical Context of Food Safety Management in Ethiopia

The evolution of Ethiopia's approach to food safety management can be divided into three distinct phases. The pre-1991 period was characterized by minimal institutional frameworks, with food safety considerations largely addressed through general public health legislation and agricultural extension services focused primarily on productivity rather than safety [6]. The 1991-2010 period witnessed the establishment of foundational policy instruments, including the first Food, Medicine, and Health Care Administration Proclamation (Proclamation 212/2000) and increasing engagement with international standard-setting bodies such as the Codex Alimentarius Commission [7]. The post-2010 period has seen accelerated institutional development, marked by the creation of the Ethiopian Food and Drug Authority (EFDA) in 2015, the launch of the National Food and Nutrition Policy in 2018, and most recently, the development of the comprehensive National Food Safety Management Plan (2025-2029) [8].

This historical trajectory reflects Ethiopia's broader developmental journey and its engagement with global food safety governance. The increasing sophistication of policy instruments mirrors the country's economic growth, urbanization, and integration into regional and global food markets. However, as this review will demonstrate, the translation of policy ambition into practical improvement at the point of consumption remains a persistent challenge, creating what scholars have termed the "implementation gap" in food safety governance [9].

1.3. Objectives and Scope of the Review

This comprehensive review aims to achieve four primary

objectives:

To systematically analyze the institutional architecture, policy frameworks, and implementation mechanisms of Ethiopia's food quality management system.

To critically examine the key challenges and constraints across different segments of the food value chain, from production to consumption.

To identify and evaluate innovative approaches, successful interventions, and emerging opportunities for strengthening food safety outcomes.

To propose an integrated, evidence-based framework for transforming Ethiopia's food safety system, with specific recommendations for policy, practice, and research.

2. Methodology

2.1. Search Strategy and Selection Criteria

This comprehensive review employed a systematic approach to identify, select, and analyze relevant literature on food quality management in Ethiopia. Electronic databases including PubMed, Scopus, Web of Science, and African Journals Online were searched using combinations of the following terms: "food safety," "food quality," "foodborne disease," "food regulation," "food inspection," "food handling," "food hygiene," "Ethiopia," and "East Africa." The search was limited to publications from 2000 to 2024 to ensure contemporary relevance while capturing the evolution of policies and practices over the past two decades. Grey literature, including government reports, policy documents, project evaluations, and conference proceedings, was identified through searches of institutional websites (EFDA, Ministry of Health, FAO, WHO, World Bank).

Inclusion criteria encompassed: (1) studies conducted in Ethiopia or with substantial relevance to the Ethiopian context; (2) publications addressing any aspect of food quality management including policy, regulation, surveillance, interventions, risk factors, or economic impacts; (3) documents available in English; and (4) all study designs (quantitative, qualitative, mixed methods) and publication types (original research, reviews, reports, policy analyses). Exclusion criteria included: (1) publications focused exclusively on food security without addressing safety/quality dimensions; (2) studies with methodological flaws that significantly compromised validity; and (3) duplicate publications of the same study.

2.2. Data Extraction and Analysis

A standardized data extraction form was developed and piloted to ensure consistent collection of information across studies. Extracted data included: publication details (authors, year, title, source); study characteristics (design, sample, location); key findings; methodological strengths/limitations; and implications for policy/practice. For quantitative studies, specific data points (prevalence rates, compliance percentages,

economic estimates) were extracted where available.

The analysis followed a thematic synthesis approach, combining both deductive (theory-driven) and inductive (data-driven) elements. Initial coding was guided by a conceptual framework adapted from the World Health Organization's Building Blocks for Food Safety Systems [10], encompassing: (1) policy and regulatory frameworks; (2) institutional structures and coordination mechanisms; (3) inspection and compliance systems; (4) laboratory capacity and surveillance; (5) risk communication and community engagement; and (6) human and financial resources. As analysis progressed, additional themes emerged from the data, leading to refinement of the coding framework. Quality assessment of included studies considered appropriateness of design, methodological rigor, and relevance to review questions, though no studies were excluded based solely on quality assessment given the review's comprehensive nature.

2.3. Limitations of the Review Methodology

Several limitations should be acknowledged. First, publication bias may exist, with successful interventions more likely to be documented and published than unsuccessful ones. Second, the heterogeneity of study designs, methods, and outcome measures limited direct comparability across studies. Third, the review likely underrepresents certain perspectives,

particularly those of small-scale actors in the informal sector whose experiences may be less documented in formal literature. Fourth, the rapidly evolving policy landscape means some findings may become dated as new initiatives are implemented. Despite these limitations, the review provides the most comprehensive synthesis to date of evidence on Ethiopia's food quality management system, with explicit acknowledgment of evidence gaps and areas requiring further research.

3. Governance and Policy Framework

3.1. Institutional Architecture and Mandates

Ethiopia's food safety governance involves a complex network of institutions with overlapping and sometimes competing mandates. The Ethiopian Food and Drug Authority (EFDA), established under Proclamation 1112/2019, serves as the primary regulatory agency with responsibility for "ensuring the safety, quality and efficacy of food, medicine and other health commodities" [11]. EFDA operates under the Ministry of Health and maintains a headquarters in Addis Ababa with eight regional branch offices. The authority's structure includes directorates for food safety and nutrition, medicine and other health products, laboratory services, and regulatory compliance.

Table 1. Key Institutions in Ethiopia's Food Safety Governance System.

Institution	Primary Mandate	Key Legislation/Authority	Main Food Safety Activities
Ethiopian Food and Drug Authority (EFDA)	Overall regulation of food safety	Proclamation 1112/2019	Licensing, inspection, standard setting, risk assessment, outbreak investigation
Ministry of Agriculture	Agricultural production and animal health	Rural Land Administration Proclamation; Animal Diseases Proclamation	Veterinary services, pesticide regulation, irrigation water quality
Ministry of Trade and Regional Integration	Domestic and international trade	Trade Practice Proclamation	Market surveillance, trade standard enforcement
Regional Health Bureaus	Domestic and international trade	Trade Practice Proclamation	Market surveillance, trade standard enforcement

Beyond EFDA, multiple sectoral ministries play significant roles in food safety management:

Ministry of Agriculture oversees food safety at the production level, including veterinary public health, pesticide regulation, and irrigation water quality.

Ministry of Trade and Regional Integration regulates food standards in commercial exchanges and oversees commodity exchanges that include food products.

Ministry of Industry is involved in standards development for processed foods and support to food industries.

Ethiopian Standards Agency (ESA) develops voluntary and

mandatory standards for various products including food.

National Metrology Institute ensures measurement accuracy in food testing and trade.

3.2. Policy Framework Evolution

Ethiopia's food safety policy framework has evolved significantly over the past two decades. The foundation is established in the 1995 Constitution, which in Article 44 states that "All persons have the right to a clean and healthy environment" and specifically mentions environmental health and

food safety as state responsibilities [12]. Building on this constitutional foundation, several key policy instruments have been developed:

National Food and Nutrition Policy (2018): This comprehensive policy adopted a multi-sectoral approach to addressing malnutrition, with food safety identified as a key component. The policy emphasizes the importance of safe food for nutritional outcomes and establishes principles for risk-based regulation, stakeholder engagement, and alignment with international standards [13].

Food and Medicine Administration Proclamation (1112/2019): This legislation provides the legal basis for EFDA's operations, outlining its powers regarding licensing, inspection, standard-setting, and enforcement. The proclamation introduced several modern regulatory concepts including risk-based inspection, product traceability requirements, and provisions for emergency control measures [11].

National Food Safety Management Plan (2025-2029): Currently in final development stages, this five-year strategic plan represents the most ambitious effort to date to create a coherent, integrated food safety system. The plan is organized around five strategic pillars: (1) strengthening governance and coordination; (2) enhancing foodborne disease surveillance and response; (3) improving food safety along value chains; (4) building scientific capacity and infrastructure; and (5) promoting food safety culture through communication and education [8].

One Health Strategic Framework (2023-2027): Recognizing the interconnectedness of human, animal, and environmental health, this framework establishes mechanisms for collaboration between the health, agriculture, and environment sectors on issues including zoonotic diseases and antimicrobial resistance in the food chain [14].

Despite this progressive policy development, implementation has faced significant challenges. A 2022 assessment found that while 85% of food safety policies were rated as "adequate" in content, only 35% were fully implemented, with resource constraints, capacity gaps, and coordination problems cited as major barriers [15].

3.3. Legislative and Regulatory Instruments

The regulatory framework for food safety in Ethiopia consists of multiple layers of legislation, from proclamations (primary legislation) to regulations (secondary legislation) to directives and guidelines (operational documents). This complex regulatory environment presents challenges for both regulators and regulated entities.

Key legislative instruments include:

Food and Medicine Administration Proclamation (1112/2019): The cornerstone legislation establishing EFDA's mandate and powers.

Standardization Proclamation (102/1998): Establishes the Ethiopian Standards Agency and provides for the development of mandatory and voluntary standards.

Trade Practice Proclamation (685/2010): Regulates unfair trade practices including adulteration and mislabeling of food products.

Animal Diseases Proclamation (267/2002): Provides for control of animal diseases including those transmissible through food.

Plant Protection Proclamation (128/1998): Regulates pesticides and plant pests that may affect food safety.

At the operational level, EFDA has developed numerous regulations and guidelines covering specific aspects of food safety, including:

Food Hygiene and Safety Regulation (2021)

Food Labeling Regulation (2020)

Food Additives Regulation (2019)

Maximum Limits for Contaminants in Food Regulation (2021)

However, regulatory alignment remains a challenge. A 2021 analysis identified 17 instances of conflicting requirements between different food safety regulations, particularly regarding inspection frequencies, sampling protocols, and permissible limits for contaminants [16]. Furthermore, many regulations are developed with limited consultation with small-scale food businesses that constitute the majority of the sector, resulting in requirements that are impractical or impossible for these operators to meet.

3.4. Coordination Mechanisms and Challenges

Effective food safety governance requires coordination across multiple sectors and levels of government. Ethiopia has established several formal coordination mechanisms:

National Food Safety Steering Committee: Established in 2020 and chaired by the Ministry of Health, this high-level committee brings together representatives from all relevant ministries to provide strategic direction and resolve inter-sectoral issues [17].

One Health National Food Safety Technical Working Group: Operating under the National Food Safety Steering Committee, this technical body focuses specifically on zoonotic diseases and antimicrobial resistance issues at the human-animal-food interface [14].

Regional Food Safety Task Forces: Established in most regions, these task forces coordinate implementation at sub-national levels, though their effectiveness varies considerably across regions.

Despite these structures, coordination remains a persistent challenge. A 2023 study of food safety governance in four regions found that only 30% of planned inter-sectoral meetings actually occurred, joint inspection activities represented less than 5% of total inspections, and information sharing between agencies was largely informal and inconsistent [18]. The study identified several underlying factors: competing institutional priorities, budget silos, unclear protocols for collaboration, and limited accountability for coordination outcomes.

The federal structure of Ethiopia adds another layer of complexity to coordination. While EFDA sets national standards and policies, implementation is primarily the responsibility of regional health bureaus and lower administrative levels (zones, woredas, kebeles). This decentralization can lead to variations in interpretation and enforcement of regulations. Some regions have developed their own supplementary guidelines, creating a patchwork of requirements that complicates compliance for businesses operating in multiple regions [19].

4. Food Safety Along Value Chains

4.1. Production-level Challenges and Practices

Food safety risks originate at the production level, where practices related to soil management, water use, animal husbandry, and pesticide application can introduce hazards that persist throughout the value chain. In Ethiopia's predominantly smallholder farming system (approximately 12 million smallholder farms), food safety knowledge and practices vary considerably.

Fresh Produce Production: Vegetable and fruit production, particularly in peri-urban areas, often involves the use of contaminated irrigation water. Studies in the Central Rift Valley found that 65-80% of irrigation water samples from rivers and lakes used for vegetable production contained fecal coliform levels exceeding WHO guidelines for irrigation water [20]. The use of untreated wastewater is common in some areas, driven by water scarcity and limited alternatives. Pesticide misuse represents another significant concern, with studies

documenting: application of banned or restricted pesticides (particularly in the Ethiopian floriculture sector's potential spillover effects), insufficient pre-harvest intervals, and inadequate personal protective equipment use by 70-85% of smallholder farmers [21]. Post-harvest handling practices also introduce risks, with vegetables often placed directly on the ground, transported in contaminated vehicles, and stored at ambient temperatures that promote microbial growth.

Animal-Source Food Production: Livestock production systems range from pastoralist systems in lowland areas to intensive dairy production around urban centers. Food safety concerns include: zoonotic diseases (brucellosis prevalence of 2-6% in cattle nationally, higher in pastoral systems), antimicrobial residues (with 15-30% of milk samples in some studies containing antibiotic residues above maximum limits), and microbial contamination from poor animal health and hygiene [22, 23]. Traditional slaughter practices, particularly during religious festivals, often occur outside approved facilities with minimal hygiene controls. A study of informal slaughter in Addis Ababa found that 40% of meat samples were contaminated with *E. coli*, and 12% with *Salmonella* species [24].

Cereal and Pulse Production: Mycotoxin contamination represents the primary food safety concern for staple grains. Aflatoxin contamination is widespread, with studies finding that 30-60% of maize and groundnut samples exceed Ethiopian standards (10 ppb total aflatoxins) [25]. Contamination occurs both pre-harvest (through fungal infection of crops) and post-harvest (through improper drying and storage). Climate variability and changing rainfall patterns may be increasing mycotoxin risks in some regions.

Table 2. Key Food Safety Hazards at Production Level in Ethiopia.

Commodity Group	Primary Hazards	Prevalence/Indicators	Main Contributing Factors
Fresh Vegetables	Microbial pathogens (<i>E. coli</i> , <i>Salmonella</i>), pesticide residues	65-80% of irrigation water contaminated; 30-50% of produce with unacceptable pesticide residues	Contaminated irrigation water, pesticide misuse, poor worker hygiene
Animal Products	Zoonotic pathogens (<i>Brucella</i> spp., <i>Salmonella</i>), antimicrobial residues	2-6% brucellosis seroprevalence in cattle; 15-30% of milk with antibiotic residues	Inadequate animal healthcare, improper drug use, poor slaughter hygiene
Cereals & Pulses	Mycotoxins (aflatoxins, fumonisins)	30-60% of maize/groundnuts exceed aflatoxin standards	Pre-harvest fungal infection, improper drying and storage
Dairy Products	Microbial pathogens, antibiotic residues, adulterants	40-70% of raw milk with high bacterial counts; 10-20% adulterated with water	Lack of cooling, unhygienic handling, intentional adulteration

4.2. Processing and Transformation

Food processing in Ethiopia occurs across a spectrum from

traditional home-based methods to modern industrial operations. Each presents distinct food safety challenges and opportunities.

Traditional Processing Methods: These methods, used by

millions of households and small-scale enterprises, include fermentation (injera, kocho), drying (meat, grains), and milling. While some traditional processes enhance safety (fermentation can reduce pathogens), inadequate controls can introduce risks. For example, traditional drying of meat and fish on open racks exposes products to insects, dust, and microorganisms. Traditional fermentation vessels may not be properly cleaned between batches, leading to cross-contamination. A study of traditional dairy processing found that 45% of traditionally fermented milk (ergo) samples contained *Staphylococcus aureus*, with 15% producing enterotoxins [26].

Small and Medium Enterprises (SMEs): The growing SME sector includes bakeries, pasta manufacturers, juice processors, and dairy processors. These enterprises often struggle with food safety management due to limited technical knowledge, inadequate infrastructure, and cost constraints. A survey of 150 food processing SMEs in Addis Ababa, Hawassa, and Bahir Dar found that only 35% had formal food safety plans, 25% conducted regular testing of products, and less than 20% had employees with formal food safety training [27]. Common deficiencies included inadequate temperature control, poor equipment sanitation, and insufficient pest control.

Large-Scale Industrial Processing: Industrial processors, particularly those exporting or supplying supermarkets, generally have better food safety systems. Many have implemented Hazard Analysis Critical Control Point (HACCP) systems and achieved international certifications (ISO 22000, BRC, IFS). However, even in these facilities, challenges persist, including: reliance on raw materials from smallholder suppliers with variable safety standards, high staff turnover requiring continuous training, and infrastructure limitations such as intermittent power supply affecting refrigeration.

Emerging Processing Technologies: Several promising technologies could enhance food safety in Ethiopian processing, including:

- Ultraviolet (UV) treatment for water disinfection and surface decontamination.

- Modified atmosphere packaging to extend shelf life of perishable products.

- Biocontrol agents for mycotoxin reduction in grains.

- Rapid testing kits for onsite quality monitoring.

However, adoption of these technologies remains limited due to cost, technical complexity, and lack of awareness.

4.3. Distribution, Transportation, and Storage

The "middle segment" of value chains—transportation, storage, and wholesale—represents a critical but often neglected component of food safety management in Ethiopia. Unlike production and retail, these activities receive limited regulatory attention despite their importance in maintaining food quality and safety.

Transportation Systems: Food transportation occurs through diverse means: human portage, animal transport, non-refrigerated trucks, and occasionally refrigerated vehicles

for high-value products. A study of vegetable transportation from rural farms to Addis Ababa found multiple risk points: produce loaded directly onto truck beds (85% of cases), mixing with non-food items (40%), extended transit times without temperature control (average 8 hours for leafy vegetables), and inadequate cleaning of transport containers (<10% cleaned between loads) [28]. For animal products, the lack of dedicated livestock transport vehicles means animals are often transported in the same vehicles used for other goods, increasing contamination risks.

Storage Infrastructure: Storage limitations contribute significantly to post-harvest losses and safety deterioration. Key issues include:

- Ambient temperature storage:** The norm for most commodities, allowing microbial growth and insect infestation.

- Inadequate warehouse management:** Poor stock rotation, pest infestation, and moisture control problems.

- Limited cold chain:** Particularly critical for perishable products. Ethiopia has approximately 15,000 cubic meters of public cold storage capacity, concentrated in Addis Ababa and a few regional capitals, far below estimated needs [29].

- Traditional grain storage:** Often ineffective against insects and moisture, contributing to mycotoxin formation.

- Market Infrastructure:** Wholesale and retail markets, where most food exchanges occur, generally lack basic food safety infrastructure. A 2022 assessment of 50 major markets across Ethiopia found: 65% lacked potable water points, 80% had inadequate drainage, 90% had insufficient waste management systems, and only 5% had temperature-controlled storage areas [30]. These infrastructure deficits create environmental conditions that promote contamination and rapid spoilage.

4.4. Retail and Food Service Sector

The retail and food service sector represents the final point of control before food reaches consumers. In Ethiopia, this sector is dominated by informal and small-scale operators, presenting unique food safety management challenges.

Informal Retail Sector: This includes open-air markets, roadside vendors, and small neighborhood shops (souks). These outlets handle approximately 80% of food retail in urban areas [4]. Common food safety issues include: exposure of uncovered food to dust and insects (observed in 70-90% of informal vendors), inadequate temperature control for perishables (affecting 60-80% of vendors), use of contaminated water for washing or preparation (40-60% of vendors), and poor personal hygiene among handlers (only 20-30% observed washing hands at critical times) [31]. Regulatory oversight of informal vendors is limited due to their mobility, large numbers, and economic importance as livelihood sources.

Formal Retail Sector: Supermarkets and grocery stores, while representing a small portion of the market (approximately 5% of food retail in Addis Ababa), are growing rapidly. These establishments generally have better infrastructure and

management systems but face their own challenges: maintaining cold chains with intermittent electricity, ensuring supplier compliance, and managing staff turnover. A study of 30 supermarkets in Addis Ababa found that while 80% had refrigeration equipment, only 45% monitored temperatures regularly, and 60% had no formal supplier approval process [32].

Food Service Establishments: This category ranges from five-star hotels to street food vendors. Street foods are particularly important for urban food security, providing affordable meals to millions daily. However, studies consistently show high levels of microbial contamination in street foods. Research in Hawassa found that 50% of ready-to-eat street foods contained *E. coli*, and 20% contained *Salmonella* species [33]. Contributing factors include: inadequate cooking/reheating, cross-contamination from raw to cooked foods, prolonged holding at unsafe temperatures, and use of contaminated water. Formal food service establishments (restaurants, hotels) generally perform better but still show significant gaps in food safety management systems.

Emerging Retail Models: New retail formats are emerging that may influence food safety practices:

Online food delivery platforms: Growing in major cities, creating new challenges for maintaining food safety during delivery.

Specialty stores and organic markets: Catering to higher-income consumers, often emphasizing food safety as a marketing point.

Shopping malls with integrated food courts: Introducing new food service models with centralized management.

5. Key Challenges and Constraints

5.1. Regulatory and Institutional Constraints

The translation of food safety policy into effective practice faces multiple regulatory and institutional barriers that collectively undermine system performance.

Fragmented Legal Framework: As noted earlier, food safety regulation in Ethiopia involves multiple laws and regulations administered by different agencies. This fragmentation creates confusion for both regulators and regulated entities. A business operating in the food sector may need licenses or approvals from 4-5 different agencies, each with separate requirements, processes, and timelines [34]. The costs and complexities of compliance disproportionately affect small and medium enterprises, potentially driving them further into informality.

Capacity Limitations in Regulatory Agencies: Regulatory bodies at all levels face significant capacity constraints:

Human resources: EFDA has approximately 500 staff nationwide, with only about 150 dedicated to food safety functions—clearly inadequate for regulating a food system serving 120 million people [35]. Regional and local health departments, which bear primary responsibility for inspection, are similarly understaffed.

Technical expertise: Many inspectors lack specialized training in food science, risk assessment, or modern inspection techniques. A 2022 assessment found that only 40% of food inspectors had received any formal food safety training beyond basic orientation [36].

Operational resources: Inspectors often lack basic equipment (thermometers, sampling kits, transport) needed for effective oversight. Budget allocations for food safety are limited, with most resources directed to salaries rather than operational activities.

Inconsistent Enforcement Practices: Enforcement approaches vary considerably across regions and even among individual inspectors. Factors contributing to inconsistency include: ambiguous regulations open to interpretation, limited supervision and quality control of inspection activities, and the influence of personal relationships or corruption in some instances. A study of inspection practices in three regions found that similar establishments received different ratings and recommendations from different inspectors, undermining the credibility of the regulatory system [37].

Limited Use of Risk-Based Approaches: Most food safety regulation in Ethiopia follows a compliance-based model with uniform requirements applied to all establishments regardless of their risk profile. This approach inefficiently allocates limited regulatory resources, focusing equal attention on high-risk and low-risk establishments. While EFDA's strategic plan emphasizes risk-based regulation, implementation remains limited due to lack of risk data, technical capacity, and information systems to support risk categorization [8].

5.2. Economic and Market Constraints

Economic factors significantly influence food safety outcomes, creating both supply-side and demand-side constraints.

Cost of Compliance: For food businesses, implementing food safety measures involves direct costs (equipment, testing, certification) and indirect costs (training, documentation, management time). These costs represent a particular burden for small enterprises operating on thin margins. A study of dairy processors found that implementing basic food safety improvements would increase production costs by 15-25%, potentially making products unaffordable for many consumers [38]. Without mechanisms to share these costs or reward compliance (through price premiums or market access), businesses have limited incentive to invest in safety.

Informality and Its Implications: The predominance of informal food businesses presents multiple challenges for food safety management. Informal operators typically: operate without registration or licenses, making them difficult to monitor; have limited access to formal training and support services; lack stable business premises, hindering infrastructure improvements; and prioritize daily survival over long-term investments in safety. Yet efforts to enforce formalization without providing viable alternatives can negatively impact food security and livelihoods, creating policy dilemmas.

Market Structure and Incentives: Ethiopia's food markets generally do not provide adequate economic rewards for food safety. Several factors contribute to this:

Low consumer willingness to pay:

Limited product differentiation: In informal markets, food is often sold in bulk without branding or labeling that could communicate safety attributes.

Short value chains: Many products move directly from producer to consumer, reducing the number of intermediaries who might enforce quality standards.

Seasonal glut and scarcity: Fluctuations in supply lead to variable quality standards, with lower standards often accepted during scarcity periods.

Trade-Offs Between Safety and Other Attributes: Food safety sometimes conflicts with other valued food attributes. For example, traditional fermentation processes that enhance flavor may not achieve complete pathogen reduction. Sun-drying that preserves food without energy costs exposes products to environmental contamination. Traditional slaughter methods that have cultural or religious significance may not meet modern hygiene standards. Navigating these trade-offs requires approaches that respect cultural practices while managing risks.

5.3. Infrastructure and Technological Gaps

Inadequate physical infrastructure represents a fundamental constraint on food safety improvement across the value chain.

Cold Chain Deficits: Maintaining temperature control is essential for many perishable foods, yet Ethiopia's cold chain infrastructure remains underdeveloped. Key gaps include:

Pre-cooling facilities: Lacking at most production sites, leading to field heat accelerating deterioration.

Refrigerated transport: Limited availability, with most perishables transported at ambient temperatures.

Cold storage: Insufficient capacity, particularly at wholesale markets and retail levels.

Last-mile refrigeration: Most small retailers and households lack refrigeration.

The economic implications are substantial. Post-harvest losses for perishable commodities are estimated at 30-50%, with safety deterioration contributing significantly to these losses [39]. Beyond economic losses, temperature abuse allows proliferation of pathogens like *Salmonella* and *Listeria* in high-risk products.

Water and Sanitation Infrastructure: Access to safe water and adequate sanitation is fundamental to food safety, yet significant gaps persist:

Only 52% of the population has access to basic drinking water services, with urban-rural disparities (93% urban vs. 42% rural) [40].

Food businesses, particularly in markets, often lack dedicated water points, leading to use of potentially contaminated water.

Handwashing facilities with soap are unavailable in most

food handling settings.

Waste management systems in markets and food business areas are generally inadequate.

Energy Infrastructure: Unreliable electricity supply affects food safety in multiple ways: disrupting cold chains, limiting use of electrical equipment for processing, and forcing reliance on alternative fuels that may produce contaminants. Power outages occur regularly even in major cities, with rural areas experiencing more frequent and prolonged outages.

Laboratory Capacity: Effective food safety management requires laboratory testing for monitoring, surveillance, and compliance verification. Ethiopia's food testing capacity faces several limitations:

Geographic concentration: Most testing capacity is in Addis Ababa, with limited capability at regional levels.

Equipment and reagent shortages: Many laboratories lack essential equipment or cannot maintain it due to budget constraints.

Technical expertise: Shortage of trained food microbiologists and chemists.

Accreditation: Few laboratories have international accreditation, limiting recognition of test results.

A 2021 assessment found that Ethiopia has approximately 15 public food testing laboratories with a total capacity of about 50,000 tests annually—far below estimated needs for a country of its size and complexity [41].

5.4. Knowledge, Attitude, and Practice Gaps

Human factors—the knowledge, attitudes, and practices of all actors in the food system—fundamentally shape food safety outcomes. Significant gaps exist at all levels.

Food Handler Knowledge and Practices: Those who directly handle food—farmers, processors, transporters, vendors, cooks—often lack essential food safety knowledge. Studies consistently show:

Limited understanding of microbial hazards and cross-contamination concepts.

Inadequate knowledge of temperature control requirements.

Poor personal hygiene practices, particularly handwashing at critical times.

Belief in traditional practices that may not effectively control hazards.

Training programs for food handlers exist but reach only a small fraction of the estimated 5-7 million people working in food-related occupations in Ethiopia [42]. Most training occurs in formal establishments, with informal sector workers having limited access.

Management and Leadership Awareness: Owners and managers of food businesses play a crucial role in establishing food safety culture and allocating resources. However, many prioritize immediate economic concerns over safety investments. A survey of 200 food business managers found that only 35% considered food safety a "high priority," while 60% viewed it as "important but secondary to other concerns" like

cost reduction and customer acquisition [43].

Regulator and Extension Agent Capacity: As noted earlier, regulatory staff often lack specialized food safety expertise. Similarly, agricultural extension agents, who interact with millions of smallholder farmers, receive minimal training on food safety aspects of production. The public health workforce, including health extension workers (HEWs), has broader health training but limited focus on food-specific risks.

Educational System Gaps: Formal education systems provide limited food safety education. Few secondary schools include food safety in curricula, and university programs in agriculture, health, and food science often provide theoretical knowledge with limited practical application. Technical and vocational education (TVET) programs for food-related trades exist but vary in quality and coverage.

6. Consumer Perspectives and Market Dynamics

6.1. Consumer Knowledge, Attitudes, and Practices

Consumer behavior represents both a determinant of and response to food safety risks. Understanding consumer perspectives is essential for designing effective interventions.

Awareness and Knowledge Levels: Studies indicate moderate to high awareness of food safety concepts among Ethiopian consumers, but with significant knowledge gaps. In urban areas, 70-85% of consumers report awareness of foodborne illnesses and basic hygiene principles [44]. However, understanding of specific hazards is limited—few consumers can name common foodborne pathogens or identify high-risk foods. There is particular confusion between food quality attributes (freshness, appearance) and safety attributes (microbiological safety, chemical contaminants). Many consumers equate "clean" appearance with safety, underestimating risks from invisible hazards like microbes or toxins.

Risk Perception: Consumer perceptions of food risks do not always align with scientific risk assessments. Several patterns emerge from research:

High concern about chemical hazards: Consumers express greater concern about pesticide residues and food additives than microbial risks, despite microbial pathogens causing more documented illness.

Trust in familiar sources: Food from familiar vendors or traditional sources is perceived as safer, regardless of actual hygiene practices.

Minimization of personal risk: Many consumers believe they can control risks through household practices like washing and cooking, reducing perceived need for assurance earlier in the chain.

Varying concern by food type: Meat and dairy products generate higher safety concerns than fruits and vegetables.

Purchasing Behaviors and Decision Factors: When making

food purchases, safety is rarely the primary consideration for most Ethiopian consumers. Studies across multiple cities consistently find the following hierarchy of decision factors:

Price (primary factor for 70-85% of consumers)

Freshness/appearance (important for 60-75%)

Taste/preference (important for 50-65%)

Convenience/accessibility (important for 40-55%)

Safety/hygiene (primary factor for only 15-25%) [45]

This hierarchy reflects economic constraints (most consumers have limited food budgets), cultural factors (strong preferences for certain tastes and textures), and practical considerations (limited time for food acquisition and preparation).

Household Food Handling Practices: Practices within households can either mitigate or amplify food safety risks. Common practices include:

Washing: Nearly universal for fruits and vegetables, but often with contaminated water or inadequate methods.

Cooking: Generally thorough for meat and legumes, but some traditional dishes involve minimal cooking.

Storage: Limited refrigeration leads to short storage times for perishables, but also means foods are often held at unsafe temperatures.

Reheating: Variable practices, with some consumers reheating foods inadequately.

A study of household food handling in Addis Ababa found that while 90% of households washed vegetables, only 30% used treated water or disinfectants, and only 40% separated raw and cooked foods during preparation [46].

6.2. Market Signals and Economic Incentives

Market mechanisms play a crucial role in shaping food safety outcomes by creating (or failing to create) economic incentives for safer production and handling.

Price Premiums for Safety: In theory, markets should reward safer products with price premiums. In practice, such premiums are limited in most Ethiopian food markets due to:

Information asymmetry: Consumers cannot easily verify safety claims, reducing willingness to pay premiums.

Commodity nature of most foods: Unbranded, undifferentiated products dominate markets.

Income constraints: Many consumers cannot afford to pay more even if they value safety.

Trust deficits: Consumers may not believe safety claims from unfamiliar sources.

Exceptions exist in niche markets (organic products, certain branded items) and for specific consumer segments (higher-income, expatriate, or health-conscious consumers). For example, pasteurized milk from formal processors commands a 30-50% price premium over raw milk in Addis Ababa, though it represents less than 20% of the market [47].

Certification and Labeling Systems: Various certification and labeling approaches attempt to communicate safety attributes to consumers:

Mandatory labeling: Required for certain products (nutritional labeling for packaged foods, expiration dates) but enforcement is limited.

Voluntary certification: Includes organic certification, HACCP certification for processors, and various quality marks. These primarily serve export markets or high-end domestic markets.

Informal signals: Vendors may use visual cues (clean appearance, white coats) or verbal assurances to signal safety.

Effectiveness of these systems is limited by low consumer awareness of certification meanings, counterfeit labels, and the additional costs of certification for producers.

Market Segmentation: Ethiopia's food markets are increasingly segmented by safety standards:

Export markets: Subject to stringent international standards, with dedicated supply chains.

Formal domestic markets (supermarkets, hotels, institutions): Moderate standards, some quality requirements.

Informal markets: Minimal standards, price-driven competition.

This segmentation creates a "two-tier" system where resources and attention focus on higher-value segments, potentially neglecting the majority of consumers who rely on informal markets.

Role of Intermediaries and Collectors: In longer value chains, intermediaries (collectors, wholesalers, processors) can enforce standards through specifications and rejection of substandard products. However, their effectiveness varies. In the dairy sector, milk collection centers often test for adulteration and reject visibly contaminated milk. In the vegetable sector, collectors typically prioritize appearance over microbiological quality. Strengthening the capacity and incentives for intermediaries to enforce safety standards represents a potential leverage point for improvement.

6.3. Communication and Education Strategies

Effective risk communication and consumer education are essential components of a food safety system, yet receive limited attention and resources in Ethiopia.

Existing Communication Channels: Food safety messages reach consumers through various channels:

Mass media: Occasional programs on radio and television, particularly during disease outbreaks.

Health extension workers: 40,000 HEWs nationwide provide community health education, including some food safety messages.

Schools: Limited inclusion in health education curricula.

Food businesses: Some provide basic information to customers.

Social networks: Word-of-mouth and community leaders influence perceptions and practices.

However, these channels are rarely coordinated or based on systematic communication strategies. Messages often emphasize knowledge transfer rather than behavior change, and

rarely address the practical constraints consumers face.

Effective Communication Principles: Research suggests several principles for more effective food safety communication in the Ethiopian context:

Use trusted messengers: Health professionals, religious leaders, and respected community members are more credible than government officials alone.

Address practical constraints: Acknowledge economic limitations and suggest feasible improvements.

Use positive framing: Emphasize benefits (health, pride in clean food) rather than just risks.

Leverage social norms: Highlight that "most careful people" practice certain behaviors.

Provide specific, actionable guidance: Rather than "be clean," demonstrate proper handwashing technique.

Innovative Approaches: Several innovative communication approaches show promise:

Entertainment-education: Incorporating food safety messages into popular media (drama, music).

Mobile technology: Using SMS or apps to deliver timely information (e.g., alerts about contaminated products).

Market-based communication: Visual cues at point of purchase (color-coded hygiene ratings, simple icons).

Participatory methods: Community dialogue and co-creation of solutions rather than top-down messaging.

Education in Formal Systems: Integrating food safety into educational curricula at multiple levels could have long-term impacts. Potential approaches include:

Primary schools: Basic hygiene and safe food handling.

Secondary schools: Food science and safety concepts.

Universities: Specialized programs in food safety and regulation.

Vocational training: Food safety modules for food handlers and inspectors.

7. Innovations and Promising Approaches

7.1. Technological Innovations

Technology offers promising solutions to longstanding food safety challenges in Ethiopia, particularly when adapted to local contexts and constraints.

Digital Solutions for Traceability and Compliance:

Blockchain-based traceability: Pilot projects in the coffee and spice sectors demonstrate potential for enhancing transparency and verifying safety claims. For example, a partnership between Ethiopian coffee cooperatives and European buyers uses QR codes to provide consumers with information about production practices [48].

Mobile inspection applications: EFDA has piloted tablet-based inspection systems that standardize assessment criteria, generate digital reports, and facilitate data analysis. Early results show improved consistency and efficiency compared to

paper-based systems [49].

Online licensing and reporting portals: EFDA's i-Register system allows businesses to apply for licenses online, reducing face-to-face interactions and potential corruption. Similar systems for reporting foodborne illnesses or complaints are under development.

Low-Cost Sensing and Testing Technologies:

Paper-based sensors: Emerging technologies allow detection of contaminants (like aflatoxins or pathogens) using paper strips and simple readers, potentially enabling testing at farm or market level.

Mobile phone-based detection: Researchers are developing attachments that allow smartphones to function as microscopes or spectrophotometers for basic food testing.

Internet of Things (IoT) sensors: Low-cost temperature and humidity sensors with GSM connectivity can monitor cold chain integrity, sending alerts when conditions deviate from safe ranges.

Processing and Preservation Technologies:

Solar-powered cold storage: Modular cold rooms powered by solar energy address both energy access and cold chain gaps, particularly in off-grid areas. Pilot projects for fruits, vegetables, and dairy show 40-60% reduction in post-harvest losses [50].

Ultraviolet and ozone treatment: Small-scale systems for water disinfection and surface decontamination in processing facilities.

Modified atmosphere packaging: Locally produced packaging that extends shelf life of perishable products using gas mixtures.

Digital Platforms for Knowledge Sharing:

Mobile learning applications: Providing food safety training to handlers and inspectors via smartphones, with interactive content and assessments.

Expert networks: Platforms connecting food businesses with technical experts for remote consultation.

Data dashboards: Visualizing food safety inspection data, test results, and disease surveillance information to support decision-making.

7.2. Institutional and Business Model Innovations

Beyond technology, innovative approaches to organizing food systems show promise for improving food safety outcomes.

Collective Action and Farmer Organizations:

Producer cooperatives: When effectively organized, cooperatives can implement collective food safety measures, achieve economies of scale in testing and certification, and enhance bargaining power with buyers. The success of dairy cooperatives in implementing milk quality testing demonstrates this potential [51].

Contract farming arrangements: Formal agreements between processors and farmers that include specific quality and

safety requirements, with technical support and premium prices for compliance.

Geographical indications: Protecting and promoting products from specific regions (like Ethiopian coffee or teff) can incentivize collective quality management to protect brand reputation.

Public-Private Partnerships (PPPs):

Shared infrastructure: Joint investment in facilities like testing laboratories, cold storage, or training centers that serve multiple businesses.

Co-regulation approaches: Industry associations developing and enforcing standards with government oversight, potentially more efficient than pure government regulation.

Joint training initiatives: Government and private sector collaborating on workforce development programs.

Market-Based Approaches to Regulation:

Differentiated licensing: Tiered systems with graduated requirements based on business size and risk, lowering barriers for small operators while maintaining standards for larger ones.

Hygiene rating schemes: Public display of inspection results (like letter grades or smiley faces) that inform consumer choice and create market incentives for improvement.

Insurance products: Linking food safety compliance to reduced insurance premiums for businesses.

Informal Sector Integration Strategies:

Designated vending zones: Providing informal vendors with improved infrastructure (water, waste disposal, shelter) in exchange for compliance with basic hygiene standards.

Progressive formalization: Stepwise pathways from informality to formality, with support at each stage.

Vendor associations: Strengthening collective voice and self-regulation within informal sectors.

7.3. Successful Interventions and Case Studies

Several specific interventions in Ethiopia demonstrate what is possible with well-designed, context-appropriate approaches to food safety improvement.

Dairy Safety Improvement Program (DSIP): Implemented in the Oromia and SNNP regions from 2018-2022, this program combined training of smallholder dairy farmers, establishment of milk collection centers with testing capacity, and consumer education campaigns. Key outcomes included: 40% reduction in bacterial counts in milk at collection points, 25% increase in farmer income due to reduced spoilage and premium prices, and 30% increase in consumer confidence in dairy products [52]. The program's success factors included: engaging farmers as partners rather than targets, integrating technical solutions with market incentives, and adapting international standards to local realities.

Addis Ababa Market Hygiene Initiative: Launched in 2021, this city-wide program focused on improving infrastructure and practices in 10 major markets. Interventions included: installation of water points and handwashing stations, waste

management systems, vendor training, and a public hygiene rating system. After two years, observational studies showed: 60% reduction in visible contamination in market areas, 40% increase in vendor handwashing at critical times, and significant improvements in consumer perceptions of market hygiene [53]. The initiative demonstrated the importance of municipal leadership, integrated approaches addressing multiple factors simultaneously, and sustained engagement with vendor associations.

School-Based Food Safety Education Program: Implemented in 50 schools in the Amhara region, this program integrated food safety into existing health education, trained teachers, engaged parents, and established school gardens as practical learning sites. Evaluation after three years showed: significant improvements in student knowledge and reported home practices, reduction in absenteeism due to gastrointestinal illness (18% decrease compared to control schools), and spillover effects as students influenced family behaviors [54]. The program highlighted the potential of schools as multipliers for food safety messages and the importance of practical, experiential learning approaches.

Digital Food Safety Monitoring in Export Value Chains: Several Ethiopian export companies (in coffee, spices, and cut flowers) have implemented digital traceability systems to meet international buyer requirements. These systems use mobile data collection at farm level, barcoding for tracking through processing, and online platforms for buyer access to information. Beyond meeting export requirements, these systems have enabled companies to: identify and address contamination sources more quickly, provide technical feedback to farmers, and differentiate their products in competitive markets [55]. While focused on export sectors, these approaches offer lessons for domestic value chains as digital costs decrease and capabilities increase.

8. International Perspectives and Comparative Analysis

8.1. Regional Context and Comparisons

Ethiopia's food safety challenges and approaches must be

understood within the broader East African context, where countries face similar constraints while developing diverse strategies.

Kenya: Often considered a regional leader in food safety governance, Kenya has established the Kenya Bureau of Standards (KEBS) and developed relatively strong inspection systems, particularly for formal sector and export products. Kenya's approach emphasizes public-private partnerships and has made significant investments in laboratory capacity. However, like Ethiopia, Kenya struggles with the informal sector, which supplies most food to low-income populations [56]. Kenya's experience with street food vendor associations that implement self-regulation offers potential lessons for Ethiopia.

Tanzania: Tanzania's food safety system is characterized by even greater fragmentation than Ethiopia's, with responsibilities divided among multiple ministries without a clear lead agency. Tanzania has experimented with community-based approaches, training local health committees to conduct basic food safety monitoring in rural areas where government reach is limited [57]. These decentralized, community-engaged models may offer insights for Ethiopia's extensive rural areas.

Rwanda: Rwanda has pursued an ambitious centralization and digitization strategy, establishing the Rwanda Food and Drugs Authority (RFDA) with strong political backing. Rwanda's use of technology for regulation—including mobile reporting systems and centralized databases—has improved efficiency but faces challenges of limited stakeholder consultation and adaptability to local contexts [58]. Rwanda's experience highlights both the potential and limitations of top-down, technology-driven approaches.

Uganda: Uganda maintains separate agencies for food (Uganda National Bureau of Standards) and drug regulation, creating coordination challenges similar to Ethiopia's pre-EFDA structure. Uganda has developed innovative approaches to reaching small-scale processors through mobile testing units and simplified standards [59]. Their experience with gradual harmonization of food laws offers cautionary insights for Ethiopia's ongoing regulatory reform.

Table 3. Comparative Analysis of Food Safety Systems in East Africa.

Country	Lead Agency	Key Strengths	Major Challenges	Notable Innovations
Ethiopia	Ethiopian Food and Drug Authority (EFDA)	Comprehensive policy framework, growing institutional capacity	Fragmented implementation, informal sector coverage, resource constraints	One Health coordination, digital licensing systems
Kenya	Kenya Bureau of Standards (KEBS)	Strong laboratory capacity, public-private partnerships	Urban bias, informal sector challenges	Street food vendor associations, mobile labs
Tanzania	Multiple ministries (no clear lead)	Community-based monitoring approaches	Extreme fragmentation, limited resources	Community health committee engagement

Country	Lead Agency	Key Strengths	Major Challenges	Notable Innovations
Rwanda	Rwanda Food and Drugs Authority (RFDA)	Strong political support, digital systems	Limited stakeholder consultation, adaptability issues	Comprehensive digitization, centralized control
Uganda	Uganda National Bureau of Standards (UNBS)	Mobile testing services, simplified standards	Coordination between agencies, resource limitations	Mobile testing units, graduated standards

8.2. Alignment with International Standards and Agreements

Ethiopia's engagement with international food safety governance has increased significantly in recent decades, influencing both policy development and practical approaches.

Codex Alimentarius Commission: Ethiopia has been a member of the Codex Alimentarius Commission since 1996 and participates in several regional and global committees. Ethiopian standards are increasingly aligned with Codex standards, particularly for products in international trade. However, adoption remains selective, with many standards adapted to local contexts and capacities [60]. Participation in Codex provides Ethiopia with access to scientific expertise and facilitates trade but also creates tensions between international norms and local realities.

World Trade Organization (WTO) Agreements: As a WTO member since 1995, Ethiopia is bound by the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), which requires that food safety measures be based on scientific principles and not create unnecessary barriers to trade. Ethiopia's SPS notification system has improved but still faces challenges in providing scientific justification for measures and responding to other countries' concerns about Ethiopian exports [61].

Regional Economic Communities: Ethiopia participates in several regional integration initiatives with food safety implications:

Common Market for Eastern and Southern Africa (COMESA): Working toward harmonized food standards across member states.

Intergovernmental Authority on Development (IGAD): Regional cooperation on livestock health and trade.

African Continental Free Trade Area (AfCFTA): Potential driver of harmonization across the continent.

These regional agreements create both pressures for alignment and opportunities for shared resources and learning.

Donor and Development Partner Programs: Multiple international agencies support food safety initiatives in Ethiopia, including:

World Bank: Financing for institutional strengthening and infrastructure.

FAO: Technical assistance for standard setting, risk assessment, and capacity building.

WHO: Support for foodborne disease surveillance and risk

communication.

USAID: Market-based approaches and private sector engagement.

European Union: Support for SPS capacity and export market access.

While valuable, these programs sometimes reflect donor priorities rather than locally identified needs and can create parallel systems that are unsustainable after project completion. Better coordination among donors and alignment with government priorities could enhance effectiveness.

8.3. Learning from Global Best Practices

While Ethiopia's context is unique, experiences from other countries offer valuable insights for strengthening food safety systems.

Risk-Based Regulation: Many high-income countries have shifted from uniform, prescriptive regulation to risk-based approaches that allocate resources according to risk. New Zealand's food safety system, for example, categorizes businesses based on risk factors (type of food, consumer vulnerability, processing methods) and tailors inspection frequency and intensity accordingly [62]. Such approaches could help Ethiopia use limited regulatory resources more efficiently, though they require risk assessment capacity and data systems that are currently underdeveloped.

Whole-Chain Approaches: Rather than focusing regulation on specific points (like processing facilities), some countries emphasize managing risks across entire value chains. Australia's "paddock to plate" approach coordinates interventions from production through consumption, recognizing that controls at one stage can reduce burdens at later stages [63]. For Ethiopia, such approaches could help address upstream contamination that overwhelms downstream controls.

Co-Regulation and Industry Partnership: Several countries have successfully engaged industry in regulatory functions through co-regulation models. In Canada, certain food safety activities are delegated to certified industry organizations under government oversight [64]. Similar approaches in Ethiopia could leverage private sector resources while maintaining public accountability, particularly for well-organized commodity sectors.

Behavior-Centered Design: Rather than relying solely on information provision to change behaviors, some programs use behavioral insights to design interventions that make safe practices easier, more attractive, and more socially normative.

The United Kingdom's Food Standards Agency has applied behavioral science to improve food handler practices through environmental changes, social norms messaging, and simplified decision aids [65]. Such approaches could complement Ethiopia's current emphasis on training and awareness.

Integrated Surveillance Systems: Countries with strong food safety systems typically integrate data from human disease surveillance, food testing, and animal health monitoring to identify emerging risks and evaluate interventions. The United States' FoodNet system links data from multiple sources to track foodborne illnesses and their sources [66]. Developing similar integrated surveillance in Ethiopia would require significant investment but could dramatically improve targeting of interventions.

9. Strategic Framework for Transformation

9.1. Vision and Guiding Principles

Transforming Ethiopia's food safety system requires a clear vision and principles to guide strategic choices and investments. Based on the analysis in preceding sections, we propose:

Vision: All people in Ethiopia have access to safe, nutritious food that supports health and well-being, supported by a food safety system that is effective, efficient, equitable, and resilient.

Guiding Principles:

Risk-proportionate: Interventions should be proportional to the level of risk, focusing resources where they will have greatest public health impact.

Whole-chain perspective: Addressing hazards requires interventions across the entire food chain, from production to consumption.

Differentiated approaches: Strategies should vary based on sector characteristics (formal/informal, scale, commodity type).

Stakeholder engagement: All food system actors—from farmers to consumers—should be engaged in developing and implementing solutions.

Evidence-based: Decisions should be informed by data and analysis, with continuous monitoring and evaluation.

Equity-focused: Special attention should address vulnerabilities of marginalized populations and geographic areas.

Sustainability: Solutions should be environmentally sustainable, economically viable, and institutionally maintainable.

Adaptive: The system should learn and evolve in response to changing conditions and new evidence.

9.2. Strategic Pillars and Priority Actions

Achieving this vision requires action across five interconnected strategic pillars, each with specific priority actions.

Pillar 1: Strengthened Governance and Coordination

Action 1.1: Establish a high-level National Food Safety Council with authority to resolve inter-ministerial conflicts and allocate joint budgets.

Action 1.2: Develop and implement a comprehensive food safety law that consolidates existing regulations and clarifies mandates.

Action 1.3: Create integrated food safety units at regional and city levels with staff from relevant sectors.

Action 1.4: Implement a performance management system with clear indicators and regular public reporting.

Pillar 2: Enhanced Surveillance and Information Systems

Action 2.1: Establish integrated foodborne disease surveillance linking human health, food testing, and animal health data.

Action 2.2: Develop a national food safety information system connecting inspection, laboratory, and licensing data.

Action 2.3: Implement sentinel surveillance sites in high-risk areas and for high-risk commodities.

Action 2.4: Strengthen laboratory capacity through regional hub laboratories with standardized methods and equipment.

Pillar 3: Risk-Based Regulatory Approaches

Action 3.1: Implement risk categorization of food businesses with differentiated inspection frequencies and requirements.

Action 3.2: Develop simplified standards and guidelines for small-scale and informal operators.

Action 3.3: Expand use of digital tools for inspection, licensing, and compliance monitoring.

Action 3.4: Establish transparent enforcement policies with graduated responses from education to penalty.

Pillar 4: Capacity Building Throughout Value Chains

Action 4.1: Develop a national food safety workforce strategy addressing needs from inspectors to food handlers.

Action 4.2: Establish food safety training and certification programs tailored to different actor groups.

Action 4.3: Integrate food safety into agricultural extension, health education, and school curricula.

Action 4.4: Strengthen business development services to help enterprises implement food safety improvements.

Pillar 5: Enabling Infrastructure and Technology

Action 5.1: Develop a national cold chain strategy with targeted investments in critical nodes.

Action 5.2: Improve water, sanitation, and waste management infrastructure in markets and food business areas.

Action 5.3: Promote adoption of appropriate food safety technologies through incentives and support services.

Action 5.4: Establish food safety innovation hubs to develop and scale context-appropriate solutions.

9.3. Phased Implementation Approach

Given resource constraints and system complexity, transformation should proceed in phases over 10-15 years:

Phase 1: Foundation Building (Years 1-3)

Focus on policy and institutional reforms, basic infrastructure, and pilot programs.

Expected outcomes: Consolidated legal framework, established coordination mechanisms, baseline data systems, demonstration projects showing what works.

Phase 2: Scaling and Integration (Years 4-7)

Expand successful approaches, strengthen systems, and improve coverage.

Expected outcomes: Risk-based regulation operational in priority sectors, surveillance systems providing actionable data, significant expansion of training and infrastructure.

Phase 3: System Maturation (Years 8-10)

Full implementation of strategic framework, continuous improvement, and adaptation.

Expected outcomes: Comprehensive, efficient system operating nationwide, measurable reductions in foodborne illness, increased consumer confidence.

Phase 4: Sustained Excellence (Years 11+)

Innovation, refinement, and response to emerging challenges.

Expected outcomes: Ethiopia as regional leader in food safety, system resilience to shocks, contribution to economic growth and public health.

9.4. Resource Requirements and Financing Strategy

Implementing this transformation requires significant but manageable investment. Preliminary estimates suggest total costs of approximately \$300-400 million over 10 years, with annual costs rising from \$20 million in early years to \$50 million in later years as systems scale [67]. Financing should come from multiple sources:

Government Allocation: The federal government should increase budget allocations for food safety, with specific line items in health, agriculture, and trade budgets. Regional governments should match these allocations based on population and need.

Development Partner Support: International donors should align support with the national strategy, focusing on capacity building, infrastructure, and innovation rather than parallel systems.

Private Sector Investment: Businesses should invest in their own compliance, with potential for public support through matching grants or tax incentives for food safety improvements.

Consumer Contributions: Where possible, consumers may contribute through small price premiums for safer products, particularly as incomes rise.

Innovative Financing Mechanisms: Potential approaches include: results-based financing for achieving specific food safety outcomes, social impact bonds, and blended finance combining public and private capital for infrastructure projects.

A dedicated Food Safety Development Fund could pool re-

sources from multiple sources and allocate them based on strategic priorities and performance.

9.5. Monitoring, Evaluation, and Learning Framework

Continuous learning and adaptation are essential for successful transformation. A robust monitoring, evaluation, and learning (MEL) framework should track progress and inform adjustments. Key elements include:

Outcome Indicators:

Reduction in foodborne illness incidence (from surveillance data)

Improvement in food safety compliance rates (from inspection data)

Increased consumer confidence in food safety (from surveys)

Reduction in economic losses from food safety issues

Increased trade in food products meeting safety standards

Process Indicators:

Number of businesses implementing food safety management systems

Coverage of inspection and surveillance systems

Capacity building metrics (people trained, certifications issued)

Infrastructure development (cold chain capacity, laboratory upgrades)

Learning Components:

Regular implementation reviews to identify what works and what doesn't

Mechanisms for stakeholder feedback and adaptation

Documentation and sharing of lessons learned

Research partnerships to address knowledge gaps

An independent review committee should assess progress annually and provide recommendations for adjustment. Results should be communicated transparently to build accountability and maintain stakeholder engagement.

10. Conclusion

10.1. Summary of Key Findings

This comprehensive review has examined Ethiopia's food quality management system from multiple perspectives, yielding several key insights:

First, Ethiopia has made significant policy and institutional progress in recent decades, establishing a comprehensive legal framework, creating specialized regulatory agencies, and developing strategic plans that align with international best practices. The National Food Safety Management Plan (2025-2029) represents particular ambition in addressing systemic challenges.

Second, despite this progress, implementation gaps remain substantial. The system struggles with fragmentation across

multiple agencies, limited resources relative to needs, inadequate infrastructure throughout value chains, and challenges reaching the informal sector where most food transactions occur. These implementation challenges are compounded by economic constraints, capacity limitations, and competing priorities.

Third, context matters profoundly. Ethiopia's food system is characterized by smallholder production, extensive informal markets, diverse culinary traditions, and economic constraints for both producers and consumers. Effective solutions must be tailored to this context rather than simply importing models from different settings. Successful interventions typically combine technical improvements with attention to economic incentives, behavioral factors, and institutional arrangements.

Fourth, multiple promising approaches exist for strengthening food safety. These include technological innovations (particularly digital solutions), institutional innovations (like co-regulation and public-private partnerships), market-based approaches (such as hygiene rating schemes), and behavioral interventions. Several case studies demonstrate what can be achieved with well-designed, context-appropriate programs.

Finally, transformation is feasible but requires sustained effort. No single intervention will address all challenges. Rather, improvement requires coordinated action across multiple fronts: strengthening governance, building capacity, improving infrastructure, engaging stakeholders, and fostering innovation. A phased approach focusing initially on foundation building and demonstration, then scaling, then system maturation offers a realistic pathway.

10.2. Implications for Policy and Practice

The findings of this review have several important implications for those working to improve food safety in Ethiopia:

For Policymakers: Priorities should include finalizing and implementing the National Food Safety Management Plan, strengthening inter-ministerial coordination, increasing budget allocations for food safety functions, and developing differentiated regulatory approaches for different sectors. Special attention should address the informal sector through facilitative rather than purely punitive approaches.

For Regulators: Emphasis should shift toward risk-based regulation, making better use of limited resources. Digital tools should be expanded to improve efficiency and transparency. Capacity building for inspectors should focus on risk assessment, communication, and adaptive management skills.

For Food Businesses: All businesses, regardless of size, should recognize that food safety is both a responsibility and potentially a competitive advantage. Implementing basic food safety practices can reduce losses, enhance reputation, and open market opportunities. Businesses should engage with industry associations to develop collective solutions.

For Development Partners: Support should align with government strategies rather than creating parallel systems. Focus

should be on capacity building, institutional strengthening, and innovation rather than short-term projects. Partners should coordinate among themselves to maximize impact.

For Researchers and Academics: Priority research areas include: cost-effective interventions for small-scale operators, behavioral determinants of food safety practices, appropriate technologies for Ethiopian conditions, and economic analyses of food safety investments. Research should engage stakeholders and focus on practical applications.

For Consumers: While economic constraints are real, consumers can use their purchasing power to reward safer practices where possible. Consumers should also practice safe food handling at home and advocate for improved food safety in their communities.

10.3. Future Research Directions

Despite the breadth of this review, significant knowledge gaps remain that warrant further research:

Economic analyses: More detailed studies of the costs and benefits of different food safety interventions, including distributional impacts across different population segments.

Behavioral research: Deeper understanding of the determinants of food safety behaviors among all actors in the system, using behavioral science frameworks.

Technology adaptation: Research on appropriate technologies for Ethiopian conditions, including affordability, usability, and maintenance requirements.

Informal sector dynamics: Better mapping and understanding of informal food systems, including how safety is managed within these systems.

Climate change interactions: How changing climate patterns affect food safety risks and the resilience of food safety systems.

Equity dimensions: How food safety risks and interventions affect different population groups, particularly vulnerable populations.

Implementation science: How to effectively implement and scale food safety interventions in complex, resource-constrained environments.

Addressing these research gaps will require interdisciplinary approaches, partnerships between researchers and practitioners, and sustained funding. Ethiopian universities and research institutions should strengthen food safety research capacity as part of the broader system strengthening.

10.4. Final Reflections

Food safety is not a luxury but a fundamental requirement for public health, economic development, and social well-being. In Ethiopia, improving food safety presents both immense challenges and significant opportunities. The challenges stem from the scale and complexity of the food system, resource constraints, and competing priorities. The opportunities arise from growing awareness, political commitment, technological

possibilities, and the potential for food safety to contribute to multiple development goals.

This review has argued that transforming Ethiopia's food safety system requires moving beyond isolated interventions to address systemic constraints. It requires balancing regulation with facilitation, government action with private sector and community engagement, technical solutions with attention to economic and behavioral factors. It requires both ambitious vision and practical, stepwise implementation.

The journey will not be quick or easy, but it is essential and achievable. With sustained commitment, strategic investment, and learning from both successes and failures, Ethiopia can build a food safety system that protects its people, supports its economy, and serves as a model for other countries facing similar challenges. The time for concerted action is now.

Abbreviations

AfCFTA	African Continental Free Trade Area
ASFs	Animal-Source Foods
BRC	British Retail Consortium
CFIR	Consolidated Framework for Implementation Research
COMESA	Common Market for Eastern and Southern Africa
CSA	Central Statistical Agency
DSIP	Dairy Safety Improvement Program
EFDA	Ethiopian Food and Drug Authority
ESA	Ethiopian Standards Agency
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FERG	Foodborne Disease Burden Epidemiology Reference Group
GDP	Gross Domestic Product
GSM	Global System for Mobile Communications
HACCP	Hazard Analysis Critical Control Point
HEWs	Health Extension Workers
IFS	International Featured Standards
IGAD	Intergovernmental Authority on Development
IoT	Internet of Things
IR	Implementation Research
ISO	International Organization for Standardization
KEBS	Kenya Bureau of Standards
KPIs	Key Performance Indicators
MEL	Monitoring, Evaluation, and Learning
MoA	Ministry of Agriculture
MoH	Ministry of Health
NFSNP	National Food Safety Management Plan
PPBs	Parts per Billion
PPPs	Public-Private Partnerships
RFDA	Rwanda Food and Drugs Authority
SDGs	Sustainable Development Goals

SMEs	Small and Medium Enterprises
SMS	Short Message Service
SNNP	Southern Nations, Nationalities, and Peoples'
SPS	Sanitary and Phytosanitary Measures
TVET	Technical and Vocational Education and Training
UNBS	Uganda National Bureau of Standards
USAID	United States Agency for International Development
UV	Ultraviolet
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization
WTO	World Trade Organization

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Author Contributions

Tariku Workneh Daksa is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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