



Morse, Tracy D. and Masuku, Humphreys and Rippon, Sarah and Kubwalo, Hudson (2018) Achieving an integrated approach to food safety and hygiene—meeting the sustainable development goals in Sub-Saharan Africa. *Sustainability*, 10 (7). ISSN 2071-1050 , <http://dx.doi.org/10.3390/su10072394>


This version is available at <https://strathprints.strath.ac.uk/64746/>

Strathprints is designed to allow users to access the research output of the University of Strathclyde. Unless otherwise explicitly stated on the manuscript, Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Please check the manuscript for details of any other licences that may have been applied. You may not engage in further distribution of the material for any profitmaking activities or any commercial gain. You may freely distribute both the url (<https://strathprints.strath.ac.uk/>) and the content of this paper for research or private study, educational, or not-for-profit purposes without prior permission or charge.

Any correspondence concerning this service should be sent to the Strathprints administrator: strathprints@strath.ac.uk

Article

Achieving an Integrated Approach to Food Safety and Hygiene—Meeting the Sustainable Development Goals in Sub-Saharan Africa

Tracy D. Morse ^{1,2,*} , Humphreys Masuku ^{3,4}, Sarah Rippon ¹ and Hudson Kubwalo ⁴

¹ Department of Civil and Environmental Engineering, University of Strathclyde, Level 5 James Weir Building, 75 Montrose Street, Glasgow G1 1XJ, UK; sarah.rippon@strath.ac.uk

² Centre for Water, Sanitation, Hygiene and Appropriate Technology Development, University of Malawi Polytechnic, Private Bag 303, Chichiri, Blantyre 3, Malawi

³ Ministry of Health, Government of Malawi, Capital Hill, Lilongwe 3, Malawi; masukuh@who.int

⁴ World Health Organisation (Malawi), ADL House, Lilongwe 3, Malawi; kubwaloh@who.int

* Correspondence: tracy.thomson@strath.ac.uk; Tel.: +265-(0)999945779

Received: 12 June 2018; Accepted: 5 July 2018; Published: 10 July 2018



Abstract: Improving food safety and hygiene is integral to the successful attainment of the Sustainable Development Goals (SDGs). Foodborne diseases continue to impose a high burden on low- and middle-income countries (LMICs), particularly children under five years, and meeting stipulated conditions for both domestic and export markets can be challenging. This paper reports a situation analysis exploring the challenges faced in the food safety sector in LMICs, using Malawi as an example. The analysis used a desk and policy review, literature search, key informant interviews, and focus group discussions to provide national data, which was then subject to thematic analysis. The analysis established there is a significant threat to public health and market access due to uncoordinated, outdated or incomplete regulatory framework, poorly defined mandates, limited infrastructure, lack of equipment and skilled personnel, inadequate resources, and limited awareness and ability to comply with standards. Food safety and hygiene improvements must strike a balance between market access gains and protection of public health. To achieve this, the sector requires effective integration at national level in food security, nutrition, health, economic development, agriculture, and poverty reduction. Solutions for each country must be context-specific and take into consideration national realities if they are to be successful.

Keywords: food safety; Sustainable Development Goals; regulation; Malawi; policy; LMIC

1. Introduction

The Sustainable Development Goals (SDG) envisage “a world where we reaffirm our commitments regarding the human right to safe drinking water and sanitation and where there is improved hygiene; and where food is sufficient, safe, affordable and nutritious” [1]. However, specific focus in the SDGs has been placed on issues of nutrition, food security and sustainable agriculture, water, sanitation and hygiene, economic development, and poverty reduction, with little to no mention of specific food safety practices.

Historically, the control and reduction of foodborne disease has not been a development priority, despite its integral role in the health and well-being of the world’s population. The Foodborne Disease Burden Epidemiology Reference Group (FERG) recently reported that foodborne disease has a health burden equal to, or in excess of, malaria, HIV/AIDS, or tuberculosis, with 98% of the burden falling on Low and Middle Income Countries (LMICs) and children [2]. Within these settings, foodborne disease is also exacerbated by the burden imposed on an understaffed and over-utilized healthcare system,

and the associated reduced productivity. These are further compounded by emerging issues such as aflatoxin control and antimicrobial resistance, which are introducing new and complex concerns for human health into the food chain [2–7].

In addition to household food safety concerns [8], we must also consider the implications of poor food hygiene standards on trade and industry through both domestic and international trade participation. The majority of African nations struggle to meet conditions laid down by the World Trade Organization Sanitary and Phytosanitary (SPS) Agreement for export markets [9–11], and attempts to support improved food safety and hygiene systems in African nations have been recognized by the African Union (AU) as a priority in the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods [12]. However, as with the SDGs, the primary focus has been on support for food security and the improvement of nutrition indicators. Nevertheless, this commitment also includes the establishment of a central African Food Standards body which could support national regulation and reporting. This body has not been established to date, although progress has been made on capacity building and development of an associated continental reference laboratory [13]. Although the issues of nutritional quality and safety of food are inextricably linked, donor-driven responses to stunting and malnutrition has led to much stronger support for the nutrition sector, to the detriment of the food safety sector. This could be addressed if nations developed and affected a multi-sectoral approach, strengthening inter-sectoral collaboration to address current weaknesses and improve coordination mechanisms. Within such resource-limited settings, this approach is essential to achieve maximum impact [2,10].

Improving food safety conditions in Africa in both domestic and commercial settings presents numerous challenges due to poorly developed infrastructure and services (e.g., access to clean water), inadequate knowledge and skills in food workers, and a significant lack of data [2,3,10]. These insufficiencies are then compounded by outdated, weak and dysfunctional regulatory and laboratory systems [3,7,10]. This situation is exemplified in Malawi, where current food safety systems have been described as ‘weak’, ‘fragmented’, ‘not well coordinated’, and ‘lacking in capacity’ [14,15], and although various donor-led projects have attempted to address these issues, to date, no coherent nationwide strategy for food safety control has been developed either in isolation or in integration with other key areas of food security, nutrition, trade and industry, or public health.

Located in Sub-Saharan Africa, Malawi has a population of over 18 million with an agriculture-based economy; 80% of the population are subsistence farmers, with agricultural products forming one third of GDP and 90% of export revenues [16]. Domestically, food constitutes 54% of household expenditure [16], with maize, cassava, and potatoes forming 60–65% of calorific intake; with food security defined as access to maize, 73% of the population reported low food security [16], which is compounded by poor diet diversification and subsequent nutrition-related illnesses [17]. Food represents 8% of imports, primarily as low-risk products [18], and 28% of exports, including tea, sugar, coffee, and nuts to EU (50%) and regional partners. Unfortunately, increasing access to external markets is limited due to poor compliance with international food safety frameworks.

In order to develop a realistic road map for LMICs taking into account national needs, and those of international agencies, a comprehensive situation analysis is needed. Recent reports of food safety situations in African countries have demonstrated overlapping issues in several Sub-Saharan countries, including conflicting mandates, lack of reliable data and a lack of adequate resources [10,19]. These studies reflected food safety situations in relation to the burden of disease and the policy framework respectively, and have relied on published data and self-reporting from authorities. There have been few objective in depth country studies in Sub-Saharan Africa that have examined food safety in a wider national and regional context, taking into consideration implications for both trade and public health to identify realistic and appropriate recommendations to improve the sector for national development and achievement of the SDGs.

This paper presents the complete current food safety situation in Malawi, taking into consideration the WHO guidelines for sector development and the most recent findings from African and global

studies, which have considered the potential impact of improved food safety standards in LMICs. The specific objectives of the situation analysis were to

- Analyse the performance of the national food safety system;
- Evaluate institutions/agencies involved in food safety; and
- Identify strengths and weaknesses to be addressed in policies and action plans.

As an example of the current situation in LMIC in Sub-Saharan Africa, this paper provides a detailed examination of the general and specific opportunities that can be exploited to improve inter-sectoral collaboration, and support Malawi and other LMICs to address both public health and trade weaknesses, thereby reducing the burden of disease and supporting economic development in-line with the SDGs and the aligned Malawi Growth and Development Strategy III [20].

2. Materials and Methods

A Situation Analysis was initially conducted in 2014 (full report in supplementary material) and updated in 2017 to assess the key components of the current national food safety system in Malawi in line with WHO/FAO guidelines [21,22]. The analysis took a holistic approach to data collection, taking into consideration the multidisciplinary nature of food safety and hygiene in Malawi, and the wide range of stakeholders who have a role to play in the sector. Data was sought from an external desk review and key informant interviews.

2.1. Desk Review

The external desk review focused on identification and analysis of published and unpublished (verified from reliable sources) data in the form of peer reviewed literature, regulatory documents, grey literature, and published national surveys and reports. These were identified through web-based searches in Google, GoogleScholar, and PubMed using the following keywords: food, food safety, food hygiene, food regulation, food inspection, food contamination, foodborne disease, foodborne disease outbreaks, and food quality. Each was searched in combination with Malawi or Africa separately. Further documents were identified from regulatory libraries and through snowballing and information provided by key informants. All data and information gained from the desk review was ratified by key stakeholders ($n = 23$) through presentation and feedback during a final workshop to endorse the research findings.

2.2. Key Informant Interviews

Key stakeholders and key informants were identified in collaboration with WHO and the Ministry of Health staff. In total, information was gained from 78 key informants as outlined in Table 1. Key informant interviews (KIIs) were conducted on a one to one basis using a semi-structured questionnaire for between 60 to 90 min with 61 participants, and two focus group discussions were held using a prepared guide for 1.5 h. The final ratification workshop took place over two days, and all interviews and discussions were facilitated by the authors (TM and SR).

All participants provided informed consent for their interviews to be recorded, and data contained to be shared and quoted where appropriate.

Questionnaires were developed based on the recommended documents in the WHO (2012) Guidelines for Developing and Implementing National Food Safety Policy and Strategic Plan. The questionnaire was adapted to contain the areas specific to particular stakeholders to reduce the volume of questions and remove those questions which were irrelevant for specific sectors as outlined in Table 1.

Questionnaires addressed areas of

- District/business profiles;
- Inspections—qualifications and training, personnel, regulatory frameworks, experience, equipment, challenges and constraints;
- Surveillance and laboratories—methods, capacity of laboratories, qualifications, certifications;
- Consumers—education, access to complaints mechanisms;
- Research—previous work and research on all areas of food safety and hygiene;
- Engagement—inter-sectoral engagement, private sector and regulatory or consumer bodies;
- Funding—support provided to the sector or planned for the future.

Table 1. Summary of key informants (KIs) interviewed for the situation analysis.

Sector	Number of KIs	Method Used	Documents Used
Public	54	KII & Workshop	Semi-structured questionnaires for: <ul style="list-style-type: none"> • Central Government (Ministry) positions. • Laboratories offering services for food analysis and examination • District and City Assemblies (Local Government). • Health education.
Private	7	FGD & Workshop	FGD guide for food retailers/importers ($n = 3$) and exporters ($n = 4$)
Bi/multilateral donors	6	KII & Workshop	Semi-structured questionnaire for donor support and priorities.
Academia	7	KII & Workshop	Semi-structured questionnaires for: <ul style="list-style-type: none"> • Academic and research institutions. • Laboratories offering services for food analysis and examination
Professional Bodies	1	KII & Workshop	Semi-structured questionnaires for: <ul style="list-style-type: none"> • Central Government (Ministry) positions • District and City Assemblies (Local Government). • Health education.
Consumers	3	KII & Workshop	Semi-structured questionnaire for: <ul style="list-style-type: none"> • Consumer representatives • Health education.

2.3. Data Analysis

Data from the desk review was summarised and triangulated with the findings of key informant interviews. Interviews were recorded with digital audio recorders and on paper. All audio files were listened to and compared to notes from the semi-structured questionnaire to ensure that no issues had been lost. This data was then subject to thematic analysis based on the following areas:

- Current characteristics and trends related to food and agricultural production and processing including food imports and exports;
- Capacity of key institutions and agencies involved in food safety and quality control addressing roles and mandates, legal basis and interagency coordination;
- Availability and status of food policies, laws, and regulations looking at both their enforcement and their compatibility with international standards;
- Capacity of food inspection services including human and material resource needs;
- Capacity of laboratories for examining and analysing food samples and related outbreak samples in terms of human, financial, and material resources;
- Epidemiological profile outlining the prevalence and incidence of foodborne diseases, if known, and any existing procedures for investigating and notifying foodborne diseases;

- Profile of food safety information, education and communication (IEC) activities and services including consumer participation, extension and advisory services, human resources, and training requirements.

3. Results

Thematic analysis of these key areas identified the following current situation:

3.1. Current Characteristics of Food Industry in Malawi

Ranking 152nd in the world in terms of GDP per capita [23], Malawi's economy is heavily based on agriculture. Agriculture contributes 64% of the total income of the rural population, and least 74% of the population lives below the poverty line, earning less than US\$1.5 per day. This is reflected in the 83% of households engaged in agriculture, and 73% that are food insecure [16]. As such, food security is the primary concern of the government and population. Food imports constitute approximate 8% of total imports and are primarily low risk products. Food exports make up 28% of all exports and are primarily sugar, coffee, tea, and groundnuts [18].

There is currently no comprehensive database of commercial food premises in Malawi. However, evidence gathered from main stakeholders estimated over 16,800 premises, including retail premises (66%), eating places (18%), hotels (5%), markets (4%), meat processing (3%), food processing plants (2%), bakeries (1%), and dairies (1%). This does not include the large number of informal food vendors who play a significant role in the food sector, providing a large proportion of day-to-day food to rural and urban households through market settings.

3.2. Food Safety Management

Six ministries within the Government of Malawi have oversight of food safety issues (Figure 1), with 15 directorates within these ministries and further sub-departments within these. Key informants reported limited interdepartmental or inter-ministerial collaboration in terms of food safety despite the overlap in departments and mandates, particularly between the Ministry of Health, Ministry of Agriculture, Irrigation and Water Development, and the Ministry of Industry, Trade and Tourism. As there is no coordinating agency, key informants were confused regarding who has oversight, citing multiple authorities including the Malawi Bureau of Standards, Ministry of Health and Pharmacies, Medicines and Poisons Board.

The lack of consolidated database of food premises at district or national level currently leads to an overlap in enforcement and inconsistent messaging to both the consumers and private sector. Private sector key informants indicated that they are confused and frustrated with support, services, and what they perceive as the poor use of resources.

“There is significant overlap in the activities of Ministries and Agencies which leads to bad feeling between government employees and confusion for the private sector”. Consumer Association of Malawi.

“There is need for improved coordination among key sectors involved in food hygiene and safety especially Ministries of Health, Agriculture, Tourism and Malawi Bureau of Standards”. District Environmental Health Officer.

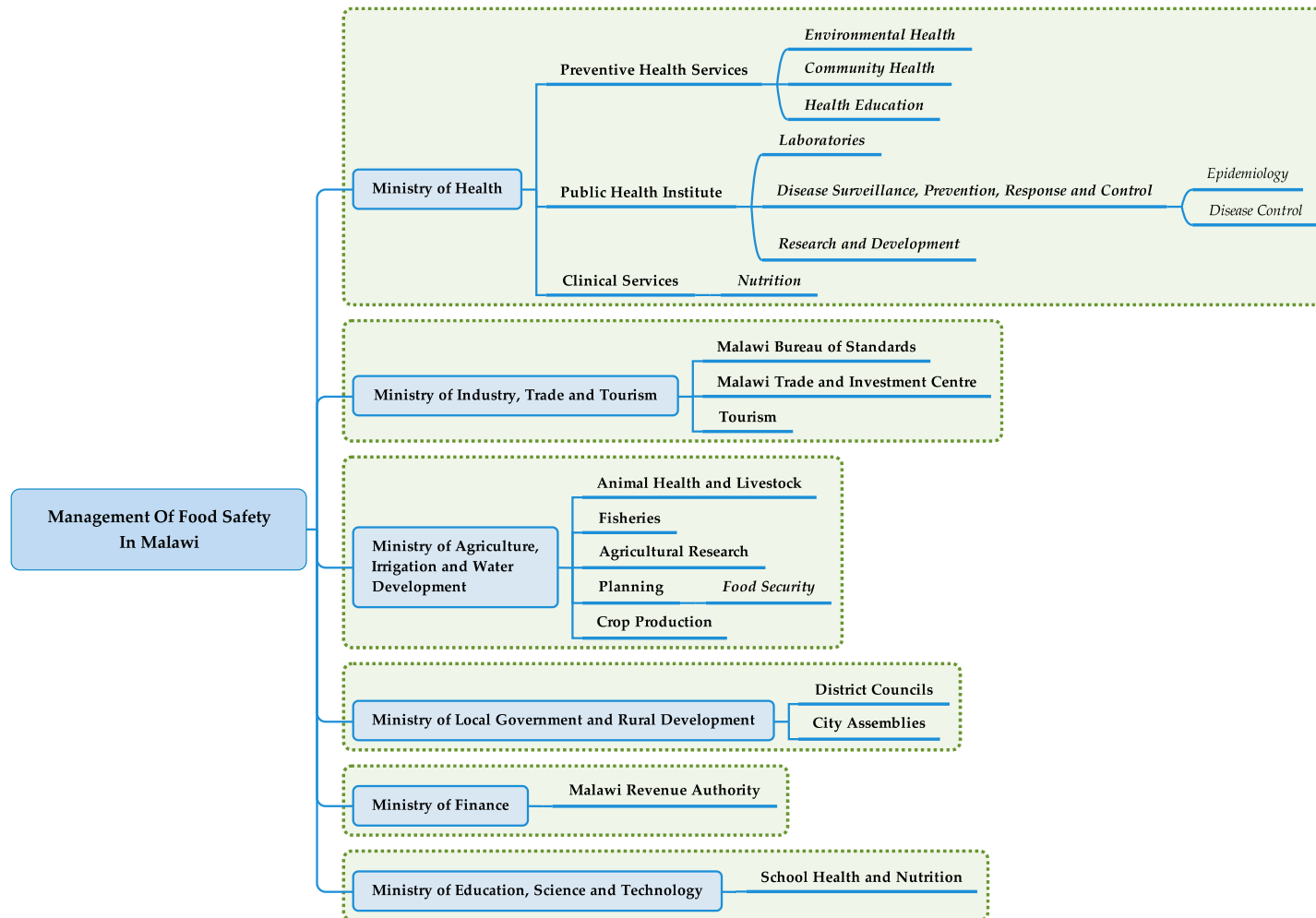


Figure 1. Government ministries involved in food safety.

3.3. Regulatory Framework

Malawi is subject to both national and international regulatory frameworks, through its membership of the United Nations, African Union, Southern African Development Community (SADC), and Common Market for East and Southern Africa (COMESA), and as a food-producing nation with a responsibility for public health and economic development. Malawi actively participates in the Codex Alimentarius Commission (CAC) through the National Codex Contact Point (NCC) at the Malawi Bureau of Standards (MBS). Despite the National Codex Committee failing to meet since 2009, the standards and recommendations of the CAC are integrated within the standards developed by MBS, and ratified through their specific technical working groups.

From policy to mandatory standards, the regulatory framework is extensive, but is fragmented and lacks harmonization. This was confirmed by all respondents, and ratified by review of current policies and legislation. The lack of an over-arching or integrated policy means that regulation sits within specific ministries in relative isolation (Table 2). This is reflected in the Acts of Parliament and associated Regulations/Standards which have been developed in a responsive manner causing duplication, the enactment of inappropriate product specific Acts, and limited implementation. For example, the Iodisation of Salt Act 1995 was implemented to address the specific need to control salt sales in Malawi and ensure all salt is iodised, which was a reaction to a specific donor-driven health need.

Table 2. Summary of main policies and legislation which affect food safety and quality in Malawi.

Current Related Policies	Current Acts of Parliament
Nutrition Policy (and strategy) 2009	Public Health Act 1948
National Alcohol Policy 2012	Malawi Bureau of Standards Act 1972:2012
National Fisheries and Aquaculture Policy 2012	Fisheries Conservation and Management Act 1997
Health Promotion Policy 2013	Meat and Meat Products Act 1976
National Quality Policy 2014	Milk and Milk Products Act 1971
National Agriculture Policy 2016	Pharmacy, Medicines and Poisons Act 1988
National Environmental Health Policy (draft)	Local Government Act 1998
	Hotels and Tourism Act 1968 (plus amendments)
	Iodisation of Salt Act 1995
	Consumer Protection Act 2003
	Competition and Fair Trade Act 1998
	Control of Goods Act 1968
	Business Licensing Act 2012

However, collaboration can be achieved, as seen through the formation of the National Quality Policy (2014), which has significant crossover with food quality issues, and was developed with sector stakeholders. Domestication of international standards has also been achieved through the formulation and gazetting of MBS mandatory ($n = 123$) and voluntary ($n = 42$) standards related to food in the last 15 years, primarily reflecting the CAC standards as outlined above. Nevertheless, key informants felt that,

“The development process for standards and regulations must not simply reflect that from other countries but address the specific needs of Malawi as it develops both public health and trade connections”. Preventive Health Services, Ministry of Health

Several unsuccessful attempts have been made in the last 20 years to produce a Food Safety Act, although a Draft Bill is currently being developed within the Ministry of Health. However, this is being led by the Department of Nutrition rather than the Preventive Health Services Section and may continue to frustrate proponents for interdepartmental collaboration.

3.4. Inspection Services

The fragmented regulatory framework directly affects the efficacy and management of enforcement and inspection services. Overall, six Ministries (11 departments) were reported to be conducting food safety inspections, ranging from high risk commercial food premises focused on export, to informal vendors for the local markets (Table 3).

The quality of inspections was found to be affected by four factors.

1. Under resourcing of food inspectors

Food inspecting officers at District/City level are placed through decentralised offices within the Ministries of Health, and Agriculture, Irrigation and Water Development (e.g., environmental health officers, veterinary assistants). Proportions of inspecting officers at this level ranged in ratio from 1 inspector to 1159 population to 1 inspector to 728,285 population. It was not possible to determine the ratio for commercial food premises due to the lack of a consolidated database. However, this range causes a significant variation in the quality and consistency of service delivery.

Ministries without decentralised offices at District/City level have inspecting officers at specific sites across the country. For example, the Department of Tourism has 34 staff in 12 locations proportionate to the number of premises for which they are responsible, and the Department of Fisheries has staff located at high-risk markets and landing sites. Despite this effort, all ministries are severely understaffed in terms of food safety and hygiene enforcement and support (Table 4).

Responses from all key informants indicated a lack of essential equipment available for food safety and hygiene inspections. MBS was the most effective, reporting that they had cameras and sampling equipment. However, no respondent indicated use of protective clothing or probe thermometers at the time of interview.

2. The lack of clear delineation of responsibilities for specific food premises

The lack of clear delineation between ministries and departments currently leads to over inspection of some premises, (e.g., commercial premises who already practice self-regulation to achieve international certification for export), and lack of inspection in premises which are potentially high risk due to their practices, or their target consumers, (e.g., restaurants, school kitchens, boarding schools, hospitals, and prisons).

3. Lack of consistent and aligned regulatory framework

Currently, inspectors use regulations specific to their line Ministry, leading to inconsistent approaches, requirements, and enforcement. The range of enforcement officers, some of whom operate without clear criteria, guidelines, and standards, leads to confusion and overlap of enforcement for food businesses. An example of good practice here is the direct reference within the Hotels and Tourism Regulations to the use of the Malawi Standard 21: Food and Food Processing Units—Code of Hygienic Conditions [24]. This leads to a consistency of standard between the Department of Tourism and the Malawi Bureau of Standards, which is not currently achieved elsewhere.

4. Lack of guidance and consistency for how and when to conduct inspections

Inspection frequency is at the discretion of the enforcing agency, as Malawi has not instigated a risk-based inspection framework. With deficient human resources outlined above, it would be more effective if inspection frequency were based on risk to health. However, there are a number of issues which may prevent this approach being implemented, e.g., MBS is primarily self-funded through invoicing for four inspections per year. Therefore, changing to a risk-based scheme may have an impact on income to the parastatal organization, affecting its ability to operate.

Similarly, inspection methods currently assess specific standard requirements through a checklist. There was no evidence that agencies use a risk-based method of inspection to assess public health

risk from practices they witness, and there is little to no consistency in the checklists used between agencies. Even within District level environmental health departments, of the 89% of districts who responded, there was no consistency in their use of specific codes of practice or checklists for food safety enforcement.

Feedback from the private sector supported these findings, highlighting frustrations with the current inspection and food safety control procedures, citing a lack of

- Oversight for inspecting agencies;
- Clarity from inspecting agencies on their roles and powers;
- Consistency in inspection approach;
- Control on illegal imports;
- Rapid response on product sample testing; and
- Consistency in labelling requirements between products and producers.

Table 3. Roles of ministries in food safety.

Inspection Services	Laboratory Services	Information, Education and Communication
Ministry of Health Environmental Health Nutrition Community Health	Ministry of Health Public Health Institute	Ministry of Health Health Education Environmental Health Community Health Nutrition Research Epidemiology
Ministry of Industry, Trade and Tourism Malawi Bureau of Standards Tourism	Ministry of Industry, Trade and Tourism Malawi Bureau of Standards	Ministry of Industry, Trade and Tourism Malawi Bureau of Standards Malawi Trade and Investment Centre
Ministry of Agriculture, Irrigation and Water Development Animal Health and Livestock Fisheries Crop Production	Ministry of Agriculture, Irrigation and Water Development Agricultural Research Laboratories	Ministry of Agriculture, Irrigation and Water Development Agricultural Research Food Security
Ministry of Education, Science and Technology School Health and Nutrition	Ministry of Education, Science and Technology School Health and Nutrition	Ministry of Education, Science and Technology School Health and Nutrition
Ministry of Local Government and Rural Development District Council City Council		
Ministry of Finance Malawi Revenue Authority		

Table 4. Personnel involved in food inspection.

Department	Positions
Malawi Bureau of Standards	Quality Assurance Officers Testing Officers Metrology Officers
District Health Offices	Environmental Health Officers Assistant Environmental Health Officers
District Assemblies	Trade Officers Market Supervisors
City Assemblies	Environmental Health Officers Assistant Environmental Health Officers
Agriculture and Fisheries Offices	Veterinary Officers Assistant Veterinary Officers Fisheries Officers
Department of Tourism	Tourism Officers

3.5. Laboratories

For food safety and quality, laboratory services are needed for routine surveillance, examination and analysis of samples tied to outbreaks, and commercial testing.

Seven laboratories based in government (Table 2) and academic institutions are able to examine and analyse food samples and provide a range of services including routine surveillance (nutrition, aflatoxins and set standards), examination of samples associated with food poisoning outbreaks, and commercial testing for export. Currently, none of these tests are certified by an external body, and laboratory staff referred to several regular challenges including availability of reagents, maintenance of the cold chain, standardized testing, and the delivery of time sensitive samples with adequate notification and information.

District based key informants outlined a desire to increase their capacity at a local level to analyse samples and reduce their reliance on central based laboratory services, which they feel constrict their ability to improve food safety and hygiene.

“Routine medical examination of food handlers is a good area that is hazy as it requires a lot of effort to address. We tried but failed as the hospital could not provide all the laboratory supplies required for the service”. District Environmental Health Officer

“District hospital laboratories should have the capacity to test food products or items suspected of being contaminated with a foodborne disease causing agent. Currently the trend is that our laboratories test only human excreta to determine the causative agent”. District Environmental Health Officer

Efforts have been made to address these challenges including the consolidation of existing laboratories under the Public Health Institute of Malawi (Figure 1), and formation of the Laboratory Association of Malawi (LAM). LAM aims to build a network between laboratories to provide a range of externally certified tests and improve sector efficiency within the current limited capacity. The sector is also being supported by the US\$12 million Standardization, Quality Assurance, Accreditation and Metrology (SQAM) Infrastructure program [25]. This programme aims to increase exports; increase national revenues; improve protection of consumer rights and consumer safety; improve technical capacity; and strengthen small and medium-sized enterprises (SMEs).

These areas are critical for the promotion of exports in-line with the Government’s Economic Recovery Plan and the National Export Strategy [26,27].

Both consumers and the private sector indicated a lack of confidence in the in-country laboratory systems in terms of facilities and human resources, preferring to send samples to certified laboratories in other countries in the region such as South Africa and Kenya, despite the higher cost.

3.6. Surveillance of Foodborne Disease

Malawi lies between having no formal system, to having syndromic surveillance, where foodborne disease is monitored through health facilities, communities and other data sources, allowing unusual patterns of foodborne disease to be detected. Currently, monitoring of disease in Malawi is the responsibility of District Health Offices who report through the Health Information Management Systems to the Ministry of Health. This data focuses on the Integrated Disease Surveillance and Response (IDSR) program [28], and therefore includes cholera, bloody diarrhoea, and diarrhoea with dehydration among under fives. However, specific diagnosis is dependent on health seeking behavior, laboratory facilities, and skilled laboratory technicians, which are often unavailable. The IDSR system in Malawi does not currently reflect reporting of food-related incidents of international importance, as required by the updated IDSR Technical Guidelines in 2010 [28].

Routine surveillance is constrained by underdeveloped infrastructure and services and limited research on the bacteriological [29–33] and chemical contamination [4,5,34–36] of food, with the majority of Malawi-based data held in grey literature and academic institutions. Significant steps have been made in surveillance of aflatoxins due to their political exposure and significant impact

on both trade and health. This momentum has been supported and maintained by the formation of the Malawi Action Program for Aflatoxins (MAPAC) which is a subsidiary of the Pan African group [37,38]. This group maintains regular meetings, discussions on national controls, and has the support of UN Agencies such as FAO to drive aflatoxin control for both domestic and external consumption. This group has developed an effective multi and inter-sectoral approach to the issue of aflatoxins within Malawi, and although they are dealing with a specific food safety issue in a vertical manner, they provide an example of how inter-sectoral collaboration can be achieved. Nevertheless, continuing issues of foodborne disease and related emerging issues such as antimicrobial resistance (AMR) have received little to no attention in Malawi, an issue which needs to be addressed if an evidence based approach to food safety from farm to fork is to be attained.

3.7. Information, Education, and Communication (IEC)

IEC activities examined included extension and advisory services offered by government (Table 2), industry, trade associations and educational institutions, both in terms of commercial and domestic food production. Currently lack of integration or coordination is leading to unsustainable communication programmes that are reactive, top down, and donor-driven. Despite the enactment of the Consumer Protection Act (2003) in Malawi, there has been minimal impact on consumer rights to date. As outlined by the Consumer Association of Malawi,

“(In Malawi) there are unsustainable education campaigns by different players, the public don’t know about food safety issues and they are not aware of their right to complain or where to complain”.

In terms of education, three main areas were identified:

1. Training and competence of enforcement officers

There is currently a lack of consistency in training requirements for enforcement officers. An evaluation of qualifications for all enforcement agencies indicated qualifications from certificates to degrees in a variety of subject areas, with little to no competence-based training, mentoring, or supervision.

2. Training of food handlers

There is no requirement for formal training of food handlers, and therefore few businesses invest in this education. Training is offered by several public agencies and educational institutions on an ad-hoc basis in the form of one day or one week basic and intermediate food hygiene courses targeting food handlers. However, these opportunities are more likely to be exploited by companies who are already managing self-regulation through international certifications to support export of their products. With no legal requirement for food handler training, high-risk domestic businesses are unlikely to invest in this form of training.

3. Public awareness and education

Public education is currently achieved through ad-hoc mass media programmes. Donor-driven programmes and school curricula focus on food production and nutrition with little emphasis on hygiene practices to complement these. More recently, there have been specific research programmes seeking to improve food hygiene, particularly in relation to weaning foods [39] in recognition of the potential impact on diarrhoeal disease reduction. However, it will take time to realize any related change in national policy, programming, or practice.

4. Discussion

Foodborne disease is responsible for an estimated 420,000 deaths per year, the burden of which lies with under five children (40%) primarily in Africa and Asia [40]. As such, food safety is an issue

which should be given equal emphasis with food security and nutrition. Despite this, food safety and hygiene are more inferred than explicit in the SDGs related to health and wellbeing, reducing hunger (through provision of safe, nutritious, and sufficient food), and economic development. As a cross cutting area, food safety is relevant across a wide range of sectors and across borders, including agriculture, trade, tourism, and public health. This makes consistency of management, regulation, and support a challenge to achieve, particularly in LMIC in areas such as Sub-Saharan Africa. Not only must existing food safety concerns be addressed, but the sector must also consider the complexity of the informal market which constitutes up to 80% of domestic food sales and the management of emerging challenges, such as aflatoxins and antimicrobial resistance, which cross the plant-animal-human interface and require an interdisciplinary 'one health' approach [10,41]. Studies exploring the use of market incentives to leverage food safety in developing countries have shown improvements in the case of high value products for export, including spillover effects to local communities, such as improved income and health standards [42]. This is also evident in Malawi, with the production and export of macadamia nuts, tea, coffee, and groundnuts all leading to improved hygiene standards from farm to fork. However, these have been primarily driven through co-regulation and self-regulation processes to leverage access to markets and do not reflect a similar improvement in production for the domestic market.

Improving food safety and hygiene at a national level can have widespread impact on a population, from reducing diarrhoeal disease [43] to increasing economic growth. However, achieving this through poorly resourced settings needs effective structures, planning, and political will. The study of Malawi is informed by a wide range of stakeholders from all levels in the food safety sector, providing a holistic overview of its current strengths and weaknesses. There was consensus in all areas, irrespective of the KIs attachment to the public, private, developmental, or consumer sectors, and the subsequent workshop ensured that all results and recommendations were ratified by these groups. The situation analysis was limited by the small number of interviews with both consumer and private sector, the lack of comprehensive national data for foodborne disease, and commercial food premises. Nevertheless, this paper provides detailed outlines of the barriers to an effective food safety and hygiene system, which are needed if realistic and appropriate solutions are to be proposed. Overall, the analysis identified that to support the household, domestic or international markets would require significant progress and support focused on three key areas.

4.1. A Framework for Food Safety Management

Food safety is a complex area, forming a nexus with several other sectors, including water, energy, trade, agriculture, nutrition, and health. As such, these sectors share responsibility and require effective coordination. The current lack of coordination and alignment in the management of the food safety sector between nine ministries in Malawi has led to significant discord and appears to be skewed towards food sufficiency (in terms of nutrition and security) with little integration of food safety. Similarly, the WHO (2007) reported a lack of coordination as a significant concern in 43 African countries, where they had between one (Angola, Cameroon, Ethiopia, Guinea, Madagascar, Senegal, Togo) and eight (Tanzania) agencies responsible for enforcement [44]. Despite the developing nature of these countries, Mylona et al. (2018) also reported similar concerns in the European Union, where there was less emphasis on social, environmental, and economic determinants of food safety and more focus on sufficient and innovative food supply [6]. In order to address this weakness, there needs to be a holistic approach to food systems, which allows stakeholders to find a balance between the three equally important aspects, food safety, nutrition, and security, all of which impact on market access. The current overlapping mandates in Malawi have caused confusion and subsequent apathy and frustration for both consumers and the private sector. This affects the safety of food being consumed and Malawi's ability to develop and extend its exports [11].

There is a consensus that food safety is best managed by a 'farm to fork' approach that ensures control along the value chain based on a risk paradigm. However, it is very difficult to achieve this

if there is no clear line of oversight or collaboration within Government, an issue also identified in other Sub-Saharan countries [3]. Only with clear ownership and support can appropriate interventions and systems specific to food safety be effectively implemented and maintained across the country. Restructuring to create a single unified body or an integrated system is likely to be most effective and in line with SADC guidelines [45]. However unless given the appropriate political will and support, and long term planning with relevant stakeholders, this could lead to further confusion. The intention of such a body would not be to 'take over' the system but rather to coordinate roles and align activities to appropriate government departments through a single National Food Policy. Such a body would have to be multisectoral and objective in its oversight and mandate, ensuring consistency of approach, improved services, and effective education programs. The use of a central body to establish a national database would also ensure a clear delineation of roles and responsibilities and increase transparency. This would also lead to effective use of resources, through reduced duplication of effort, better communication, and, in the long-term, increased confidence and support from both the consumer and private sectors. It is apparent there is not an effective model for this in LMICs to date [3], and any process and development must be cognisant of the specific context in which it is being established and realistic in its objectives [10]. These results also show that with the low priority afforded to food safety at present, a central body may not be a realistic achievement in the first instance, and planning may require an interim coordination phase which supports existing systems while transitioning to a national enabling environment.

The lack of overarching policy relating to food safety also affects the direction and consolidation needed for an effective framework. An attempt to address these gaps in both policy and regulation has been made by the WHO (Guidelines for Developing and Strategic Plan (2012)), Food Safety and Nutrition Food Law Guidelines (n.d.), and SADC (Regional Guidelines for the Regulation of Food Safety in SADC member states (2011)) [22,45–47]. However, in the case of Malawi, the lack of specific food policy (but seven related policies) and 13 Acts of Parliament specific to food make their consolidation and streamlining complex and politically challenging. Again, this situation is equally reflected in other African countries, which have a wide range of regulatory systems and frameworks across the continent, with the number of food laws reported for each country varying between one (Angola, Central African Republic, Comoros, Republic of Congo, Democratic Republic of Congo, Cote D'Ivoire, Guinea, Guinea Bissau, Seychelles, and Togo) and 25 (Kenya), and many of those reported specifically focused on horticulture [44]. In Malawi, Acts of Parliament were also found to be product-specific (e.g., Iodisation of Salt Act), reflecting both the lack of overarching food safety legislation and the impact of donor-driven agendas on national mandates.

The situation analysis presented here forms the basis for the review of the current regulatory framework and provides evidence that several actions are needed through wide stakeholder consultation. The first step is the development of a specific national Food Safety Policy and Strategy to be embedded within the National Health Policy. These documents must lay down a detailed plan for the review and consolidation of current regulations, as well as provide clarity and long term planning for subsequent collaboration and consistency between managing agencies. Integration with existing policies and programmes will be fundamental to successful implementation, and planned activities therein must also be realistic and supported with funding to ensure they can be positively realised. Any revision of the food safety framework must ensure integration with policies related to vulnerable and marginalised groups, for example, nutrition, HIV/AIDS, sanitation, and hygiene. The formation of a strong regulatory framework through a supportive policy environment is a key component for Malawi and other low-income countries to address if they are to meet the needs of both the domestic and international markets. However, such a framework must not be maintained at central level in isolation but disseminated and put into action through appropriate local government mechanisms.

4.2. Achieving Compliance

The regulatory framework is needed to support the development and maintenance of standard systems. However these systems must be cognisant of the limited infrastructure, human resource and skills base available in LMIC to achieve this. As such, to move the sector forward, a risk-based paradigm must be embedded on three levels; (1) identify the high risk areas which are contributing to foodborne disease for the focus of control, (2) to determine the frequency of inspection/visits based on risk to health, and (3) to underpin the method of inspection with risk-based assessments, allowing space for both proactive and reactive enforcement and education [42].

Identification of priority areas for targeting resources may be based on two prerequisites. Firstly, in the commercial sector, an emphasis for support may be placed on leveraging market incentives to promote economic growth. However this cannot outweigh the estimation of burden of disease from specific sectors. The lack of an effective surveillance system in Malawi means it is difficult to determine the potential for disease from the commercial sector. However, we must also consider the significant role played by the informal sector on the burden of disease. Any pathway to reducing the burden of foodborne disease must recognise the role of household food preparation and consumption in this setting. As 93% of the rural population engage in and are primarily dependent on farming, day-to-day foods are either grown or purchased in small quantities from local markets and informal traders [48]. These areas are largely neglected in current food safety programmes, where the most vulnerable members of the population, including under fives, bear 40% of the foodborne-disease burden [2]. Recent outbreaks of cholera across Malawi and neighbouring countries have reinforced this need to address the informal market to control the spread of communicable diseases through poor food hygiene practices [49,50]. Further research is needed to understand the national burden of disease associated with food in Malawi and to evaluate the quality and safety of foods being consumed, if resources are to be effectively used to target high-risk areas. Nevertheless, in the first instance, the WHO (2015) Estimates of the Global Burden of Foodborne Diseases is a detailed reference point for prioritisation [40].

Secondly, national priorities should be supported with a framework of inspection and regulation. It is recognised that globally, food safety and hygiene promotion are no longer focused on regulation alone but combine these efforts with co-regulation and the implementation of proactive preventive systems. In the EU, there has been a shift in governance to co- and self-regulation driven by consumers and markets [51]. However, achieving this level of governance in LMICs, outside the high-value product export market, still needs significant development in terms of accepted standards, and consumer expectations. The ability to undertake inspections is limited by a number of factors including personnel (both quantity and competence), and facilities (inspection equipment and laboratories). Using a risk-based system for informing inspection frequency can assist with prioritising work and placing a focus on those high-risk premises which pose a more significant risk to health. Such a system linked with a central database would allow regulation to be clearly delineated between enforcement agencies and staggered for inspection based on risk thereby helping with challenges in human resource availability.

In addition to resolving inspection intervals, the quality of regulatory services is also integral to improving compliance. Current inspections are based on checklist systems to determine compliance with specific items outlined in the appropriate regulations for each responsible agency. Although valuable as an aide memoire, current checklists in Malawi are focused on a “walls, floors, and ceilings” approach to inspection, measuring the presence or absence of tangible items. This form of inspection is limiting as it requires compliance with specific standards, which may be appropriate for a commercial fully equipped premises but cannot be similarly applied to an informal or street trader. High-income countries have moved toward a focus on risks rather than rules in the last decade, measuring both inherent food safety risks and those posed by management and controls. However, this relies on qualitative assessment in the food sector, and has a critical reliance on the skill and experience of inspecting officers to make subjective judgements [52]. With this in mind, and based on the limited

skills and personnel available in Malawi and similar countries, a hybrid of the traditional checklist and risk evaluation would seem the most appropriate way forward to achieve compliance. This must take the opportunity to learn from others, and maintain a context appropriate system which can support improved food safety across the sector.

From an external market access perspective, capacity also needs to be developed within national standards organisations. Although approved as voluntary standards in Malawi, ISO food-related standards can only be officially audited and certified from external bodies (e.g., South African Bureau of Standards) at high cost to the exporting company. Increasing this capacity in-country would improve opportunities for smaller businesses to comply with international standards for export and increase prospects for economic development in this sector.

Improvements in enforcement and surveillance need the appropriate support services including laboratory testing. Across Africa, there are a range of public health laboratories which should be able to support food safety services. However, evaluations of these laboratories, including those in Malawi, have shown substandard performance for the isolation of enteric diseases [53,54]. This limitation has been recognised by the AU through their proposal to develop a network of reference laboratories across the continent providing quality assured services, although this system is not yet in place [9]. As a country, Malawi has recognised the limitations of the current laboratory services and has made significant efforts through capacity-building in the Public Health Laboratory and Laboratory Association of Malawi to address these. These laboratories are also integral in the improvement of foodborne disease surveillance and the identification and management of outbreaks within the country. However, there remain substantial challenges to providing a quality assured, independent and certified laboratory service for food safety in the country, and prioritisation should be given to systems which can support both market access and public health controls. This could include the use of rapid tests at a local level to determine real time risk, reduce the burden on laboratories, and provide both evidence and support for improved food hygiene standards. For example, the use of ATP systems to measure cleaning efficiency or monitor compliance could be an innovative way to support educational and compliance systems [55,56].

4.3. Building Capacity

Underpinning the attainment of food safety and hygiene in LMICs is the need for capacity and competence across the sector, from the general public to enforcement officers and business owners. A number of capacity-building programmes have been launched in the last 10 years, with a focus on improving food safety to build market access [41,57]. In Malawi, this has been reflected through the numerous programs which have supported specific small to medium enterprises to develop food safety systems and therefore increase their opportunities for export. Although providing support and success for the beneficiaries, it is clear that this support has not helped to build national capacity to address food safety concerns.

Capacity in the food safety context addresses several sectors and cadres making this a complex issue that needs to be tackled on different levels. In the first instance, consumer awareness is key in driving improvement in food safety systems. Studies have shown that consumer knowledge of food safety across Africa is lower than Asia and may be associated with lower income [58]. However, targeted studies in Benin, Tanzania, and Kenya have shown that consumers have an awareness of potential health risks from agri-based foods in local markets and, in some cases, have demonstrated a willingness to pay more for safer products [59–63]. These studies demonstrate that with the correct consumer advice and awareness there can be a consumer based drive to improved food safety standards from both informal and formal markets. Nevertheless, this is challenging in low-income settings such as Malawi, where food security receives a much higher priority at household level than food safety. Consumer awareness may come from a number of different sources, and a focus on mass media is a natural consideration when such a wide audience needs to be reached. Such campaigns need to be context-specific and take into consideration consumer buying power, producer behaviour, and effective

behaviour communication, which targets appropriate responses in the consumer [61]. Food producers, whether farmers producing primary products or informal and formal food retail and preparation businesses, also need to be appropriately trained and educated on safe food hygiene practices. Again, these need to be context-specific, contribute to knowledge and provide clear and realistic mechanisms by which food safety can be achieved in a low income setting. A more practical, competence-based approach to training is more likely to have an impact on practice than classroom-based knowledge transfer [64]. Such courses and support can be provided through different suppliers such as inspecting officers, educational establishments, non-governmental organisations, and private training companies. However, they should all be monitored and supervised by a central body to ensure consistency and quality of training provided. This may require the development of country specific training toolkits by central organisations, which address the prioritised high-risk areas. These toolkits can then be made available to relevant stakeholders, with associated training of trainers to ensure consistency of approach and trainer competence. This approach moves away from the previously funded support to individual companies from external bodies and emphasises building internal capacity to support and develop national food safety programmes which can make a sustained impact on the sector.

As outlined within issues of compliance, capacity building is also integral for the implementing agencies. Regulatory staff need to be appropriately qualified [45] and also receive competence-based training and evaluations to ensure that they can implement a risk based and proactive form of enforcement, and move away from the checklist form of inspection which lacks support and development.

5. Conclusions

Attainment of effective food safety systems in LMICs is inextricably linked to the SDGs and must be embedded in food security, nutrition, disease prevention, water, sanitation and hygiene, economic development, and poverty reduction programs at a national and regional level. However, this is currently hindered by limited communication and integration at both policy and practice levels. Barriers to success can appear insurmountable due to overlapping mandates, lack of clear policy and regulation frameworks, conflicting priorities, and lack of capacity. As outlined in the WHO's Global Analysis and Assessment of Sanitation and Drinking Water, "there remains a discrepancy between global aspirations and national realities" in terms of the SDGs (p. ix). As such, solutions to the food safety and hygiene situation should be cognizant of the local context and risk-based paradigm.

A comprehensive situation analysis such as this can inform the development of a realistic road map for LMICs taking into account national needs and those of international agencies. An inclusive road map can also provide guidance for potential supporting agencies to ensure that the sector is driven as a cross-cutting issue with strong foundations rather than an ad-hoc donor-driven approach which does not support long term development and sustainability. For example, as Malawi currently prioritizes the control of aflatoxins, nutrition, and food security, these findings can ensure that there is not a vertical response to each single concern but rather a concerted and embedded effort to integrate solutions across sectors. Such a holistic approach can ensure the sustainability and efficacy of future interventions. The generation of political will is also imperative, and despite its greater influence, market investments cannot be the primary focus, as they cannot be relied upon to achieve food safety and hygiene in the domestic setting. A balance must be struck between the gains from market access and the need to protect public health.

Despite increasing evidence that foodborne disease has a significant role to play in LMIC disease burden, further research that allows evidence-based decisions and policy development to be made is imperative. Such research should focus on both the current gaps and emerging issues in the sector, including understanding the role of food safety in value chain development, efficacy of training and mentoring systems on practice and regulation, testing of context appropriate food safety management and inspection systems, identification of effective methods to improve food safety behaviors in

domestic settings, effective management of aflatoxins, and the role of food in the development and transmission of antimicrobial resistance.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2071-1050/10/7/2394/s1>. The full situation analysis report is available at [https://pure.strath.ac.uk/portal/en/publications/situation-analysis-of-food-safety-in-malawi\(63982c27-acfb-4fe3-9bdf-50dd625698ca\).html](https://pure.strath.ac.uk/portal/en/publications/situation-analysis-of-food-safety-in-malawi(63982c27-acfb-4fe3-9bdf-50dd625698ca).html).

Author Contributions: Conceptualization, H.M. and H.K.; Methodology, T.D.M. and H.M.; Formal Analysis, T.D.M. and S.R.; Investigation, T.D.M. and S.R.; Writing—Original Draft Preparation, T.D.M.; Writing—Review and Editing, S.R. and H.M.; Project Administration, T.D.M.; Funding Acquisition, H.K.

Funding: This work was funded by the World Health Organisation (Malawi) and conducted in partnership with the Ministry of Health, Government of Malawi.

Acknowledgments: The authors would like to thank all key informants for their input and open honest approach to providing the data for this study. We also thank Tara Beattie and Eileen Chappell for their comments and feedback during the development of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. UN Sustainable Development Goals 2015–2030. Available online: <https://www.globalgoals.org> (accessed on 11 June 2018).
2. Havelaar, A.H.; Kirk, M.D.; Torgerson, P.R.; Gibb, H.J.; Hald, T.; Lake, R.J.; Praet, N.; Bellinger, D.C.; de Silva, N.R.; Gargouri, N.; et al. World Health Organization global estimates and regional comparisons of the burden of foodborne disease in 2010. *PLoS Med.* **2015**, *12*, e1001923. [CrossRef] [PubMed]
3. Grace, D. White Paper Food Safety in Developing Countries: Research Gaps and Opportunities. Feed the Future. 2017. Available online: <https://cgspace.cgiar.org/handle/10568/81515> (accessed on 28 May 2018).
4. Matumba, L.; Monjerezi, M.; Chirwa, E.; Lakudzala, D.D.; Mumba, P. Natural occurrence of AFB1 in maize and effect of traditional maize flour production on AFB1 reduction, in Malawi. *Afr. J. Food Sci.* **2009**, *3*, 413–425.
5. Matumba, L.; Monjerezi, M.; Khonga, E.B.; Lakudzala, D.D. Aflatoxins in sorghum, sorghum malt and traditional opaque beer in southern Malawi. *Food Control* **2011**, *22*, 266–268. [CrossRef]
6. Mylona, K.; Maragkoudakis, P.; Miko, L.; Bock, A.K.; Wollgast, J.; Caldeira, S. Viewpoint: Future of food safety and nutrition—Seeking win-wins, coping with trade-offs. *Food Policy* **2018**, *74*, 143–146. [CrossRef]
7. WHO. National Food Safety Systems in Africa—A Situation Analysis. In Proceedings of the FAO/WHO Regional Conference on Food Safety for Africa, Harare, Zimbabwe, 3–6 October 2011.
8. Woldt, M.; Moy, G.G. *Literature Review on Effective Food Hygiene Interventions for Households in Developing Countries*; FHI 360/FANTA: Washington, DC, USA, 2015; Available online: <https://www.fantaproject.org/sites/default/files/resources/Food%20Hygiene%20Literature%20Review.pdf> (accessed on 28 May 2018).
9. African Union. Recommendations: For the Missions, Functions and Structure of Africa Union Food Safety Authority and Rapid Alert System for Food and Feed. 2013. Available online: <http://www.au-ibar.org/component/jdownloads/finish/30-panspso/2171-recommendations-for-the-missions-functions-and-structure-of-african-union-food-safety-authority-and-a-rapid-alert-system-for-food-and-feed> (accessed on 5 October 2017).
10. Grace, D. Food safety in Low and Middle Income Countries. *Int. J. Environ. Res. Public Health* **2015**, *12*, 10490–10507. [CrossRef] [PubMed]
11. Kleih, U. National SPS Coordination Mechanisms: An African perspective. Natural Resources Institute University of Greenwich (UK). 2012. Available online: http://www.standardsfacility.org/sites/default/files/STDF_NationalSPSCoordinationMechanisms_EN_0.pdf (accessed on 22 March 2018).
12. African Union Malabo Declaration on Accelerated Agricultural Growth Transformation for Shared Prosperity and Improved Livelihoods. 2014. Available online: <https://au.int/en/documents/20150617-2> (accessed on 11 June 2018).
13. African Union. Prioritising Food Safety in Africa. 2015. Available online: https://au.int/sites/default/files/documents/33005-doc-prioritizing_food_safety_in_africa-eng.pdf (accessed on 11 June 2018).
14. FAO. Review of food and agricultural policies in Malawi. MAFAP Country Report Series, Rome. 2015. Available online: http://www.fao.org/fileadmin/templates/mafap/documents/Malawi/MCR_May2015.pdf (accessed on 8 July 2018).

15. FAO/WHO. Situation Analysis of Food Safety Systems in Malawi. In Proceedings of the FAO/WHO Regional Conference on Food Safety for Africa 2005, Harare, Zimbabwe, 3–6 October 2005; Available online: <http://www.fao.org/tempref/docrep/fao/meeting/010/j6122e.pdf> (accessed on 9 July 2018).
16. NSO. *Government of Malawi Integrated Household Survey 2016–2017*; National Statistics Office: Zomba, Malawi, 2017; Available online: http://10.150.35.18:6510/www.nsomalawi.mw/images/stories/data_on_line/economics/ihs/IHS4/IHS4%20REPORT.pdf (accessed on 10 May 2018).
17. Mazunda, J.; Droppelmann, K. Maize Consumption Estimation and Dietary Diversity Assessment Methods in Malawi. Policy Brief, Malawi Strategy Support Program, International Food Policy Research Institute, IFPRI. 2012. Available online: <http://www.ifpri.org/publication/maize-consumption-estimation-and-dietary-diversity-assessment-methods-malawi> (accessed on 5 October 2017).
18. World Bank. Food Exports from Malawi. 2015. Available online: <http://www.tradingeconomics.com/malawi/exports> (accessed on 5 October 2017).
19. WHO. *Food Safety Policies and Legislation in African Region*; WHO: Geneva, Switzerland, 2007.
20. Government of Malawi. Malawi Growth and Development Strategy III 2017–2022. 2017. Available online: <https://www.afidep.org/resource-centre/downloads/policy-guidelines/malawi-growth-development-strategy-mgds-iii-2017-2022/> (accessed on 11 June 2018).
21. FAO/WHO. *Assuring Food Safety and Quality: Guidelines for Strengthening National Food Control Systems*; FAO/WHO: Geneva, Switzerland, 1997; Available online: <http://www.who.int/foodsafety/publications/guidelines-food-control/en/> (accessed on 5 October 2017).
22. WHO Guidelines for Developing and Implementing National Food Safety Policy and Strategic Plan. 2012. Available online: <http://www.afro.who.int/sites/default/files/2017-06/developing-and-implementing-national-food--main-english-final.pdf> (accessed on 9 July 2018).
23. World Bank Gross Domestic Product 2016. 2016. Available online: <http://databank.worldbank.org/data/download/GDP.pdf> (accessed on 11 June 2018).
24. Malawi Bureau of Standards (MBS). *MS21:2002—Food and Food Processing Units—Code of Hygienic Conditions*; Malawi Bureau of Standards: Blantyre, Malawi, 2002.
25. UNIDO (Internet). Available online: <http://www.unido.org/what-we-do/advancing-economic-competitiveness/o72296/malawi-national-quality-infrastructure-forges-ahead/sqam-project-in-malawi.html> (accessed on 5 October 2017).
26. Government of Malawi Economic Recovery Plan. 2013. Available online: <http://www.eisourcebook.org/cms/June%202013/Malawi,%20Economic%20Recovery%20Plan%202012.pdf> (accessed on 26 October 2017).
27. Government of Malawi National Export Strategy 2013–2018. 2013. Available online: [http://www.eisourcebook.org/cms/March_2013/Malawi%20National%20Export%20Strategy%20\(NES\)%20Main%20Volume.pdf](http://www.eisourcebook.org/cms/March_2013/Malawi%20National%20Export%20Strategy%20(NES)%20Main%20Volume.pdf) (accessed on 8 July 2018).
28. WHO. Technical Guidelines for Integrated Disease Surveillance and Response in the African Region 2010. Available online: <http://www.afro.who.int/publications/technical-guidelines-integrated-disease-surveillance-and-response-african-region-0> (accessed on 5 October 2017).
29. Mngoli, K.C.; Ng'ong'ola-Manani, T.A. Microbiological quality of fresh lettuce sold at Lilongwe market, Malawi: Does purchasing time matter? *Afr. J. Microbiol. Res.* **2014**, *8*, 491–495. [[CrossRef](#)]
30. Tanganyika, J.; Mfitlodze, W.M.; Mtimuni, J.P.; Phoya, R. Microbial quality of goat carcasses in Lilongwe, Malawi. *Chem. Biol. Technol. Agric.* **2017**, *4*, 27. [[CrossRef](#)]
31. Taulo, S.; Wetlesen, A.; Abrahamsen, R.; Kululanga, G.; Mkakosya, R.; Grimason, A.M. Microbiological hazard identification and exposure assessment of food prepared and served in rural households in Lungwena, Malawi. *Int. J. Food Microbiol.* **2008**, *125*, 111–116. [[CrossRef](#)] [[PubMed](#)]
32. Taulo, S.; Wetlesen, A.; Abrahamsen, R.; Narvhus, J.A.; Mkakosya, R. Quantification and variability of *Escherichia coli* and *Staphylococcus aureus* cross-contamination during serving and consumption of cooked thick porridge in Lungwena rural households, Malawi. *Food Control* **2009**, *20*, 1158–1166. [[CrossRef](#)]
33. Wilson, C. Pigs, Zoonoses and Antimicrobial Resistance in Kenya and Malawi. 2017. Available online: <https://www.vettimes.co.uk/app/uploads/wp-post-to-pdf-enhanced-cache/1/pigs-zoonoses-and-antimicrobial-resistance-in-kenya-and-malawi.pdf> (accessed on 25 May 2018).

34. Gokah, I.; Kauma, B.; Kachiwala, C.; Chavula, C.; Henson, S.; Cassidy, D. *Using Multi Criteria Decision Analysis to Identify and Prioritize Key Sanitary and Phytosanitary Capacity Building Options and Needs for Malawi*; Ministry of Industry and Trade, USAID: Lilongwe, Malawi, 2012. Available online: http://www.standardsfacility.org/sites/default/files/MCDA%20Final%20Report%20Malawi_0.pdf (accessed on 8 July 2018).
35. Monyo, E.S. *Assessing Occurrence and Distribution of Aflatoxins in Malawi*. Research, Chitedze Research Station, Lilongwe, Malawi; Ministry of Agriculture, ICRISAT: 2009. Available online: <http://oar.icrisat.org/7380/1/Aflatoxins.pdf> (accessed on 5 October 2017).
36. Orvestedt, S. *Waste Management and Impact on People's Health When Cultivating on Sites Contaminated with Heavy Metals—Minor field study Made in Zomba, Malawi*. Master's Thesis, SLU, Swedish University of Agricultural Sciences, Uppsala, Sweden, 2015. Available online: https://stud.epsilon.slu.se/8630/1/orvestedt_s_151119.pdf (accessed on 8 July 2018).
37. MAPAC (Malawi Action Plan for Aflatoxin Control). Ministry of Industry and Trade: Lilongwe, Malawi. 2013. Available online: [https://www.mitc.mw/images/downloads/policies/Malawi-Program-for-Aflatoxin-Control-\(MAPAC\)-Final-Report.pdf](https://www.mitc.mw/images/downloads/policies/Malawi-Program-for-Aflatoxin-Control-(MAPAC)-Final-Report.pdf) (accessed on 8 July 2018).
38. UNIDO. *Independent Evaluation. Malawi Capacity Building for Aflatoxin Management and Control in Groundnuts. Evaluation*; UNIDO: Vienna, Austria, 2012; Available online: https://www.unido.org/sites/default/files/2012-06/Aflatoxin%20Malawi%20final%20evaluation%20report_0.pdf (accessed on 8 July 2018).
39. Chidziwisano, Esteves-Mills and Morse. *Impact of Community-Based WASH and Food Hygiene Interventions on Diarrhoeal Disease Incidence in Children under Five*. 2016. Available online: <http://www.sharesearch.org/research/impact-community-based-wash-and-food-hygiene-interventions-diarrhoeal-disease-incidence> (accessed on 3 May 2018).
40. WHO. *WHO Estimates of the Global Burden of Foodborne Diseases: Foodborne Disease Burden Epidemiology Reference Group 2007–2015*; World Health Organization: Geneva, Switzerland, 2015; ISBN 978 92 4 156516 5.
41. FAO. *Evaluation of FAO's Contribution to Strategic Objective 4: Enabling Inclusive and Efficient Agricultural and Food Systems—Review of the implementation of FAO's Strategy for Improving Food Safety Globally*. 2017. Available online: <http://www.fao.org/3/a-bd712e.pdf> (accessed on 17 May 2018).
42. Unnevehr, L. Food Safety in Developing Countries: Moving beyond exports. *Glob. Food Secur.* **2014**, *4*, 24–29. [CrossRef]
43. Lanata, C.F. Studies of food hygiene and diarrhoeal disease. *Int. J. Environ. Health Res.* **2003**, *13* (Suppl. 1), S175–S183. [CrossRef] [PubMed]
44. SADC. *Regional Guidelines for Regulation of Food Safety in SADC Member States*. 2011. Available online: https://www.sadc.int/files/7714/4179/4721/Regional_Guidelines_for_the_Regulation_of_Food_Safety_in_SADC_Member_States__EN.pdf (accessed on 11 June 2018).
45. WHO/AFRO *Guidelines for Food Safety and Nutrition Food Law Guidelines*. Available online: <http://www.afro.who.int/publications/food-safety-and-nutrition-food-law-guidelines> (accessed on 4 May 2018).
46. Mensah, P.; Mwamakamba, L.; Mohamed, C.; Nsue-Milang, D. Public Health and Food Safety in the WHO African Region. *Afr. J. Food Agric. Nutr. Dev.* **2012**, *12*, 6317–6335.
47. National Statistical Office (NSO) [Malawi] and ICF. *Malawi Demographic and Health Survey 2015-16*; NSO: Zomba, Malawi; ICF: Rockville, MD, USA, 2017.
48. WHO. *Situational Report No. 160. Cholera Outbreak*. 2018. Available online: http://www.afro.who.int/sites/default/files/2018-04/Zambia_Sitrep_Cholera%20-%202018%20-%20%2024%20March%202018.pdf (accessed on 12 May 2018).
49. WHO. *Weekly Bulletin on Outbreaks and Other Emergencies*; WHO: Geneva, Switzerland, 2018; Available online: <http://apps.who.int/iris/bitstream/handle/10665/259850/OEW02-0612012018.pdf;jsessionid=14000D910B9C52C8EF56F30C9D755D91?sequence=1> (accessed on 8 July 2018).
50. Unnevehr, L.; Hoffman, V. Food safety management and regulation: International experiences and lessons for China. *J. Integr. Agric.* **2015**, *14*, 2218–2230. [CrossRef]
51. Black, J.; Baldwin, R. Really Responsive Risk-based Regulation. *Law Policy* **2010**, *32*, 181–214. [CrossRef]
52. Frean, J.; Perovic, O.; Fensham, V.; McCarthy, K.; von Gottberg, A.; de Gouveia, L.; Poonsamy, B.; Dini, L.; Rossouw, J.; Keddy, K.; et al. External quality assessment of national public health laboratories in Africa, 2002–2009. *Bull. World Health Organ.* **2012**, *90*, 191–199. [CrossRef] [PubMed]
53. Magwedere, K.; Songabe, T.; Dziva, F. Challenges of Sanitary Compliance Related to Trade in Products of Animal Origin in Southern Africa. *Ital. J. Food Saf.* **2015**, *4*, 5114. [CrossRef] [PubMed]

54. Leon, M.B.; Albrecht, J.A. Comparison of adenosine triphosphate (ATP) bioluminescence and aerobic plate counts (APC) on plastic cutting boards. *J. Foodserv.* **2007**, *18*, 145–152. [[CrossRef](#)]
55. Powell, S.C.; Attwell, R.W. The use of ATP-bioluminescence as an objective measure of food hygiene standards. *Int. J. Environ. Health Res.* **1997**, *7*, 47–53. [[CrossRef](#)]
56. Global Food Safety Partnership. African Food Safety Capacity Building—Landscape Mapping to Assess Effectiveness. 2016. Available online: <https://www.gfsp.org/portfolio/african-food-safety-capacity-building-landscape-mapping-assess-effectiveness> (accessed on 17 May 2018).
57. Ortega, D.L.; Tschirley, D.L. Demand for food safety in emerging and developing countries. *J. Agribus. Dev. Emerg. Econ.* **2017**, *7*, 21–34. [[CrossRef](#)]
58. Alphonse, R.; Alfnes, F. Consumer willingness to pay for food safety in Tanzania: An incentive-aligned conjoint analysis. *Int. J. Consum. Stud.* **2012**, *36*, 394–400. [[CrossRef](#)]
59. Alphonse, R.; Alfnes, F. Eliciting Consumer WTP for Food Characteristics in a Developing Context: Application of Four Valuation Methods in an African Market. *J. Agric. Econ.* **2016**, *68*, 123–142. [[CrossRef](#)]
60. Lagerkvist, C.J.; Hess, S.; Okello, J.; Karanja, N. Consumer Willingness to Pay for Safer Vegetables in Urban Markets of a Developing Country: The Case of Kale in Nairobi, Kenya. *J. Dev. Stud.* **2012**, *49*, 365–382. [[CrossRef](#)]
61. Lagerkvist, C.J.; Hess, S.; Okello, J.; Hansson, H.; Karanja, N. Food health risk perceptions among consumers, farmers, and traders of leafy vegetables in Nairobi. *Food Policy* **2013**, *38*, 92–104. [[CrossRef](#)]
62. Vidogbéna, F.; Adégbidi, A.; Tossou, R.; Assogba-Komlan, F.; Martin, T.; Ngouajio, M.; Simon, S.; Parrot, L.; Zander, K. Consumers' Willingness to Pay for Cabbage with Minimized Pesticide Residues in Southern Benin. *Environments* **2015**, *2*, 449–470. [[CrossRef](#)]
63. Soon, J.M.; Baines, R.; Seaman, P. Meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers. *J. Food Prot.* **2012**, *75*, 793–804. [[CrossRef](#)] [[PubMed](#)]
64. WHO. *UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) 2017 Report: Financing Universal Water, Sanitation and Hygiene under the Sustainable Development Goals*; WHO: Geneva, Switzerland, 2017; ISBN 978-92-4-151219-0. Available online: http://www.who.int/water_sanitation_health/publications/glaas-report-2017/en/ (accessed on 25 May 2018).



© 2018 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).