Food and Agriculture Organization of the United Nations

TRAINING HANDBOOK - FIRST EDITION

Enhancing Early Warning Capabilities and Capacities for Food Safety

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Training Handbook

First Edition

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Abbreviations

ANSES	French Agency for Food, Environmental and Occupational Health & Safety
AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine (China)
AU-IBAR	African Union – Inter-African Bureau for Animal Resources
CCH	Canadian Centre for Coastal Health
CFIA	Canadian Food Inspection Agency
CIFOR	Council to Improve Foodborne Outbreak Response
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EFSA-SCER	European Food Safety Authority-Scientific Committee and Emerging Risks
EMPRES	Emergency Prevention System for Food Safety (FAO)
EPIS	Epidemic Intelligence Information System
ERDS	Emerging Risk Detection Support (Netherlands)
EW	Early warning
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration (United States)
FSIS	Food Safety and Inspection Service (United States)
FSA	Food Standards Agency (United Kingdom)
IHR	International Health Regulations (2005)
INFOSAN	International Food Safety Authorities Network
ISS	Integrated *Salmonella* Surveillance (British Columbia, Canada)
OzFoodNet	New South Wales Enteric Disease Outbreak Surveillance System
PHAC	Public Health Agency of Canada
RASFF	Rapid Alert System for Food and Feed
SPS	Sanitary and Phytosanitary
WHO	World Health Organization

Glossary

Note: This document aims to provide working definitions for selected terms which are frequently used during the workshop and in its supporting materials. Where possible the definitions presented include or expand upon existing and internationally accepted terminology. The objective of this glossary is not to set and develop new standards, but to provide a common terminology in the context of early warning (EW) in food safety.

Driver of change
A driver references the underlying cause of change that might lead to the presence or potential occurrence of an emerging food safety risk. A driver of change could also lead to opportunities to enhance EW capacity. These may or may not be directly related to the issue at hand. Some examples of key drivers specific to food safety include globalization, changing demographics, farming intensification, and economics.

EW signal
Initial information suggesting that a potential ongoing or emerging food safety hazard or threat is occurring or could occur. Signals can be generated by traditional food safety surveillance systems (e.g. food inspection, laboratory surveillance) or less traditional food safety intelligence (e.g. foresight). EW signals may be difficult to detect and analyse, and care must be taken to avoid spurious information (e.g. not indicative of a true food safety threat or adverse event).

EW system
In the context of food safety, EW systems include various tools, technologies, processes, and resources used to monitor, detect, and verify EW signals, analyse data and information arising from such signals, and disseminate and communicate alerts to stakeholders at appropriate levels for the purpose of informing risk management actions and decision-making.

Emerging risk
A risk that results from a newly identified hazard to which a significant exposure may occur, or from an unexpected new or increased exposure or susceptibility to a known hazard (European Food Safety Authority [EFSA], 2007).

Food control
Food control is a mandatory regulatory activity of enforcement by national or local authorities to provide consumer protection and ensure that all foods during production, handling, storage, processing, and distribution are safe, wholesome and fit for human consumption; conform to safety and quality requirements; and are honestly and accurately labelled as prescribed by law (FAO/World Health Organization [WHO], 2003). The three basic characteristics of food control infrastructure include food law and accompanying regulations; a food inspectorate, analytical services and compliance unit; and supporting services such as education and training (FAO, 2000).

Food inspection
Food inspections are commonly conducted at abattoirs and food processing facilities, retail food premises (e.g. restaurants), and other food establishments as part of a national or local food control system in order to determine compliance with food safety and quality standards and regulations, and to determine if a food safety hazard exists (FAO, 2008). If a hazard is identified, the nature and extent of the issue is assessed and appropriate actions to eliminate or minimize potential risks are taken. Although primarily the role of government regulators, food inspection systems benefit from the assistance of industry, other government agencies and departments, and consumers.

Food safety alert
Alarm that warns risk managers about an impeding, unusual, or potentially adverse food safety threat or event at any stage of the food chain, from farm to consumer.

Food safety surveillance
The systematic and ongoing collection, analysis, interpretation and dissemination of data on signals of potential food safety threats or adverse events. Incorporates both *food chain surveillance* (primarily an agrifood agency activity that includes the identification, monitoring, and surveillance of hazards or threats along the food chain) and *public health surveillance* (primarily a public health agency activity that includes routine monitoring for food-borne illnesses in people).

Food safety threat or adverse event
An imminent harm or danger that threatens the production and provision of safe food.

Foresight
The activity of looking forward to gain insight about what will happen in the future. This insight is often integrated into planning and risk management.

Hazard
A biological, chemical, or physical agent in, or condition of, food with the potential to cause an adverse health effect (FAO/WHO, 2015).

Horizon scanning
A foresight method that acquires information about broad signals or trends via direct (e.g. research) or indirect (e.g. opinion) means to provide decision-makers with a view of future conditions that may challenge the established assumptions and beliefs, which form the basis of current decisions and processes.

Intelligence (for EW)
The actionable information (i.e. knowledge, experience, insight, surveillance, data) that is used to support decision-making. Intelligence gathering is the structured activity of collecting this

information while intelligence analysis seeks to understand the value, application, and implication of the information collected. Intelligence is collected by surveillance and foresight (e.g. horizon scanning) methods, and can be used to support EW and risk management activities.

Risk
In the context of food safety, refers to a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food (FAO/WHO, 2015).

Rapid alert network
The critical lines of regional, national, and/or international communication infrastructure necessary to rapidly disseminate information, communicate the risks, and raise an alert about an EW signal to relevant stakeholders such as government authorities, consumers, industry, and the media, in order to facilitate timely and appropriate responses and actions.

Risk assessment
A scientifically based process consisting of the following steps: i) hazard identification; ii) hazard characterization; iii) exposure assessment; and iv) risk characterization (FAO/WHO, 2006). Within the context of an EW system, rapid risk assessments are undertaken in the initial stages of a food safety threat or adverse event, whereas formal risk assessments are produced at a later stage of an event, usually when more time and information is available (European Centre for Disease Prevention and Control [ECDC], 2011).

Risk communication
The interactive exchange of information, knowledge, and opinions throughout the risk analysis process concerning risk, risk-related factors, and risk perceptions among risk assessors, risk managers, consumers, industry, the academic community, and other interested parties, including the explanation of risk assessment findings and the basis of risk management decisions (FAO/WHO, 2006).

Risk management
The process, distinct from risk assessment, of weighing policy alternatives in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers and for the promotion of fair trade practices, and, if needed, selecting appropriate prevention and control options (FAO/WHO, 2006).

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CHAPTER 1

Introduction

Background

The consumption of unsafe foods is an important cause of human illness and mortality worldwide, and the potential for unsafe foods to cross borders has increased with the growth of international trade in food and feed commodities (Ercsey-Ravasz *et al.*, 2012). EW systems that result in the timely detection and response to food safety events are necessary to minimize the negative effects of these events on human health and welfare, as well as the effects on global trade, income, employment, and food security. EW systems refer to the tools, processes, resources, and networks used to identify and verify EW signals, analyse data and information arising from such signals, and communicate associated alerts appropriately to relevant stakeholders in order to inform risk management actions and decision-making.

One of the primary goals of any EW system should be to enable prevention and timely mitigation of serious national or international food safety emergencies arising from potential adverse events along the entire food chain, from farm to fork (Kleter and Marvin, 2009). With this goal in mind, countries should strive to develop and strengthen their national EW capability and capacity, and to link those with regional and global EW and rapid alert networks.

Traditionally, EW systems have relied primarily on reactive approaches to detecting food safety hazards in the food chain, focusing on early identification, mitigation, and control of food contamination events or human illnesses once they have already occurred (Marvin *et al.*, 2009). There is increasing international momentum to strengthen the predictive capacity of EW systems, so that data related to broad signals and drivers of the occurrence of new and emerging food safety issues can be collected, analysed, and communicated to better anticipate and respond to immediate and less immediate food safety threats (Marvin *et al.*, 2009; Danan *et al.*, 2011; van de Brug *et al.*, 2014). EW systems that effectively integrate both predictive and reactive capacity are needed to support countries' strategic decision-making and emergency preparedness, prevention, and mitigation efforts.

The Emergency Prevention System for Food Safety (EMPRES Food Safety) unit of FAO works with FAO members and other partners to prevent and manage global food safety events and emergencies. The main aim of EMPRES Food Safety is to prevent and control food safety risks. In collaboration with their WHO counterparts, the EMPRES Food Safety Unit has been developing a five-year strategy to accomplish two key objectives: 1) to effectively assist countries in building and enhancing EW capacities in food safety, and 2) to establish global, sustainable, and collaborative EW food safety networks and partnerships to guide and bring together country, regional, and global-level initiatives and pilot projects.

Overview of national EW systems

EW systems should not be developed in isolation, but should rather be linked with and built upon the existing infrastructure elements of national agrifood production and control systems, which form an essential foundation for EW activities, capabilities, and capacity. EW systems should therefore take into account the country-specific objectives, priorities, dynamics, and anticipated trends within existing systems and infrastructure. This includes food value chains, food inspection systems, laboratory networks, surveillance programmes, as well as risk analysis capacities.

While recognizing the need to tailor and adapt the concept to specific country contexts, a functional, national EW system can be conceptualized around three pillars of sequential processes and functions (Figure 1.1).

Pillar 1 relates to all of the tools, processes, and systems that might contribute to the detection of initial EW signals, including surveillance programmes, inspection systems, and intelligence-gathering foresight techniques (e.g. horizon scanning). Detected signals can relate to immediate, emerging, ongoing, or future food safety threats. Finally, this pillar includes all of the processes, arrangements, and the necessary technological platforms to share surveillance information and signals and to maintain databases.

Pillar 2 includes the verification and investigation of signals identified by surveillance, monitoring, and intelligence-gathering foresight techniques to filter out potential false alarms (e.g. through trace-backs, trace-forwards, and epidemiological investigations). The nature of the investigation and the primary agency responsible to lead it (e.g. agrifood or public health authority) will depend on where along the food chain the signal is detected. This stage relies on other critical elements and capabilities of food control systems, including risk assessment (or rapid risk assessment in the context of emergencies) of potential threats or adverse events, and the identification of potential options for risk management.

Pillar 3 relates to the establishment and enhancement of national rapid alert networks to facilitate and coordinate EW activities, from identification and verification of signals, to drafting of alerts and their timely dissemination to relevant stakeholders and audiences at all

appropriate levels (local communities, national, regional, and/or global). This should include integration and linkages with relevant global and regional rapid alert networks, including the International Food Safety Authorities Network (INFOSAN), a joint WHO and FAO initiative (WHO, 2015). Communication of timely alerts informs decision-making and effective implementation of actions for the prevention or mitigation of food safety risks.

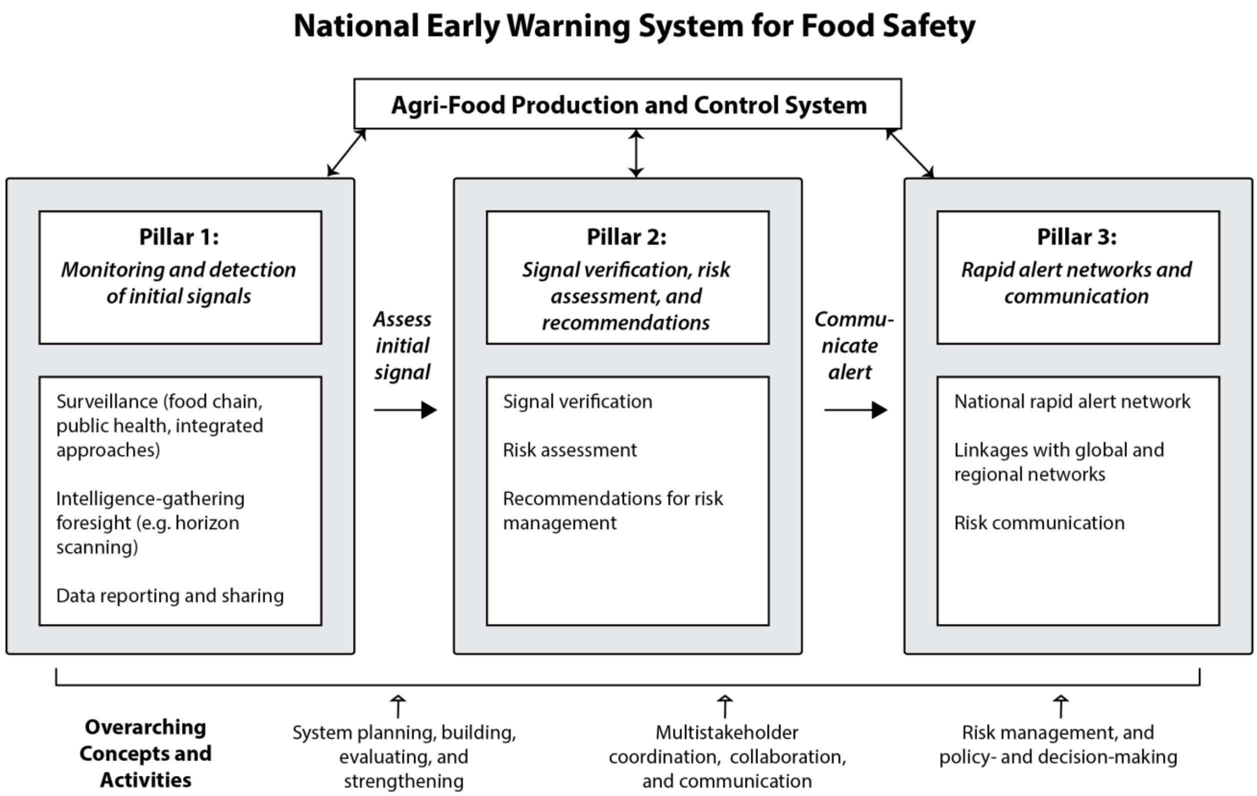

Figure 1.1: Processes and functions of a national EW system for food safety.

Countries should continuously monitor, evaluate, improve, and strengthen their EW system to ensure that it is functioning effectively and efficiently. This should include ongoing strategic planning and analysis of critical EW system objectives, priorities, needs, gaps, opportunities, and challenges. A country-specific plan should be developed and maintained that outlines how such factors have been considered and are being addressed to support EW capability and capacity.

Another overarching element of EW systems is the importance of continuous collaboration, coordination, and communication between multiple stakeholders. Like broader agrifood production and control systems, EW systems operate at the interface of food, agriculture, and public health. In order to function effectively at the national level, concerted efforts from all relevant sectors are required. Appropriate linkages, support, and commitment are needed

among all stakeholders, and their various roles and responsibilities should be clearly established, communicated, and understood.

EW systems should be linked with the national risk analysis framework for food safety (FAO/WHO, 2006). Risk assessment is a key activity of Pillar 2, in assessing possible food safety threats and adverse events to determine any associated risks to consumers. Risk communication principles form an essential component of Pillar 3, in supporting the timely and effective dissemination of alerts. EW systems provide important inputs to inform risk management at multiple levels, including possible policy- and decision-making actions that might be considered in response to a verified signal and real or potential food safety threat.

Objectives of this handbook

This handbook has been developed as a guide for countries to meet the following primary objectives:

1. To increase understanding of EW systems and their relevance to ongoing improvement of national (and where applicable, regional) food control systems.
2. To enable the establishment of sustainable and collaborative national EW systems for food safety, including linkages with relevant rapid alert networks, at regional and global levels.
3. To provide practical tools and approaches for improving EW capability and capacity at the national, regional, and global levels, including, for example, surveillance and intelligence for early detection of events, threat verification and assessment, and communication of alerts to decision-makers.
4. To provide an opportunity to work through practical questions and case studies related to the EW concept and to develop actionable proposals for improving a country's own EW system.

Scope of the handbook

The handbook is intended to provide a general overview of the key elements of a national EW system for food safety and to stimulate critical thinking, discussions, and problem solving in support of developing and strengthening such a system. To this end, a combination of actionable items, tools, and checklists are provided throughout the handbook.

This handbook is not an academic textbook. Although sufficient detail to introduce or explain key concepts is provided where it is warranted, this handbook does not describe all elements related to EW systems in full detail. Instead, it focuses on critical features and considerations that are not covered in other resources. Where appropriate, references are provided for additional details and guidance. For example, further information about developing national

food safety emergency response plans, developing national food recall systems, and applying risk analysis principles during food safety emergencies can be found in a series of FAO/WHO guides on these topics (FAO/WHO 2010; FAO/WHO 2011; FAO/WHO, 2012). Further information about outbreak investigations in the context of food-borne disease is available from the WHO (2008), and additional guidance on risk communication as applied to food safety can be found in a forthcoming FAO/WHO guide (FAO/WHO, 2015).

Target audience

The intended audience for this handbook is managerial and senior-level professionals from agrifood, public health, and other national authorities and agencies with the mandate for (or who are in a position to mandate) food safety surveillance, signal verification, risk assessment, and multiagency communication and coordination, including direct interactions with national food safety risk managers and decision-makers. A basic working knowledge of food value chains, surveillance techniques, sampling strategies, and food safety risk analysis is assumed.

How this handbook was developed

This handbook is a culmination of work previously conducted by EMPRES Food Safety, Agriculture and Consumer Protection Department of the FAO, and the Canadian Centre for Coastal Health (CCH). This work began with a structured literature review and a survey of food safety experts for their opinions regarding EW systems and rapid alert networks for food safety events (FAO/CCH, 2013). The technical report generated from the review and survey was used to provide background for an FAO-sponsored technical workshop on the same subject that also included consideration of horizon scanning (FAO, 2013). The workshop brought together experts in food safety from around the globe to Rome, Italy, during 22–25 October 2013. This handbook was then put together by the EMPRES Food Safety group in collaboration with CCH, Petra Muellner, and George Prpich. An initial draft of the handbook was pre-tested during a regional workshop co-hosted by EMPRES Food Safety and the African Union Inter-African Bureau for Animal Resources (AU-IBAR) on "Enhancing East African's EW Systems for Food Safety" (Nairobi, Kenya, 27–31 October 2014) (AU-IBAR, 2014). It was then updated and pre-tested again at a regional workshop in Budapest, Hungary, 1–4 June 2015, serving 13 countries from Europe and Central Asia, after which it was peer-reviewed by several international experts.

How to use this handbook

There are seven chapters in this handbook. The current Chapter 1 provides a brief introduction to and overview of EW systems for food safety and outlines the objectives, scope, target audience, and development of the handbook. In Chapter 2, background context of agrifood

production and control systems is provided to highlight their importance and role in shaping a country-specific EW system.

Chapters 3–5 cover different aspects of EW Pillar 1: "monitoring and detection of initial signals". Chapter 3 provides a background and overview of food safety surveillance systems and approaches as key tools to facilitate early detection of signals. Chapter 4 briefly introduces the concept of foresight and intelligence techniques, such as horizon scanning, which can be used to add additional anticipatory capacity to EW systems with the aim to detect and anticipate medium- to long-term signals and trends with possible implications for food safety decision-making and emergency preparedness. Chapter 5 provides a detailed description of the key components, characteristics, approaches, and challenges related to early detection of signals that could result in adverse food chain or public health events. Some different examples of functioning EW systems are provided in this chapter and an EW diagrammatic tool (the "EW matrix") is introduced and discussed in detail, which allows stakeholders to plot and evaluate their EW system characteristics, strengths, gaps, and opportunities.

Chapter 6 introduces and discusses the different actions and processes that might occur as a result of an identified signal, from signal verification to assessment of potential threats or adverse events, development of recommendations for action, and communication of alerts to appropriate stakeholders via rapid alert networks. Key characteristics and functions of rapid alert networks are discussed, with a focus on national networks and linkages with regional and global initiatives. Examples are illustrated of existing national and regional networks for food safety, and an overview of the INFOSAN initiative is provided. This chapter covers elements of EW Pillar 2 (signal verification, risk assessment, and recommendations) and Pillar 3 (rapid alert networks and communication).

Chapter 7 concludes the handbook by providing practical guidance on aspects to be considered when planning, evaluating, and improving a national EW system.

Within each chapter, case studies and examples are provided whenever possible to facilitate real-world application and understanding of the concepts presented. These examples, as well as other tips or points for clarification, are occasionally highlighted as text boxes, and some concepts are further illustrated through supporting diagrams or figures.

Finally, there is no one-size-fits-all approach to EW for food safety. The unique national context and situation should drive the composition and strategy for a country-specific EW system. As a result, the examples of working systems and networks included in this handbook are meant to help compare and contrast different solutions, and are not intended to be directly applicable to all contexts and situations or to represent a gold standard approach.

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CHAPTER 2

Agrifood Production and Control Systems – Implications for Early Warning

This chapter provides an overview of agrifood production and control systems, including different types of food chains and considerations to ensure that food produced is safe for consumption. The objectives of the chapter are to illustrate the role and impact of national and regional agrifood production and control systems for developing or enhancing an EW system.

Key Ideas

- Agrifood production systems are complex, dynamic, and evolve constantly.
- Understanding the specifics of a country's agrifood production systems is an important first step to build and improve a food control system.
- Food control systems provide the foundation of EW capabilities; for example, through the surveillance activities conducted.
- Failure of food control systems can lead to widespread adverse consequences not only to public health and consumer protection, but also to local and regional economies, international trade and market access, stakeholder livelihoods, and consumer confidence.
- Low- and middle-income countries can face particular challenges in food control due to a lack of enabling factors such as policies, infrastructure, resources, and coordination in the food supply chain, which all contribute to the effectiveness of an EW system.
- Investments are needed to ensure and enhance the safety of food generated by food chains in low- and middle-income countries.
- As hazards can arise anywhere along the food supply chain, it is important to manage risks using an integrated approach (and preferably early in the food chain continuum).

Introduction

This chapter provides an overview of agrifood production and control systems (for brevity reasons referred to henceforth as food production and control systems) and how their features impact on EW system development. This understanding coupled with a good knowledge of food safety surveillance (Chapter 3), applied to anticipate or early detect food safety threats, should always be taken into consideration when assessing and addressing EW gaps, needs, and strategy development at the national and regional levels.

Food production systems

Food production systems include all efforts to generate food products for human consumption. Food production, processing, and marketing systems are known to be complex and evolve continuously (FAO, 2006). Per definition, a system is made up of two different aspects: a set of components and a network of functional relationships, which work together to reach an objective. In each system, components interact through links (FAO/WHO, 2011). Food production usually happens within a food system that, like a web, contains several dependencies that link production, processing, and consumption with the wider environment. Food systems encompass food chain activities as well as the outcome of these activities and their governance (Vermeulen, Campbell, and Ingram, 2012).

Key stakeholders in food production include:

- Primary producers such as farmers, fishers, and foresters
- Agricultural input and equipment suppliers and service providers (e.g. pesticide and feed suppliers, transport companies)
- Food processors
- Food distributors, retailers, and food service
- Consumers
- Government agencies responsible for agriculture, fisheries, forestry, environment, industry, trade, and in particular those responsible for protecting human, animal, and environmental health
- Academia and primary education in food and agriculture
- Financial and credit institutions
- Non-governmental organizations and relevant representative organizations of the civil society such as farmers and fishers unions, industry, trade, and consumer organizations

Food production systems vary substantially among countries and regions. For example, in many developing countries, food systems are highly fragmented and depend on a large number of small producers rather than a few larger ones (FAO, 2006). While this has socio-economic benefits, traditional production and handling processes are often challenged by factors such as

intensification of agricultural practice, changing demographics, globalization, climate change, and emerging food safety risks (FAO, 2006; Henson and Jaffee, 2006).

The composition and structure of a production system in a country will always be dependent on the given context, including factors such as:

- Geography (e.g. climate, watershed, arable land)
- Demographics (e.g. population growth and age, degree of urbanization)
- Socio-economics (e.g. level of poverty)
- Policies (e.g. agriculture policy, land tenure, trade policy)
- Cultural traditions and anthropologic factors (e.g. consumption patterns)

Factors linked to globalization such as demography, shifting consumption patterns, trade liberalization, climate change, and urbanization, apply pressure on food systems worldwide (Henson and Jaffee, 2006; Vermeulen, Campbell, and Ingram, 2012), forcing them to adapt to changing needs and threats. Understanding these dependencies is vital later on when developing surveillance and EW systems for food safety.

Food production is commonly visualized as a supply chain of individual processes (Figure 2.1). As product transformations and transactions take place along a chain of interrelated activities from farm to table, value is added successively. The term “value chain” has thus been used to characterize these interconnected, coordinated linkages along a continuum from land and inputs to primary production up to the consumer (FAO, 2007). In some cases, the supply can further be linked through a “cold chain” during which continuous refrigeration or freezing is used to prevent multiplication of microorganisms and extend the shelf life of food (Vermeulen, Campbell, and Ingram, 2012).

Generally food chain activities encompass a large number of activities, including:

- Manufacturing and distribution of inputs (e.g. seeds, fertilizer, or animal feed)
- Agricultural production and fisheries (e.g. crops and livestock)
- Processing (primary and secondary)
- Packaging and storage
- Transportation
- Marketing and retail
- Food service and catering
- Domestic food management and waste disposal

Overall, there is great diversity in food chains, ranging from large and complex food chains to smaller and shorter chains serving more local or informal markets (FAO, 2007). A mix of both chains might be present in a given country or region for different commodities. Figure 2.2 provides a visualization of different value chains in food production. Moreover, increasingly due to globalization of the agrifood supply, different steps in the food chain might be conducted in

more than one country for some commodities, further complicating food control, surveillance, and traceability efforts (Ercsey-Ravasz *et al.*, 2012). For example, a commodity might be produced in one country, processed in another, and then exported to different international markets for retail distribution. Food control strategies should be tailored to the unique complexities of each food chain.

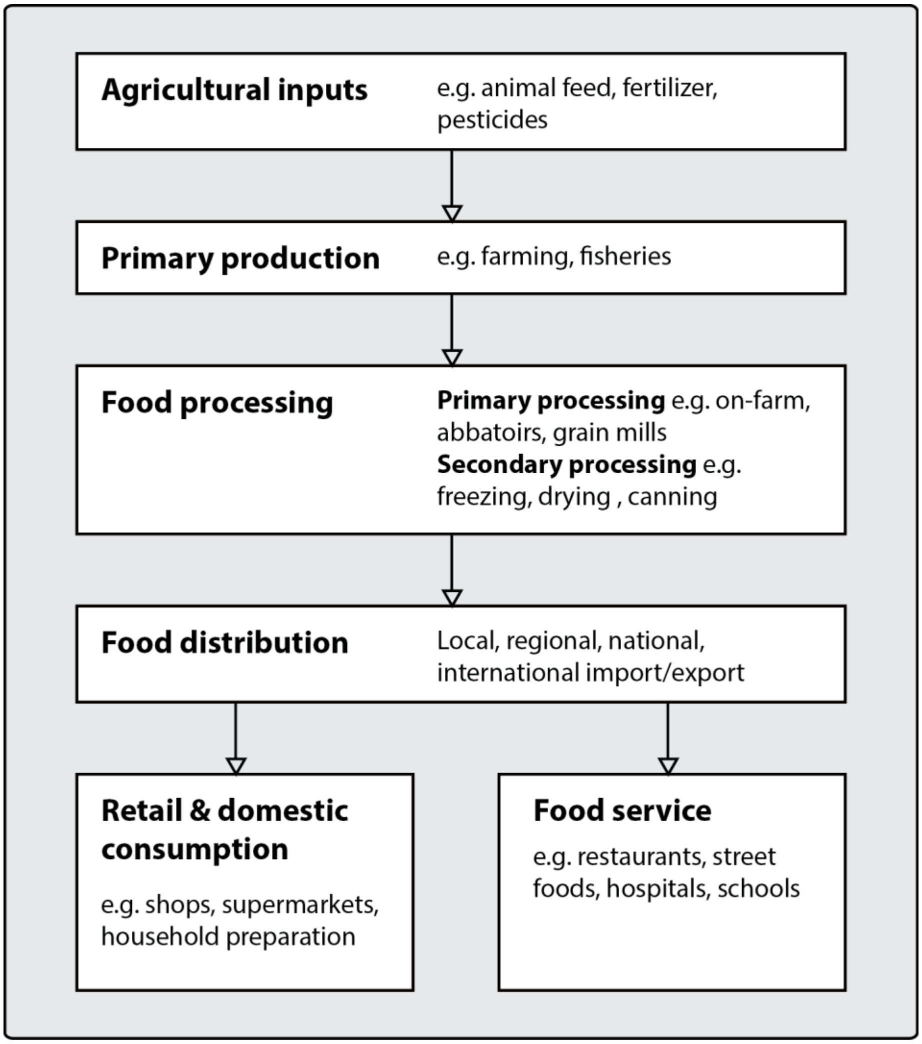

Figure 2.1: Overview of the principal stages of the food chain (adapted from FAO, 2006).

Food control systems

Food control systems should cover all food produced, processed, and marketed within a country, including imported food (FAO, 2006; EDES, 2012). It is of utmost importance that food safety is not considered in isolation, but conceived as an organized system with the aim of producing safe and suitable food (FAO, 2006; EDES, 2012). Strengthening food control systems

is an important step towards improved food safety, and the establishment of food control systems has become a pressing issue in many countries. It is now recognized that the responsibility for safe food is shared by producers, industries, government authorities, and consumers at all levels of the chain, from farm to processing, distribution, retail and consumption (Mwamakamba *et al.*, 2012).

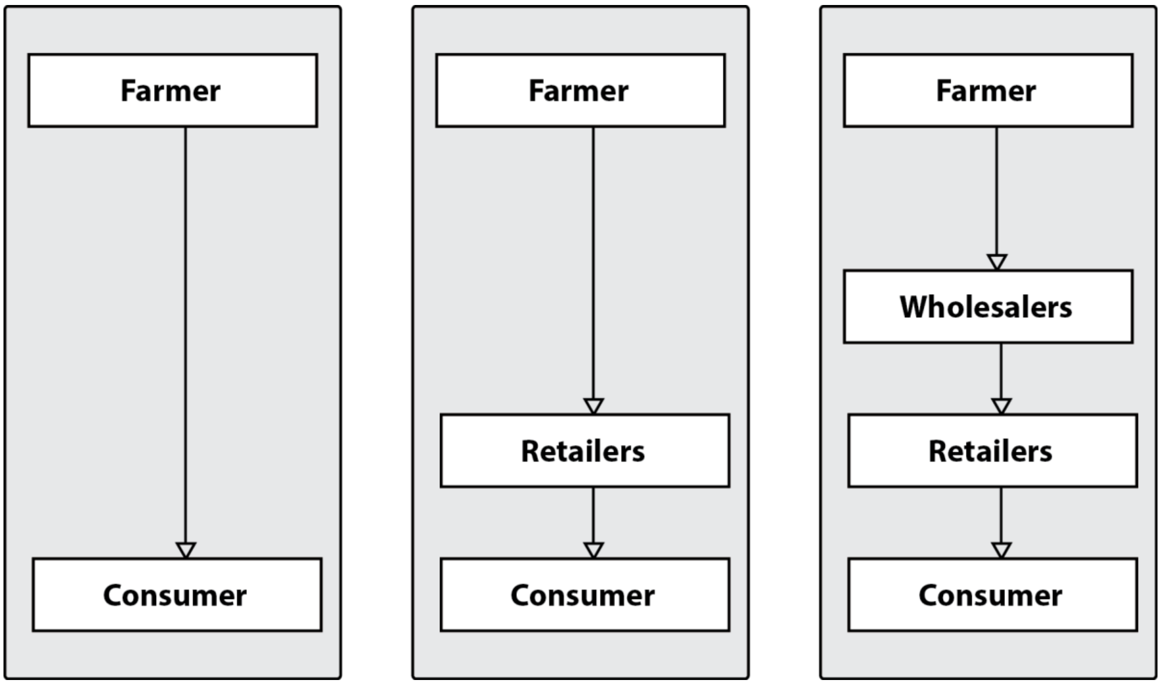

Figure 2.2: Differing lengths and composition of food chains, illustrating the change from short, traditional food chains to longer and often more complex food chains.

There is an increasing emphasis on the development of holistic food control systems that use an integrated whole-of-chain approach, because food safety risks can occur at any point along the chain (Mwamakamba *et al.*, 2012). Depending on the nature of the food chain continuum, an integrated food chain approach will include different steps.

The main components of food control systems

Food control systems serve three main purposes: protect public health; protect consumers; and contribute to economic development. The first step for developing a food control system should be the setting of clear objectives to guide how the system is built, run, and eventually evaluated.

Principle objectives include:

1. Protect public health, for example, through:

- Identifying and responding to food safety threats and hazards along the food chain
- Implementing control measures to reduce or eliminate threats and hazards in foods and to prevent and mitigate consumer exposure
- Increasing the reporting and response to food-borne illnesses and outbreaks

2. Protect consumers from unwholesome, mislabelled, or adulterated food, for example, through:
   - Reducing negative quality attributes of food such as spoilage, contamination with filth, and discoloration
   - Preventing food fraud and adulteration

3. Contribute to economic development, for example, through:
   - Maintaining in-country consumer and trading partner confidence in food safety
   - Decreasing the socio-economic costs and food security impact from lost production
   - Securing market access for exports

When food control systems fail, the adverse consequences can be severe and can spread throughout the entire food system (Hennessy, Roosen, and Jensen, 2009). A number of major public health scares have occurred in recent years, highlighting the severity and reach of food safety issues (see Box 2.1 for an example). The consequences of a food safety contamination event or system failure may spread further down the chain and could exceed the immediate impact on public health, as the necessary destruction of food may affect food security, incomes, employment, stakeholder livelihood, consumer confidence, access to international markets, and food prices. For example, food system failures could compromise a county's capacity to meet minimum mandatory standards for trade under the World Trade Organization's Sanitary and Phytosanitary (SPS) Measures Agreement (Henson and Jaffee, 2006; EDES, 2012). In addition to trade impacts, national economic consequences of food safety incidents can be major (Yang *et al.*, 2009; Hoffmann, Batz, and Morris Jr., 2012).

Particularities of food production and control in low- and middle-income countries

Low- and middle-income countries often face particular challenges in food production and control. For example, consequences of food safety failures can exacerbate existing challenges, including poverty, malnutrition, and famine (Hennessy, Roosen, and Jensen, 2009). Other food safety challenges could include: limited awareness and expertise about food safety; outdated legislation and regulation; and inadequate policies, coordination, capacity, infrastructure, and resources (FAO, 2006; Henson and Jaffee, 2006; Mwamakamba *et al.*, 2012). Food production and control in low- and middle-income countries may be especially sensitive to climate change, possibly compromising future food security in these regions (Vermeulen, Campbell, and Ingram, 2012).

Box 2.1: Melamine crisis leads to significant health, trade, and economic impacts

In China in 2008, counterfeiting of milk with melamine resulted in six deaths, 300 000 illnesses, and 115 types of affected food products in many countries. Melamine was used to mask the fraudulent dilution of milk with water by increasing its apparent protein content. The adulteration went undetected because commonly used methods for protein analysis of milk cannot distinguish between nitrogen from melamine and nitrogen from milk proteins. The crisis led to 68 countries recalling or banning imports of milk and milk products from China, while other countries implemented targeted testing of products suspected of containing melamine, or took other regulatory measures (e.g. establishing limits for melamine in food or feed). The crisis caused millions of dollars in losses to the Chinese dairy industry and significantly affected its market credibility.

Source: Gossner et al., 2009; Yang et al., 2009.

The highly fragmented nature of food systems in low- and middle-income countries can also pose potential food safety problems. For example, as a large quantity of food passes through a multitude of food handlers and middlemen, the risk of contamination and adulteration increases (FAO, 2006). Public policy and investment to improve the safety of food distribution channels in these countries will be crucial to preserve the viability of smallholder agriculture and to support smallholder interests (FAO, 2006). Informal markets like street kiosks, corner stores, or open wholesale markets play a significant role in low- and middle-income countries, where, as a consequence of rapid urbanization, an estimated one-quarter of food expenditures are incurred outside of the home. These entities are associated with major food safety concerns due to potential for contamination, adulteration, and lack of basic infrastructure (e.g. water quality, power reliability, and access to education or training) (FAO, 2006; Hennessy, Roosen, and Jensen, 2009). Food safety investments in these markets would help to support their role in the food supply chain, leading to direct benefits for local farmers, traders, and economies (McCullough, Pingali, and Stamoulis, 2008).

While some low- and middle-income countries have improved their food control systems, many countries still struggle with the basics of effective food control (Mwamakamba *et al.*, 2012). A major problem in a number of African countries, for example, is that traditional food control systems do not provide agencies with a clear enough mandate and authority for preventive action (Mwamakamba *et al.*, 2012). This often results in food safety programmes that are reactive and enforcement orientated rather than preventive and holistic (EDES, 2012). A lack of overall strategic direction for food safety means that limited resources are not properly utilized (FAO, 2006). These challenges limit a country's ability and capacity to effectively detect, analyse, and respond to emerging and enduring food safety threats.

Food production and control systems – consequence for national EW system development and enhancement

Food production and control systems provide a necessary foundation for national EW capabilities and capacity. A sound understanding of these systems is required to be able to identify the most suitable points in the supply chain for surveillance (including EW) and subsequent actions. As many food safety problems are systematic in nature, it is also important for them to be addressed in a systematic manner (Hennessy, Roosen, and Jensen, 2009). Any EW effort should therefore aim to build on existing national and regional food production and control systems and take a stepwise approach to improvement, carefully balancing competing priorities with resource constraints.

Overall, the focus of food control is shifting away from reactive, end-point testing towards more integrated food chain approaches and risk-based management of the production process (FAO, 2006; Mwamakamba *et al.*, 2012). Strengthening national food control capacity will improve a country's ability to prevent the escalation of adverse food safety events into possible human illnesses, outbreaks of disease, and food trade and economic consequences.

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CHAPTER 3

Food Safety Surveillance

This chapter describes how food safety surveillance is a key tool to improve national and regional capacities for food safety threat identification and monitoring and how it relates to improving EW system capabilities.

Key Ideas

- As a key component to a functioning food control systems, food safety surveillance can identify and monitor for food safety threats and adverse events, providing a foundation for EW capabilities and capacity.
- Food safety surveillance includes identification and monitoring of hazards along the food chain (primarily an agrifood agency activity) and food-borne illnesses in people (primarily a public health agency activity). Both types of surveillance are needed to continuously improve food safety along the whole food chain continuum.
- Many surveillance approaches can be used, including traditional, laboratory-based methods as well as non-traditional approaches such as syndromic (e.g. monitoring of drug sales) and event-based (e.g. media and web monitoring) surveillance.
- The choice of surveillance approach will largely depend on the specific information needs, context, resources, and other factors.
- To maximize early detection capabilities, a combination of different food safety surveillance approaches along the food chain continuum might be necessary.
- In the absence of a well-developed food control system, regular food inspection is an important starting point for surveillance.
- Building EW-capable surveillance systems requires concerted efforts at the national and regional levels, including collaboration and integration of data from agrifood, public health, and other sources.

Introduction

Surveillance is defined as the "systematic and ongoing collection, analysis, interpretation and dissemination of data for public health and food safety action" (WHO, 2012). Surveillance is a central element of food control systems and provides an integral foundation for EW capabilities. Regardless of how advanced a food control system is, surveillance can and should be performed to measure, demonstrate, and enhance system performance. For any preventive food control system to be successful it must be able to detect food safety events reliably and quickly, which is also referred to as early detection capability. Early detection forms the basis for EW and subsequent rapid alert activities.

Food safety surveillance

In the context of food safety, surveillance can refer to:

- *Food chain surveillance* – primarily an agrifood agency activity to describe the identification, monitoring, and surveillance of hazards or threats along the food chain.
- *Public health surveillance* – primarily a public health agency activity to describe routine monitoring for human food-borne disease. The vehicle of disease is often not known and the cases observed could be caused by many exposures, including food, water, and person-to-person spread or animal contact (Council to Improve Foodborne Outbreak Response [CIFOR], 2009).

Various methods for capturing information about food-borne disease exist, including notifications of food poisoning, laboratory report surveillance, outbreak surveillance, and international surveillance networks (Smulders and Collins, 2005). While public health surveillance is very meaningful and may contribute to the early detection of changes in disease occurrence or priority setting, it can only measure events happening at the very end of the food chain and typically only includes cases severe enough to be detected. The latter is often referred to as the "tip-of-the iceberg" (Figure 3.1).

To monitor and continuously improve food safety, the ability to detect both changes in disease patterns and variations in food supply chain contamination is a necessity. The differentiation between food chain and public health surveillance is therefore an important one, and the terms should not be used interchangeably. Throughout this handbook, both forms of surveillance are referred to under the broader umbrella of *food safety surveillance*, recognizing that close collaboration is needed between agrifood, public health, and other agencies involved in order to adequately detect and respond to potential threats or adverse food safety events along the entire food chain continuum.

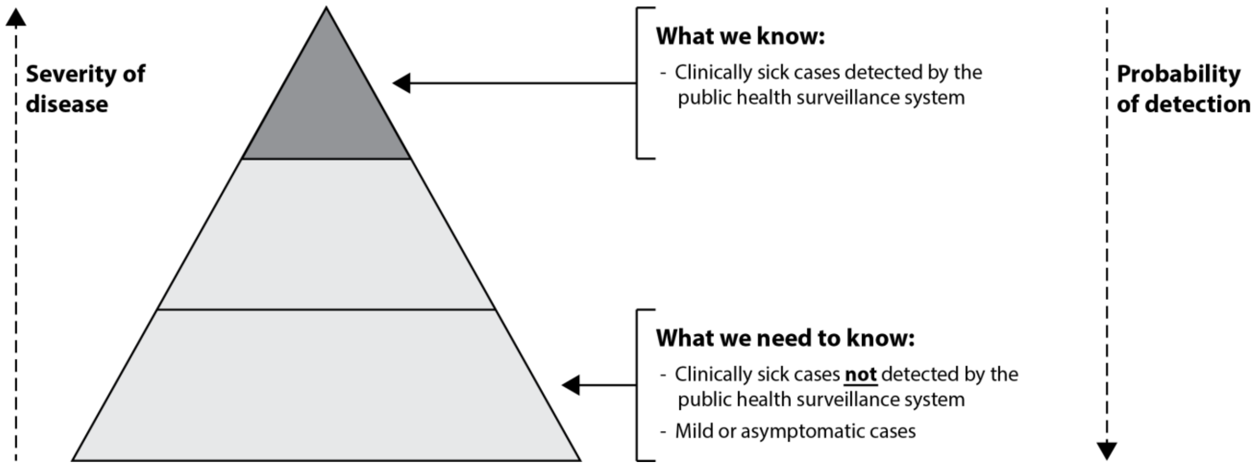

Figure 3.1: Illustration of burden of disease that is captured by public health (food-borne disease) surveillance.

Overall, the main aims of food safety surveillance fall into the following five categories (WHO, 2012):

1. Estimate the extent of contamination of food products or commodities (*food chain surveillance*), and the burden of food-borne disease in people (*public health surveillance*)
2. Monitor trends
3. Detect aberrations and adverse events
4. Assess and evaluate control programmes
5. Generate data for risk analysis

In addition, international trade and associated agreements like the World Trade Organization's SPS Measures Agreement require transparent, science-based decision-making. Importantly, the infrastructure of established surveillance programmes in one area can also serve as a framework to strengthen other surveillance activities (Lo Fo Wong *et al.*, 2005).

Surveillance practices vary widely (CIFOR, 2009), are highly context dependent, and can be conducted for several different purposes (Box 3.1). For example, routine and systematic monitoring is often conducted by national and regional governments to obtain data on the occurrence or levels of contamination of food-borne pathogens, indicator organisms, and chemical hazards in various food products and commodities.

One of the main components of any surveillance system is data collection, which can be classified as either "passive" or "active" (Salman, 2003). A description of these two approaches to data collection is illustrated in Box 3.2. Both active and passive data collection do not ensure the early detection of food safety threats or adverse events; however, they provide essential EW capacity and can help to identify patterns warranting further investigation (Salman, 2003).

Box 3.1: Different objectives, different data, different systems

Objective: Detecting food safety threats or adverse events
Early detection of food safety threats or adverse events (e.g. contamination in the food chain) is one of the primary objectives of surveillance. Any data to inform such a system would have to provide EW information to inform response activities. Active surveillance would be highly recommended in such a situation as it provides the most accurate and timely information.

Objective: Monitor intervention programmes
Specific programme indicators could be used to assess and monitor the effectiveness of intervention programmes. These could be based on passive surveillance through, for example, regular testing of food products. This type of surveillance could support the review or implementation of food safety policies. While it could generate EW signals, this type of surveillance should not be relied upon as a primary source of EW surveillance.

Source: Nsubuga et al., 2006.

One important consideration in an active surveillance system is the specific sampling strategy used to select samples from the target population, the latter of which could include establishments (e.g. monitoring of hygiene conditions of processors or retailors), animals, food products, or people (Eurostat, 2010). Sampling can be conducted using objective (random), selective (random but from a subpopulation), census, suspect (non-random but purposive), or convenience (non-random) approaches (Eurostat, 2010). The most appropriate approach will be dictated by the objectives and needs of the surveillance system, risk managers, and situational context.

Food safety surveillance – which is the most suitable approach?

Overall, surveillance can be specific to a pathogen or hazard. Such pathogen- or hazard-specific surveillance includes the systematic collection, analysis, and dissemination of information about laboratory-confirmed illnesses or well-defined syndromes as part of prevention and control activities (CIFOR, 2009). Furthermore, this can also include data collected from the whole food chain continuum; for example, samples taken during primary processing of a food product. This approach is often used for notifiable or reportable diseases, such as those falling under WHO International Health or World Organisation for Animal Health (OIE) reporting regulations and regulatory monitoring programmes in food for chemical and microbiological contaminants.

Box 3.2: Active and passive data collection in surveillance

Active data collection

Active collection of data refers to the systematic or regular recording of events, often in a specified population or group of samples. This might include the collection of samples on a farm or a slaughterhouse as well as screening animal or human medical records. An example of such data collection is the bovine spongiform encephalopathy screening of fallen and emergency slaughtered cattle in Europe. Active data collection is often also initiated in the context of an outbreak of food-borne disease in humans, where frontline practitioners and laboratories collect and report specified data to assess the impact of any response and control measures. Active data collection can be very costly, in particular where the prevalence of the event is very low.

Passive data collection

Passive collection of data involves the reporting of suspected events by stakeholders at their discretion. Passive systems are most effective where awareness and educational levels of data providers are high. In the context of human or animal disease, cases with a high fatality rate would likely be reported more frequently under such a scheme.

Source: Salman, 2003.

A distinction must be made between food inspection and surveillance. Food inspections are commonly conducted at food processing plants like abattoirs or slaughter facilities, retail food premises, and other food establishments in order to determine compliance with food law. If a hazard is identified, the nature and extent of the issue is assessed and appropriate actions to eliminate or minimize potential risks are taken. Although primarily the role of government regulators, food inspection systems benefit from the assistance of industry, other government agencies and departments, and consumers. Many national food control systems rely on food inspection to ascertain compliance with food safety and quality standards and regulations (FAO, 2008). In the absence of a well-developed food safety surveillance and food control system, regular food inspection is an important starting point.

The following section introduces in more detail some examples of specific surveillance approaches that provide value to EW capacity. Ultimately, each surveillance approach has strengths and weaknesses that need to be carefully balanced against resource availability and context. The following approaches are covered below:

- Laboratory surveillance
- Syndromic surveillance
- Event-based surveillance
- Complaint-based surveillance

- Targeted, sentinel, and risk-based surveillance
- Participatory surveillance
- Integrated surveillance

Laboratory surveillance

Laboratory surveillance can include active or passive surveillance based on data collected by laboratories. Laboratory-based surveillance has strengths that include high specificity and data quality and can be implemented along the whole of the food chain. Some consider it the most useful system for monitoring long-term trends in food-borne disease (Smulders and Collins 2005) and food safety hazards. Weaknesses include passive reliance on sample submission and the necessity for infrastructure and highly trained personnel. Molecular subtyping and next-generation gene-based technologies, as well as chemical forensic techniques, are currently expanding the power of laboratory-based surveillance to detect food-borne disease outbreaks and link cases to a food or other source through the use of molecular fingerprinting and whole-genome sequencing (Nsubuga *et al.*, 2006; Stasiewicz, den Bakker, and Wiedmann, 2015).

Syndromic surveillance

Syndromic surveillance aims to detect food safety hazards, contamination events, and illnesses earlier than traditional systems through identification of non-specific indicators such as disease symptoms or proxy measures like drug sales, web intelligence, or compliance with food control law and regulations. As a surveillance component it is well suited to EW due to its high sensitivity, but it often needs to be combined with other surveillance components to ensure a high enough specificity (May, Chrieten, and Pavlin, 2009). Sources of information for syndromic surveillance vary, but might include clinical data from medical or veterinary practitioners, drug sales records, web search trends, food inspection reports, or food product traceability data (e.g. cold chain temperature logs). Some challenges for syndromic surveillance include developing standardized and reliable indicators, and promoting integration with different existing food safety surveillance systems. Syndromic surveillance, while generally reported to be flexible and relatively inexpensive, is often limited by a considerable burden of false alarms, and an inability to distinguish between signals and background noise. However, it can be an appropriate choice in low-resource settings or where high system sensitivity is desired.

Event-based surveillance

Event-based surveillance is an organized and rapid capture of food safety event information from rumours and other *ad hoc* or unstructured reports. Such surveillance is not necessarily based on the routine collection of data. Sources of information may include media, health or food safety workers, and non-governmental organization reports. Recent advances in event-based surveillance include text-mining techniques, computer-supported event detection systems, and advanced algorithms that support the collection and processing of large amounts

of data from multiple sources. However, these surveillance approaches require collaboration between multiple stakeholders and the presence of trained experts who can appropriately interpret and act on the detected signals.

Complaint-based surveillance

Complaint-based surveillance includes any system that collects information from anyone suffering from food-borne disease that is attributed to a particular food establishment, food product, or event. Furthermore, it can include complaints about malpractice and quality issues in food production or food safety, including physical contamination of foods. Notification or complaint systems are intended to receive, triage, and respond to reports from the community about possible food safety threats or adverse events to conduct prevention and control activities (WHO, 2012).

Targeted, sentinel and risk-based surveillance

Targeted, sentinel, and risk-based surveillance systems focus efforts on specific subpopulations.

- *Targeted surveillance* refers to focusing sampling efforts on high-risk populations or groups of samples. This could for example include sampling of hamburger meat processed in large quantities, which is known to be of higher risk of *E. coli* O157 contamination than unprocessed meat (Salman, 2003). Targeted surveillance is primarily used to increase the effectiveness and efficiency of a surveillance system where the event is more common in the target group than in the general population and where specific risk factors for the event are known.

- In *sentinel surveillance*, a prearranged sample of reporting sources is used to detect and monitor unusual threats or events. It is assumed that the sample or sentinel population indicates trends in the total population. Sentinel surveillance can offer an effective way to use limited resources and can work very well for monitoring common or frequent events (Nsubuga *et al.*, 2006).

- *Risk-based surveillance* refers to surveillance programmes in which the design of exposure and risk assessment methods have been applied together with traditional design approaches in order to assure appropriate and cost-effective data collection. Risk-based surveillance approaches are guided by information about the occurrence of hazards associated with particular foods, the likelihood of consumers being exposed to such hazards, the consequences of exposure, and the capacity of the food control system to mitigate associated risks (Stärk *et al.*, 2006). As a result, they aim to demonstrate to consumers and other stakeholders that foods are being produced under conditions which minimize adverse health effects.

Participatory surveillance

Participatory surveillance refers to the gathering and integration of traditional knowledge systems and community perceptions and priorities to support ongoing surveillance programmes. Participatory surveillance uses an approach called “participatory rural appraisal” to collect local knowledge from key stakeholders for the purposes of surveillance. For example, participatory surveillance was used to improve surveillance of highly pathogenic avian influenza in Indonesia, Sub-Saharan Africa, South Sudan and Egypt (Mariner *et al.*, 2014). Participatory approaches can be of particular value in the context of food safety and EW systems as they can provide food safety information that might not be possible to gather with traditional means like product sampling. Participatory surveillance is an evolving concept that should be adapted and evaluated to each specific context.

Integrated surveillance

Integrated surveillance systems consider data from human, animal, food, and environmental sources and are based on the awareness that the complex interrelationships between humans, animals, and the environment can only be understood with well-integrated and multidisciplinary programmes (Smulders and Collins, 2005; WHO, 2013). Integrated food chain surveillance enables attribution of the burden of disease to specific food categories through the use of monitoring information from multiple sources (WHO, 2012). Furthermore, such systems can be built under a “One Health” framework, where human, animal, and environmental health are unified to achieve an improved outcome for all sectors and to effectively deal with problems that emerge at the interface of the different sectors (Parmley *et al.*, 2013). International guidance is available, for example, on how to develop an integrated surveillance programme for antimicrobial resistance in food-borne bacteria (WHO, 2013).

Surveillance approaches – recommendations for efficient design in the context of EW

Of the various surveillance approaches described above, some can be used at multiple points along the food chain continuum, while others are useful only at a specific point. Following an integrated and holistic food chain approach, data can and should be collected at different stages of the chain by relevant departments and agencies (e.g. agrifood and public health). Where possible, all readily available surveillance information applicable to food safety in a given region or country should be integrated to support comprehensive EW capacity (e.g. linking of human medical records due to food-borne disease with syndromic surveillance of drug sales with targeted surveillance of hazards in the food chain). A dedicated multidisciplinary surveillance unit, consisting of epidemiological, chemical, and microbiological expertise, can then support coherent analysis of such integrated data to ensure timely response to possible food safety threats and adverse events along the entire food chain (Lo Fo Wong *et al.*, 2005).

Recent years have also seen an increasing amount of non-traditional approaches to food safety surveillance, such as intelligence-gathering foresight techniques, to better anticipate medium- to long-term threats to the food chain using a variety of broad signals from multiple sources. Foresight approaches in the context of EW for food safety are described in more detail in Chapter 4.

Figure 3.2 illustrates how different surveillance approaches provide information at different steps of the food value chain. The most appropriate approach to surveillance in a given context should be informed by the scope, objectives, resource availability, and composition of a country's food production and control system. For example, a surveillance approach that works well for longer, more complex food supply chains in developed countries may not be most appropriate, economical, or effective for more informal and shorter chains typically present in low- and middle-income countries. Given the diversity in food production and in value chains described in Chapter 2, it is important that any surveillance system supporting EW capabilities is context specific and tailored to the national food production and control system. It many cases, it is likely that a combination of different surveillance approaches will be of most benefit.

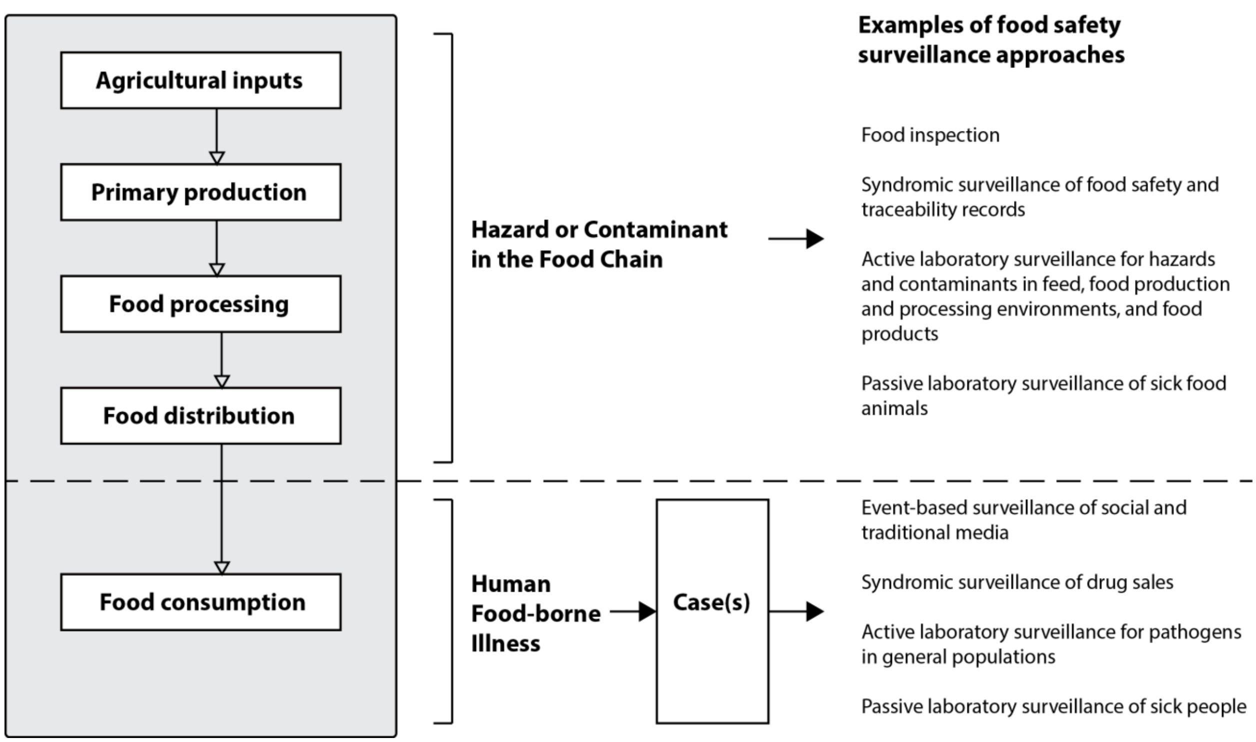

Figure 3.2: Illustration of the continuum of EW for food safety, showing examples of different food safety surveillance approaches along the food value chain (adapted from FAO/CCH, 2013).

Data reporting, sharing, and other surveillance challenges and considerations

EW signals and threats identified through a surveillance programme aim to provide information for food safety action. For example, a surveillance system is of little value if the information gathered is not distributed to decision-makers and is not oriented towards action (Salman, 2003). Both food chain and public health surveillance programmes are critical to support the early identification of food safety threats or adverse events and subsequent rapid alert activities (FAO/WHO, 2010; FAO/WHO, 2011).

A coordinated, multidisciplinary approach is needed to support more efficient and effective food safety surveillance. This includes participation of stakeholders from all sectors in the food chain continuum (Lo Fo Wong *et al.*, 2005; Parmley *et al.*, 2013), and is of particular importance with respect to reporting and sharing of data for EW. Under a national approach to food safety, commonly the ministries of health and agriculture form a strategic partnership as key stakeholders. Other agencies may be responsible for the implementation of food safety surveillance, often through associated reference laboratories. These laboratories are frequently the main point of access for traditional (laboratory-based) surveillance data.

It is important for all ministries and agencies to work closely together to ensure that the surveillance system operates efficiently and effectively, and provides a comprehensive overview of the national food safety status. In addition, other stakeholders, such as industry and non-governmental organizations, need to be considered within this framework. The integration of food safety surveillance activities can be improved through communication, collaboration, coordination, and central data storage (FAO/WHO, 2010; Figure 3.3). The United Kingdom Food Standards Agency (FSA) and EFSA are both examples of food safety coordinating bodies working at the national and regional levels, respectively (EFSA, 2015; FSA, 2015).

The food industry is responsible for the quality and safety of their products, and therefore is a major stakeholder in food safety (Lo Fo Wong *et al.*, 2005). Data from industry certification schemes and food safety management programmes, such as hazard analysis and critical control point analysis, can be used to inform national food safety surveillance efforts. For example, close cooperation between the public and private sectors can make an important contribution to outbreak investigations by tracing back human infection at the end of the food chain to a specific contamination event in the early stages of the chain (FAO/WHO, 2010).

The use of surveillance data may vary depending on the specific mandate and goals of each organization or agency. While national agencies are often interested in monitoring trends over time to inform food safety policy, regional and local agencies may have more immediate goals. Ideally, public health and agrifood surveillance systems are integrated in order to better facilitate the detection of new or emerging contaminants. Rewarding stakeholders and data providers for their participation through regular feedback can be crucial for sustainability of an EW surveillance system. In addition, surveillance data often need to be shared or reported across jurisdictional borders.

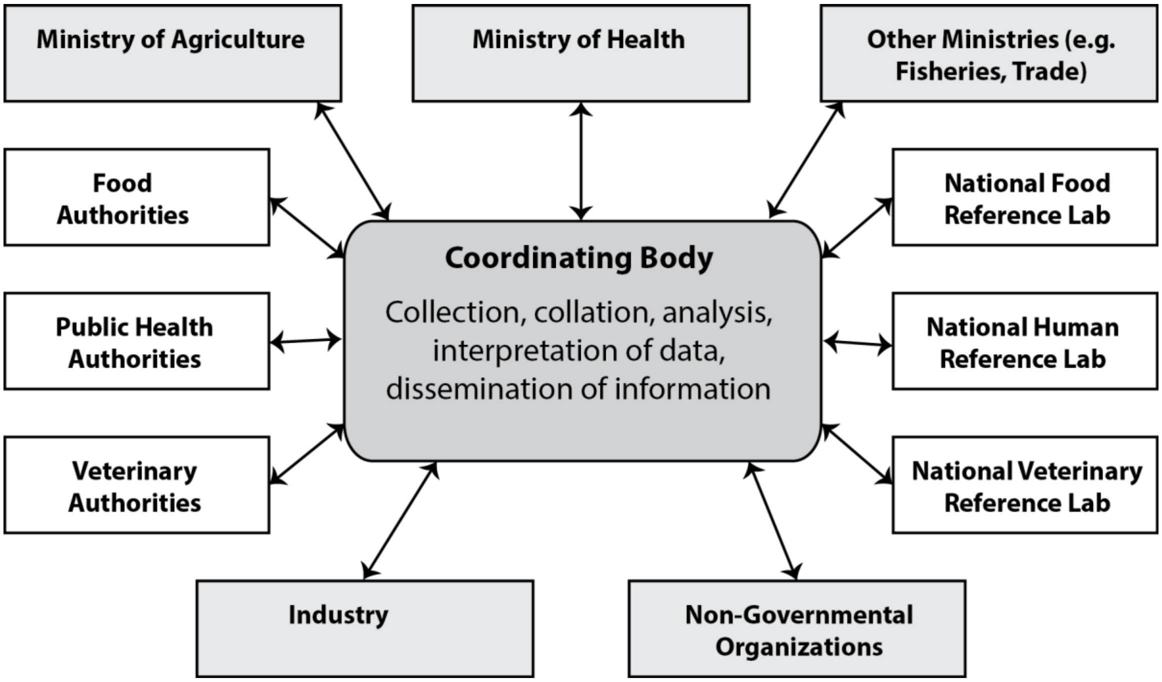

Figure 3.3: Overview of a national approach to food safety surveillance (adapted from Lo Fo Wong *et al.*, 2005).

Finally, there are some data sharing and reporting challenges that should be considered and may need to be overcome to strengthen a country's food safety surveillance programme, including:

- The collection and storage of data by multiple government agencies and other organizations (e.g. industry) can be difficult to access when not available in a single, integrated source or location.
- Surveillance data collected for a specific purpose (e.g. industry monitoring programmes) may not be ideally suited for the purposes of EW systems.
- Often surveillance systems and networks are not designed to be flexible and adaptable enough for accepting and working with varying data sources and technologies.

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CHAPTER 4

Food Safety Foresight and Intelligence

This section broadly introduces the concept of foresight, in particular the techniques commonly used to identify, structure, and interpret intelligence used to inform EW systems. This chapter provides an overview of foresight and intelligence-gathering approaches and provides examples of their use to inform EW systems.

Key Ideas

- Foresight thinking leads to development of proactive food safety strategies.
- Foresight techniques help decision-makers explore highly uncertain issues in advance of their occurrence, prompting long-term thinking that improves decisions about the direction of future policy or risk management strategies.
- Foresight promotes preparedness in the food safety chain through the development of strategic plans that are sufficiently flexible to respond to a range of possible futures.
- Foresight techniques compliment EW systems by collecting and interpreting intelligence that may be more or less broadly related to food safety threat identification and monitoring.
- Horizon scanning is a foresight technique used to gather intelligence about drivers of change in a food system. Identified signals might indicate new or re-emergent hazards, which can contribute to a country's early detection capabilities.

Introduction

Food safety incidents and emergencies often result in devastating impacts to public health and economic trade in both developed and developing countries. These incidents occur despite the existence of effective food control systems and surveillance initiatives. As a result, interest is gathering in techniques that can inform decisions about the management of emerging food

issues before they occur. Foresight techniques represent a class of tools that can support decision-makers' needs to be proactive and strategic about their food safety decisions. The aim of this chapter is to introduce the concept of foresight and the different available foresight techniques (e.g. horizon scanning) used to gather and interpret intelligence for the purpose of informing EW systems.

As an important caveat, foresight and intelligence are not replacements for traditional surveillance systems. Instead, foresight and intelligence may be used to complement existing, well-developed surveillance and control systems. In this function, foresight and intelligence extend the capabilities of surveillance systems by considering regional or global issues that may be otherwise unsupported by traditional surveillance data. In addition, foresight promotes strategic thinking about EW capabilities and risk management options, thus improving the overall quality of food control systems.

Foresight and intelligence

We are often unable to reliably predict the occurrence of emerging food safety risks. Over the medium- to long-term range (e.g. 5–20 years), this capacity is almost non-existent. This is because quantifiable data to inform most proactive surveillance techniques is likely unavailable. Foresight techniques that can integrate a mix of different data sources (e.g. scientific evidence, observations, experience, global trends, or expert insights) can help to address this issue. We term this type of data "intelligence", and in the absence of quantifiable surveillance data, it is used to support decisions.

Commonly used foresight techniques include scenario planning and horizon scanning. Scenario planning is a structured way to think about the future and can be used to explore the development of strategies and plans that take into account multiple possibilities. Horizon scanning is a structured method for gathering, categorizing, and interpreting a variety of information from local, regional, and global sources (e.g. newspapers, local government, and international agencies). Both techniques use intelligence to help improve our understanding and anticipation of difficult and uncertain food safety problems.

Foresight methods do not aim to predict the future. Instead, they help decision-makers to think about, anticipate, and prepare for the future through a more wide-ranging and comprehensive understanding of possible alternative future scenarios and considerations. In addition, they aim to challenge our current assumptions and inform decision-makers on multidisciplinary perspectives of an issue to stimulate new, creative ways of thinking about problems and possible solutions (Amanatidou, 2014).

The use of foresight in the food safety sector is relatively new. International examples of foresight and intelligence gathering include the United Kingdom Government Office for Science Foresight Projects, Policy Horizons Canada, and the Australian Animal Health Scanning Report

(see the additional information section below for further details). These organizations use horizon scanning techniques to gather information about trends and insights. Elsewhere, foresight techniques have been used with success in business planning (e.g. Shell Scenarios) and other sectors (Sutherland *et al.*, 2011).

Foresight is intended to change the way an organization thinks about food safety; transitioning from being reactive (responding to events as they happen) to proactive (seeking new opportunities for issue prevention and management). From this strategic perspective, foresight techniques may be used to identify gaps within an organization's knowledge base, test policy assumptions, develop a research plan, inform future monitoring practices, or assess the vulnerability of a food system.

Outputs from foresight activities do not replace traditional scientific evidence. Instead, these techniques are used to support threat identification and monitoring activities within EW systems by challenging conventional perspectives.

Where does foresight fit within the EW concept?

EW systems are designed to prevent, or enable the timely mitigation of, a serious national or international food safety emergency through the earliest possible detection, verification, and alerting of hazards and contamination events. Foresight supports EW systems by gathering information and intelligence about emerging issues in advance of their occurrence, and by using this information to inform the development of proactive risk management strategies.

Similar to surveillance techniques, foresight approaches are frequently used to gather information, in particular trends, experiential, or qualitative information. However, unlike traditional surveillance techniques that may have a targeted focus, foresight seeks to gather diverse information from across the local, regional, and global levels. This broadening of perspective extends the capabilities of traditional surveillance and strengthens the capacity of EW systems to identify emerging risk issues.

Foresight techniques can support EW capacity through three main functions: a) intelligence gathering; b) strategy development; and c) priority setting (Figure 4.1). Intelligence-gathering techniques, such as horizon scanning (used to detect and monitor signs of change within a food system), primarily contribute to EW Pillar 1: "monitoring and detection of initial signals" (see Figure 1.1). Strategy development and priority-setting techniques, such as scenario planning (used to understand the impacts of food safety issues under different imagined conditions and often used to inform strategic planning) and multicriteria decision analysis (used to rank and compare different policy options), respectively, might also identify early warning signals, but primarily contribute to EW Pillar 2: "signal verification, risk assessment, and recommendations".

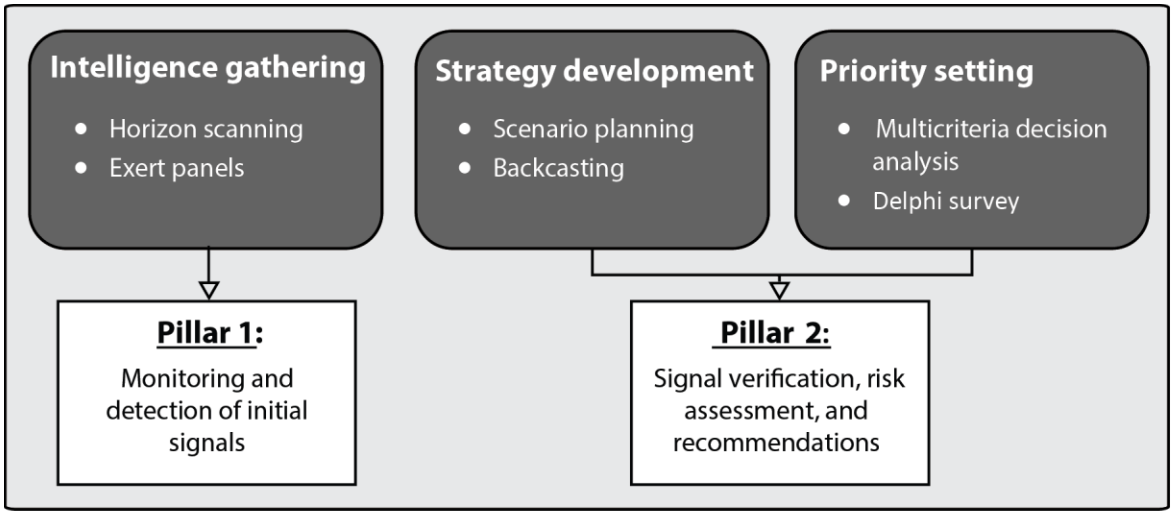

Figure 4.1: Categorization of commonly used foresight techniques in support of EW Pillars 1 and 2 within the context of EW systems for food safety. For a full description of each method, as well as other foresight methods applicable to EW for food safety, refer to Appendix A.

Further information on different foresight techniques that could be used to support EW capacity for food safety is provided in Appendix A. However, it should be noted that the appropriate selection and implementation of these methods requires a suitably qualified project team with sufficient expertise, along with organizational and decision-maker support, adequate resources, and a clear understanding of the foresight scope, objectives, expected outcomes, and timeframe.

Foresight techniques and application to food safety

Foresight techniques may complement EW systems that forecast and detect public health and food safety events in advance of their occurrence by providing intelligence about threats and vulnerabilities across the food chain continuum in the absence of quantifiable surveillance data. For example, foresight could be used to inform future strategies for managing the risk of aflatoxin contamination in maize by gathering local knowledge about maize storage, global climate and regional maize production trends, and advances in aflatoxin monitoring. Foresight provides decision-makers with strategic perspectives about food safety issues, and this type of proactive thinking also benefits other individuals within the food sector including analysts, scientists, producers, processors, and the public.

In general, foresight techniques are similar to traditional surveillance techniques in that they are most effective when used continuously to take into account the dynamic nature of food systems. In addition, foresight techniques are highly collaborative and interdisciplinary, integrating multiple perspectives into a single decision process. For example, multistakeholder

workshops coupled with scenario analysis are often used to generate intelligence about future events.

Foresight-derived intelligence may be used to support a number of different types of decisions. Two case studies of the use of these approaches to support food safety decision-making are presented below: the first illustrates how foresight methods can be used to inform long-term strategic decision-making (Box 4.1), and the second describes how one national food safety agency uses foresight techniques to explore vulnerability and emerging risks within a complex global supply chain (Box 4.2). The next section focuses more specifically on one intelligence-gathering foresight method – horizon scanning – that has particular utility in the context of early signal detection for food safety.

Box 4.1: Building long-term strategy for food safety and nutrition

The Directorate General for Health and Consumers of the European Commission recently commissioned a foresight project to identify critical challenges to food safety and nutrition in the European Union and their future evolution up to 2050, their potential impacts, and necessary changes to prepare for these challenges. The project included stakeholder and expert workshops and consultations, a process to identify key drivers of change, a literature review, expert interviews, and scenario planning. A set of nine driver-specific scenarios were developed focusing on key drivers such as: the global economy, trade, and new agrifood chain structures; consumer attitudes and behaviour; and climate change. Unique food safety and nutrition challenges were identified and discussed for each scenario. A stakeholder survey was conducted to rate the plausibility of each scenario, its potential impacts, and measures that could be taken to face the challenges posed by the scenario. The foresight project was used to provide insights and guidance for the development of future strategic policy decisions and related research needs.

Source: European Commission, 2015.

Box 4.2: Identifying emerging food safety risks

EW surveillance systems are effective for identifying disease outbreaks as they occur, but how might a government prepare for an outbreak that has not yet occurred? The United Kingdom's FSA applies foresight approaches such as expert consultation and horizon scanning to gather intelligence about new and emerging risks that may impact global food supply chains. Using the example of a complex food system, the FSA uses intelligence from producers, processors, manufactures, and retailers to identify, characterize, and map risks. Emerging issues often include (but are not limited to) contamination, adulteration, product availability, and insights about the structure of the food system. This information is used to

inform short-term surveillance strategies (e.g. monitoring of vulnerable points along the food chain continuum), as well as long-term policy decisions (e.g. development of good agricultural practice accreditation schemes).

Source: FSA, 2013.

Generating insights — the role of horizon scanning

Horizon scanning is a foresight technique that consists of a structured approach of consistent data gathering to provide organizations with ongoing intelligence to support medium- to long-term thinking about food safety issues. Horizon scanning inputs may include sources such as global trends, academic or trade journal insights, newspaper articles, expert judgment, or public opinion (Palomino *et al.*, 2012, Amanatidou *et al.*, 2012). Organizations may use this intelligence to support particular decisions (e.g. risk management), other foresight activities (e.g. scenario planning), or to monitor disease and food safety incidents in support of EW. Horizon scanning may generate intelligence to inform medium-term research strategies, to identify gaps in regulation, or to support discussions about policy development.

Horizon scanning programmes have been developed previously by several organizations worldwide (see the additional information section below for some examples). Figure 4.2 presents a generic process for building a horizon scanning function to support EW for food safety. A more detailed description of each step is provided in Appendix B. Box 4.3 illustrates a case study of how one government department implements horizon scanning at the national level to provide intelligence about emerging issues with implications for animal health.

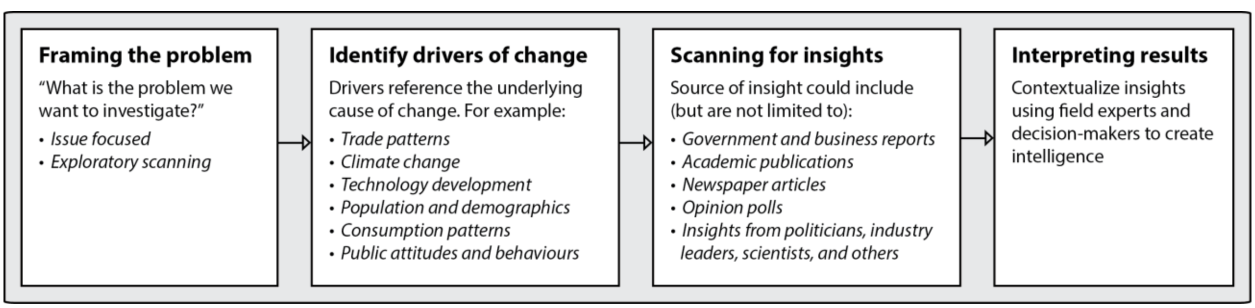

Figure 4.2. A description of the key steps involved in the development of a horizon scanning function.

Box 4.3: Horizon scanning – insights for animal health

The Animal Division of the Australian Department of Agriculture conducts various horizon scanning functions to identify, monitor, and assess the signals – weak or strong – that

precede emerging issues (whether threats or opportunities) relevant for the management of animal health in Australia. To identify such issues, the division conducts environmental scanning of various media, scientific literature, and other sources in areas such as biotechnology, emerging diseases, science and society, climate change, and food safety. A summary of notable events and emerging issues, called the "Animal Health Scanning Report", is prepared and published bimonthly online: http://www.agriculture.gov.au/animal/health/strategy/ocvo-scanning-report. This report covers any social, technical, environmental, or other issues that could affect animal health and the management of animals in Australia in the future. For example, recent issues of the report have highlighted topics such as rapid, remote diagnostic-test technology that can upload data to mobile networks, and the likelihood of increasing global demand for meat products from non-traditional meat animals. Through these activities, the Animal Division aims to identify significant emerging issues before they become critical in order to improve the department's strategic positioning.

Source: Australian Department of Agriculture, 2015.

What is the outcome of foresight and horizon scanning approaches and how do we know if they are successful?

Foresight techniques are intended to broaden a decision-maker's perspective about the potential issues that may impact a food system or their policies. Specifically, a decision-maker may use outputs to support strategic planning, risk-based decision-making, and issue prioritization. For the types of value-laden decisions involved in complex, medium- to long-term food safety issues, foresight approaches are likely to be supported by expert judgment and multiple criteria decision-making tools (Prpich *et al.*, 2011).

The benefits derived from foresight and intelligence gathering are subtle and difficult to measure quantitatively. Their benefits may be best measured through a process evaluation of indicators such as the quality and level of decisions informed, the confidence the approaches provide decision-makers with to progress an issue, and the development of foresight organizational culture (e.g. increased involvement in foresight activities) (Amanatidou, 2014).

The robustness of foresight approaches can be enhanced by ensuring that a wide and diverse range of insights and information sources are gathered and used in analysis. In addition, it can be useful to regularly examine policies and procedures for assumptions, and to test whether these might hold up to key drivers, trends, and threats identified through foresight and horizon scanning approaches.

In general, foresight and horizon scanning approaches can be considered as effectively functioning if the EW system is able to routinely and consistently identify, assess, and analyse a

multitude of known, emerging, and unexpected food safety issues and threats and provide actionable insights to decision-makers so that they can make more informed decisions.

Additional information

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CHAPTER 5

Early Detection of Signals through Surveillance and Intelligence

This chapter explores the integration and networking of surveillance and intelligence programmes to enhance and facilitate the prediction or earlier detection of food-related hazards and illnesses. An EW diagrammatic tool (the "EW matrix") is introduced and explained. The tool allows stakeholders to plot the general to specific characteristics of food safety signals against their relative position on a given food supply chain, and can help countries to identify their surveillance gaps and opportunities to improve EW system capacity.

Key Ideas

- Both traditional surveillance programmes and intelligence approaches contribute to a country's capacity for earlier detection and response to food safety signals.
- Ultimately, the goal of an EW system is to detect a signal as early as possible along the food chain continuum, before it results in a public health threat or adverse event.
- The EW matrix presented in this chapter provides a tool for stakeholders to evaluate the scope of food chain and public health surveillance systems in their country or region and to identify gaps and opportunities in their EW capacity.
- An EW system should not be developed in isolation, but should rather be built on existing or planned surveillance infrastructure of the food control system.
- An EW system should be evaluated routinely to determine how well it is working.

Introduction

For the purpose of this chapter, food supply chains (or value chains) are described as a linear series of activities from production through to the sale of food products. In reality, food chains are dynamic, complex, and more accurately described as a network rather than as a linear chain

(Parliament of Canada, 2013). They involve a strategic partnership of producers, processors, marketers, food service companies, retailers, shippers, suppliers, and consumers (Ontario Ministry of Agriculture, Food and Rural Affairs, 2013). Biological, chemical, physical, or radiological contamination of feed and food products may affect the food supply chain, resulting in a "food safety event". In contrast, "public health events" occur after the consumption of contaminated food by an individual person or group of people, resulting in food-borne disease.

Historically, the development of food safety monitoring and surveillance programmes has been in response to the identification of signals following cases or outbreaks of clinical food-borne disease in people (i.e. *public health surveillance*). As we have learned more about these signals through research and subsequent outbreaks, such programmes have been adapted in an effort to improve food safety and to reduce food-borne disease by detecting and responding to food safety signals closer to the point of contamination (i.e. *food chain surveillance*). As discussed in Chapter 4, foresight and intelligence programmes have taken this a step further by trying to identify changing circumstances (e.g. political, economic, trade) that might eventually lead to contamination of feed and food products, to better anticipate future food safety events. EW systems may comprise any of these surveillance approaches.

The strength of an EW system lies in the fact that it incorporates and connects multiple types of monitoring, surveillance, and intelligence-gathering approaches. In doing so, an EW system has the advantage of being able to anticipate, detect, and share information on signals from various agrifood sectors, at multiple locations along the food chain, and with public health, to facilitate integrated preparedness and timely, actionable responses. Ultimately, the goal of an EW system is to detect and act upon a signal as early as possible along the food chain, before it results in a public health threat or adverse event.

The monitoring of, surveillance for, and response to food safety threats and adverse events requires a multidisciplinary approach that involves stakeholders from all sectors in the food chain and public health (Lo Fo Wong *et al.*, 2005). The stronger these networks are, the earlier food safety signals can be detected and acted on. In addition, effective EW capacity requires a sound understanding of the different food value chains, including food trade patterns, in a country or region to identify and better anticipate new opportunities for food contamination and surveillance. An understanding of the baseline situation is also needed, for example, of the endemic prevalence of hazards in food animals and products along the food chain and of background levels of food-borne disease in people, to determine when aberrations or unusual events might be occurring and to properly target surveillance efforts in necessary areas.

The EW matrix

The EW matrix (Figure 5.1) provides a visual tool for stakeholders to:

1. Subjectively measure the scope of food safety surveillance and intelligence programmes within their country, and
2. Identify possible gaps and opportunities in a country-wide network of surveillance programmes in the detection of EW signals related to food safety.

By mapping their existing surveillance and intelligence-gathering programmes onto Figure 5.1, stakeholders will be able to better integrate them into a cohesive EW system. The tool will also provide stakeholders with greater familiarity of the complexity of EW signals generated and collected by such programmes, and will provide guidance on where to enhance EW capacity to address any identified gaps and opportunities. In this section, the components of the EW matrix are described. A discussion on how to use this diagrammatic tool follows.

Figure 5.1 consists of four quadrants, which move from left to right with increasing specificity of the initial signal, and from top to bottom along the food chain continuum and ending with a public health event (individual case, cluster of cases, or outbreak). Programmes that predict possible problems, or that detect events not related to a specific hazard or aetiology, are located to the left of the diagram; programmes that detect clinical signals of a given hazard or aetiology, and those systems that provide laboratory confirmation of a specific hazard, are located to the right of the diagram. Programmes designed to detect food safety events are located in the upper half of the diagram, and those that detect public health events are located in the lower half of the diagram.

Each quadrant is further described as follows: surveillance programmes in the upper left (1) attempt to identify visibly spoiled foods and/or changes in policy, technology, or processes that might lead to problems in the future. Programmes in the lower left (3) look for presumed food-related human illnesses. Surveillance activities in the upper right (2) include sampling within the food value chain to find contaminants and specific hazards, and activities in the lower right (4) attempt to verify specific diagnoses or aetiological causes of food-borne disease in people.

Mapping intelligence programmes onto the EW matrix

Some agencies are exploring foresight methods in an attempt to better anticipate medium- to long-term food safety issues and priorities (Chapter 4). The purpose of these methods is to identify changing trends and drivers in new technologies, global trade, or other areas (e.g. urbanization, climate change) that might result in future food safety threats or adverse events. On the EW matrix, intelligence-gathering programmes are located to the far left of quadrants 1 and 3 in Figure 5.1, where general signals and changing drivers predict a pending problem in food safety or public health, but do not otherwise indicate a causative hazard or aetiology.

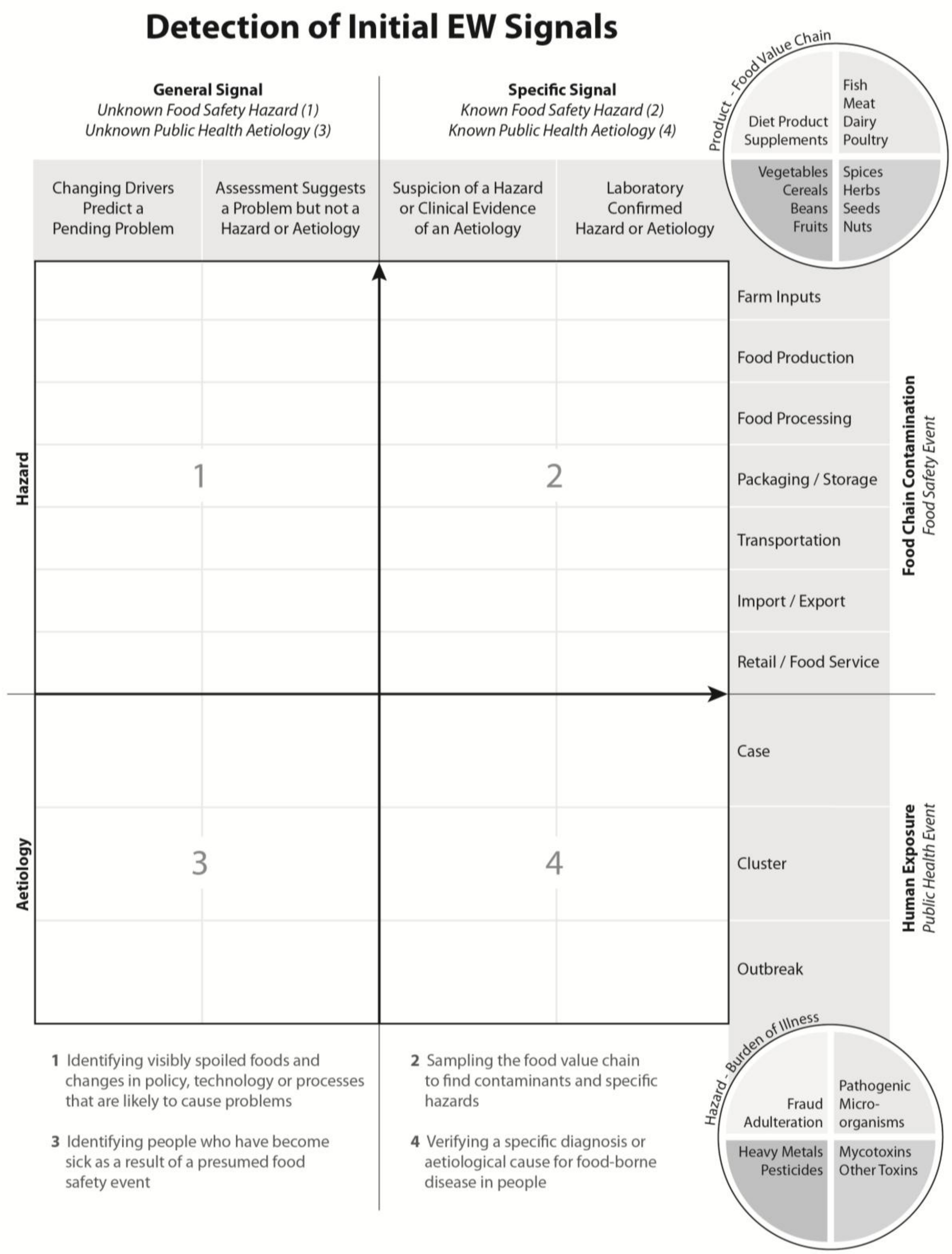

Figure 5.1: Diagrammatic representation of how and where EW systems detect initial signals.

Mapping surveillance programmes onto the EW matrix

For the purpose of this discussion, consider a single food value chain, for example, ground beef, ready-to-eat meats, instant rice, or powered milk. Each of these could be affected by any number of contaminants, including biological ones such as parasites, bacteria, and viruses; chemicals and toxins arising from natural or artificial sources; and physical contaminants including disruptions in the cold chain and visible spoilage, among others. Contaminants may enter a food chain at any point along the continuum as a result of on-farm management decisions through to inadvertent, intentional, or even fraudulent additions during processing, storage, distribution, marketing, and food service. Programmes that seek to identify food safety events in the food chain can be plotted in quadrants 1 and 2 of the EW matrix (Figure 5.1). Some contamination events are only discovered following an outbreak of food-borne disease in human populations; monitoring and surveillance programmes for public health events can be plotted in quadrants 3 and 4.

Surveillance and monitoring programmes work within this complex array of variables, with some programmes taking a general approach (quadrants 1 and 3 in the EW matrix) and others being more highly specialized (quadrants 2 and 4 in the EW matrix). For example, food inspection systems that generate general food safety signals (e.g. quadrant 1) are those that tend to monitor for visibly spoiled foods or food control compliance indicators (e.g. "breaks" in cold chain). Other programmes target more specific signals of a food chain contamination event, and use targeted sampling strategies to sample food/feed and by-products at a specific point (or points) along the food chain (e.g. quadrant 2). The far right of quadrant 2 in the EW matrix is reserved for laboratories that seek to identify and characterize specific hazards that have entered the food chain. Quadrants 3 and 4 of Figure 5.1 mirror this discussion, but are specific to public health events. Surveillance programmes generating signals related to cases or outbreaks of sick people, possibly as a result of contaminated food but where the aetiological cause is unknown, are located to the bottom left of Figure 5.1. Programmes targeting more specific signals of human exposure to a food safety event, including laboratory confirmation of aetiologies, are located in quadrant 4.

Integrated surveillance programmes with more inclusive objectives, or those that have greater capacity for detecting signals of varying specificity, may overlap across multiple quadrants. In these cases, programmes can be plotted centrally in one or more cells that match best with their primary signal detection capabilities, and range bars can be extended across other cells to represent a programme's secondary detection capabilities (see Figure 5.2 for an example).

Populating the EW matrix with real-world examples

Figure 5.2 shows an example of an EW matrix with 10 real-world surveillance, monitoring, and intelligence-gathering programmes mapped onto the diagram to illustrate how the EW matrix tool works.

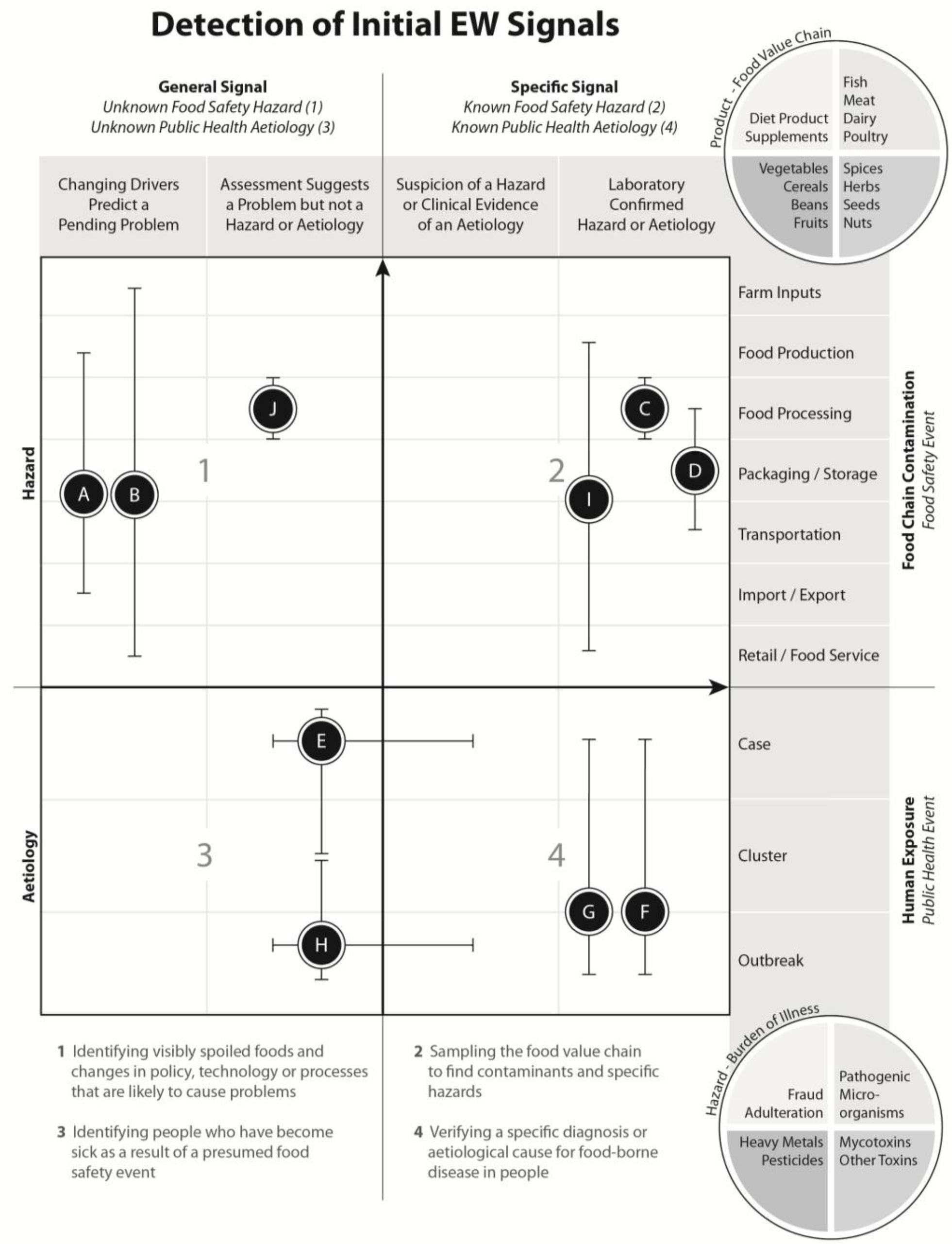

Figure 5.2: Diagrammatic representation of example named systems that detect initial EW signals. Programmes are plotted in the cell that corresponds to their primary signal detection capabilities, with range bars extending across other cells to represent secondary detection capabilities.

Legend: (A) Emerging Risk Detection Support (ERDS); (B) EFSA Scientific Committee and Emerging Risks (EFSA-SCER); (C) Canadian Food Inspection Agency (CFIA): *E. coli* O157:H7 surveillance; (D) General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ): Melamine; (E) Minnesota Foodborne Illness Complaint Line and RUSick2 Forum; (F) CaliciNET; (G) PulseNet; (H) New South Wales Enteric Disease Outbreak Surveillance System (OzFoodNet); (I) Integrated *Salmonella* Surveillance (ISS); (J) CFIA: general meat inspections.

A brief overview of the example EW programmes is shown in Table 5.1 and will give the reader insight into why the markers are placed as they are in Figure 5.2. For more details on these programmes, references are provided to the literature and available online materials. Examples here show surveillance, monitoring, and intelligence-gathering programmes from different locations around the world. This is done to explore where various working programmes might fit on the EW matrix.

Table 5.1: A brief summary of the 10 example EW systems mapped onto Figure 5.2.

	Programme	Location	Programme type	Primary objective	Signal specificity	Website (Reference)
A	ERDS	Netherlands	Predictive	Identify emerging risks	Intelligence	http://www.afsg.nl/InformationManagement/index.php?option=com_content&task=view&id=28&Itemid=37&lang=en (Groeneveld *et al.*, 2009)
B	EFSA-SCER	European Union	Predictive	Identify emerging risks	Intelligence	http://www.efsa.europa.eu/en/scer/aboutscer (Robinson *et al.*, 2012)
C	CFIA: *E. coli* O157:H7 surveillance	Canada	Reactive	Agrifood chain	Laboratory	http://www.inspection.gc.ca/
D	AQSIQ: melamine	China	Reactive	Agrifood chain	Laboratory	http://app.aqsiq.net/laboratory
E	Minnesota Foodborne Illness Complaint Line and RUSick2 Forum	Minnesota / Michigan, United States	Reactive	Public health	Syndromic	http://www.health.state.mn.us/divs/idepc/dtopics/foodborne/reporting.html (Wethington and Bartlett, 2004; Li *et al.*, 2010)
F	CaliciNET	United States	Reactive	Public health	Laboratory	http://www.cdc.gov/norovirus/reporting/calicinet/index.html (Vega *et al.*, 2011)
G	PulseNet	Multiple Countries	Reactive	Public health	Laboratory	http://www.pulsenetinternational.org (Swaminathan *et al.*, 2001)
H	OzFoodNet	Australia	Reactive	Public health	Syndromic	http://www.ozfoodnet.gov.au/ (Cretikos, Telfer, and McAnulty 2008)
I	ISS	British Columbia, Canada	Reactive	Agrifood chain	Laboratory	http://www.bccdc.ca/dis-cond/a-z/_s/SalmonellaInfection/SalmonellaAnnualReports.htm (Galanis, Parmley, and De With, 2012)
J	CFIA: general meat inspections	Canada	Reactive	Agrifood chain	Food inspection	http://www.inspection.gc.ca/

If we assume that the 10 programmes in Figure 5.2 represent the entirety of EW systems available to one country, one could then ask "are there any surveillance, monitoring, or intelligence-gathering gaps in this national EW system?" Such gaps, and potential opportunities to enhance EW capacity, can be identified by shading in areas of the EW matrix that are not covered by the existing EW programmes.

Figure 5.3 shows the following (shaded) gaps based on the 10 example programmes:

- The "Product – Food Value Chain" button on the upper right corner of Figure 5.3 shows that only one (the unshaded "meats" quarter) of the four food value chain categories is covered by the existing EW surveillance programmes. This hypothetical country, therefore, does not have surveillance programmes in place to cover the remaining three food value chain categories.
- The "Hazard – Burden of Illness" button on the bottom right corner of Figure 5.3 shows that two of the four potential aetiological categories (the unshaded "fraud/adulteration" and "pathogenic microorganisms") are covered. There are no surveillance programmes to identify chemical, mycotoxin, and other toxin hazards.
- In quadrants 1 and 2 of Figure 5.3, the food inspection programme is focused on identifying general signals in the food processing section of the food chain. There is no additional listed capacity for picking up general or suspected signals at other points in the food chain. This country has specific targeted laboratory surveillance for three hazards – *Salmonella*, *E. coli* and melamine, for which only *Salmonella* is an integrated system across most of the food value chain.
- Similarly, in quadrant 4, this hypothetical country only has capacity to identify a few specific pathogenic food-borne microorganisms. Quadrant 3 indicates that syndromic surveillance capacity is in place for detecting gastrointestinal diseases, but may not capture food-borne diseases that manifest as "other than" gastrointestinal.
- There are no emerging risk programmes directed towards changing drivers that would predict potential cases of food-borne disease of unknown aetiology.

In using the EW matrix to identify and evaluate potential gaps, it should be noted that if fewer gaps are identified, this does not necessarily correspond to a more effective or resilient EW system. For example, the situational country context could dictate that it might be preferable or necessary to focus actively on one or more specific aspects of the system (e.g. commodities or hazards). The appropriate combination of EW surveillance capacity should be guided by the country context, resources, priorities, and other needs.

Overlaying multiple food chains and hazard categories on EW systems

You may find that as you map programmes onto Figure 5.1, some are specific for a certain food chain, hazard, or aetiology. For example, the French Agency for Food, Environmental and

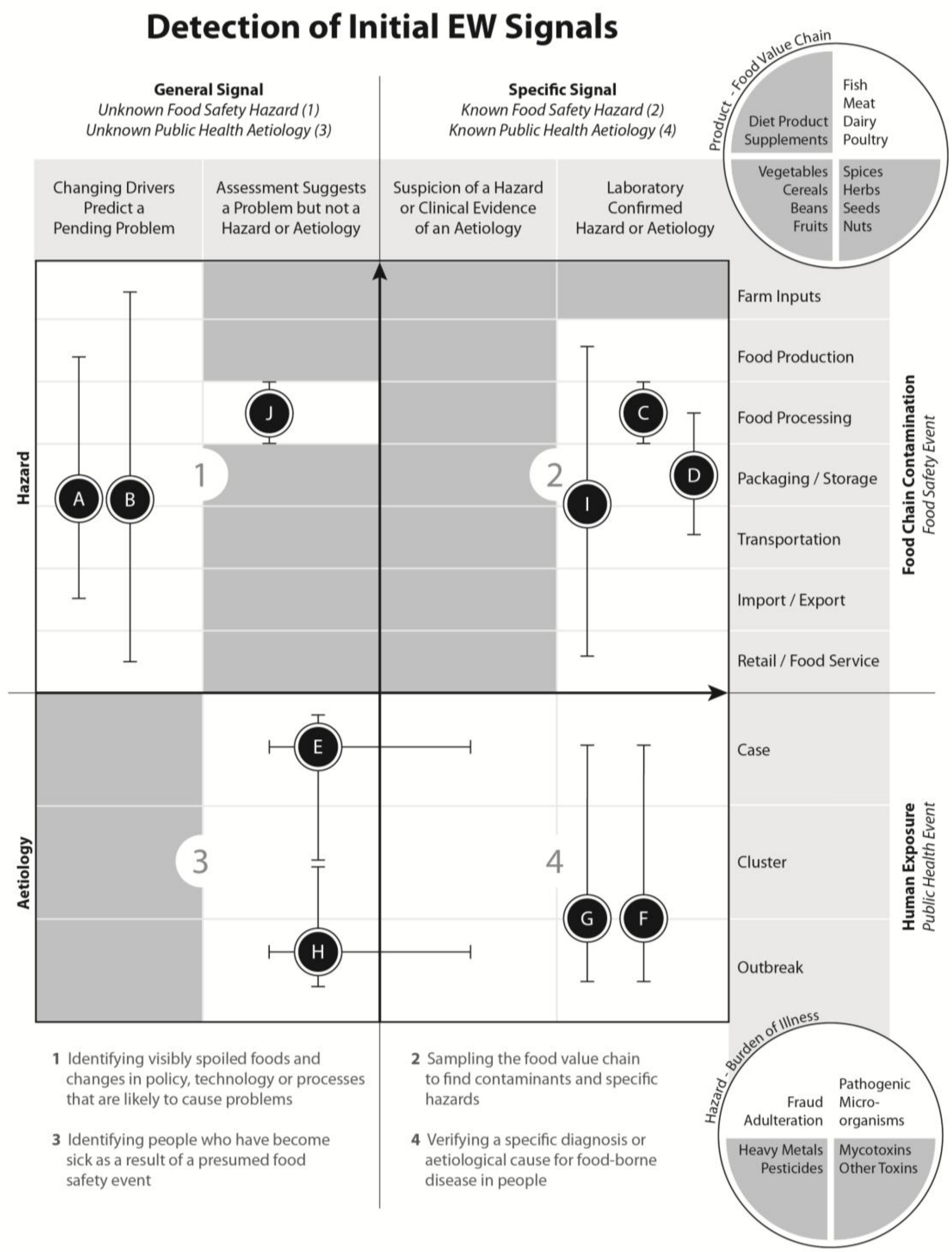

Figure 5.3: Diagrammatic representation of example named systems that detect initial EW signals, with shaded areas highlighting potential gaps in surveillance coverage.

Legend: (A) ERDS; (B) EFSA-SCER; (C) CFIA: *E. coli* O157:H7 surveillance; (D) AQSIQ: melamine; (E) Minnesota Foodborne Illness Complaint Line and RUSick2 Forum; (F) CaliciNET; (G) PulseNet; (H) OzFoodNet; (I) ISS; (J) CFIA: general meat inspections.

Occupational Health and Safety's (ANSES) *Salmonella* Network is a targeted national epidemiological surveillance programme that monitors for non-human *Salmonella* throughout the food chain (ANSES, 2015). You will likely need to map them on a separate diagram from, say, a system that is designed to identify aflatoxins in imported nuts. These diagrams can be overlaid one over the other to illustrate a country's complex matrix of surveillance, monitoring, and intelligence-gathering programmes. This concept of overlapping surveillance programmes is illustrated in Figure 5.4.

Some EW programmes may be common across multiple value chains. The Canadian Food Inspection Agency (CFIA), for example, works to: ensure that fish, plants, and animals produced locally in Canada, or imported from other countries, are free of diseases and pests; prevent or minimize potential impacts of zoonotic disease through regular surveillance, inspections, and outbreak response; respond to food safety emergencies or threats to agricultural or forest biosecurity; oversee inspections of food and agricultural inputs and products at the border through the Canada Border Services Agency; and issues food recalls as required (CFIA, 2014).

Furthermore, the CFIA has strong networks with, and frequently works closely alongside, other partners including the Public Health Agency of Canada (PHAC), animal health specialists, and laboratories (CFIA, 2014). Other programmes, such as the previously introduced ANSES *Salmonella* Network (ANSES, 2015), target very specific food value chains, hazards, or aetiologies.

Suppose all of the surveillance, monitoring, and intelligence-gathering programmes specific to livestock agriculture and associated food-borne disease hazards are drawn onto Figure 5.1; now map all such programmes specific for milk and milk products onto a new Figure 5.1, and then all such programmes specific for fruits, nuts, and vegetables onto another Figure 5.1. By overlaying these diagrams on top of each other, you can create something resembling Figure 5.4, where EW matrix "i" could represent the livestock food chain, "ii" could represent the dairy chain, and "iii" could represent fruits, nuts, and vegetables. There may be linkages between these matrices, such as the case with the CFIA. EW systems, therefore, are a minimum of three-dimensional "constructs" of surveillance, monitoring, and intelligence-gathering programmes that permit the flow of information (i.e. signals from adverse food safety events or threats) across food value chains, among stakeholders, and along the food chain continuum. In other words, EW systems are a network of people and programmes that proactively seek to ensure the safety of food and food products.

Diagnosing problems or "troubleshooting" an inefficient or ineffective national EW system

A national EW system should be evaluated routinely to determine how well it is working. Components of an EW system might be considered inefficient or ineffective if there are indications that identified adverse food safety events could have been detected earlier in the

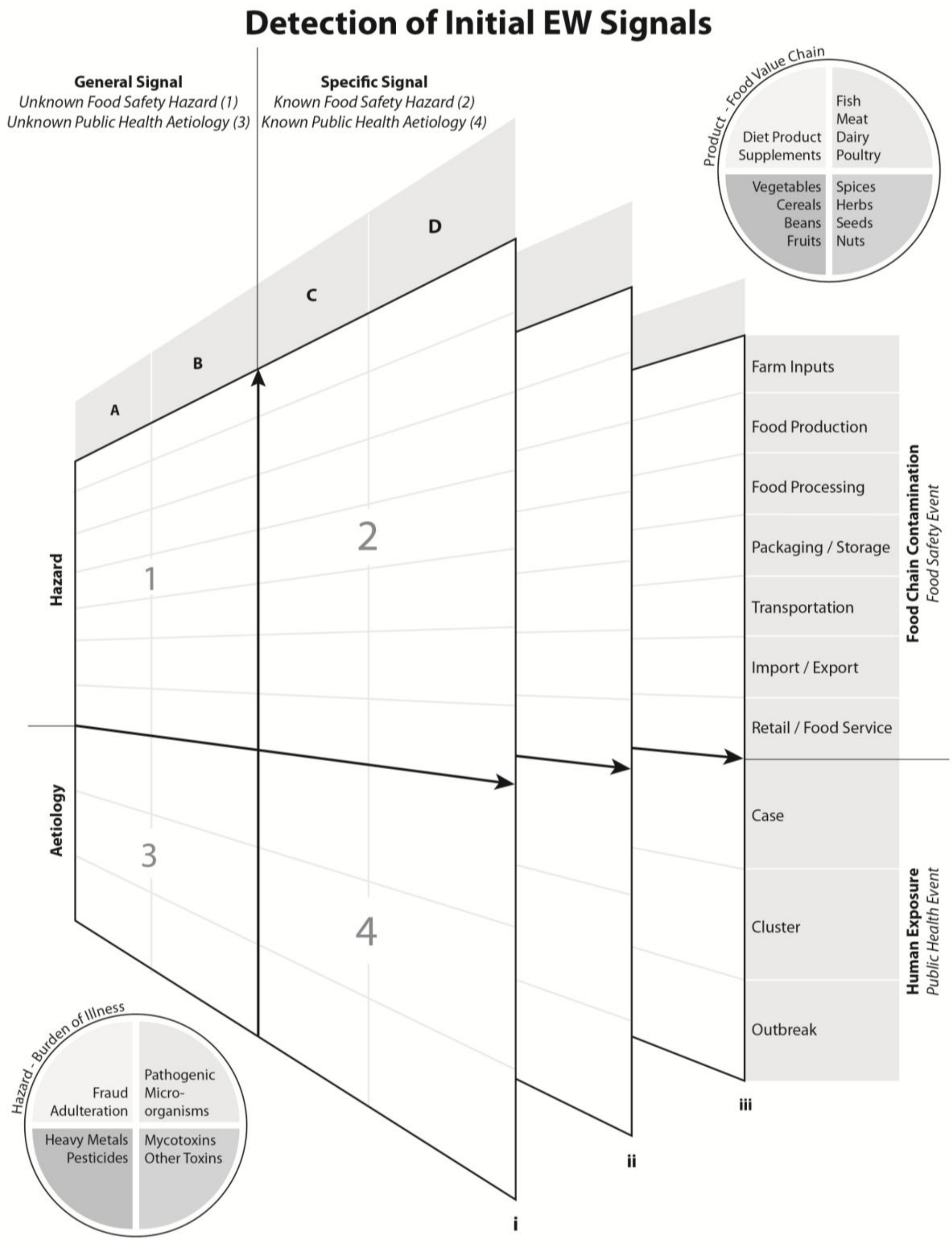

Figure 5.4: EW matrix diagrams can be developed to illustrate the signal detection capabilities across multiple food chains, with each food chain represented by a separate matrix (i.e. i, ii, and iii).

food chain, possibly preventing or mitigating negative impacts on public health and the industry. Such a finding should trigger a diagnostic exercise to review lessons learned and to identify if any appropriate corrections or improvements to the EW system can be made.

The principle parts of an EW system troubleshooting exercise could be structured as follows:

- Map out where your country's food comes from and where it goes – to develop a current situational awareness of potential priority hazards.
- Itemize all EW surveillance programmes in a country and map them onto corresponding EW matrix diagrams according to their food value chain and type of hazard.
- Identify surveillance gaps and opportunities – gaps in coverage of a food value chain, for specific hazards, or in regions of the EW matrix of general and specific signals along the length of a food chain or during a public health event, and potential opportunities to improve EW detection capabilities to address identified gaps.
- Determine whether new surveillance or intelligence-gathering approaches are needed to target a high-priority, recently emerged food hazard or public health aetiology.
- Review recent food safety event occurrences in your country to determine if changes can be made to the EW system to increase the likelihood that a similar event would be identified earlier in the food chain. Consider conducting a simulation exercise of a possible food safety event to test, evaluate, and improve the preparedness and resiliency of the EW system using a realistic scenario.
- Explore how quickly the system could respond to changes in food imports or exports, or in food production chain procedures, or in how food is prepared in the country. Are there ways to improve the country's situational awareness of changing conditions?
- Make sure the public health quadrants of the EW matrix are covered to the extent that human disease can be traced to food safety events before they become major outbreaks. This is the "safety net" for discovering events involving new or emerging food hazards, known food hazards which are not a target of a specific surveillance programme, or known hazards that have slipped through a faulty existing surveillance programme.
- Develop and pursue answers to questions that are specific to your context and as they arise during the process. Can you list some of those questions now, given what you know about the EW system in your country?

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CHAPTER 6

Rapid Alert Networks for Food Safety – Connecting Early Warning Signals to Effective Actions

This chapter covers the steps that should be taken once an EW signal is identified, including its verification, assessment, and dissemination of an alert to appropriate stakeholders to take necessary actions. The role of a national rapid alert network is to disseminate the information generated by EW systems to relevant stakeholders to support a quick and coordinated response. This chapter focuses on national rapid alert networks – what they are, why they are needed, and how they work – including how they can be linked and integrated with relevant rapid alert networks at the global and regional levels.

Key Ideas

- After receiving an EW signal, a series of actions needs to be taken by appropriate stakeholders within a rapid alert network to verify and investigate the signal, assess possible risks, and identify and take necessary actions. These actions can be facilitated through national rapid alert networks.
- To operate successfully and efficiently, rapid alert networks require strong resource investments and collaborations, linkages, and trust among the relevant stakeholders.
- Countries should link their national rapid alert networks with relevant networks at the global and regional levels, including integration with INFOSAN. This may include developing new regional networks where needed among geographically close countries that mutually engage in food trade.
- Dissemination of rapid alerts should follow key risk communication principles: they should be actionable, easy to understand, provide context, and have obvious next steps, and they should be open, transparent, responsive, and timely.

- National rapid alert networks should be updated and evaluated at regular time intervals, and after major food safety events, to assess and improve their efficiency and effectiveness.

Introduction

The previous chapter covered the importance of developing and maintaining national EW surveillance capacity to identify food safety signals of real or potential food contamination or public health events. Actions then need to be taken to validate identified food safety signals as true or false. A true signal means that a contaminated food product may be present in the food distribution chain and at risk to be consumed by people; illnesses may have already occurred, in which case time is of the essence. It may help to consider the following questions: How much contaminated product is out there? Where has it been distributed? Is it currently on store shelves or in consumer's homes? What is the product shelf life? Is the food production chain still producing more contaminated product? What is the nature of the contamination and how will it affect people if they consume it? What can be done to mitigate its effects? Are relevant communication systems functional?

This chapter begins by describing the specific and time-sensitive actions that need to be taken to answer these questions and to protect consumers (EW Pillar 2). For such activities to work quickly, consistently, and under appropriate control, a country needs to be prepared. This can be ensured through the presence of a structured and functional national rapid alert network (EW Pillar 3). A national rapid alert network ensures that the right people and processes are in place and connected to one another to move from an EW signal to appropriate action. This chapter describes national rapid alert networks in detail, as well as the importance of integrating with INFOSAN at the global level, and linking with other relevant global and regional initiatives.

Signal verification, risk assessment, and recommendations for action

After receiving a signal from EW surveillance that a food safety threat or potential adverse event may have occurred, a series of actions needs to be taken by appropriate stakeholders of the national rapid alert network to:

- Verify the signal as a true positive – that it has identified a real threat or event
- Assess possible risks of the threat or event to food safety and human health
- Consult with appropriate stakeholders and develop risk management options
- Choose the best response option(s)
- Craft and transmit alerts to trigger the chosen responses/actions
- Follow up with relevant stakeholders to ensure that actions achieve their intended consequences

For these actions to progress towards the desired outcome, the process as well as the roles and responsibilities of relevant stakeholders should be predefined.

Signal verification is a critical first step once a potential food safety threat or adverse event is identified through surveillance or monitoring programmes. Verification should systematically gather information about the potential threat or adverse event through investigative efforts. Such efforts will depend on the nature of the signal, and might include (WHO, 2008; CIFOR, 2009; ECDC, 2015b):

- *Epidemiological investigations* – outbreak, cluster, and case response (e.g. descriptive epidemiology, case interviews, case-control or case-case analytical studies)
- *Trace-backs* – tracing a potential threat or adverse event backwards through the food chain to its potential origin
- *Trace-forwards* – tracing a potential threat or adverse event forward in the food chain to avoid exposure or further spread
- *Environmental investigations* – evaluation of environmental factors that contributed to the potential threat or adverse event (e.g. inspection of food establishments, collection and analysis of food or environmental samples)

It is important at this stage to identify and screen-out potential false alarms, i.e. signals that do not correspond to actual food safety hazards or threats, in order to preserve time and resources for managing real events and to prevent unnecessary negative consequences (e.g. trade restrictions). Positive diagnostic tests for hazards arising from regular sampling and testing within the food chain itself may need to undergo confirmatory testing, for example, to eliminate the possibility of a false-positive result, chain-of-possession mishaps, or labelling errors. Precautionary measures (e.g. public notices or products recalls) may be warranted while awaiting the results of confirmatory testing.

The verification step as described above may not be directly applicable to signals identified by intelligence-gathering foresight methods (e.g. horizon scanning). Such signals should instead be assessed for their likely level of occurrence and impact to determine the potential level of monitoring required or need for other follow-up actions.

Once a signal is verified, the scope and potential impact of the food safety threat or event should be assessed by risk assessors. The detail and time taken to inform this risk assessment is influenced by the potential magnitude of impact, probability of occurrence, and the anticipated timeframe between signal detection and event occurrence. Events involving signals that are detected just prior to an imminent crisis will not benefit as much from extensive modelling and scenario building as from the opinion of experts in the field.

Risk management options are then developed and provided to risk managers, who decide on the most appropriate responses and any alerts needed to trigger the necessary actions. Risk managers will then need to look at the potential severity of the hazard, nature of the food value

chain affected, and at what point(s) the adverse event occurred to determine who needs to be alerted. The strategy development and priority-setting foresight methods introduced in Chapter 4 (e.g. scenario planning, multicriteria decision analysis) can provide additional insights to inform risk managers about the potential consequences, impacts, and trade-offs associated with different management options and actions.

More detailed and specific (i.e. step-by-step) guidance on signal verification and risk assessment methods is beyond the scope of this handbook. Readers should refer to a series of complementary FAO/WHO guides (FAO/WHO, 2010; FAO/WHO, 2011; FAO/WHO, 2012) and other comprehensive resource and training documents (e.g. WHO, 2008; CIFOR, 2009; ECDC, 2011; Health Canada, 2011; ECDC, 2015b; United States Centers for Disease Control and Prevention, 2015) that cover these and related topics in much more detail.

National rapid alert networks

Why are national rapid alert networks needed for food safety?

Most countries have a system to connect their food safety surveillance activities to those responsible for investigating the causes of signals emanating from these activities, and ultimately to those who can take necessary action (e.g. by removing contaminated products from the market, or appropriately communicating risks to the public). The capacity of this system can be expected to vary from one country to another, and may be affected by any number of factors. Nevertheless, the people or agencies tasked with identifying, verifying, and acting on food safety signals can be said to form a network because of the communications that must pass among them for a response to a food safety event to happen. There are several advantages for countries to recognize this network as a formal, national rapid alert network that can be supported and potentially strengthened to better manage food safety hazards and threats.

Examples of the rationale for national rapid alert networks include:

- Even with EW surveillance systems generating signals, a country will be ineffective in reducing the public health and other impacts of adverse food safety events if they do not connect a properly functioning national rapid alert network to their EW systems.
- Intensification of some of our food value chains means that once a food product becomes contaminated it has the potential to affect large numbers of people; a significant number of people, processes, and places may need to be alerted quickly to take appropriate actions.
- Investing in the expertise, processes, and technologies needed to construct an effective EW system does not in itself guarantee that food safety signals will be converted into appropriate alerts and communicated to the appropriate stakeholders.

- The people receiving and verifying EW signals may not be well connected or trained in communication, or aware of the full ramifications of the signal.
- It is a waste of resources to generate EW signals in the absence of capacity to appropriately verify, assess, and rapidly communicate them.
- Risk managers need the information provided by rapid alert networks to prioritize their tasks and make timely and appropriate, evidence-based decisions.
- Rapid alert networks can provide reassurance to trade partners, as they demonstrate the exporter's ability to detect and mitigate possible food safety risks in their products.

What are national rapid alert networks?

A national rapid alert network consists of multiple stakeholders and communications that together foster swift and appropriate responses to food safety signals identified through an EW surveillance system. The network manages the flow of food safety incident information by connecting all stakeholders involved in the initial detection of an EW signal to its verification and assessment, communication of subsequent alerts, and eventual actions. The connections between rapid alert network stakeholders need to be timely, accurate, informative, and precise. It is critical to know who needs to be contacted and when, in order to support effective alert communication. Alerts are often predefined and may be prescriptive, triggering actions that need to be taken by targeted stakeholders. The rapid alert network is often responsible for initiating follow-up communications and procedures with relevant stakeholders.

Who is involved in a national rapid alert network?

Membership in a national rapid alert network should include all stakeholders involved in the process of identifying EW signals, verifying and assessing those signals, and communicating and receiving alerts to take necessary follow-up actions. A list of potential stakeholders that may be involved in a national rapid alert network for food safety includes, but is not restricted to:

- Those who identify EW signals through surveillance and intelligence-gathering systems, such as laboratories contributing data on food hazards and human cases
- Those who verify and assess threats and adverse events related to identified signals (e.g. outbreak investigators, environmental health inspectors, and risk assessors)
- Risk communicators
- Risk managers and decision-makers
- Food control regulators and inspectors
- Food industry partners (e.g. farmers, processors, distributors, retailers, caterers)
- Specific businesses involved in a food safety incident or event
- Academics, researchers, and educators
- Media outlets

- Consumers

The stakeholders in a national rapid alert network are diverse and should represent a variety of different organizations, sectors, and jurisdictions (rather than a single agrifood or public health agency). Many stakeholders may be part of government, some national, others provincial or state or local (municipal). Stakeholders within a network may form specific task forces or groups to formally coordinate and achieve specific tasks, such as during the investigation and control of outbreaks (CIFOR, 2009). Industry groups will often be members of the network, and experts working for universities or private companies may be contributing members. The media and consumers could also be part of the network, particularly as key target audiences of risk communication information, but may not be involved in early stages of information exchange while risks are still being assessed and confidential and proprietary information is discussed. Funding may be provided by a number of sources to maintain and evolve the network. Networks should be supported by information technology staff to facilitate communication among stakeholders.

Given the diversity of stakeholders involved in a rapid alert network, it is unlikely that the relationship among them will be hierarchical. This relationship will more likely resemble a true network where connections between the members – i.e. the type and frequency of communications between them – will vary depending on their expertise and responsibilities. Many stakeholders will be permanent members of the network; others may participate less frequently or only in certain circumstances. An example of the latter would be a food processor or production-line unit where a contamination event has been identified. They will be a part of the network for as long as it takes to clear up the incident.

An example of a national rapid alert network

Box 6.1 introduces one example of a national rapid alert network for food safety. Although not explicitly called a rapid alert network, the CFIA food recall system has many of the characteristics and functions of a national rapid alert system for food safety. An illustration of how the CFIA recall system managed a recent food contamination event is described below, which may help to foster a deeper understanding of how a national rapid alert network enables EW systems to produce a timely and effective set of responses to food safety events.

In 2012, *E. coli* O157:H7 was found in beef trimmings that had been shipped by a packing plant in Western Canada to another facility for further processing. The finding – which represented a "signal" that a food safety event had occurred – arose from routine sampling that was carried out as part of the food inspection systems of both the CFIA and, because some product was exported, the United States Food Safety and Inspection Service (FSIS).

Earliest network contacts in the present example were to compare findings with the United States FSIS, to alert the packing plant and associated facility that contaminated product had

been identified, to ask the laboratory about more details regarding the *E. coli* that was found, and to mobilize the internal group in the CFIA responsible for investigating the incident. By Day 3 the CFIA had issued the packing plant a "Corrective Action Request" that required the plant to increase their product testing and to provide complete information regarding product distribution and sampling.

Box 6.1: The CFIA food recall system

This CFIA food recall system is one example of a rapid alert network linked to a national food inspection system. Similar systems exist in other countries. In the event of a possible adverse food chain event, the CFIA's role is to inform the public, oversee implementation of a product recall, and verify that industry has removed recalled products from store shelves. When a recall is necessary, the CFIA generates alerts and sends them to implicated companies to initiate a voluntary recall. The company is responsible for immediately contacting all of its accounts (e.g. distributors or retailers) that received recalled product and the CFIA provides guidance or assistance when needed. When necessary, the public is directly alerted. The specific protocols triggered and the precise subset of the network to contact depends on the nature and scope of the contaminating event.

Based on Health Canada's health risk assessment, the CFIA determines the most appropriate action, including whether or not to recall the product. If a recall is necessary, the CFIA decides what class to assign to the recall: Class I (high risk of serious adverse health consequences or death if the product is consumed); Class II (moderate risk); or Class III (low and no risk). When an immediate public alert is necessary, the CFIA will issue an alert to the media. The CFIA also makes recall information available via its website, an email distribution list, Twitter, Facebook, RSS feeds, widgets, and a mobile app.

If food has been recalled, it is the responsibility of industry to remove it from the marketplace immediately. The CFIA conducts effectiveness checks to verify that unsafe food has been removed from store shelves.

Source: CFIA, 2015.

As more details of the contamination event became known, more of the network was contacted to alert them of the incident and enable them to take action. Several specific production days were identified by investigators as the ones upon which product had been contaminated. The CFIA notified the PHAC of the incident, and a CFIA laboratory was asked to type the *E. coli* O157:H7 to enable cross-matching with the *E. coli* strain isolated from people who might become ill following exposure to the product. The Health Risk Assessment Group from Health Canada became involved. After more production days were implicated in the incident, an investigative team was sent to the packing plant to review the situation.

Several kinds of alerts were issued by the CFIA and other members of the rapid alert network during this event. These included an alert from the plant to its customers on Day 10 that it was recalling beef trimmings from three days of their production, and health hazard alerts from the CFIA and the plant on Day 13 advising the public not to eat or sell specified ground beef products. The health hazard alert was later expanded to include more specified days of production. On Day 15, the provincial health agency (Alberta Health Services) notified the PHAC Outbreak Management Division of four cases of *E. coli* infection in people and posted a public health alert directed to health workers. FSIS also posted a public health alert that warned United States' consumers of the incident.

An expanded health alert was eventually released after two more days of production and a second product (steaks) were implicated in the incident. Multiple communications of follow-up investigations and a brief suspension of the operating license of the plant were required to draw the incident to a close. The CFIA recall system, functioning as the lead group in the rapid alert network for the incident, had initiated those communications to ensure actions had been taken to remove contaminated product from the food value chain and minimize further consumer exposure to that contaminated food product. Ultimately, 18 people became sick from exposure to the contaminated food product; none died.

Rapid communication of alerts through the national network of food safety organizations helped bring this food safety incident to a quick conclusion and minimized its impact. Network stakeholders had specific responsibilities that contributed expertise, regulatory power, and response capacity. Responsibility for carrying out specific tasks to control this food contamination event had been established by a set of policies and regulations for each jurisdiction. This policy framework ensured that the organizational parts of the rapid alert network were in place so that the network could respond promptly when a food safety event was identified by the existing EW surveillance systems. The presence of appropriate policy and regulatory frameworks also ensured that the lead agency would be able to compel industry to take the actions needed to remove contaminated food products from the market, and make the production line changes needed to prevent contamination of additional product.

INFOSAN and the International Health Regulations

Given our current global market, the increasing complexity of various food chains, and the international trade of feeds, food ingredients, and foods, food safety incidents involving multiple countries from disparate regions can be expected. This necessitates the presence of efficient and well-organized networks capable of receiving, processing, verifying, and sharing accurate food safety alerts internationally. INFOSAN works at the global level, fostering collaboration among national rapid alert networks and building EW capacity to protect consumers and public health (see Box 6.2 for an overview of the initiative).

Box 6.2: INFOSAN overview

Since its inception in 2004, INFOSAN is a global network of food safety authorities that exchange timely alerts and information on food safety events to prevent the international spread of contaminated food and food-borne disease and to strengthen food safety systems. This is achieved by promoting rapid exchange of information during food safety events, sharing information on important food safety issues of global interest, promoting collaboration between countries, and helping countries strengthen their capacity to manage and respond to food safety risks.

INFOSAN is a joint initiative of the WHO and FAO and has 181 member countries. Member countries appoint INFOSAN national Emergency Contact Points to coordinate rapid alert activities. These contact points must represent a government authority responsible for food safety. In addition, INFOSAN encourages countries to designate additional focal points from other government departments to reflect the multidisciplinary nature of food safety and promote intersectoral collaboration.

National Emergency Contact Points have several roles, including informing the INFOSAN secretariat about the presence of contaminants (hazards) in foods and feeds and food-borne disease in the country. WHO and FAO regional food safety advisors provide technical support and guidance regarding food safety within their respective region. They can also obtain information from local authorities and report food safety events to the INFOSAN secretariat.

After receiving a report or notification, the INFOSAN secretariat decides whether to take action or not, based on consideration of factors including the distribution of the hazard and its impact on global public health and society. The decision may be to contact other specific INFOSAN members that might have been affected, or the entire network, and provide advice and support for international product recalls or other actions. The secretariat can also become involved in food safety events as follows:

- *Verification:* request additional details from an INFOSAN Emergency Contact Point.
- *Consultation:* provide technical advice or information to INFOSAN members.
- *Coordination:* obtain and disseminate information to INFOSAN members regarding a food safety event of international concern; this may or may not result in an INFOSAN alert/notice being posted on the INFOSAN community website.

Since 2012, communication between INFOSAN members is supported through the INFOSAN community website: https://extranet.who.int/infosan/.

Source: WHO/FAO, 2013; WHO/FAO 2014; WHO, 2015.

The adulteration of Chinese milk products with melamine in 2008, and the resulting global response to that event, highlighted the need for INFOSAN (see Box 2.1 in Chapter 2). The melamine incident involved 22 manufacturers of powdered infant formula. Forty-seven countries received melamine-contaminated products (Gossner *et al.*, 2009). INFOSAN played an important role in managing the incident globally, collecting and distributing laboratory test results for melamine carried out in various countries and acting as the central stakeholder through which Chinese authorities communicated with affected countries. Gossner *et al.* (2009), in their description and analysis of the event, noted that "this incident, and the rapid spread of the affected products worldwide, has evidenced the need for a mechanism for coordination and information exchange linking food safety authorities and promoting the rapid exchange of information." Another example of INFOSAN's role in response to an international outbreak of acute non-viral hepatitis is highlighted in Box 6.3.

Box 6.3: INFOSAN highlight – international outbreak of acute non-viral hepatitis

In 2013, an outbreak of acute, non-viral hepatitis occurred in the United States that caused 97 reported illnesses, resulting in at least 47 hospitalizations, three liver transplants, and one death. The outbreak was associated with the consumption of dietary supplements marketed for energy boosting, body building, and weight loss. Investigations by the United States Food and Drug Administration (FDA) indicated that the products were adulterated with aegeline, a new ingredient that was not approved for use in the products.

Initially, the INFOSAN secretariat was notified that the implicated products were not exported to other countries. However, further investigations revealed that the products were available for purchase globally on the Internet. An INFOSAN alert was subsequently posted to members of the network, which prompted the identification of additional cases of acute non-viral hepatitis linked to the consumption of this product from countries in Europe, Asia, and the Western Pacific. The INFOSAN secretariat worked closely with INFOSAN Emergency Contact Points of these countries to exchange timely information about the outbreak and to aid in their investigative, trace-back, and response efforts to prevent further illnesses and mitigate the impact of the incident.

Source: FDA, 2014; WHO/FAO, 2014.

In addition to participation in INFOSAN, which is voluntary, countries may have legally binding rapid alert reporting requirements under the International Health Regulations (IHR) (2005). The purpose and scope of the IHR (2005) are "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade" (WHO, 2007). Given their broad scope, the regulations cover events of international importance that involve contaminated food and outbreaks of food-

borne disease. Communication and reporting requirements under the IHR (2005) should generally be conducted by a national IHR Focal Point (WHO, 2007). A country's national IHR Focal Point and INFOSAN Emergency Contact Point should work closely together to facilitate the reporting, management, and response to public health emergencies of international concern related to food. In some cases, both roles might be shared by the same individual to enhance reporting efficiencies.

Regional rapid alert networks

Linking national rapid alert networks within a regional framework can facilitate the identification and response to potential food safety hazards and threats across the borders of countries that are geographically close and mutually engaged in agrifood trade. An advantage of a regional rapid alert network can be the sharing of information about adverse food safety incidents identified at member nations' borders. When food products imported from outside of the regional network are identified as a problem at one member country's border crossing, rapid transmission of the information through the alert network ensures that all border crossings in the network are informed. The Rapid Alert System for Food and Feed (RASFF), involving countries of the European Union, is an example of a formal regional rapid alert network that is highlighted further in Box 6.4. In Europe, many of the INFOSAN emergency contact points are the same as the RASFF contact point for a country, enabling efficiencies for both networks.

Box 6.4: The RASFF regional rapid alert system

RASFF was initiated in 1979 to "provide food and feed control authorities with an effective tool to exchange information about measures taken responding to serious risks detected in relation to food or feed. This exchange of information helps Member States to act more rapidly and in a coordinated manner in response to a health threat caused by food or feed" (European Commission, 2011). RASFF members include the European Commission, EFSA, the European Free Trade Association Surveillance Authority, and 32 member countries including all European Union countries, Lichtenstein, Iceland, Norway, and Switzerland.

Each country and the European Commission has a contact point that is responsible for transmitting information to RASFF and receiving alerts from RASFF. Information for RASFF alerts originates from food safety signals generated by member country border inspections, food inspection systems, public health systems, company own-checks (verified by official authorities), and EW systems. RASFF member countries inform the European Commission who verifies the information before sending it to RASFF members as one of three types of alerts or "notifications":

- *Alert notification:* a food or feed presenting a serious health risk is on the market and rapid action is required.

- *Information notification:* a risk has been identified in a food or feed but the product is not on the market or the risk is not considered to be serious.
- *Border rejection:* food and feed consignments that have been tested and rejected at the external borders of the European Union when a health risk has been found.

Any information related to the safety of food and feed products that has not been communicated as an alert or an information notification, but which is judged valuable for the control authorities, is sent out as "RASFF news".

RASFF uses a web-based IT platform called iRASFF to exchange real-time notifications and alerts among members of the network. The public and other stakeholders can search for summaries of RASFF notifications via the RASFF Portal (https://webgate.ec.europa.eu/rasff-window/portal/), while a restricted area called the RASFF Window is used to inform countries that are not members of the network of notifications in which they are involved. Recently a RASFF Consumers Portal was launched that facilitates identification of notifications sorted by country. More information about RASFF is available in their annual reports.

Source: European Commission 2009, 2011, 2015.

Another example of a regional rapid alert network is the ECDC's Epidemic Intelligence Information System (EPIS), which is a web-based communication platform that allows nominated public health experts to exchange technical information about emerging public health threats that might have a potential impact in the European Union (ECDC, 2015a). EPIS includes a food- and water-borne disease platform that facilitates the early detection, assessment, and response to multinational molecular typing clusters and outbreaks of food- and water-borne diseases in 28 European Union member states, three countries in the European Economic Area, and 14 other countries internationally (ECDC, 2015a).

The European Union rapid alert networks described above may be useful models to consider for countries in other regions to develop their own regional networks. For instance, the presence of a central stakeholder for alerts connected to multiple countries that each have their own national contact point can dramatically improve the timeliness of reporting food safety information arising in one member country to all members of the network.

Two simulated network diagrams are shown in Figure 6.1 to illustrate the difference between a regional rapid alert network model (e.g. RASFF) and a rapid alert network with no central stakeholder. In a network with no central stakeholder to coordinate dissemination of alerts, transmission of information from any one country to the rest in the network requires many steps before reaching a majority of the countries. It does not directly reach those countries that are disconnected from the network. In the right-hand diagram containing a RASFF-like central stakeholder, that same information can reach the entire network of countries much more rapidly and efficiently.

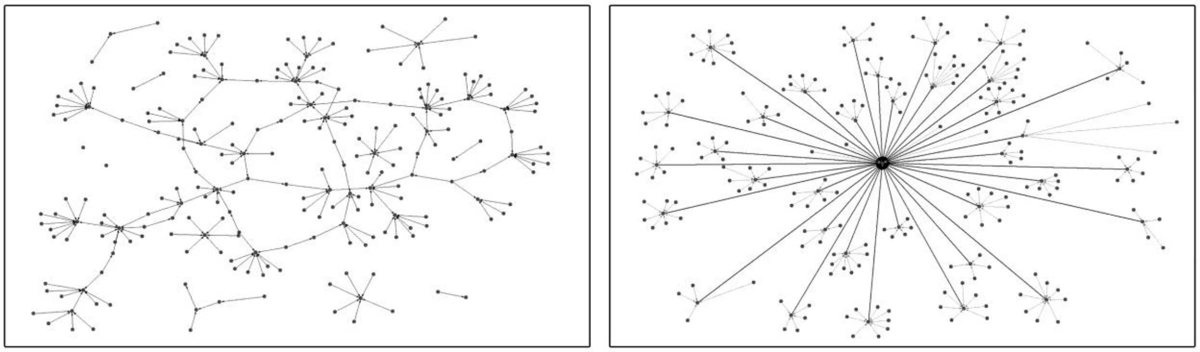

Figure 6.1: Two simulated regional rapid alert networks, one with random connections among countries (illustrating rapid alert network inefficiencies) and one with connections through a central stakeholder like RASFF (illustrating a coordinated rapid alert network to support timely and efficient communication and response).

However, RASFF and EPIS both involve a group of countries that were already connected by a formal economic union, which likely helped to form the structure and deeply connected regulatory framework. Other countries should develop a regional approach that fits with the political realities and food trade specifics and context of their region.

Crafting and communicating alerts

Alerts produced by a national rapid alert network need to be crafted and disseminated with precision. They will ideally be tailored to target audiences, easy to understand, provide sufficient context, outline logical next steps, and follow risk communication principles (FAO/WHO, 2015). Risk communication principles for food safety messages include *openness, transparency, responsiveness* and *timeliness*.

Openness refers to the opportunity for dialogue (two-way communication) and knowledge exchange among all rapid alert network stakeholders when feasible. Knowledge exchange should include a continuous and iterative process of interaction and engagement among all stakeholders (Rajić and Young, 2013). This process can be useful for jointly developing risk communication strategies and messages. It also offers the chance to obtain relevant information to inform risk assessment and/or management decisions, can increase the likelihood that decisions and actions are "fit for purpose", and contributes to evidence-informed decisions and actions. For example, stakeholders may be invited to submit evidence, participate in a meeting where risk management options are discussed, or comment on draft messages before they are finalized.

Transparency means a set of policies, practices, and procedures that enable stakeholders to understand how decisions on risk assessment, management, and communication have been made. This means that information supporting the risk management decision (e.g. outcome of the risk assessment, research reports, data) and documentation about the decision-making process (e.g. minutes of meetings) should be made accessible to interested stakeholders (e.g. published on websites or be available on request).

Responsiveness is the extent to which those responsible for food safety address the target audiences' risk communication needs and expectations in their communication activities. Risk communicators should also be responsive to changes in the external environment, including unplanned and unforeseen events (e.g. misinformation, emerging questions and concerns, misconceptions), and revise or reinforce messages accordingly.

Timeliness of communication, even in the presence of uncertainty or knowledge gaps about the risk, is instrumental in protecting public health and building and maintaining stakeholder trust.

It is important that risk communication efforts are tailored to the needs and concerns of target audiences in order to maximize their effectiveness and dissemination. Important considerations for tailoring risk communication include (FAO/WHO, 2015):

- The target audience's knowledge gaps, behaviours, concerns, and perceptions about the risk;
- The cultural and socio-economic backgrounds of target audiences (e.g. reading abilities, language needs); and
- The information sources, channels, and methods that are *trusted*, *frequently used*, and *accessible* by the target audiences.

To identify, prevent, and address unintended consequences of risk messages, it is important to (FAO/WHO, 2015):

- Validate messages with relevant stakeholders and inform them of the communication activity before actually communicating;
- Test messages with the participation of target audience(s), though this may not be feasible during emergency response situations; and
- Monitor and adjust risk messages as the issue evolves (e.g. responding to emerging concerns or areas of confusion among stakeholders and target audiences).

When communicating to the public about a food safety issue under conditions where risk information is associated with uncertainty, such as during a food safety emergency, or where there are gaps in knowledge, it is important to (FAO/WHO, 2011; FAO/WHO, 2015):

- Acknowledge what is known and what are the areas of uncertainty
- Communicate what is being done to reduce uncertainties

- Communicate the implications of remaining uncertainties for food safety
- Acknowledge that early messages may change as further information is gathered and verified
- If possible, provide advice about what people can do to protect themselves and how to access additional information
- Release and discuss more complete information when it becomes available, its implications, and any revised course of action that may further protect food safety and prevent illness

During emergencies there may not be enough time to fully consult with all relevant target audiences and stakeholders to inform message development. It could be valuable to have consultative groups (e.g. stakeholder groups) available during emergencies to obtain feedback in order to understand the concerns of the stakeholders. Two-way communication channels (e.g. telephone lines) are also useful to provide stakeholders and target audiences with opportunities to seek or provide information, and to receive feedback on specific concerns and broader communication needs.

Most risk communication issues that involve food safety directly involve and have implications for different governmental departments and groups within society (e.g. public health departments, agrifood departments, industry, consumer organizations). Effective coordination of communication efforts among these stakeholders is important to reduce the likelihood of confusing and even contradictory public information, and to prevent loss of organization's credibility and effectiveness (FAO/WHO, 2015). Coordination of communication efforts is particularly important and challenging during emergencies, when messages often need to be changed frequently, and developed in a very short time frame, in consultation with a wider range of agencies and stakeholders than in normal situations. During emergency food safety situations, it is often useful to identify one agency to coordinate communication efforts on behalf of the rapid alert network, to appoint one or more appropriate spokespersons, and to hold daily media briefings to ensure consistency and timeliness of messages and to avoid confusion (FAO/WHO, 2011).

Diagnosing problems or "troubleshooting" an inefficient or ineffective national rapid alert network

Timeliness of reporting has been identified as a major requirement for successful EW systems and rapid alert networks (Collier & Doan, 2012; Hoffman *et al.*, 2005; Wethington & Bartlett, 2004). There is a need to be able to rapidly exchange information among relevant stakeholders. Marvin *et al.* (2009) noted that "if warnings do not reach the relevant authorities in time, this may hinder timely and adequate prevention, intervention, and control activities." Poor timeliness may be related to inadequate staffing levels and technological barriers. Investments in these areas may be necessary to improve the timely reporting of alerts related

to food safety threats (Hoffman *et al.*, 2005; May, Chrieten, and Pavlin, 2009). In developing countries, further improvements to rapid alert networks could be made through enhancements to communication infrastructure (including internet access), the use of automated reporting, and the use of volunteers in low staffing areas to support rapid alert network activities and functions (May, Chrieten, and Pavlin, 2009).

National rapid alert networks should be evaluated periodically for their effectiveness and sustainability. What can be done if concern arises from such an evaluation that a national rapid alert network is too slow to respond? That is to say, what if it takes longer than expected to go from discovering an EW signal to taking necessary preventive or mitigation actions (e.g. issuing a food recall)? Such a concern should trigger a "troubleshooting" exercise to diagnose inefficiencies in the network that obstructed the flow of communications and actions. A whole-network approach to the diagnostic process is likely to be more effective than employing a fractured approach that focuses upon only one part of the network.

The following are a series of steps to facilitate troubleshooting an inefficient or ineffective national rapid alert network:

- Identify all stakeholders of your national rapid alert network and indicate the connections among them according to the communications, alerts, and actions you expect them to share. The connections can be mapped-out and illustrated using a network diagram similar to Figure 6.1. Recognize that this network diagram may differ from existing organization charts for the agencies involved.
- Compare the roles and responsibilities of the various stakeholders in your network with the parts of a national rapid alert network that may be needed for it to be functional and sustainable (presented earlier in this chapter). Identify if any important stakeholders are missing from your network. Determine why they are missing and make plans to add them to the network.
- Review recent food safety events to explore how rapidly and effectively the network stakeholders connected to share information, transmit alerts, and take actions. Identify if there were problems with timeliness or effectiveness.
- Determine if the alert process needs to be better documented, and if alert templates should be generated for various scenarios. Check that alerts are easy to understand, provide sufficient context, outline logical next steps, and follow risk communication principles. Build in some flexibility to adapt alerts to new or unforeseen situations.
- Ensure that responsibilities regarding who crafts and distributes alerts are clearly negotiated and understood; a task force of stakeholders could be considered to coordinate some rapid alert activities. Plan for alerts that must be issued outside of business hours, and during staff illness or vacation.
- Verify that network stakeholders have the resources to respond effectively to requests for action. New forms of funding or synergies with stakeholders in other national networks may need to be negotiated to accelerate response times.

- Confirm that the network has enough authority to effectively request actions or to take action. Requests to the regulatory stakeholders may be needed to upgrade food safety regulations and enforcement.
- Differentiate between deficiencies in EW surveillance coverage and problems with the rapid alert network itself. Refer to the troubleshooting exercise presented at the end of Chapter 5 to manage the former.
- Develop and pursue answers to questions that are specific to your context, and as new questions arise during the process. Can you list some of those questions now, given what you know about the rapid alert network in your country?

Lack of trust can be a key limitation to the success of some national rapid alert networks. For example, there is risk to income and reputation for private sector companies, food sectors, or nations named in an alert. However, timely, open, transparent, and responsive communication of alerts can actually prevent negative economic consequences and improve stakeholder credibility (FAO/WHO, 2015). Ongoing dialogue about the need for notification, incentives for notification, and the impacts of alerts can improve trust between rapid alert network stakeholders.

National rapid alert networks can become out-of-date quickly, especially in systems with frequent changes in civil service structure or high employee turnover. Plans must be made to periodically update contact lists and create awareness among network stakeholders regarding the importance of maintaining continuity of the network. In addition, rapidly changing technologies may push rapid alert networks to update to more effective, easier-to-use technology as it becomes available and familiar to stakeholders. However, replacing technological platforms too frequently may fatigue users who are comfortable with existing systems. It is important that the steps used to distribute alerts are tested periodically so that users are aware of changes to websites or social media allowing alerts to be distributed rapidly.

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CHAPTER 7

Planning, Building, and Strengthening Early Warning Capacity in Food Safety

The previous chapters of this handbook have described the different components, functions, processes, and considerations of EW systems, including rapid alert networks, for food safety. This final chapter aims to bring this information together to provide practical guidance on how countries can plan, build, and strengthen such systems and link them with relevant regional and international initiatives. An “EW Strategy Tool” is introduced that provides a practical resource to assist stakeholders in putting the theory described into practice. This will allow countries to enter a progressive pathway towards more resilient EW capacity and capability.

Key ideas

- Fundamentally, almost all surveillance and intelligence systems can provide EW signals related to food safety threats.
- An essential overarching element of all EW systems includes continuous and effective collaboration, coordination, and communication between multiple sectors and stakeholders across all steps of the EW process; from the identification of an initial EW signal to subsequent actions and responses.
- EW system design should follow a structured approach to ensure that it operates efficiently, effectively, and sustainably.
- An EW Strategy Tool is available to assist countries in their efforts to plan and build efficient and effective national EW systems.
- The tool consists of a checklist that provides an inventory of aspects to be considered when building or enhancing a national EW strategy, and a priorities assessment to describe the main opportunities and gaps that a specific EW strategy can be built upon and will need to address.

Components, functions, processes, and considerations of EW systems in food safety

This handbook has guided users through the different components, functions, processes, and considerations of EW systems in food safety. The handbook first provided an overview of agrifood production and control systems, and how understanding the specifics of a country's agrifood production system is an important first step in building and improving a food control system (Chapter 2). Food control systems provide the foundation of EW capabilities, for example, through the surveillance activities conducted. It was concluded that as hazards can arise anywhere along the food supply chain, it is important to manage risks along the entire chain using an integrated food chain continuum as well as risk-based approach.

As a key component of a functioning food control system, food safety surveillance can identify and monitor food safety threats, providing a foundation for EW capabilities and capacity (Chapter 3). However, in the absence of a well-developed food control system, regular food inspection is an important starting point for surveillance. To maximize early detection capabilities, a combination of different food safety surveillance approaches along the food chain continuum might be necessary. The handbook also introduced readers to the concepts of food safety foresight and intelligence (Chapter 4). Applied examples were provided to demonstrate how foresight techniques, including horizon scanning, can complement EW and lead to the development of proactive food safety strategies, help decision-makers to better anticipate highly uncertain issues in advance of their occurrence, and promote strategic preparedness.

Signals from both surveillance and intelligence-gathering systems can make a contribution to EW and facilitate the prediction or earlier detection of potential food safety threats and adverse events (Chapter 5). Ultimately, the goal of an EW system is to detect a signal as early as possible along the food-chain continuum, before it results in a public health signal or threat. An EW diagrammatic tool (the "EW matrix") was introduced to help countries to identify their surveillance gaps and opportunities to improve EW system capacity and capability.

To protect consumers from adverse food safety events, a country needs to be prepared to respond quickly and appropriately to EW signals of food safety events. A series of actions needs to be taken by appropriate stakeholders to verify identified signals, assess possible risks, consult with relevant stakeholders, and identify and take necessary actions (Chapter 6). National rapid alert networks were identified as key components of EW systems to facilitate these activities. To enhance response capacity, national rapid alert networks should integrate and link with relevant global and regional networks, including INFOSAN.

Designing effective and efficient EW systems – integration as the way forward

Integrated EW approaches will depend upon the ability of multiple individuals, organizations, and components to collaborate and function together effectively and efficiently. Multiple surveillance and intelligence systems, each with different approaches and objectives, when interconnected and networked together in an integrated approach, will improve EW endeavours. Stakeholders will need to foster multiagency communication and linkages as they look for ways to connect different surveillance approaches, data, expertise, competencies, resources, and networks in support of EW capacity. Whether referring to single or integrated EW systems, it should be noted that the systems must be flexible and adaptable enough to integrate various data sources and technologies, and that EW systems are dependent on the availability of adequate human resources and technological capacity to appropriately validate and analyse signals and communicate alerts.

Surveillance and intelligence systems for food safety are often designed for purposes other than EW, such as to manage risks from food safety hazards, to monitor contamination, to evaluate policies and their implementation, or to meet specific regulatory requirements (e.g. certification schemes, export health standards). Although these systems also generate EW signals, they are not generally recognized as or referred to as EW systems. However some publications highlight the EW capacity of individual systems, in particular where a risk-based approach is used. Fundamentally, almost all surveillance and monitoring systems can provide EW signals related to a food safety threat, and therefore provide value to EW systems for food safety, independent of their position on the food chain continuum. The varying strength and specificity of the EW signals observed has been discussed in detail in Chapter 5.

It is considered critical for any EW capacity-building activities to build upon a country's or region's food production system and trade portfolio. The proportion of import to export, and the specific commodities that are imported or exported, will be a key driver behind the threats that need to be mitigated. For example, some smaller countries might be import dependent for most agrifood products, while other countries produce and export large amounts of specific products.

Evaluation of EW systems is critical to ensure the best use of available resources and to enhance system effectiveness and efficiency. However, the literature on evaluating EW systems for food safety is currently limited, and hence, no accepted standard or recommendations exist. As a result, there is a lack of information and guidance on how to set up, sustain, and evaluate these types of systems. Until more evaluations of EW systems are published in the literature, analogy from relevant fields (e.g. surveillance evaluation) and opinions of experts with experience in EW surveillance and food safety will need to be used to enhance integrated national EW systems.

EW systems for food safety may be of lower priority in countries with limited resources, or in countries that have other competing health priorities. Limited fundamental food control and surveillance infrastructure, public awareness of food safety hazards, coordinated information sharing networks, and legal and enforcement options may all contribute to the priority given to EW systems in particular countries. Individual countries will need to realize their EW capacity within the unique constraints and contexts of their situation, including identification of national or regional strengths, gaps, and opportunities.

Designing effective and efficient EW systems – what needs to be considered?

Effective EW capacity requires a sound understanding of the different food value chains, including food trade patterns, in a country or region, as well as the population's baseline health status. Development of a strategic plan is highly recommended to any country or region that wants to improve their EW capacity and capability. The overall building and enhancing of EW capacity and capabilities can be described as a process consisting of six distinct steps (Figure 7.1). Details of the process and its considerations are described in the "EW Strategy Tool" that is provided in Appendix C. This tool aims to provide handbook users with the ability to readily develop a high-level, skeleton strategy for EW in their country.

The different steps of the EW process are described in detail below. In parallel, practical examples and insights from previous training workshops are provided to highlight the application of the strategy-development process in action. All examples are based on country-specific EW strategies developed during two pilot training workshops in Kenya (Eastern Africa region including representatives from Tanzania, Ethiopia, Kenya, Uganda and Rwanda) in 2014, and Hungary (Europe and Central Asia region including representatives from Albania, Bosnia and Herzegovina, Croatia, Georgia, Hungary, Macedonia, Moldova, Romania, Russia, Serbia, Turkey and Ukraine) in 2015. This section does not provide a comprehensive inventory of response options, but is meant to demonstrate how the steps of the strategy tool link with country-specific needs and priorities for these two case study regions.

1. Describe the needs

In this first step, the food production and safety situation is analysed. This includes an assessment of key food value chains, the national or regional trade profile, and pertinent food safety hazards and threats. This step also specifies national capacity-building needs and describes the local impact that could be made through improved EW capacity and capability.

Workshop examples:

Many countries indicated a need to protect important export markets with the help of EW systems (e.g. European Union market access) or to protect their consumers from key food safety hazards arising from major value chains (e.g. aflatoxin in Africa). Increased public

awareness of food safety threats was also identified as a driver of EW needs. Obstacles to a successful EW system included limited human or infrastructure capacity such as laboratories, information technologies, or adequately trained personnel (e.g. inspectors, risk analysts, and technicians). Limited financial resources within competing priorities as well as lack of political will and stability were also identified as common challenges for EW. In many countries, EW efforts are not coordinated between the multiple agencies involved in food safety, which is a further barrier to improvement. A specific case study of EW needs identified by Uganda is highlighted in Box 7.1.

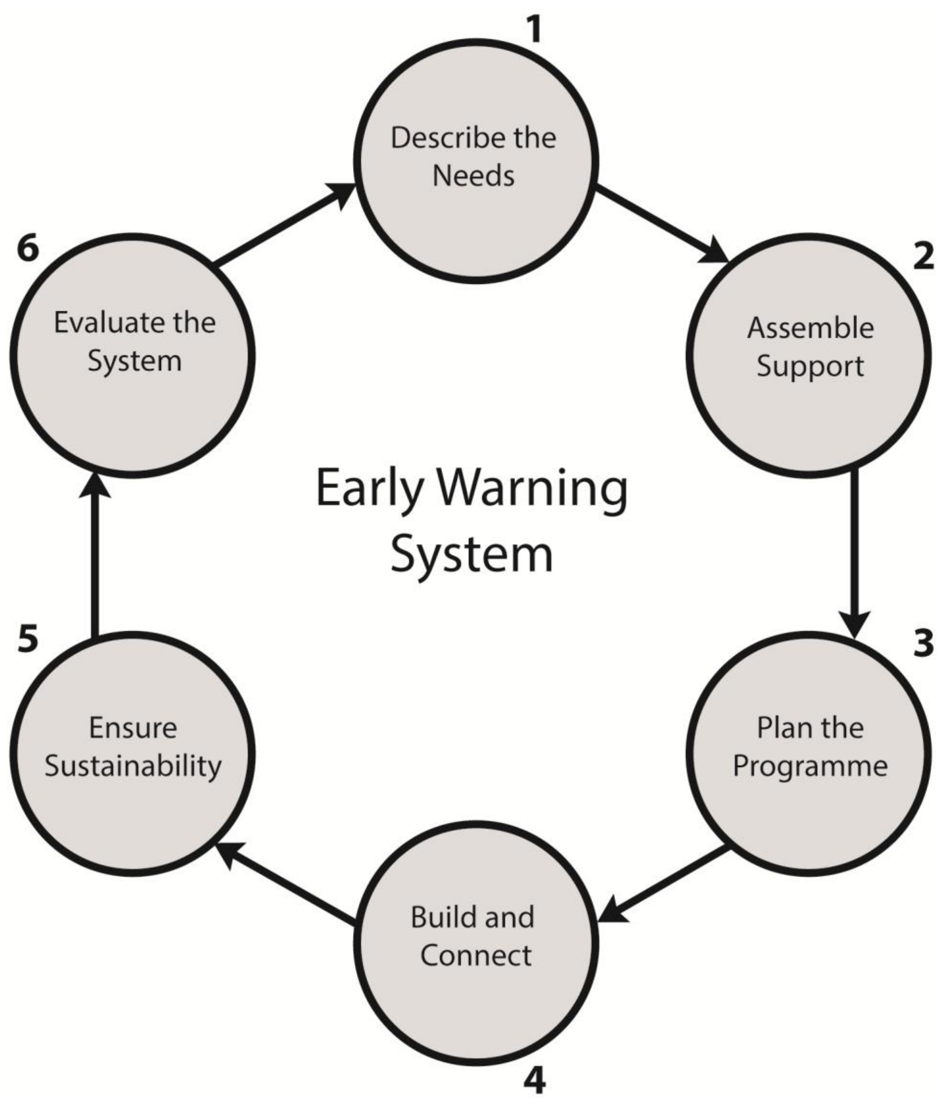

Figure 7.1: Introduction to the multifactorial process of building and enhancing national EW system capabilities and capacity.

Box 7.1: Case study – describing EW capacity needs in Uganda

During a regional training workshop in Eastern Africa in 2014, representatives from Uganda identified that the following were the biggest concerns for food production and food safety in their country:

- Insufficient legislative framework
- Capacity gaps in particular with respect to infrastructure, human resources, and competence to analyse risks and generate data
- Lack of public awareness
- Lack of SPS competencies (both enforcement and compliance)

Identifying these challenges provided the workshop participants from Uganda with an opportunity to plan an EW system to adequately address them.

2. Assemble support

In step two, stakeholders are identified and their specific needs described. Many stakeholders can be identified, and include producers, collectors and transporters, processors, service provides, consumer associations, and politicians, as well as local and national government agencies and decision-makers. Approaches to gaining the support of these stakeholders should be outlined. This step further considers how EW in the country could connect with regional and international efforts.

Workshop examples:

Creation of a unified vision for EW was frequently identified as an approach to gaining national stakeholder support, alongside improved coordination and transparency. Furthermore many countries use national contact points to improve linkages with regional and international stakeholders, including for example RASFF, INFOSAN, FAO, WHO, EFSA, or the Codex Alimentarius Commission. However, while in some regions regional infrastructure might already be well established (e.g. RASFF in Europe), in other regions (e.g. Africa), such infrastructure might not be available or is still in early phases of development.

3. Plan the programme

Step three starts with identifying existing food safety infrastructure that the EW system could be built upon. This includes, for example, existing surveillance and food control programmes and rapid alert network capacity. The essential components and capacities of the planned EW system are then described; focusing on the three 'EW Pillars' proposed in the handbook (Figure 1.1).

Workshop examples:

Specific initiatives were identified among countries to address their unique needs and situations. For example, some countries in Africa indicated a need to first improve local capacity, e.g. by strengthening community-based (participatory) surveillance or through the training of “grass roots” champions. On the other hand, countries in Europe and Central Asia with more developed food control infrastructure identified a need to integrate more advanced approaches within their EW system, such as foresight and risk assessment. Other examples of identified initiatives included: mapping of emerging issues in food safety and building of a joint EW platform to create a common understanding of issues, roles, and responsibilities and to ensure capacity at the community level. The need for adequate funds, resources, and suitable IT capacity were also commonly identified as an essential part of planning and building EW capacity.

4. Build and connect

This step describes the main stages in building the EW system and linking together its individual components. It considers how reactive and anticipatory EW components can be integrated, how goals are set, and how stakeholder responsibilities, leadership, and engagement can be ensured.

Workshop examples:

Establishment of a multisectoral technical working group to develop a work plan was identified as a common first stage in achieving improved EW capacity and capability in food safety. Some countries considered “train-the-trainer” approaches for improved human capacity during this phase and the need to focus on increasing communication, collaboration, and data sharing between animal health, food safety, public health, and all relevant stakeholders. Countries also recommended assigning responsibilities to specific stakeholders, including the need to define and assign leadership roles. Countries, particularly in Africa, identified the importance of using a ‘One Health’ approach to ensure that EW works efficiently and collaboratively across the whole food chain. A case study of goals and gaps to be addressed to build and connect an EW system in Montenegro is shown in Box 7.2.

Box 7.2: Case study – building and connecting an EW system in Montenegro

As a small country, Montenegro is import-dependent for most agrifood products, although it exports some products such as wine, spirits, and fruits. During a regional training workshop in Budapest in 2015, participants from Montenegro identified the following EW goals and gaps for their country:

- Develop more surveillance programmes
- Appoint one single authority responsible for food safety

- Improve coordination and communication between the different agencies responsible for food safety and control in the country
- Address the lack of adequate human resources and technological capacity to appropriately validate and analyse EW signals
- Improve effective collaboration, coordination, and communication among EW stakeholders
- Identify all possible data sources that can provide initial EW signals

Identifying these goals and gaps was an important step for Montenegro towards the development of their country-specific EW strategy.

5. Ensure sustainability

Step five focuses on development of strategic goals and securing long-term stakeholder commitment to ensure that the EW system is sustainable in practice.

Workshop examples:

Countries identified several steps that can be taken ensure sustainability. For example, stakeholders and service providers can incorporate EW “system thinking” into their daily activities and these can also form part of an annual action plan. Regular meetings of key stakeholders can also make an important contribution to ensuring long-term commitment. The definition of strategic goals can also enhance sustainability. Some examples identified by countries include: a reduction in food-borne disease (from a specific threat or in general); a reduction in trade recalls, rejections, and notifications; and increasing the trade volume of specific agrifood products.

6. Evaluate the system

In the final step, evaluation of the EW system is considered to ensure it is operating efficiently and effectively. Different approaches, attributes, and indicators that could be used to evaluate the EW system should be considered, as well as the need for potential modifications and changes to the system.

Workshop examples:

For this step, countries considered evaluation of timeliness as critical. Quality control measures, audits, accreditations, guidelines, and standard operation procedures were also identified as important to evaluate the performance of an EW system and its components. The need to conduct evaluation at regular intervals was frequently noted.

Designing effective and efficient EW systems – the EW strategy tool

The EW Strategy Tool (provided in Appendix C) provides stakeholders responsible for building and maintaining EW capacity and capability with the information-base required to develop and implement a sustainable skeleton strategy (i.e. high-level, actionable plan) for EW in their country. It aims to support both strategic and operational EW capacity- and capability-building, and is based on the above six-step design process. An overview of the tool is presented in Figure 7.2.

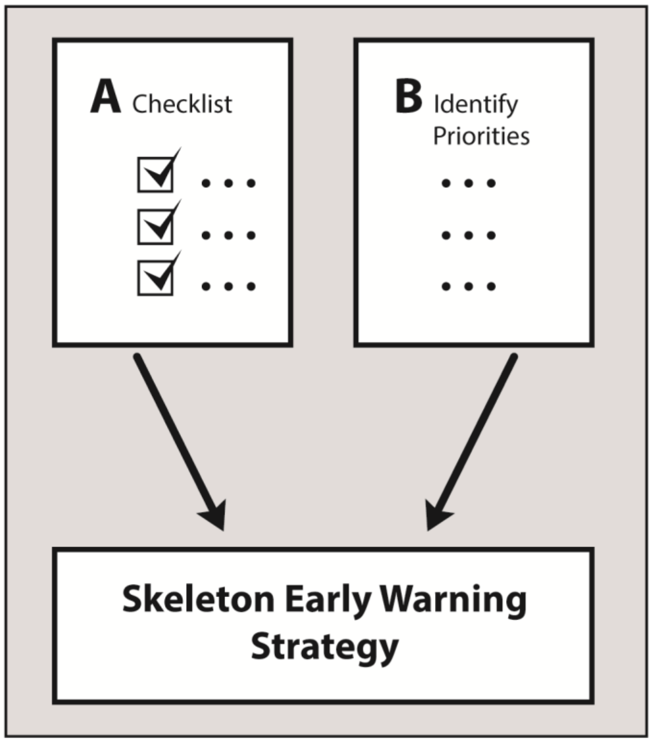

Figure 7.2: Overview of the steps included in the EW Strategy Tool.

The tool consists of:

- A six-step **checklist** that provides an inventory of aspects to be considered and tasks to be completed ('Implementation Checklist')
- A **priorities assessment** to inform a national strategy for EW

Depending on the national context, not all items in the implementation checklist part of the tool will be equally relevant. Also, the detail in which the different items are assessed will be situation-specific. It is important, however, to ensure that all items on the implementation plan are at least considered. This is to ensure that the EW strategy covers all aspects of relevance and does not contain major gaps. After working through the implementation checklist, users

should conduct a priorities assessment to describe the biggest challenges to EW in their country and the biggest strengths that EW capability and capacity can be built upon. This will help to prioritize the main opportunities and gaps that a specific EW strategy can be built upon and will need to address.

The EW Strategy Tool requires a thorough understanding of all required background information and context that is provided throughout this handbook. Therefore, the tool should be used in conjunction with the handbook, referring to relevant chapters and presented material when appropriate.

Designing effective and efficient EW systems – conclusions

Bringing together the guidance provided throughout the handbook, this final chapter has summarized the key principles of EW capacity- and capability-building in food safety. As a concluding message, efficient and effective EW always needs to account for and build upon existing food production and control infrastructure, regardless of its level of sophistication. Furthermore, an integrated and collaborative approach is essential to the success of any EW initiative. This handbook is dedicated to providing a direct link with real-world needs, rather than simply building the theoretical foundation for EW capacity and capability. Therefore, several tools are provided in this handbook for countries and regions to improve EW, including a dedicated strategy tool that will provide guidance for developing a sustainable, actionable, and strategic approach to EW.

Overall, there are many starting points to improve a national EW system. In many cases, existing infrastructure and processes already provide necessary information to support EW and can readily be integrated into EW systems with limited additional effort. Timely detection and response to food safety events through EW systems will ultimately minimize the negative effects of these events on human health and welfare, as well as the effects on global trade, income, employment, and food security.

Appendix

SUPPLEMENTARY MATERIAL

Appendix A: List of commonly used foresight techniques applicable to EW for food safety

Foresight technique	Purpose of the technique	How the technique is used	Potential strengths and weaknesses relative to food safety	Reference(s) for additional information
Backcasting	A method for developing a strategic pathway given a predefined future vision.	This method follows the identification of an ideal future scenario and is used to identify the necessary steps to reach that preferred future goal.	*Strength:* Promotes strategic thinking and removes barriers to discussion between stakeholders. *Weakness:* Requires long project time and requires careful follow-up and monitoring of progress.	(European Commission, 2008)
Delphi Survey	A structured method of surveys using domain experts to synthesize their opinions and judgements about issues where uncertain and incomplete knowledge exists	Specific methods are flexible and vary, but survey is usually conducted in two or more "rounds", where feedback from the previous rounds informs subsequent rounds. Mainly used for addressing decisions about long-term issues.	*Strength:* Provides a formal and flexible approach for obtaining expert insights in the face of uncertainty, can be used to obtain consensus. *Weakness:* Deepening on the approach used, can be time-consuming and expensive, requires careful planning, possible participant attrition in later rounds.	(European Commission, 2008; Frewer *et al.*, 2011)

Foresight technique	Purpose of the technique	How the technique is used	Potential strengths and weaknesses relative to food safety	Reference(s) for additional information
Expert Consultation	Gathering of insight and intelligence from domain experts. Information is organized using key themes or drivers.	Encompasses a range of specific methods (e.g. Delphi survey, nominal group technique) used to identify or prioritize changing trends, drivers, or emerging issues. Depending on method used, insights can be obtained from experts via questionnaires, interviews, meetings, workshops, or virtually.	*Strength:* Flexible range of methodological approaches available to obtain broad information, particularly when knowledge is scarce and uncertainty is high. *Weakness:* Depend on the specific method used (formal techniques should be used over *ad* hoc consultations when possible), in-person meetings can be costly.	(EFSA, 2014)
Expert Panels	Method that uses experts in a particular field to review or deliberate on the future of a specific matter.	A commonly used foresight method that may consist of 12–20 people who are given 3–18 months to deliberate on future aspects about specific issues related to their area of expertise.	*Strength:* Simple to set up and deploy, can integrate insights from diverse range of experiences/expertise. *Weakness:* Quality of results may vary and is dependent upon the appropriate selection of experts and their willingness to participate, require careful facilitation.	(European Commission, 2008)
Forecasting	A method used to predict a future event or trend.	Uses past data to inform models that identify the most likely future scenarios. Often used in business or environments where previous data are available.	*Strength:* Outputs are data driven. *Weakness:* Outputs are only as good as the data and model. Does not account for unpredictable or unforeseen events.	(European Commission, 2008)

Foresight technique	Purpose of the technique	How the technique is used	Potential strengths and weaknesses relative to food safety	Reference(s) for additional information
Horizon Scanning	A systematic examination of potential hazards, risks, opportunities, and likely future developments that may impact on food safety. Information is gathered from various sources (e.g. reports, media, blogs) and is organized into key themes.	This method is used to identify medium- to long-term issues or trends that could be important for decision-making, agenda setting, or articulating credible observations.	*Strength:* Varied methodology to fit needs of organization. *Weakness:* Provides basis insights and must be combined with other foresight methodologies to provide value.	(Amanatidou *et al.*, 2012; United Kingdom Cabinet Office/ Government Office for Science, 2014)
Multicriteria Decision Analysis	A semi-quantitative methodology used to rank and compare potential insights, issues or decision options.	This method is used to prioritize issues or decisions and has been applied across a range of strategic processes and sectors.	*Strength:* Flexible method to compare and contrast various issues or policy options using inputs from multiple stakeholders. *Weakness:* Can create difficulties if criteria are too vague, misunderstood or too closely related.	(European Commission, 2008)
Scenario Planning	A method that uses possible future scenarios to explore system or organizational performance.	This tool is most commonly used to inform decision-making, by enabling decision-makers to assess options and develop strategies. This is one of the most recognized and used foresight methods in both public and private organizations.	*Strength:* Stimulates critical thinking, helpful for organizing thoughts, useful tool to use when uncertainty is high. *Weakness:* Might be difficult to identify credible scenarios, need to include “wild card” futures for best results.	(European Commission, 2008; United Kingdom Cabinet Office/ Government Office for Science, 2014)

Foresight technique	Purpose of the technique	How the technique is used	Potential strengths and weaknesses relative to food safety	Reference(s) for additional information
SWOT Analysis **(Acronym for strength, weakness, opportunity and threats analysis)**	An analytical method for organizations to identify important internal and external factors as Strengths, Weaknesses, Opportunities, or Threats.	Most often used to identify strategic pathways, in particular the risks and opportunities that may be present with different decision options.	*Strength:* Simple, structured approach to organize diverse information, does not require special training. *Weakness:* Lacks prioritization of factors and has no suggestion for resolving disagreements, should be combined with other foresight methods.	(European Commission, 2008)

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Appendix B: Detailed description of steps for developing a horizon scanning function

The horizon scanning process can be divided into four logical stages:

1. Framing the problem
2. Identifying drivers of change
3. Scanning for insights
4. Interpretation of results

Step 1: Framing the problem

'What is the problem we want to investigate?' There are two types of problems that horizon scanning may address (Amanatidou *et al.*, 2012):

- *Issue focused:* Focused on specific questions or policies and searches for signals related to the issue that may inform change (e.g. changes to climate and storage conditions that could affect aflatoxin contamination in maize).

- *Exploratory scanning:* Focused on general questions and provides a broad profile of signals (e.g. changes to consumption patterns, production levels, climate, and regional politics that could affect national food safety policy).

Step 2: Identifying drivers of change

Drivers reference the underlying cause of change and are used in horizon scanning to structure the scanning process. They are identified before horizon scanning begins and reflect the needs and values of the organization (Sutherland *et al.*, 2011; United Nations Environment Programme, 2012). Where possible, they should be supported by statistics generated by global organizations (e.g. FAO, WTO, WHO)

Some relevant food safety examples include (FAO, 2013):

- *Trade patterns:* Food system trade patterns will vary (e.g. local, national, regional) and the implications of an increasingly dynamic market may have impacts on food safety.

- *Climate change:* Changing climate and increased incidence of extreme weather is affecting patterns of occurrence of food safety hazards.

- *Technology development:* The increased role of new technologies in food production, post-harvest treatment, processing, packaging, and sanitary treatment may bring about

new risks to human and environmental health or provide opportunity for improved food safety.

- *Population and demographics:* Growing global populations and sustained trends of migration to urban regions are affecting how we produce our food (e.g. urban and peri-urban agriculture), how we procure food, what we eat, and how the food system interacts with the environment.

- *Public attitudes and behaviours toward food safety:* Increasing public awareness of food safety hazards, concerns over hazards to health, and reduced confidence in the ability of current food supply systems to manage food safety risks affects the public's perception of food risks.

A recent European Commission foresight report (highlighted in Chapter 4, Box 4.1) identified a total of 10 major drivers related to food safety and nutrition challenges in 2050 in the European Union (European Commission, 2015), including several of the same or similar drivers as are noted above.

Step 3: Scanning for insights

There is a very large and wide range of specific horizon scanning methods and tools that can be used to collect signals (Amanatidou *et al.*, 2012). These methods include identification and scanning of a multitude of potential sources (e.g. government reports, academic publications, newspaper articles, opinion polls, patent applications, business leading reports, trade journals, NGO reports, experts insights) (Amanatidou *et al.*, 2012; Palomino *et al.*, 2012). The specific context, setting, and situation should inform the most appropriate combination of methods to scan for signals (e.g. needs of the client, the policy context, resources available, and nature of the topic). Frequently this will include some combination of online searches and expert opinions and insights (Amanatidou *et al.*, 2012; Palomino *et al.*, 2012).

Signals of change are likely to be weak and difficult to detect and analyse. The challenge for organizations is to ensure that the signals reflect true change in the system.

Horizon scanning efforts should be structured around a framework such as PESTLE (political, economic, social, technological, legal, and environmental) to ensure that a broad range of different dimensions are represented in the sources of evidence searched and types of signals identified (United Kingdom Cabinet Office/ Government Office for Science, 2014).

Step 4: Interpretation of the results

Identified signals must be contextualized within the organization to provide insight about where management efforts should be focused for mitigating future threats. This is arguably the

most challenging and time-consuming step in the horizon scanning process. Ultimately, the goal is to transform data into useful intelligence to inform decision-making. This stage may be facilitated by workshops, newsletters, or email updates.

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Appendix C: EW Strategy Tool

The EW Strategy Tool (introduced in Chapter 7) provides stakeholders responsible for building and maintaining EW capacity and capability with the information-base required to develop and implement a sustainable skeleton strategy (i.e. high-level, actionable plan) for EW in their country. The tool consists of:

A. A six-step **checklist** that provides an inventory of aspects to be considered and tasks to be completed (‘Implementation Checklist’)

B. A **priorities assessment** to inform a national strategy for EW

The **checklist** includes an inventory of aspects to consider and tasks to be completed when building or enhancing a national EW strategy. Depending on the national context, not all items will be equally relevant. Also the detail in which the different items are assessed will be situation-specific. It is important, however, to ensure that all items on the implementation plan are at least considered. This is to ensure that the EW strategy covers all aspects of relevance and does not contain major gaps. After working through the implementation plan, users are asked to conduct a **priorities assessment** where they describe the biggest challenges to EW in their country and the biggest strengths that EW capability and capacity can be built upon. This will help to prioritize the main opportunities and gaps that a specific EW strategy can be built upon and will need to address.

Part A: Implementation checklist

A1: DESCRIBE THE NEEDS

Please describe the **food production and food safety situation** of your country. Consider in particular the following:

- Key food value chains (consider mapping these)
- Your trade portfolio and the risks it is exposed to
- Key food safety hazards and threats

Please describe the **EW capacity needs specific to your country**. Consider in particular the following:

- Current state of your food control system
- Ability to detect and respond to food safety threats in a timely manner
- Any other constraints (e.g. legal, human resources, financial, IT)

Please describe how **increased EW capability and capacity** could improve food production and food safety in your country. Consider in particular where the biggest impact could be made.

A2: ASSEMBLE SUPPORT

Please list the **food production and food safety stakeholders** of your country. Consider in particular the following:

- The interrelationship between stakeholders (consider mapping these)
- Specific needs of individual stakeholders or stakeholder groups
- What could be done to unify national stakeholders and to gain their support?

Please identify how a national EW system in your country could **connect with relevant regional and international efforts**. How could you reach out to other countries or international organizations?

A3: PLAN THE PROGRAMME

Please identify **existing food safety infrastructure that an EW system could draw from, build upon, and connect with**. Consider in particular the following:

- Existing surveillance programmes that could contribute to the EW system (these could be mapped using the EW matrix – see Figure 5.1)
- Existing rapid alert networks and lines of communication that could contribute to the EW system
- How you are planning to integrate these exiting programmes into your EW system?

Identify the **essential components of your EW system** and how these would be built and integrated. Consider in particular the three EW pillars (Figure 1.1):

- Pillar 1: Monitoring and detection of initial signals
- Pillar 2: Signal verification, risk assessment, and recommendations
- Pillar 3: Rapid alert networks and communication

Describe the **capacities of your planned EW system**. Consider the following:

- Enforcement capacity
- Human capacity (including training)
- Other required resources
- Legal/political will (e.g. regulations and policies)
- Networking and linkages
- Technological capacity

A4: BUILD AND CONNECT

Describe the **main steps you would take in building the EW system and connecting its individual components**. Consider the following:

- How would you balance the reactive (e.g. surveillance) and anticipatory (e.g. foresight) components of the system?
- Which measures would you take to ensure leadership and clearly refined responsibilities of the relevant stakeholders?
- How will you secure stakeholder engagement?
- What would you do to set realistic goals and time frames?

A5: ENSURE SUSTAINABILITY

Describe how you would secure **long-term commitment from stakeholders** for the EW system.

Define the **strategic development goals** that you would like to achieve in the short-, medium-, and long-term.

A6: EVALUATE THE SYSTEM

How would you **evaluate the EW system and ensure that it meets its goals**? Consider in particular the following:

- What approaches and tools could you use that will help you measure if the system is operating in an efficient and effective way?
- What attributes and performance indicators could you use to evaluate the system (e.g. timelines, accuracy, completeness, sensitivity, or specificity)?
- How would the system be modified should changes be required?

Part B: Identify priorities

B1: Please identify the five main challenges to building EW capacity in your country.

B2: What are the biggest strengths in your country that an EW system can be built upon and connect with?

B3: Please describe the key recommendations to the various stakeholders that, based on this analysis, need to be incorporated into your national EW strategy.

Worldwide, food safety incidents can have a significant impact on public health, economies, agrifood trade, food security, and public confidence in the food supply. The prevention, mitigation, and management of food safety incidents globally can be enhanced through more effective early warning systems for food safety. Early warning systems help countries to better anticipate food safety threats and respond quicker through appropriate risk management actions. This publication provides a resource for countries to enhance their early warning capabilities and capacities. It emphasizes the need to build and connect links between existing food safety infrastructure (e.g. surveillance and food control) and to improve collaborative relationships among all of the different food chain stakeholders in order to protect public health and the food supply.

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